

Contract No. 18-008

Boscarino

1. Project Title: Early detection and range expansion of the invasive bloody-red shrimp, *Hemimysis anomala*, and the round goby, *Neogobius melanostomus* in the Erie Canal and upper Hudson River (Capital Region)

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Executive Summary

In sum, our project involved an estimated 300 hours of invested work time from PI Boscarino and ~1200 volunteer hours (including, but not limited to: 14 HS interns plus Poughkeepsie Day School adult chaperones and volunteers working with PI Boscarino). Our survey work covered a 175-mile stretch of the Erie Canal/Mohawk River from Lock 18 in Herkimer, NY to Lock 2 in Waterford, NY and south along the Hudson River from the Lansingburg Boat Ramp in Troy, NY to Upper Landing Park in Poughkeepsie, NY. Some of these sites were outside the purview of the Capital Mohawk (CapMo) PRISM but were critical to evaluating the range of spread of the bloody red shrimp (hereafter, BRS). Survey techniques included: (1) seining for the presence/absence of round goby and (2) plankton net sampling for BRS at a combination of lock, marina, dock and boat launch sites along the Erie Canal and Hudson River in habitat types most likely to harbor BRS (after Brown et al., 2014). We also performed a series of goby (predator) and BRS (prey) controlled feeding experiments to determine the degree to which the round goby is able to access and capture BRS under different light conditions.

Based on iMAP data entry points and our various educational outreach initiatives through this and synergistic research grants, we have received a number of follow-up requests and interest in continued BRS and goby monitoring throughout the Mohawk River/Hudson River regions and the Finger Lakes PRISM districts. We are currently engaged in a synergistic invasive species grant that includes BRS early detection and rapid response efforts with the Otisco Lake Association. This grant utilizes both plankton net and light trap sampling techniques as well as eDNA survey efforts in collaboration with Bard College. Our team continues to collaborate with Drs. Meghan Brown and Susan Cushman of Hobart and William Smith Colleges in Geneva, NY on round goby-BRS feeding interactions and habitat preferences. The LH-PRISM Aquatic Invasive Species Coordinator, Lindsay Yoder, has expressed keen interest in continuing BRS monitoring work using light traps and plankton net sampling in the summer of 2019. PI Boscarino has also worked in close association with the USGS New York Water Science Center in Troy, NY, including several communications discussing survey results and protocols involving round goby expansion in the Erie Canal/Mohawk River as well as the potential partnering of seine net surveying with eDNA sampling that the Science Center is currently developing.

We propose to present our work at three upcoming conferences/regional meetings in the spring of 2019. PI Boscarino will be presenting results of our survey and feeding experiment results at the Mohawk Watershed symposium on March 22nd at Union College as well as the CapMo PRISM partner meeting on April 2. In addition, lead intern Elinor Stapylton will present our goby survey and feeding experiment results at the upcoming Hudson River Environmental Society Symposium on May 8, 2019 at SUNY-New Paltz. Results of our goby-BRS feeding experiment work is currently being prepared for inclusion in an article entitled, “The influence of light, substrate, and fish predators on the habitat preferences and behavior of the invasive bloody red shrimp, *Hemimysis anomala*”. This manuscript is nearing completion and expected to be submitted to a peer-reviewed journal in spring, 2019.

Project Summary:

The bloody-red mysid shrimp (BRS), *Hemimysis anomala*, is a recent Ponto-Caspian invader that was first reported in North America in 2006 and has since become established in the Great Lakes, St. Lawrence River, inland lakes (Oneida, Seneca, and Cayuga Lakes, New York), the Seneca-Cayuga Canal and the Erie Canal. BRS represent a new type of organism in these systems and is a potential threat to native species in the Capital Mohawk region. The round goby, *Neogobius melanostomus*, is a recent Ponto-Caspian aquatic invader to North America that was first identified in the St. Clair River in 1990 and is continuing to spread rapidly throughout the Great Lakes system and connected waterways including the Erie Canal/Mohawk River (Kornis et al., 2012; Nevers et al., 2018). With funding from this grant, we completed the following work: (1) seining for fish targeted at identifying the presence/absence of round gobies in the Eastern Mohawk (E16-7), the Flight of Locks region of the Erie Canal (locks E 2-6; NY Canals, 2013) as well as at accessible marinas and public sampling locations on the Hudson River from Troy to Poughkeepsie, NY; (2) plankton net sampling of bloody red shrimp at the same locations as our goby seine work, and (3) performing round goby feeding experiments on BRS under different light conditions.

BRS plankton net survey results

From June-November of 2018, our team carried out a plankton net survey to evaluate the presence/absence of BRS at 29 docks, marinas and boat launches along the Erie Canal and Hudson River. BRS were reported as “present” at 12 out of 18 sites along the Erie Canal/Mohawk River (Figure 1). Our study is the first to report BRS presence in the Hudson River proper; we discovered a reproducing population of BRS off the shore of Upper Landing Park, where the Fall Kill Creek intersects with the Hudson River, in Poughkeepsie, NY (this data point was the only “BRS present” site out of 11 sites sampled on the Hudson) (Figure 2). These results indicate that BRS have rapidly expanded their range east of Lock 18 in Herkimer, NY, the most eastern site of their distribution as reported in the last published survey of the region completed in 2013 (Brown et al., 2014). We consistently found BRS at most every major lock site and marina along the stretch of the Erie Canal/Mohawk River from Herkimer to Waterford, NY, in high numbers and with individuals of multiple age classes. These are noteworthy findings as they suggest that BRS is capable of moving through canals at a rapid pace, through both lentic and lotic environments. Our results also clearly suggest how patchy BRS distribution can be at the leading edges of the invasion front and signal the need for even higher resolution sampling in the LH and CapMo PRISM regions to define how widespread their distribution is in the Hudson. We recommend a citizen science survey-based approach in these areas that will allow for this type of higher resolution, widespread sampling effort that would allow for inclusion of sampling on private property through volunteer participation. Such efforts have been successful in tracking the spread of BRS throughout the Finger Lakes region.

All “present” data points were entered into iMap Invasives and represent novel data points from this survey. Because iMap Invasives is changing their format and structure and data entry protocols in early spring 2019, we were advised to hold off on entering all

“absent” data points until the new model launches (Jennifer Dean, New York Natural Heritage Program/iMap Invasives, pers. comm. Jan. 2019).

Round goby survey results

From June-November of 2018, our team wrapped up an extensive seine net-based survey intended to evaluate not only the presence/absence of round goby at 23 marinas and boat launches along the Erie Canal and Hudson River, but also provide a snapshot of the type of fish predators present in habitats most likely to be inhabited by BRS. We caught and processed a total of 307 individual fish, including 17 different species, throughout our survey work. Smallmouth/largemouth bass, young of year (YOY) river herring and pumpkinseed/bluegill sunfish made up greater than 75% of the fish that were caught in the seines. No round goby were caught at any of the 23 sampling locations. While our survey results cannot definitively assert that round goby are not present within the CapMo PRISM region, we can conservatively state that their numbers are not high enough to be reliably caught through the same “goby-friendly” seining methods that have been successfully employed in previously funded early detection surveys.

We recommend continued seine surveying in the Erie Canal at the leading edge of the invasion front (regions just east of Utica, NY) partnered with field validation studies involving the use of eDNA as an early detection tool (i.e., ongoing USGS work). Round gobies have had moderate to significant ecological impacts in invaded systems in the Great Lakes region and it is extremely important to remain steadfast in early detection efforts in the Capital Mohawk region as we continue to build up a sufficient knowledgebase that will help inform future management decisions.

Round goby feeding experiments

Another objective of this project was to gain information on the integration of BRS as a potential prey item for round goby in invaded systems and how light levels impact predation rates. Previous fish feeding studies on BRS have focused primarily on stomach or isotope analyses (e.g., Lantry et al. 2012; Yuille et al. 2012) and have not been ground-truthed with direct observations and analyses of feeding of gobies on BRS under controlled conditions. We ran all feeding experiments in 30L aquaria at moderate mysid densities (2 mysids L⁻¹, or 60 mysids per aquarium, after Brown et al., 2012) and in preferred BRS habitat (rounded cobble substrate with interstitial BRS refuge space). Trials were run at three different light levels: twilight light conditions, dark and high light conditions (i.e., noontime light levels). At the end of each feeding trial, the aquarium water in all experimental tanks, including remaining prey, was filtered through a 120 µm sieve. Feeding rates were determined by counting the remaining number of prey left in the aquaria relative to the starting number (i.e., 60 individual BRS) after the feeding trial had ended. A total of 32 trials were run in total.

Our results suggest that goby feed most effectively in dark conditions relative to bright light and twilight conditions (24% of prey consumed per feeding period compared to 13 and 10%, respectively.) These data suggest that light may actually be a hindrance to predation success in gobies. BRS are highly sensitive to bright light levels and generally seek cover in refuges when light levels exceed 1 lux, as would be the case in the noon

light level trials (Boscarino et al., 2012). Thus, a higher percentage of BRS are likely to remain in refugia under brighter light and thus could be inaccessible to predators like gobies. BRS typically does not enter the open water column to feed planktonically until late twilight when mysid water column density peaks. Individual mysids can remain in the water column during the darker nighttime, albeit at lower densities, until dawn of the following morning. Goby have an extremely well developed lateral line sensing system and may feed most effectively at night when BRS cannot visually recognize their predators and thus may be less successful at evading their predators. Twilight may therefore represent the best time for BRS to enter planktonic waters where food reward:visual predation risk is maximized.

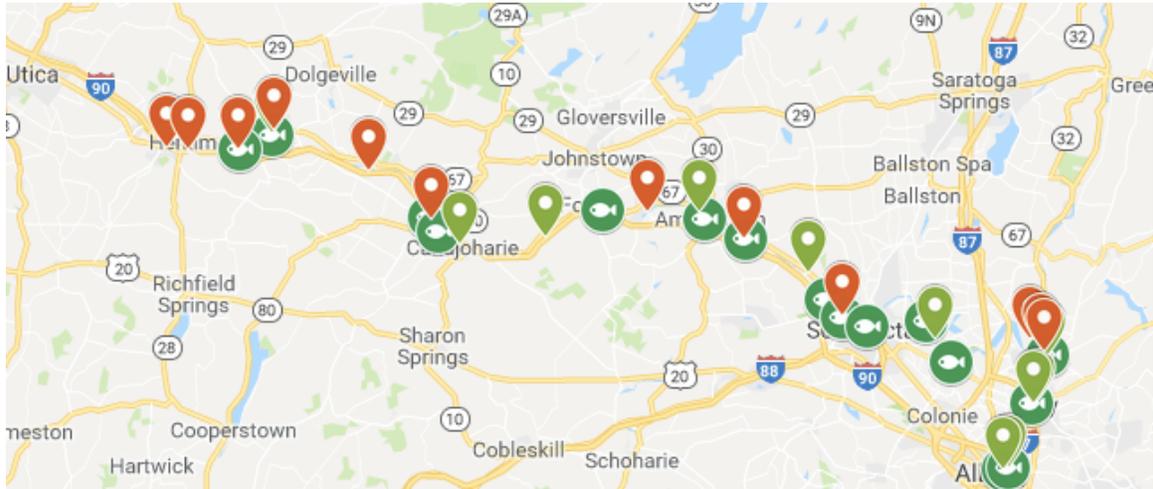
Outreach and education

Lastly, as part of our education and outreach initiatives, we developed educational brochures on BRS that will help inform canal/river users and stakeholders of BRS ecology, demography, taxonomy and identification. These educational materials include how to identify the species, how to contribute to ongoing monitoring and rapid response efforts of invasive BRS in the region and how the species is likely to impact native food webs, as well as provide tips on how to avoid their future spread throughout the region. These brochures will be made available and displayed at the upcoming spring conferences we plan to attend.

Figures

Figure 1. Results of our 2018 BRS and goby survey along the (A) Erie Canal/Mohawk River and (B) Hudson River, including all seine and plankton net sampling efforts. Orange-red/dotted and sage green/dotted placemarks indicate sites with presence and absence of BRS, respectively. Kelly green/fish placemarks represent sites where seining took place, but no goby were recorded. In 2013, there were no reported instances of BRS east of Herkimer, NY. There is still no evidence to suggest that goby have moved east of Utica, NY.

A



B

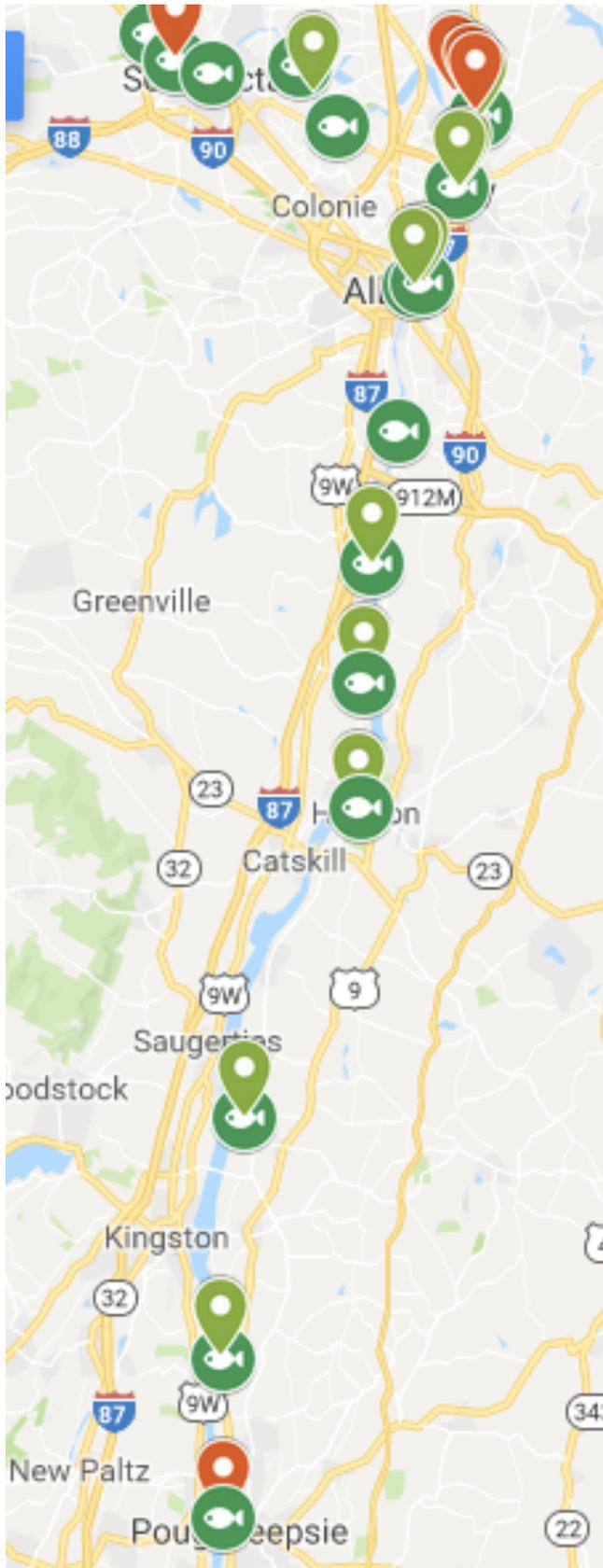


Figure 2: Dorsal view of the statocysts and truncated telson of an individual BRS caught off the shore of Upper Landing Park in Poughkeepsie, NY. This is the first report of BRS presence in the Hudson River proper. (Photo: Sonomi Oyagi)

