SOUTH CAROLINA STATE REPORT – SCDNR MARINE RESOURCES DIVISION

GULF AND SOUTH ATLANTIC REGIONAL PANEL ON INVASIVE SPECIES

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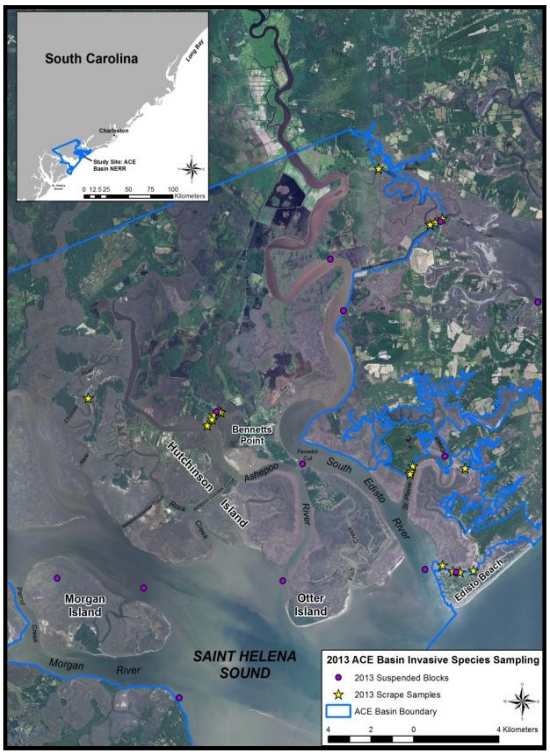
1) Surveying the presence of invasive benthic invertebrates within the ACE Basin NERR

Figure 1 (below left). Map of locations in ACE Basin NERR where substrates were deployed.



The Marine Resources Research Institute (MRRI) of the SCDNR successfully acquired State and Interstate Aquatic Nuisance Species Management Plan Program funds for FY2013 that are being used to implement targeted field sampling of fouling communities within in the ACE (Ashepoo-Combahee-Edisto) Basin NERR (National Estuarine Research Reserve).

Figure 2 (below right). Illustration of typical scrape sample collection from a floating dock piling to document the presence of invasive species within encrusting benthic invertebrate communities at stations throughout the ACE Basin NERR

During the period of April 24th to June 5th 2013 predominantly intertidal scrape samples (15cm x 15cm) were collected at locations throughout the ACE Basin NERRS at sites like that shown in Figure 2. Scrape samples were collected from existing man-made structures including floating docks, bulkheads and sea walls, all of which present viable substrate for the settlement of native and non-native benthic invertebrates.

Additionally, cinder blocks were deployed during this same period and left in the field for a minimum of 3 months to allow for the recruitment and growth of native and non-native invertebrates. The settlement blocks were recovered beginning the week of September 16th

2013. On recovery, blocks will be briefly immersed in a dilute formalin-seawater rinse to remove unattached fauna. Two replicate 15cm x 15cm samples will also be removed from each block and preserved in 95% ethanol for later examination. The remaining fauna will also be scraped from each block and any specimens represent novel native or non-native species will also be preserved in 95% ethanol and returned to the Marine Resources Research Institute laboratories for later examination and identification.

Figure 3 (right). Recovery of block and processing of substrate for the collection of native and non-native associated fauna.

All types of samples will be thoroughly examined this fall for the presence of invasive species, focusing on those associated with benthic, encrusting invertebrate communities. Furthermore, this project will also aim to highlight the presence of selected non-indigenous fouling species that are known to demonstrate variable inter-annual recruitment driven by winter temperature tolerances (e.g., the green mussel, *Perna viridis*, the titan acorn barnacle, *Megabalanus coccopoma*, and the charrua mussel, *Mytella charruana*). An archived collection of all non-indigenous and invasive species found in the ACE Basin NERR will be maintained and entered into the catalogued collection of the Southeastern Regional Taxonomic Center (SERTC) at MRRI. All such occurrences will also be reported to the Smithsonian Environmental Research Center, which maintains the National Exotic Marine and Estuarine Species Information System (NEMESIS). Published literature and unpublished data previously obtained from sampling in the ACE Basin will be summarized and presented in an updated report on non-indigenous aquatic animals in the ACE Basin NEER, and a spatially-explicit database of that information will be constructed.

2) Asian tiger shrimp, *Penaeus monodon*, catches from South Carolina in 2012-2013

In 2012, the total number of Asian tiger shrimp (*Penaeus monodon*) reported from South Carolina was 64, compared with 144 reported in 2011, and <20 per year annually between 2006 and 2010. This pattern of reduced numbers of *P. monodon* reported in 2012 compared to 2011 was reflected in other states with the GSARP region (with the exception of Georgia and Florida) and the region as a whole (195 in 2012 compared with 678 in 2011. Researchers do not believe that this reduction in reported numbers reflects a reduction in wild abundances, but rather a combination of two phenomena; 1) reporter apathy; and 2) consumption and/or sale of collected tiger shrimp. In order to address the first of these, the SCDNR recently released an updated press release to inform the public that we are still interested in both reports and specimens. In 2013, low numbers of tiger shrimp are again being reported in South Carolina, with the need for follow-up contact to gather detailed information for reporting to USGS. As in the past two years (2011 and 2012), smaller shrimp (<7" TL) are being collected from upstream habitats (i.e., tidal creeks, tidal rivers, sounds) as opposed to the predominantly shallow coastal collections

(beachfront to 5 miles offshore) from commercial trawlers in earlier years. Inshore collection methods continue to include recreational cast nets, shrimp traps and crab pots, and SCDNR electroshock fishing in 2012. In one case the reporter stated that the tiger shrimp 'jumped into the boat' in shallow (1-2 ft) water. Specimens have been collected statewide, from Cherry Grove, near the NC/SC border to the Wright River, near the mouth of the Savannah River.

Figure 4. Examples of Asian tiger shrimp, Penaeus monodon, *collected from coastal waters of South Carolina by commercial shrimp trawlers in 2013. Photo appears courtesy of Brad McDonald, with one of the more novel items used for size calibration!).*

Efforts are continuing to coordinate reports from across the southeast and Gulf region, with the goal of addressing some of the many unanswered questions about the dynamics and implications of this invasion. Tissue samples are being sent to USGS geneticists Drs. Tim King and Margaret Hunter, who are conducting microsatellite and single nucleotide polymorphism analyses to determine population structure of *P. monodon* within the region and attempting to identify the geographic source of *P. monodon* collected in coastal states in the southeast and Gulf region.

In order to document the details of these collections and summarize our knowledge on this invasion, the following manuscript was recently submitted to *Aquatic Invasions* (following its rejection by *Biological Invasions*): Fuller PL, Knott DM, Kingsley-Smith PR, Morris JA, Buckel CA, Hunter M & Hartman LD. Invasion of Asian tiger shrimp, *Penaeus monodon* Fabricius, 1798, in the western north Atlantic and Gulf of Mexico. *Aquatic Invasions*. In review.

3) Impacts of the invasive swim bladder parasite, *Anguillicoloides crassus* (Nematoda) on the American eel, *Anguilla rostrata*, in South Carolina estuaries.

Since 2011 researchers at the South Carolina Department of Natural Resources (primarily College of Charleston graduate student, Jen Hein, working with SCDNR Inshore Finfish Research Section biologists Dr. Arnott and Bill Roumillat, and assisted by a number of interns from the NSF-supported MIMES REU Program) have been studying the biology of the American eel (*Anguilla rostrata*). Our interest in this species stems from its drastic decline since 1980 and a 2011 petition to list the American eel as an endangered species. Much of this work has focused on the prevalence, intensity and physiological consequences of the invasive nematode parasite, *Anguillicoloides crassus*.

The results of the first year of the project (2011) have been presented at previous GSARP meetings and the following manuscript is currently in review for publication: Jennifer Hein, Steve Arnott, Bill Roumillat Dennis Allen & Isaure de Buron (2013). The invasive swimbladder

parasite, *Anguillicoloides crassus*: status of infection 15 years after discovery in wild populations of the American eel, *Anguilla rostrata*. *Diseases of Aquatic Organisms*. In review.

The data from the 2011 study were used in support of a current State Wildlife Grant in the amount of $47,612 recently awarded to the SCDNR to assess eels caught in 2012 and 2013 (frozen specimens) from both estuarine and freshwater habitats. The objectives of this latest study include determining eel sex, maturity, and age, monitoring the *Anguillicoloides crassus* population in South Carolina, and assessing the damage to the swimbladder caused by infection.

Thus far, *A. crassus* prevalence has been calculated at 88% (n=101) for 2012 and 2013, a significant increase from the 2011 prevalence of 45% (n=479), although this difference may be attributed to the lower sample size from the 2012-2013 survey. This prevalence may change as the backlog of samples are worked processed and sample size increases.

Additionally, glass eels (young-of-the-year) have been collected on a monthly basis since March 2013 via an eel ramp at the Goose Creek Reservoir in Hanahan, SC. The goals of these efforts are to assess glass eel ages, lengths, and *A. crassus* infection and to determine when young-of-the-year eels become infected, as very little is known of glass eel infection in North America. Results show that *A. crassus* prevalence was nearly zero in spring [March: 1% (n=90), April: 3% (n=63), May: 3% (n=37)] until June at which time prevalence drastically escalated to 35% (n=40).

4) Understanding the impacts of the Asian seaweed, *Gracilaria vermiculophylla*, on estuarine community dynamics.

Figure 5 (left): Demonstration of the potential abundance of G. vermiculophylla *on a mudflat in South Carolina (Fort Johnson, Charleston, SC in 2011).*

Researchers in Dr. Erik Sotka's laboratory (College of Charleston Grice Marine Laboratory) including a recent intern in the National Science Foundation-funded Minorities in Marine and Environmental Sciences Research Experience for Undergraduates (REU) Program hosted by the South Carolina Department of Natural Resources (Principal Investigator: Dr. Peter Kingsley-Smith) continue to study the input to consumptive and detrital food webs of the invasive Asian red alga, *Gracilaria vermiculophylla*. Invasive ecosystem engineers can have far-reaching effects on systems, especially if they provide structure where none was before. The non-native seaweed *Gracilaria vermiculophylla* has proliferated on estuarine mudflats throughout the southeastern US, including areas (South Carolina and Georgia) that historically were extremely low in seaweed biomass.

Experimental results from ongoing research by Dr. Erik Sotka and his colleagues suggest that *G. vermiculophylla* facilitates the occurrence of amphipods and gastropods and that the abundances of these taxa are dependent on the biomass of *G. vermiculophylla*. It has also been shown that *G. vermiculophylla* abundance at a regional scale is controlled in large part by the density and above ground height of the native decorator worm, *Diopatra cuprea*. This worm decorates its tube with

flotsam and *G. vermiculophylla* is a conspicuous component of the materials that *D. cuprea* uses to decorate its tubes. Using microsatellite loci, Dr. Sotka's group has begun to track the invasion pathways of *G. vermiculophylla* around the world by investigating the relatedness of this species from invaded regions around the world. These researchers have identified a great deal of genetic variation within certain invasive populations (e.g., Rhode Island, South Carolina) which were previously thought to be genetically depauperate, based on previous studies that relied upon a single mitochondrial locus (cytochrome oxidase I). Significantly, these researchers have also determined that the ultimate source of the U.S. East Coast invasion came from the Pacific coast of Japan. Further genotyping and analysis is ongoing. Finally, both laboratory and field experiments have shown that native *D. cuprea* worms and invasive *G. vermiculophylla* share a mutualistic relationship. Abundances of *D. cuprea* are greater when *G. vermiculophylla* is present, while higher growth rates of *G. vermiculophylla* are facilitated by *D. cuprea*, because the worm supports the algae at higher elevations in the photic zone of highly turbid estuaries of southeastern US. To our knowledge, this represents the first example of a mutualism between a native and invasive marine species. (For more information on this research, contact Dr. Erik Sotka, College of Charleston Grice Marine Laboratory; E-mail: sotkae@cofc.edu; Tel. No.: 843-953-9191).

5) Lionfish update: i) MARMAP data from 2011; ii) Update from College of Charleston graduate student research.

(i) The Marine Resources Monitoring, Assessment and Prediction (MARMAP) Program is a fishery-independent collaboration between the South Carolina Department of Natural Resources Marine Resources Research Institute and NOAA Fisheries. In the past, MARMAP sampling stations (n = 600 sites annually) were distributed from North Carolina (Cape Hatteras) to Florida (Cape Canaveral), targeting areas of live bottom (sponge, soft coral, algal growth), rocky outcrops and reef habitat on the continental shelf, shelf edge and continental slope, with sampling conducted from the R/V Palmetto between May and September. Starting in 2011, however, the Southeast Fishery-Independent Survey (SEFIS) took responsibility for sampling stations off the coasts of Georgia and Florida, while MARMAP/SEAMAP (Southeast Area Monitoring and Assessment Program) sampled off South Carolina and North Carolina. This change resulted from a logistical need arising from a significant increase in fisheries independent sampling within the region. MARMAP/SEAMAP will continue sampling using a still camera on the chevron traps; however, SEFIS will only use video cameras. Until very recently, SEFIS was responsible for all of the video analyses, while MARMAP/SEAMAP staff were responsible for completing the CPUE from the still photographs and life history analysis components. As of this year (2013), however, MARMAP and SEFIS are no longer using digital still cameras on the traps and all cameras on traps are now video cameras. Both SEFIS and MARMAP are responsible for reading/analyzing video. Lionfish are being recorded along with other priority species, although this data obviously cannot be used as an extension of the still photography. MARMAP researchers are hoping to obtain still images from the videos to add to the digital still images from 2010-2012, but data acquisition is still ongoing. It is hoped that data on relative abundance of lionfish over recent years may be available from these efforts in 2014

(ii) College of Charleston Graduate Program in Marine Biology student Sarah Doty continues to pursue her Master's thesis research on invasive lionfish (*Pterois volitans / miles*). Originally her research had hoped to investigate the feeding biology of lionfish on SCDNR artificial reefs; however, severe difficulties in obtaining samples from these habitats eventually forced a change

in direction. Sarah has instead been working on lionfish samples collected between January 2011 and January 2012 from Biscayne National Park, investigating the effects of lionfish size and habitat on diet composition, with an interest in lionfish consumption of Federally-managed and overfished species (e.g., snapper-group complex). Her advisory committee consists of: Dr. Gorka Sancho (College of Charleston); Dr. Peter Kingsley-Smith (SCDNR); Dr. Anthony Harold (College of Charleston); Dr. James Morris (NOAA-NMFS); and Catherine Toline (NPS). In addition to morphological identifications, Sarah has recently added a subset of DNA-barcoding to her species determinations. Data collection for this project is nearing completion with the plan to defend this winter.

6) Other invasive species observations.

On Sunday, July 28th 2013 one blue land crab, *Cardisoma guanhumi*, was observed in a burrow on Concord Street in Charleston. *Cardiosoma guanhumi* is a circumequatorial species found throughout estuarine regions of the Caribbean, Central and South America, including Colombia, Venezuela, the Bahamas and Puerto Rico. Within the US it is limited to the Gulf of Mexico and coastal Florida, as far north as Vero Beach. In the Caribbean and Central and South America, it is exploited for food, but in the US and in much of Puerto Rico it is considered a pest. The burrow diameter for this individual was approximately 50 cm and was located in soil under a section of mowed grass adjacent to a sidewalk. Yellow and blue color markings were clearly visible on the animal; sex was undetermined; carapace width was approximately that of the burrow diameter (50 cm). The animal retreated into the burrow when foot traffic came near but would emerge if there was no movement or disturbance nearby. The animal was observed at approximately 6:00pm and again at 7:30pm, however a return visit approximately 2 months later (D. Knott, pers. obs.) yielded no evidence of the crab or its burrow.

Figure 6. Location of the observation of the blue land crab, *Cardisoma guanhumi*, in downtown Charleston, South Carolina on July 28th 2013.