FINAL REPORT

South Carolina State Wildlife Grant SC-T-F17AF01207

South Carolina Department of Natural Resources

October 1, 2017 – March 31, 2019

Project Title: Range, life history, and environmental tolerances of the Waccamaw crayfish (*Procambarus braswelli*) and the hammock crayfish (*Procambarus lunzi*) of near-coastal environments.

Objectives:

The main objective of this study was to assess the geographic range, life history, and life cycle phenology of near-coastal crayfish populations as a means to inform the conservation status priorities of these species. To meet this project objective, a regional sampling effort to target species located in habitats that are unlikely to be encountered in monitoring surveys conducted by federal, state or local agencies was conducted. Many of the crayfish species inhabiting the near-coastal zone are listed as priority species, in part, due to their "data deficient" status. In such cases, increased sampling is likely to reveal new populations and a potential down-listing of their priority status. The overall goals of the project were to: 1) define the range and salinity tolerance of the Waccamaw crayfish, *Procambarus braswelli*; and 2) document life history phenology and habitat characteristics of the hammock crayfish, *Procambarus lunzi*. Due to differences between these species in our understanding of their distribution at the outset of this project, our objectives and methodological approaches were as follows:

Objective 1. Define the range extent of *Procambarus braswelli* (Waccamaw crayfish) in South Carolina while also documenting life history and life cycle attributes of this species;

Objective 2. Experimentally determine the ability of *P. braswelli* to tolerate increasing salinization of near-coastal habitats through laboratory trials;

Objective 3. Track phenology of life history and life cycle attributes of *Procambarus lunzi* (hummock crayfish);

Objective 4. Characterize the abiotic nature of the sea island environment where *P. lunzi* is found.

Accomplishments:

Objectives 1 & 2. To determine the current range of *P. braswelli*, sites were selected based on previous species records as well as using satellite and areal imagery to choose sites with appropriate habitat and accessible survey area. Between October 2017 and March 2019, a total of 46 sites, 17 in North Carolina and 29 in South Carolina, were surveyed over 6 sampling trips in the Waccamaw, Great Pee Dee, and Little Pee Dee River drainages. A total of 21 *P. braswelli* individuals were collected across three sampled location, including five form 2 (non-reproductively active) males collected on November 28, 2017 and one form 2 collected on January 24, 2018. Two sites in the Little Pee Dee contained *P. braswelli* but also contained the invasive red swamp crayfish, *Procambarus clarkii* (Figure 1a & 1b). The low abundances of *P. braswelli* and new records of *P. clarkii* indicate that *P. clarkii* is spreading to new areas and could potentially be displacing *P. braswelli*, as well as other native crayfish species. Given the low numbers of P. braswelli documented during this study, objective 2 would not be explicitly met during the timeframe of this project (see "significant deviations" below).

Objectives 3 & 4. To document life history phenology and habitat characteristics of the hammock crayfish, *P. lunzi*, a focal population was first identified for this study. A wetland located off the coast of South Carolina in Beaufort County, was surveyed in October 2017 and found to have an established population of *P. lunzi*. A Hydrolab environmental data logger, which recorded water temperature and salinity every 30 minutes, was deployed in the wetland in December 2017. In addition, water

temperature, salinity, and dissolved oxygen were recorded once during each sampling period. Temperature data show values and trends typical of seasonal changes in temperature (Figure 2). Recorded salinity measurements were above those characteristic of freshwater habitats (> 0.5 psu) for the duration of the study, but salinity steadily declined over the year from 6 psu to ~1 psu (Figure 3).

The wetland was surveyed monthly, weather permitting, for a total of nine times. For each crayfish collected during the surveys, sex, post-orbital carapace length (OCL), and reproductive state were recorded, and the crayfish were then released back into the wetland. A total of 137 *P. lunzi* individuals were caught between October 2017 and November 2018. The highest catches occurred in February 2017 and November 2018 (Figure 4). The majority of the individuals caught were juveniles (n = 105, Figure 4). Only one reproductively capable male (form 1) was caught, which was during the initial site visit in October 2017. None of the adult females collected exhibited signs of active reproduction (i.e. no ovigerous females or females in glair). The size distribution of crayfish caught did not display any clear patterns over time and the mean size of crayfish caught during each sampling event ranged from 6.7 to 14.15 mm OCL (Table 1). The presence of a reproductively active male in October 2017 suggests that matting may occur during this time period. Juveniles were present year-round, but they were collected in highest abundances during the fall and winter. This pattern, along with the presence of a reproductively active male in October, suggests that *P. lunzi* mates and brood during this time period.

The generally low abundances of crayfish collected during sampling events limited the ability to make accurate conclusions about the life history of this species; however, the environmental data, specifically the evidence of mesohaline conditions year-round in this wetland, coupled with the presence of *P. lunzi* during every sampling event, indicates this species can tolerate salinities chronically higher than those typically characteristic of freshwater wetlands.

Together, the results from this study highlight the potential ability of multiple anthropogenic stressors to influence the populations of two of South Carolina's conservation priority species. These stressors include the influence of salinization to wetland habitats, as documented in the wetland inhabited by *P. lunzi*. In addition, this study demonstrates the distribution of the invasive *P. clarkii*, a species that has been documented to greatly diminish the populations of native species, including other crayfish.

Significant deviations:

The second objective of this project was to experimentally determine the salinity tolerance of *P. braswelli*. Our first objective efforts, however, revealed that the distribution of *P. braswelli* in SC remains limited to only a few locations. In order to obtain sufficient numbers of specimens for the experimental trials, and as described in the proposal, sampling efforts were directed to locations in North Carolina where *P. braswelli* has been shown to occur in high abundances at numerous locations. *Procambarus braswelli* was not found at any of the 17 sites sampled in North Carolina and 13 of these sites contained the invasive red swamp crayfish, *P. clarkii* (Figure 1b). Many of these locations were new records for this invasive species. In addition, 11 of the sites sampled in South Carolina contained *P. clarkii* and a total of 268 *P. clarkii* individuals were collected in South and North Carolina. The widespread distribution of *P. clarkii* in this region, coupled with the low abundance of native crayfish species, including *P. braswelli*, is of great conservation concern and efforts are continuing to investigate how *P. clarkii* may be affecting native crayfish populations. Due to the alarmingly reduced abundance of *P. braswelli*, there were insufficient numbers of specimens that could be made available for an experiment designed to use 96 adult specimens.

Estimated Federal Cost: $35, 690 (amount spent this year 10/1/2018-3/30/2019)

Recommendations: Close the grant

Table 1. Minimum, maximum, and mean (± SE) ocular carapace length (OCL) of *P. lunzi* collected between December 2017 and November 2018 on North Williman Island.

Sampling month	# crayfish collected	Min (mm)	Max (mm)	Mean (mm)
December 2017	15	4.8	28.2	10.6 (± 1.6)
February 2018	35	6	22.4	11.2 (± 0.6)
April 2018	2	13.7	14.6	14.2 (± 0.3)
May 2018	1	6.7	6.7	6.7
June 2018	3	4.9	21.6	10.6 (± 4.5)
August 2018	2	-	-	-
September 2018	4	7.4	11.4	9.6 (± 0.9)
November 2018	54	4.3	26.3	10.9 (± 0.6)

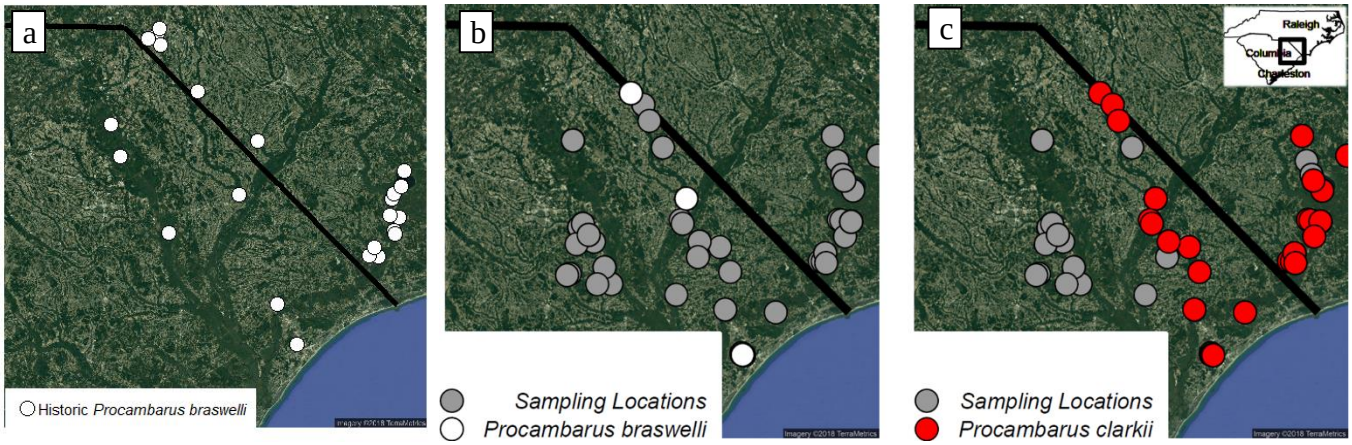

Figure 1. Maps showing sampling area in northeast SC and southeast NC with (a) showing known historic locations for *Procambarus braswelli*, (b) sampling locations and putative records for *Procambarus braswelli* from the current project's sampling, and (c) sampling locations and records for *Procambarus clarkii* from the current project's sampling.

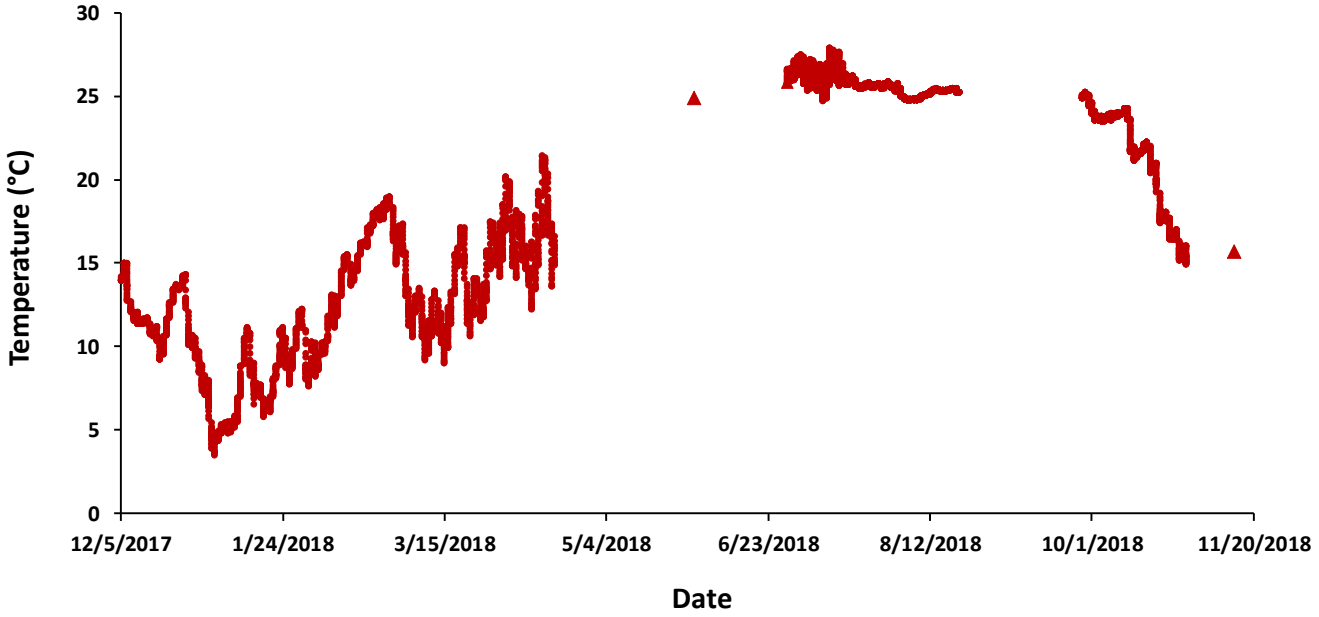

Figure 2. Water temperature in the North Williman Island study wetland recorded by submerged Hydrolab equipment logging data every 30 minutes. Gaps in data were due to equipment malfunction and thus point data during sampling events are displayed with triangles.

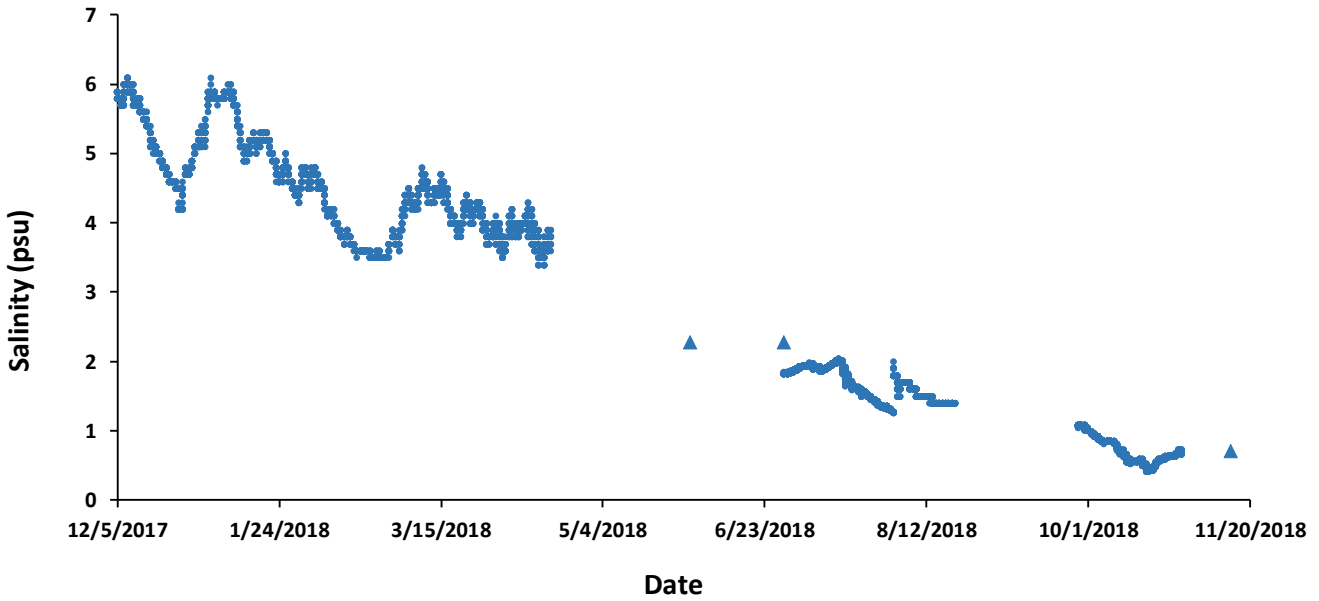

Figure 3. Salinity in the North Williman Island study wetland recorded by submerged Hydrolab equipment logging data every 30 minutes. Gaps in data were due to equipment malfunction and thus point data during sampling events are displayed with triangles.

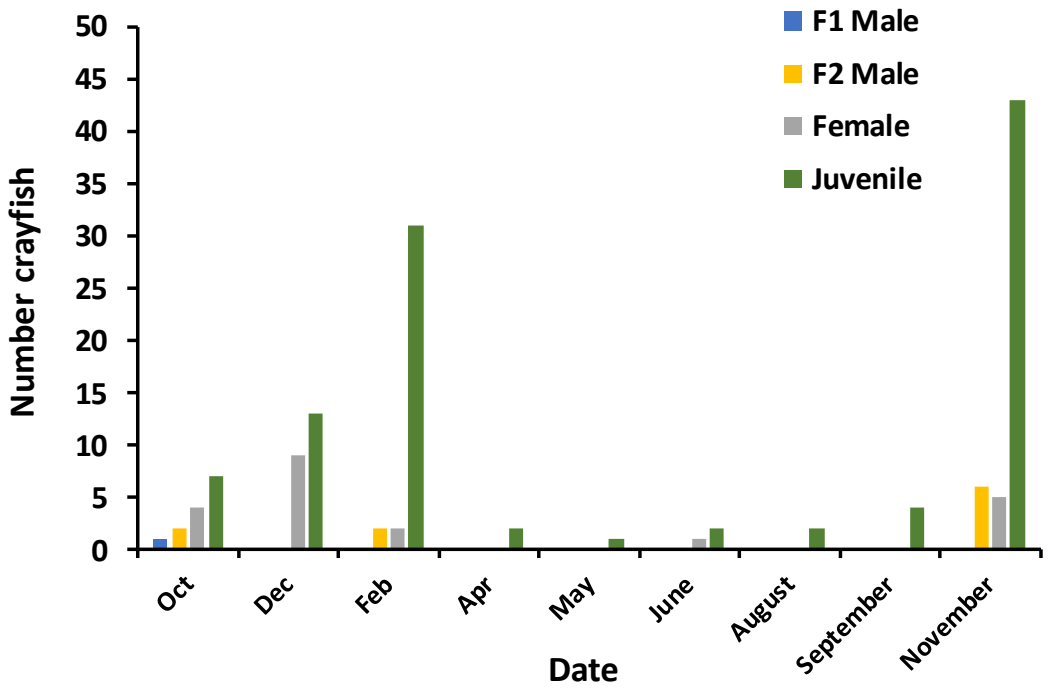

Figure 4. Abundance of crayfish in each life stage (form 1 (F1), form 2 (F2), and juveniles) caught during each sampling event.