Using long-term survey data to predict blue crab (*Callinectes sapidus*) abundance in Charleston Harbor, South Carolina

Stephen R. Czwartacki[1,2]*, Peter R. Kingsley-Smith[1] & Michael R. Kendrick[1,2]

[1]Marine Resources Research Institute, South Carolina Department of Natural Resources - 217 Ft. Johnson Road, Charleston, SC 29412

[2]Environmental & Sustainability Studies Program, College of Charleston - 66 George Street, Charleston, SC 29424

*Corresponding author: czwartackis@dnr.sc.gov

Background

- The blue crab (*Callinectes sapidus;* Fig. 1) is a highly ranked commercial and recreational fishery in South Carolina with 3.9 million lbs landed and a value of $5.1 million in 2018 (Fig. 2)

Figure 1. Blue crab (*Callinectes sapidus*)

- To support management, it is important to understand recruitment dynamics of juvenile blue crab into the adult stage – the stage that is available to commercial and recreational fishers
- Models can be developed to assess recruitment dynamics, including testing of crab abundance in any given year and its relationship to crab abundance in preceding years
- If adult abundance in a year is predicted by juvenile abundance in the prior year (e.g., 1-yr lag), this may provide a more predictive understanding of the blue crab fishery
- The South Carolina Department of Natural Resources (SCDNR) monitors the status of juvenile and adult blue crab across a range of habitat types using multiple fisheries-independent surveys

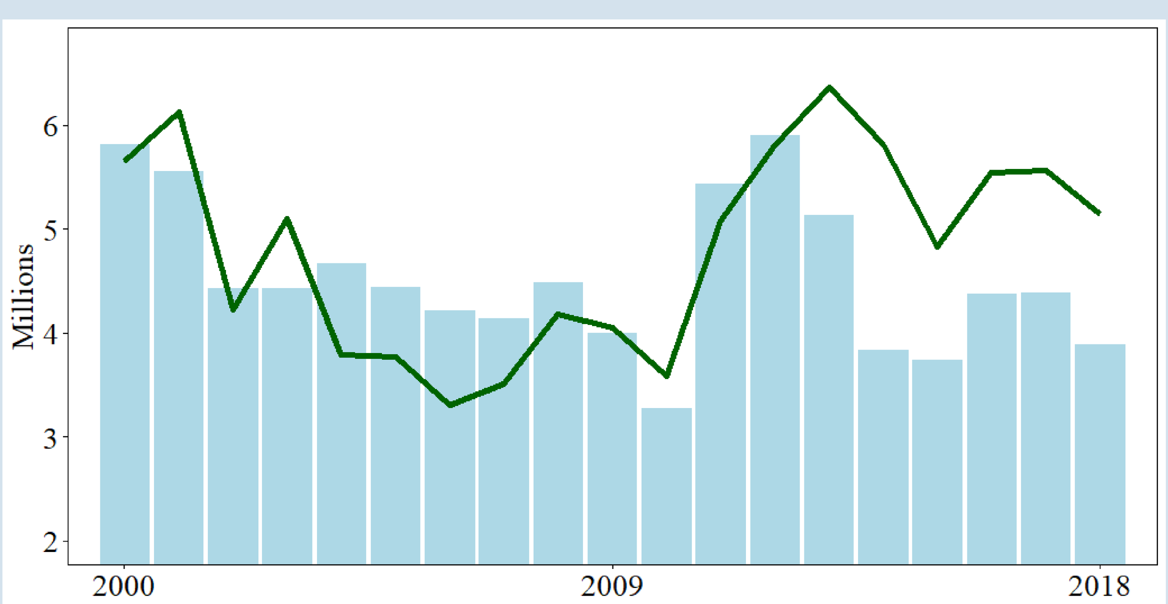

Figure 2. Annual blue crab commercial landings (2000 - 2018) in pounds landed (blue bars) and ex-vessel value (green line; source: www.accsp.org)

Research Objectives

<u>Objective 1</u>: Assess long-term trends in adult blue crab abundance from two fisheries-independent trawl surveys (Harbor Trawl and Creek Trawl)

<u>Objective 2</u>: Test the applicability of a juvenile index of adult abundance, where adult abundance in one year is predicted by juvenile abundance in the preceding year

<u>Objective 3</u>: Explore indices of abundance for size class and sexual maturity categories as they relate to blue crab abundance in subsequent years (e.g., 1-yr and 2-yr lag)

Methods

Survey Methods

- Monthly fixed station sampling in the Ashley River & Wando River watersheds and the Charleston Harbor (1980 – 2018; Fig. 3)
- Harbor Trawl survey – 7.7m net with 15 min/trawl (Fig. 4A)
- Creek Trawl survey – 4.5m net with 5 min/trawl (Fig. 4B)

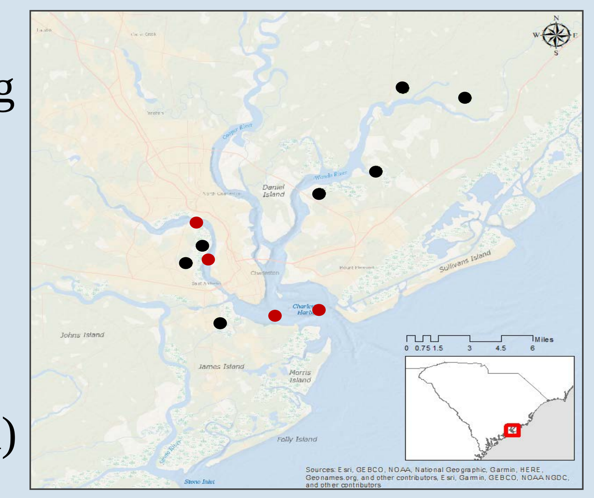

Figure 3. Map of Harbor Trawl (red) and Creek Trawl (black) sampling locations in the Ashley River & Wando River watersheds and the Charleston Harbor

- Sampling occurs at or near low tide
- Biotic data recorded as part of both surveys (size, sex, maturity; Fig. 5)
- Size determined by measurement of carapace width
- Sex and maturity determined by presence of morphological characteristics of the abdomen

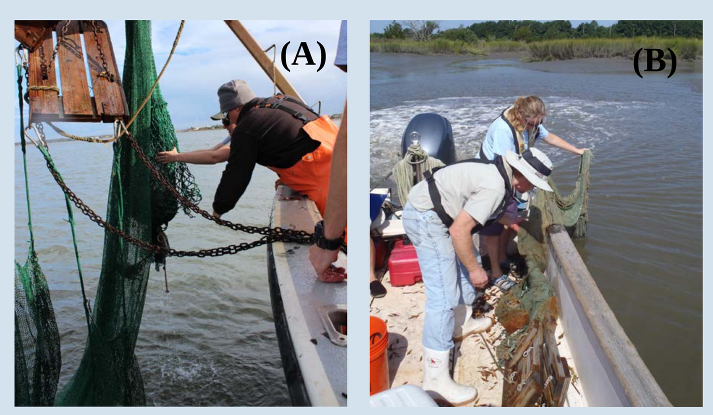

Figure 4. SCDNR Harbor Trawl aboard the R/V Silver Crescent (A) and Creek Trawl aboard a small outboard vessel (B)

Figure 5. Biotic data collection, e.g., size measured as carapace width

Analytical methods

- Ordinary least squares (OLS) approaches were used to estimate the relationships between adult and total survey abundances, and life-stage specific abundances from preceding years
- Individual crabs were assigned to the following size and sexual maturity categories:
  - Size classes: juvenile (≤60mm), subadult (61mm – 126mm), sublegal (<127mm) and adult (≥127mm)
  - Sexual maturity classes: mature female, immature female, mature male, and immature male
- Monthly means across all stations were used to calculate mean annual abundances as catch-per-unit-effort (CPUE)
- Adult CPUEs were compared to juvenile CPUEs 1 and 2 years prior to test the applicability of a juvenile index
- Additional indices of adult CPUE and total CPUE were developed using single regression models (n = 80) for each life-stage specific category at 1-yr and 2-yr lag
- Significant (α = 0.05) models were ranked by explanatory power (i.e., r^2)

Results

Objective 1

- High inter-annual variability was observed in adult blue crab abundances from the Harbor Trawl (Fig. 6A) and Creek Trawl (Fig. B) surveys

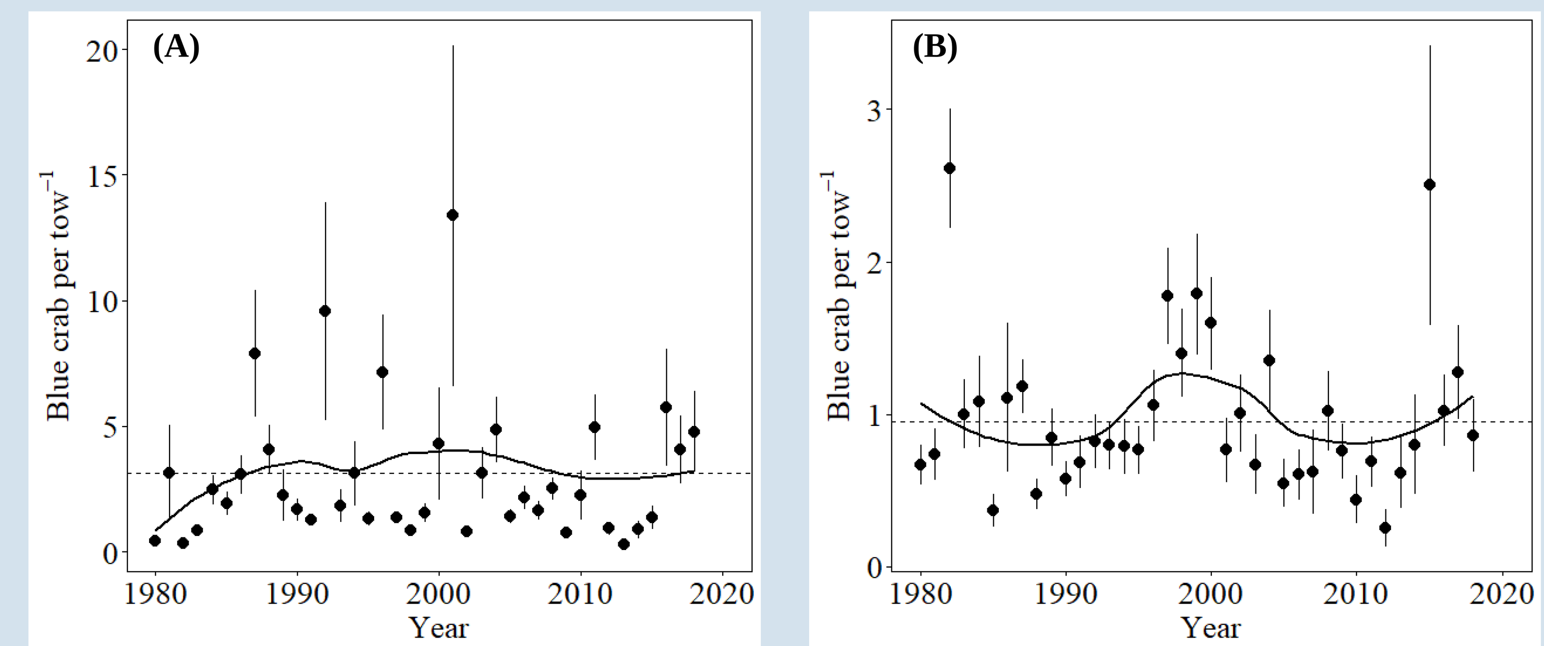

Figure 6. Mean annual adult blue crab CPUE (expressed as number of crab per tow) from the Harbor Trawl (A) and Creek Trawl (B) surveys with standard error, mean line (dashed) and LOESS smoother line (solid)

Objective 2

- Mean annual juvenile CPUE was not significantly related to mean annual adult CPUE in subsequent years for either the Creek Trawl (1-yr lag, r^2 = 0.02, *p* = 0.43; 2-yr lag, r^2 = 0.02, *p* = 0.35) or the Harbor Trawl (1-yr lag, r^2 = 0.06, *p* = 0.15; 2-yr lag, r^2 = 0.00, *p* = 0.86) survey

Objective 3

- Life-stage specific CPUEs from the Harbor Trawl were not significant predictors of total CPUE using 1-yr and 2yr lags
- In contrast, multiple time-lagged, life-stage specific abundance variables from the Creek Trawl were significant predictors of adult CPUE (not shown; r^2 <0.20) and total CPUE (Table 1)

Dependent Variable	Explanatory Variable	Summary Statistics: *p*-value	r^2	F-statistic
Total CPUE	Subadult (2-yr lag)	<0.01	0.24	11.250
Total CPUE	Mature Male (1-yr lag)	<0.01	0.23	10.880
Total CPUE	Immature Male (2-yr lag)	<0.01	0.21	9.481
Total CPUE	Sublegal (1-yr lag)	<0.01	0.21	9.316
Total CPUE	Total CPUE (2-yr lag)	<0.01	0.21	9.024

Table 1. Five highest ranking predictive models of CPUEs using time-lagged, life-stage specific abundance variables for the Creek Trawl survey ranked by explanatory power (r^2)

Discussion

- Highly variable adult abundances and an inability to develop a juvenile index of adult abundance suggest that extrinsic factors may be important for the recruitment of juvenile blue crab to the adult stage
- While no juvenile index was developed, multiple time-lagged, life-stage specific abundance variables provided significant explanatory power in predicting adult abundances
- Incorporating extrinsic factors (e.g., habitat availability, environmental conditions) into future predictive models could serve to increase explanatory power

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