High-marsh pool use by the fiddler crab, *Uca pugnax*, in a New England salt marsh

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Abstract
Current literature on salt marsh ecology cites the Atlantic Marsh Fiddler Crab, *Uca pugnax*, as a low marsh inhabitant. Over the course of approximately two months, video samples of the marsh were collected in the Banca Salt Marsh in Branford, CT. Video samples of pools were analyzed and compared to creeks and channels. Analyses revealed the densities of fiddler crabs in the high-marsh pools in some cases reached densities typical of low marsh habitat. Despite high temperatures and salinities, *U. pugnax* was observed repeatedly utilizing these high marsh pool resources both at low and high tide periods. The study conducted over the summer supports a possible theory of expansion of habitat from the known low marsh habitat into the upper marsh.

Introduction

Salt marsh habitats across the New England region and the world are important coastal environments. New England salt marsh systems typically consist of 3 distinct zones (Fig. 1), the low and high marsh, and upland transition (Teal 1969).

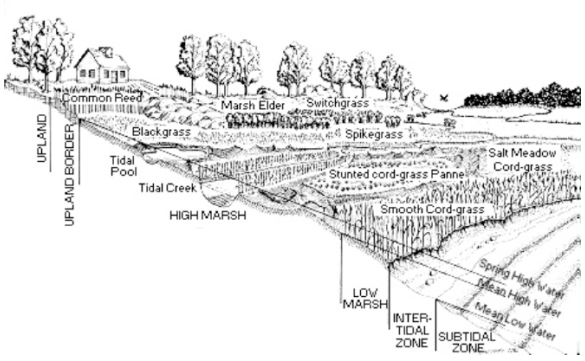

Figure 1: Idealized zonation of communities on a typical CT salt marsh.

The boundaries of each zone are determined by 3 major factors: the tidal range, duration of the tidal cycle, and the salinity tolerance of each plant species. (Teal 1969, Nixon and Oviatt 1973). An important sub-habitat, marsh pools, exists in the high marsh **(**Fig. 1) (Teal 1969). Although salt marsh pools can have harsh environmental conditions, they can provide habitat for marsh fauna. The dynamic nature of marsh pools also allows us to measure changes on the salt marshes using the pools as indicators. Great changes in salt marshes have occurred over the past few hundred years with an estimated 50-70% of all Southern New England marshes being lost to human disturbances (Bertness, Sillman, and Jefferies 2003). The objectives of this research were to observe and collect information on use of marsh pools by Atlantic Marsh Fiddler Crab, *Uca pugnax*, and compare the results to what is known about their habitat use patterns on salt marshes. Based on current literature, Uca *pugnax* is primarily found in low marsh habitats and not typically on the high marsh (Grimes, et al. 1989). *Uca pugnax* is a moderately sized crab with a brown carapace that may transition to shades of blue in various places, and males have a single enlarged yellow-white toned cheliped (Grimes, Huish, Kerby, et al. 1989). The general hypothesis tested in this study is that high marsh pools act as important habitats for *Uca pugnax* and allow the crab to expand their habitable range into the high marsh.

Methods and Materials

Video samples of pool use and physical measurements of the pools were collected from Banca Marsh in Branford, CT from June through August, 2012. Samples were collected from the back marsh only (Fig. 2). Sample collection occurred during low tide. Lunar phases were not directly considered in selecting sampling collection dates, but sampling was conducted during several different lunar periods. High-definition video samples were taken using two GoPro® HD Hero 2 video cameras mounted on 2m high PVC poles and directed down toward the substrate. Each camera recorded ~ 2-2.5 hours of data per trial. Several different pools and other habitats (tidal creeks and pannes) were sampled using the video cameras (Fig. 2). In addition to video samples, 1 m^2 quadrats were used to quantify crab densities in high marsh grass habitats.

a. Video Data Analysis: Each video was analyzed by discarding the first 20 minutes of each video to allow for disturbances to crabs by camera deployment. After this acclimation period, counts of fiddler crabs were taken every 15 minutes from the entire pool area in vision of the camera. Any video

with less than 5 data collection points was discarded from the statistical analyses. Counts from each video were normalized to density per 1 m^2 based on calculations of total pool area and used in statistical analyses.

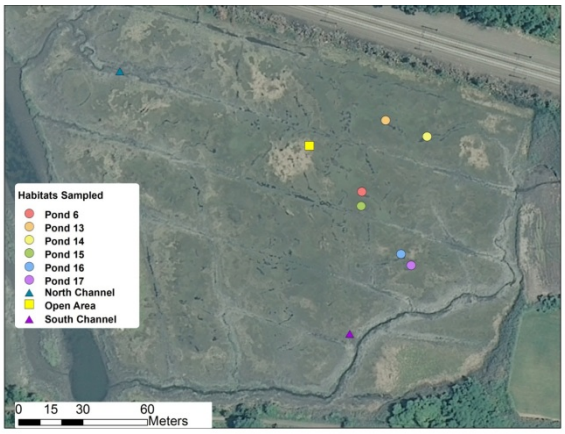

Figure 2: Location of sampling locations of all video cameras.

b. Physical Characteristics: Several physical characteristics of the pools were measured including, temperature with a multi-variable YSI meter, salinity with a standard refractometer, and dissolved oxygen using a portable YSI PrODO meter. Area and shape of each pool was measured using a Trimble GEO XH 2002 GPS unit. Mapping data was processed using a geographic information system (GIS). Depth of each pool was measured in 3 places and averaged. All physical characteristic measurements were taken on the same days at low tide to ensure consistency between pool measurements.

Results and Discussion

The density of *Uca pugnax* in high marsh pools was surprisingly high compared to previous literature, which had makes little to no mention of pool use by the marsh fiddler. Previous literature has pointed to *Uca pugnax* as primarily occupying low marsh habitats, typically creek banks. During multiple trials, crabs were seen in high marsh pools with densities in some cases matching those of the lower marsh creek banks (*Figure 3*). Densities in the pools were somewhat lower than that found in vegetation on the high marsh, such as *Spartina patens* and short *S. alterniflora.* Although crab densities in creek habitats were significantly higher than in the other habitats (one way ANOVA, $P<0.01$), the results suggest potential habitat expansion of *Uca* into the high marsh habitat.

High temperatures and salinities were recorded in some pools and *Uca pugnax* continued using the pool habitats. Temperatures and salinities of the pools ranged widely, with a maximum temperature recorded at 40°C and a maximum salinity recorded at over 50 ppt. This represents the upper thermal tolerance of *U. pugnax*, but does not represent the upper salinity tolerance of the species, which has been successfully kept alive at 175% seawater (Grimes, et al. 1989).

Two major possible sources of error were encountered in the selection of pools and counting the number of crabs. There are a large number of pools in the Banca Marsh. Pool selection was limited to shallow pools primarily based on requirements for visualizing crabs in the videos. Due to the high turbidity of the water in some pools, shallow pools were selected over those with deeper areas. A second, possibly large source of bias was found in the accuracy of counting males vs. females. The counts were skewed heavily in favor of males due to the male's enlarged cheliped. Male crabs were much easier to count vs. the female crabs that had no distinct visual cue. The lack of visual distinction for female crabs likely lead to an underestimation of their population in the counts. Therefore, conservative counts for the pool habitats can be assumed. Additionally, the color of the substrate of the pool habitat matched closely to that of the female crabs. Furthermore, the varied terrain of the creek bank allowed for easier counts of both male and female crabs. Due to this skew, the difference between creek bank and pool densities may be more similar than as measured based on the video records.

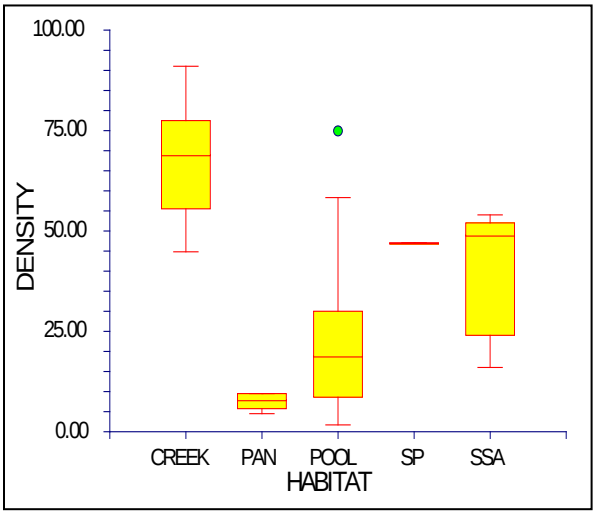

Figure 3: Box plot of habitat vs. crab density per m^2. Pan = panne; SP = *Spartina patens*; SSA = short *Spartina alterniflora*

Changes in crab behavior and movement due to the shadow of the camera rigs over the substrate were considered as another possible source of error. Avian predators common to the Branford area are known to consume fiddler crabs as part of their diet (Montague 1980). It did not appear that the behavior of the crabs was modified due to the presence of a shadow. In every video, both male and female crabs were observed repeatedly crossing through the camera shadow without reservation.

Conclusions

Previous literature has typically noted the marsh fiddler, *Uca pugnax*, as being primarily a low marsh inhabitant due to limitations in its physiological and other adaptive abilities to occupy high marsh habitat (Bertness and Miller 1984, Grimes, et al. 1989). This study has shown that the *Uca pugnax* can occupy high marsh habitats in high numbers and utilize habitats not previously noted for *Uca pugnax*. Changes on the marsh may be pushing the crab higher onto the marsh including sea level rise, loss of low marsh habitat, and biological pressure. In order to support or refute this trend, further studies will be necessary in order to measure crab densities in the pools versus other marsh habitats over a longer period of time. .

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Biography

Colin Bassett is currently a senior at the University of New Haven majoring in Marine Biology. Colin hopes to continue his education and pursue a Ph.D. in Benthic Marine Ecology. In his free time, Colin enjoys SCUBA diving and photography.