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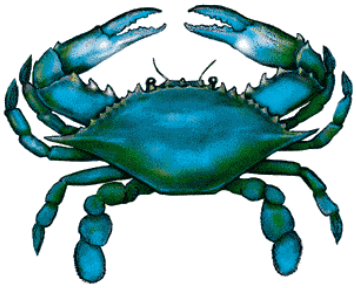

State of Basin Report

Status of Blue Crabs in South Carolina

Winter 2011 **Volume 1, Issue 1**

What is the state of the basin report?

- A newsletter to update the public about blue crab research in the ACE Basin NERR.
- A source of information regarding the life-history, ecology and behavior of blue crabs.
- A forum for your opinions regarding the status, health and future of the blue crab fishery in South Carolina.
- A public service of the SC Sea Grant Consortium and Clemson University.

Inside this issue:

Crab Population Study Begins in the ACE Basin NERR

Coastal habitats are undergoing a dramatic shift in environmental conditions due to coastal development, water management practices and global climate change. Predicting how these changes will influence the future of commercial species such as blue crabs is important to the economic stability of the region. As the number of people living in our coastal environment continues to increase, so does the need for basic research and outreach education to inform the public of the relationship between climate change, water quality issues, and the health of marine fisheries.

The blue crab, *Callinectes sapidus*, is true to its name. It really is a tasty, beautiful swimmer.

The blue crab, *Callinectes sapidus*, is a multi-million dollar industry in the state of South Carolina. This important commercial species has experienced dramatic declines throughout its geographic range including South Carolina. Blue crab annual landings have decreased by more than 30% from a high of 7.5 million pounds in 1998 to 4.0 million pounds in 2009 (Figure 1). The reason for this decline is unclear but is not due to changes in fishing effort or price. Changes in salinity, however, are negatively correlated with crab density due to decreased freshwater flow during prolonged periods of drought (Figures 2 & 3).

The SC Sea Grant Consortium recently awarded a two-year research grant to Dr. Michael Childress, a marine ecologist from Clemson University, to conduct quarterly surveys of the blue crab population in the ACE Basin National Estuarine Research Reserve. The research will be used to develop specific recommendations regarding the impact of disease, climate change, and current fisheries management on the future of the blue crab fishery. A series of public presentations will help to disseminate this knowledge to fishermen, resource managers and the general public. This ambitious project will be a collaborative effort between Clemson University, the SC Department of Natural Resources, the ACE Basin NERR, the Sea Grant Extension Service, local fishermen, and the general public.

Annual Commercial Landings Remain Stable in 2009

According to Larry DeLancey (SC DNR Biologist), the commercial landings for 2009 remained stable at 4.0 million pounds but still below the 30-year average catch of 5.58 million pounds. Annual landings decreased rapidly from 1998 to 2003 and have since leveled off at approximately 4 million pounds. This year marks the eighth consecutive below-average year. Since 1998 commercial licenses have decreased slightly from 370 to 347 but pots fished have increased slightly from 26,500 to 29,850.

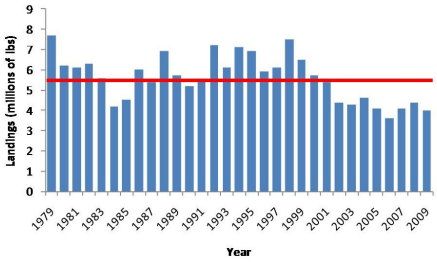

Figure 1. Annual landings have decreased by more than 30% since 1998 below the 20-year average (red line). Data are from SC DNR.

Prolonged Drought Linked to Blue Crab Decline

In the last fifteen years, the annual commercial landings of SC blue crabs have gone up and down in association with changes in average annual rainfall. From 1995 to 1998 the state of South Carolina experienced higher than average rainfall totals and crab landings increased to a peak of 7.5 million pounds. However, beginning in 1999, rainfall totals began to decrease as did the commercial landings. Over the next four years the drought continued to be one of worst in recent history and crab landings decreased to 4.2 million pounds. In 2002, the drought finally broke with a two-year period of above average rainfall, but the crab landings did not rebound. So why didn't crab landings come back up after the rains returned? One possible explanation is that increased saltwater intrusion into the salt marsh had already begun to shift the structure of plants and animals in the community. Freshwater grasses were giving way to more salt-tolerant marsh grasses and fish and shellfish were shifting more upriver. So why would an increase in salinity have a negative effect on blue crabs? They are, after all, a hearty marine species that can tolerate a broad range of salinities. There are three hypotheses that could explain this negative correlation. Higher salinities might lead to (1) more crab disease, (2) lower settlement or juvenile survival, or (3) more upriver migration. The goal of our research is to determine which of these explanations is best supported.

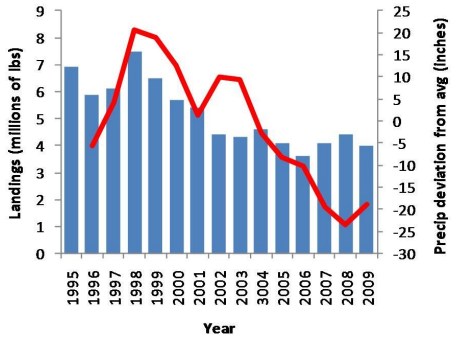

Figure 2. Annual landings of blue crabs are positively correlated with the deviation from average annual rainfall (line)

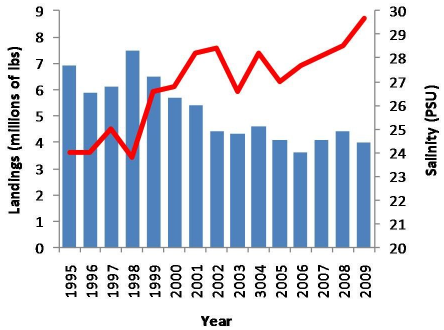

Figure 3. Decrease rainfall has led to an increase in marsh salinity and a negative correlation with annual crab landings.

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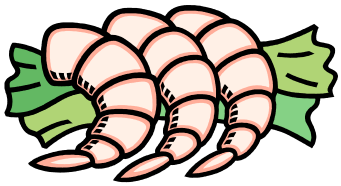


Crab Disease Decreases in ACE Basin as Discharge Increases

Blue crabs in the southeastern US are often infected with a harmful algae called *Hematodinium* sp. This single-celled algae is a parasite of many species of lobsters, crabs and other crustaceans. The parasite lives in the blood and is fatal. In the early stages of infection, it is very difficult to detect an infected crab. However, once the parasite multiplies, the host crab becomes slow and unresponsive and eventually dies. To investigate this parasite, we have been sampling blue crabs at 27 stations in the ACE Basin (Figure 4). We collect crabs and record data on their sex, carapace width and weight. We take a picture of each individual and draw a sample of blood to check for the parasite. The crabs are released alive and the blood samples are returned to Clemson for laboratory analysis. We use modern genetic techniques to check for parasite DNA in each blood sample. To date we have found 38 infected crabs out of some 1100 tested (Figure 4). The infected crabs were more common in 2008 than in 2009, in Dec more than Mar, Jun or Sept, in the Combahee more than in the Ashepoo or Edisto, and at sites closest to St. Helena Sound. These patterns are consistent with our hypothesis that disease prevalence increases with increasing salinity.

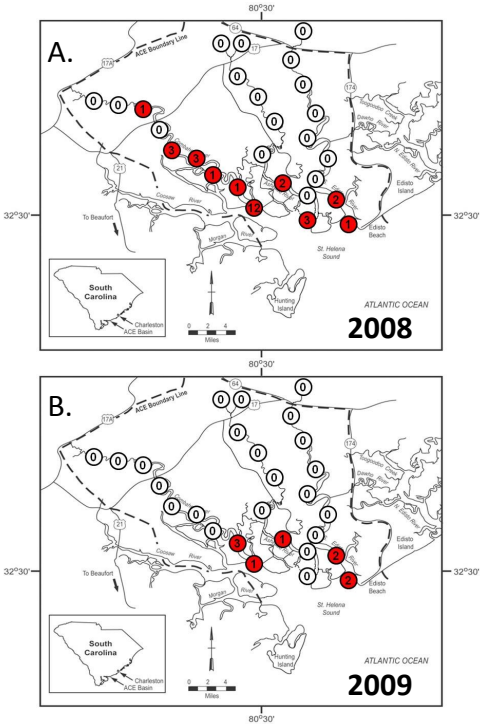


Figure 4. Number of diseased crabs decreased from (A) 29 (4.6%) in 2008 to (B) 9 (1.6%) in 2009.

What Variation in Crab Shape Can Reveal About Crab Health

The shape of a blue crab's carapace can tell us a lot about its health, age and reproductive status. Blue crabs have to shed their shell periodically to grow larger, but the new shell is not identical to the old one. Subtle changes in spine length and shell width can be used to diagnose healthy and diseased individuals. To study crab shape we examined digital photographs of over 1000 individuals collected in the ACE Basin and assigned 18 landmarks to fixed points around the carapace (Figure 5A). We used a computer program that analyzes changes in shape much like a finger-print analysis program. Most crabs differ in a single axis of shape change shown in Figures 5B & 5C. Large crabs, mature female crabs, and healthy crabs have longer lateral spines and a narrow front carapace (Figure 5B). Small crabs, male crabs and diseased crabs have shorter lateral spines and a broad front carapace (Figure 5C). This finding is important, for previous studies have suggested that infected crabs die very quickly and are unlike to molt. But our findings suggest that some infected crabs carry the disease long enough to molt and produce a carapace that has shorter spines than a similarly-sized healthy individual. Spine length is a trait that is hypothesized to provide crabs with additional protection from predatory fishes. Crabs with shorter spines are potentially more vulnerable to predators than those with longer spines.

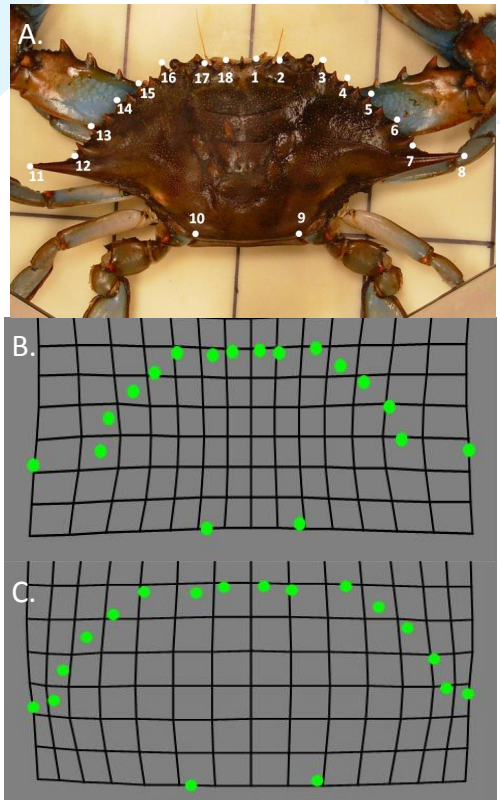


Figure 5. (A) Eighteen landmarks of carapace shape, (B) shape of healthy crabs, and (C) shape of infected crabs.

SCBCRABS: A Computer Model for Blue Crab Forecasting

As part of our ongoing effort to study blue crabs in South Carolina, we have created a computer model that simulates the spatial structure of a crab population using both estuary and riverine habitats. The model, called SCBCRABS, is an individual-based population model that tracks individual crabs from settlement to death. Crab growth and movement are linked to the environmental conditions of the model including river discharge, salinity, dissolved oxygen and temperature. Crab mortality occurs by predators, disease, cannibalism and fisheries landings. The model, originally parameterized using the water quality and crab pot sampling data from the Ashley River, is being expanded and parameterized for use in forecasting the ACE Basin blue crabs. In Figure 6, juvenile crabs are red, adult males are blue and adult females are green. Yellow circles are empty crab pots and orange circles are pots with crabs. The model has been used to compare the relative impact of changing environmental conditions as well as the impact of changing fisheries management strategies. In November 2011, we will host a blue crab forecasting workshop for fishermen and fisheries managers to discuss how such a model might be useful to predict the future of SC blue crabs.

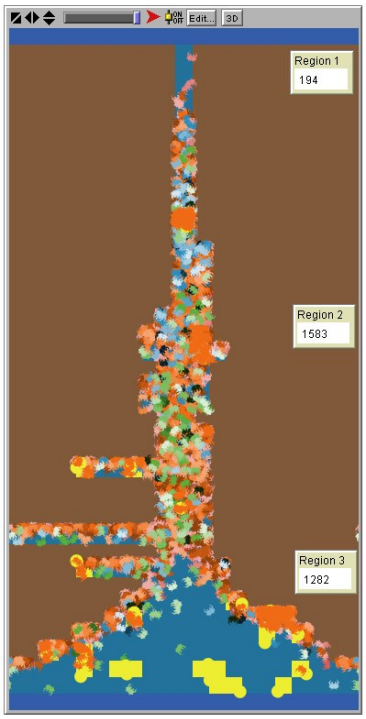
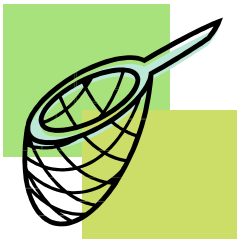


Figure 6. Output window of the SCBCRABS model showing crab distribution along a simulated river.



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Do Crabs Escape the Fishery by Swimming Upriver?

Blue crabs in the ACE Basin appear to have a seasonal migration with more crabs in St. Helena Sound in the winter and more crabs upriver during the summer. We sampled crab abundance and fishing effort at nine fixed stations quarterly to compare the relative abundance of crabs in relation to fishing effort. Figure 7 illustrates the number of crabs caught (per 4 pots—blue bars) and the number of crab pots observed (per 2 miles—red line) in the Combahee River from Sept 2008 to June 2009. During the late summer when river flow is lowest and salinity is highest, some crabs are caught above the legal fishing limit (pink sites 7-9), but by December these crabs have migrated back into the fished portion of the river. By March, crab abundance in the mid-river sites is increasing. Peak months for fishing in the river is in summer and fall with traps becoming very densely concentrated near the legal fishing boundary in the month of September. Crab density is not strongly correlated with fishing effort but there is a trend for increased fishing effort in times and locations where crabs are most abundant.

What causes crabs to migrate upriver during warm months is unknown. This seasonal migration is observed in many crab populations from the Florida gulf coast to the Chesapeake Bay. Some laboratory studies have found that crab survival and growth is highest in intermediate salinities (15-25 ppt) and this zone of optimal salinity does shift significantly in relation to river discharge. However, crabs seem to use other cues, perhaps photoperiod and temperature, to signal the start of their migration. This seasonal migration may have significant impacts on crab settlement, growth and survival. Field and laboratory studies are currently underway to understand how changes in salinity interact with this seasonal migration to influence future crab abundance.

Do crabs really escape the fishery by swimming upriver? Not likely, even in severe drought years when as many as 1/3 of the crabs are above the legal fishing limit, they always return to the fished portions of the river by December. It appears that crabs seek the more stable temperature and salinity conditions of St. Helena Sound during the winter months.

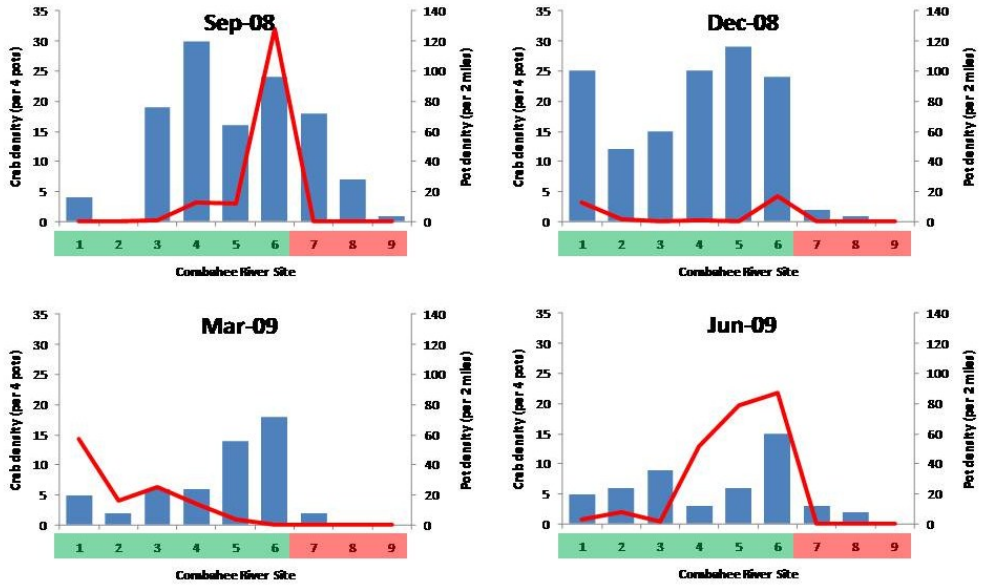
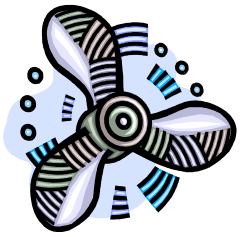


Figure 7. Crab abundance (per 4 pots) at 9 fixed stations from St. Helena Sound (site 1) to the ACE Basin northern boundary (site 9) - blue bars. The red lines indicate the number of crab pot buoys (per 2 miles of river) along this same transect. Crab abundance and fishing effort changes dramatically with season (A) Sept-08, (B) Dec-08, (C) Mar-09, (D) Jun-09.



Did you see something you liked or disliked? Would you like to contribute an article or opinion to the next State of the Basin Report? Please send your comments and ideas to Dr. Michael Childress, Department of Biological Sciences, Clemson University, Clemson, SC 29634, or by e-mail to mchildr@clemson.edu

We appreciate your honest feedback and suggestions.

Many thanks to the Conservation of Marine Resources Creative Inquiry Team for their assistance in conducting our field research.