NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM
COASTAL CAROLINAS
DROUGHT EARLY WARNING SYSTEM

STUDY EXAMINES THE FUTURE OF RIVER DISCHARGE
AND ITS IMPACT ON SOUTH CAROLINA'S VALUABLE BLUE CRAB CATCH

Forecasting a crab fishery using real-time freshwater flow data

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Blue crabs (*Callinectes sapidus*) are one of the most important commercial fisheries in the state of South Carolina with annual landings averaging 5.5 million pounds. Inter-annual variation in S.C. crab landings is significantly correlated with annual levels of freshwater discharge, explaining more than 40% of its variation.

During droughts, freshwater input to marshes decreases and salinity increases. As salinity increases, crab abundance decreases due to increasing infection by a lethal parasite, *Hematodinium sp*. However, the degree to which the population decline is linked to decreasing freshwater depends on the level of freshwater flow into the marsh.

A four-year study of the blue crabs in the ACE Basin National Estuarine Research Reserve (named for the Ashepoo, Combahee, and Edisto Rivers), South Carolina (Figure 1, right) during the 2008-11 drought found that crabs decreased in the low flow Combahee River due to increased parasites (*Hematodinium sp.*) but increased in

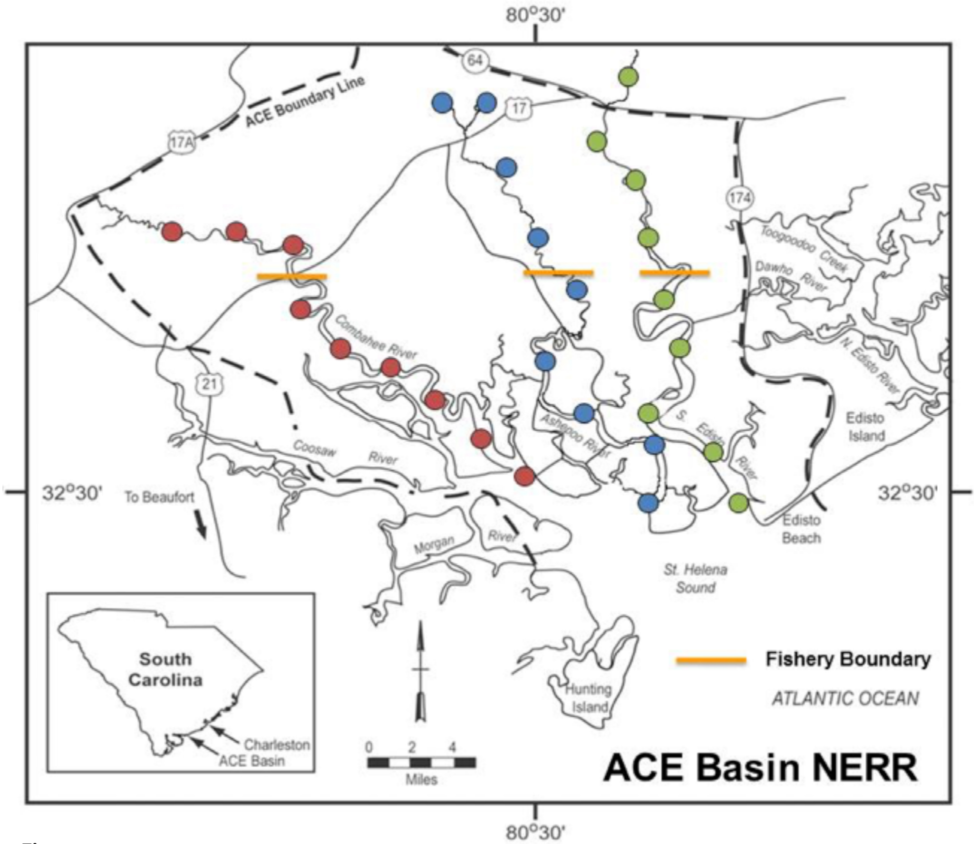

Figure 1

Map shows the locations for the field study of salinity impact on blue crab population structure in the ACE Basin National Estuarine Research Reserve, South Carolina. Twenty-seven stations (nine per river) were sampled quarterly for four years from June 2008 until May 2012. Salinity profiles along each river were related to measures of blue crab life history including disease prevalence, relative predation, post-larval settlement, and size-frequency distribution. During this drought period, blue crab abundance decreased in the low-flow Combahee River (red dots) due to increased infection by Hematodinium sp. parasites, but increased in the high-flow Edisto River (green dots) due to decreased predation by alligators. The seasonal, spatial and interannual differences in river discharge, salinity profile, growth, predation, disease, post-larval settlement, movement and fishing effort were then incorporated into a spatially-explicit individual-based population of blue crabs to estimate the non-linear effects of salinity variation on blue crab commercial landings.

FOR MORE INFORMATION regarding the SCBCRABS blue crab forecast model, visit the SC Blue Crab Forecast web blog at: http://scbcrabs.blogspot.com/.

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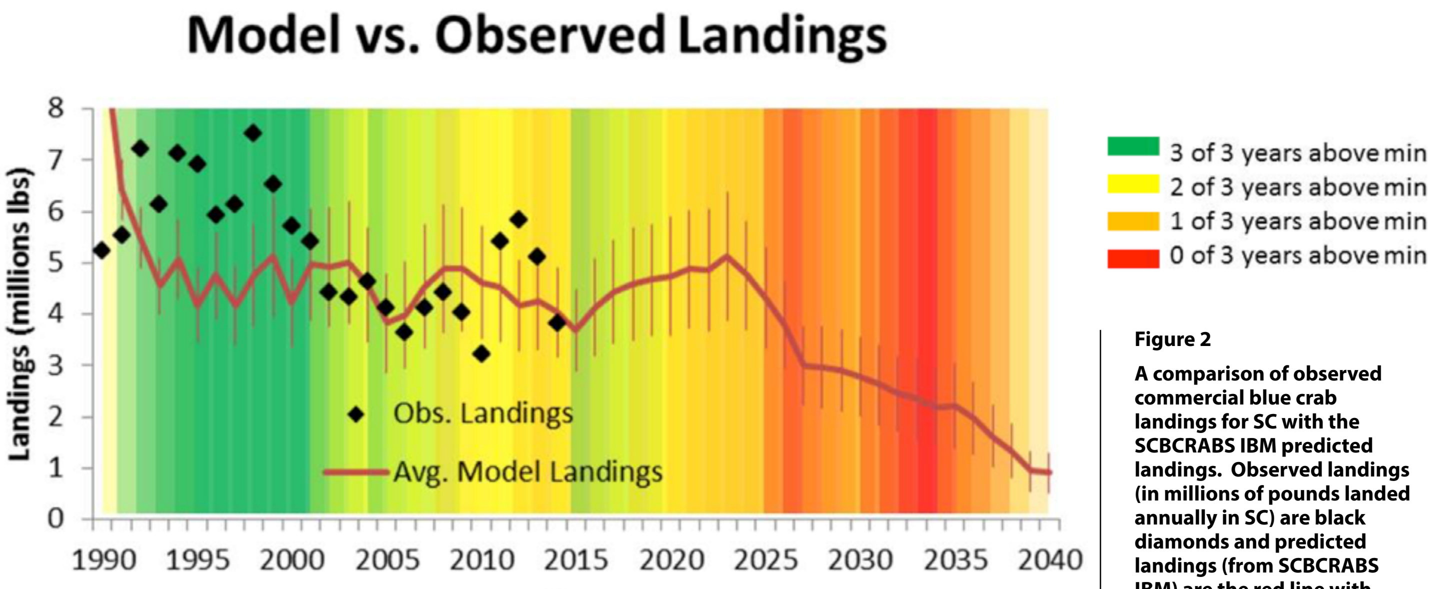

Figure 2

A comparison of observed commercial blue crab landings for SC with the SCBCRABS IBM predicted landings. Observed landings (in millions of pounds landed annually in SC) are black diamonds and predicted landings (from SCBCRABS IBM) are the red line with mean and SD for 3 replicate runs of the model.

Edisto river discharge is indicated by the color heat map based on a critical minimum discharge level of 1250 cfs average annual flow. Historical river discharge data (1990-2014) is from the USGS gaging station at Givhans Ferry, SC. Projected river discharge (2015-2040) is from a seasonal ARIMA statistical model of future river discharge levels.

When river discharge is above this critical minimum for the 3 previous years, the river condition is green for the next five years. When river discharge is below this critical minimum for the 3 previous years, the river condition is red for the next five years.

Crab landings increase during wet periods (green) and decrease during dry periods (red) and since the year 2000, observed landings typically fall within a standard deviation of the predicted landings.

the high flow Edisto River due to decreased predation by freshwater predators (alligators).

Since drought can have both positive and negative effects on blue crabs, there is considerable interest in understanding how future variation in river discharge will impact commercial blue crab landings.

This project for the Coastal Carolinas Drought Early Warning System (DEWS) used historical and forecasted Edisto river discharge levels as input for a spatially explicit, individual-based blue crab population model parameterized for conditions in the ACE Basin National Estuarine Research Reserve (http://scbcrabs.blogspot.com/).

The model crab landings for the first 25 years of historical river discharge were then standardized to the observed S.C. commercial landings for the same period. Future projections of crab landings showed that when Edisto river annual average discharge remained at or above a critical minimum level (1250 cfs annual average) for three consecutive years, statewide crab landings increased.

However, when river discharge dropped below this critical minimum, crab landings decreased.

Both statistical models of river discharge trends (seasonal ARIMA) and climate forecast surface runoff models (OpenNSPECT) suggest that the annual river discharge will continue to decrease while the interannual variation in river discharge will remain high. Given these forecasted conditions, future blue crab landings may experience periods, three to five years in duration, of increase and of decline, but ultimately, if river discharge continues to decrease, crab landings will fall to 50% of the historical commercial landings within the next 15-20 years (Figure 2).

The good news is that blue crabs occupy a large latitudinal gradient, and thus, when blue crabs are declining due to drought in the southern portion of their range, blue crabs in the northern portion of their range may be increasing due to elevated river discharge levels.

Future work will attempt to expand the blue crab forecast to examine the ability of blue crabs to persist given the likely scenarios of climate change and river discharge across their entire geographic range. We can accomplish this by incorporating both better predictions of future surface flow (ongoing collaboration with Dan Tufford and Greg Carbone of the University of South Carolina) and incorporating a real-time coastal drought index as a metric for estimating critical minimum flow conditions for blue crabs across their entire geographic range (ongoing collaboration with Paul Conrads, USGS).

This article originally appeared in the November 2015 (Vol. 5, Issue 2) edition of Dry Times, the NIDIS newsletter. Access the entire publication at: www.drought.gov/drought/what-nidis/nidis-news

What is a Drought Early Warning System (DEWS)?

A NIDIS DEWS utilizes new and existing partner networks to optimize the expertise of a wide range of federal, tribal, state, local and academic partners in order to make climate and drought science readily available, easily understandable and usable for decision makers; and to improve the capacity of stakeholders to better monitor, forecast, plan for and cope with the impacts of drought.

What is the Coastal Carolinas DEWS?

A diverse group of stakeholders convened in August 2012 in Wilmington, NC, to identify issues of concern about drought in the coastal regions of the Carolinas. Out of the meeting came the Coastal Carolinas Drought Early Warning System, a collaborative federal, state, and local interagency effort to improve early warning capacity and resilience to drought. CC DEWS activities focus on improving the understanding of drought's effects on coastal environmental resources and developing information to enhance drought monitoring and planning processes.