A Monitoring Program to Evaluate Cove Point as a Spawning Area for the Horseshoe Crab, *Limulus polyphemus*

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Abstract

We undertook a survey of horseshoe crab (*Limulus polyphemus*) spawning at Cove Point, MD in 2005. Horseshoe crabs have been reported spawning on this beach, but no quantitative surveys had been done. We surveyed the beach during nighttime high tides, once in May and twice in June. Horseshoe crabs were observed during the two June surveys. Location of each spawning group was recorded using GPS. We also collected sand cores near the high tide mark during the week following each survey. These cores were examined for horseshoe crab eggs. We found that horseshoe crabs utilize Cove Point beach for spawning. A single transect along the beach on June 7 and June 22 recorded 45 and 42 spawning groups, respectively. Most were single pairs, with doubles or triples rarely seen. Spawning groups never emerged from the wave zone, and with higher waves many were upturned. Spawning was observed only in the southern kilometer of beach. We hypothesize that beach choice for spawning is correlated with vegetation content in the beach sand. The northern beach is eroding, exposing buried vegetation and perhaps draining the marsh behind. This would likely produce hypoxic conditions in the beach sand and may prevent crabs from spawning in this area. Sand at the southern beach is accreting, and there is less marsh behind the beach. This may produce less decaying vegetation and better oxygen conditions in the beach pore water. If true, this hypothesis has implications for horseshoe crab spawning in the Chesapeake, as erosion is occurring along many shorelines throughout the Bay.

Introduction

Horseshoe crabs (*Limulus polyphemus*) are ecologically and economically important along the Atlantic coast of the United States. They spawn and deposit eggs on suitable beaches, usually during nighttime high tides in May or June (Rudloe, 1980; Shuster and Botton, 1985). These eggs are important food sources for many migrating shorebirds (Castro and Myers, 1993; Botton et al., 1994; Tsipoura and Burger, 1999). Adult horseshoe crabs are economically important as the source of Limulus amebocyte lysate, used for detecting contamination in human blood products (Berkson and Shuster, 1999).

There is evidence that horseshoe crab populations in many areas may be in decline, due to harvest for bait or degradation of spawning habitat (Berkson and Shuster, 1999; Widener and Barlow, 1999). There is thus interest in determining population numbers, spawning success and recruitment. Horseshoe crabs spawn on the Atlantic coast from Maine to Mexico, with their greatest abundance centered on Delaware Bay (Shuster, 1979). Chesapeake Bay is a smaller but important spawning area for this species and contains a horseshoe crab population genetically distinct from the Delaware Bay population (Pierce et al., 2000).

Population numbers and spawning areas have received less study in the Chesapeake than in Delaware Bay. Based upon conversations with workers at the Maryland Department of Natural Resources and US Fish and Wildlife Service, there are few published reports quantifying horseshoe crab spawning in the Chesapeake and none for some years.

The beach at Cove Point, Maryland is a spawning area for horseshoe crabs. In May 2002, P. Bushmann observed spawning during a nighttime high tide. Walking one transect, from the boardwalk south to the property line, 200 spawning females were observed within a two-hour period. The southern area of the property contained the highest number of animals, while the beach near the boardwalk had few or none. No spawning horseshoe crabs were observed during daytime high tides following or preceding this nighttime tide. To my knowledge, horseshoe crab spawning at Cove Point has not previously been rigorously examined or quantified.

In this report we describe a quantitative survey to evaluate horseshoe crab spawning activity and resulting egg density on Cove Point beach. This should make a contribution to a larger body of knowledge concerning spawning activity in the Chesapeake Bay. It hopefully will serve to establish a long-term monitoring program at Cove Point beach. Such a program could evaluate how changes to the shoreline and beach quality may impact spawning activity and reproductive success.

Material and Methods

The survey evaluated 1) spawning activity on three nights of full and new moons and 2) egg density in the sand following spawning nights. The survey protocols were consistent with those developed previously for Delaware Bay (Smith and Himchak, 2000; Smith et al., 2002). Spawning activity was evaluated at night, at high tides, on three dates: May 23, June 7, and June 22. May 23 was a full moon, with a high tide at 2:48 am. June 7 was a new moon with a high tide at 3:06 am. June 22 was a full moon with a high tide at 3:15 am. Egg density was determined within a week of these high tides, during a daytime low tide. Egg density protocols followed Pooler et al. (2003).

Spawning activity – Each survey night, the beach was checked until spawning animals were observed. The beach was then walked as a single line transect, and the positions of spawning groups were recorded using GPS. Each recording represented a single pass down the beach. The data thus provide as “snapshot” of animal density during the height of spawning activity. The number of males per female was recorded for each spawning group.

Egg density – Two transect lines were established to estimate egg density. The week following May 23, marks were laid out every 20m along a transect line that ran along the high tide mark, from the boardwalk to the lighthouse. At each mark, 2 cm diameter core was taken to a depth of 20 cm. Botton et al. (1992) found that most eggs are deposited at depths of 20 cm or less. This yielded 62 cores for that transect. Following June 7, a series of cores was taken along a transect that ran only through the area were spawning crabs were observed. Cores were 10m apart, and 31 cores were taken. These core locations were also used to collect cores following the June 22 survey. All cores were transported on ice to our laboratory, where they were treated with 10% formalin with Rose Bengal added. Samples were passed through a 1 mm^2 mesh sieve to remove as much sand and debris as possible. Egg number in each core was determined visually under a dissecting microscope.

Results and Discussion

May 23 – First survey
On the first survey night, we walked the beach from the boardwalk to the lighthouse continually from midnight to 4:00 am. No crabs were observed during this period. Cores taken the following week did not contain eggs.

June 7 – Second survey
On June 6, bad weather and high winds prevented a survey. A USFW employee, Sheila Ehler, who accompanied us, stated that the waves were too high for any crab to attempt spawning. I returned the next night, June 7, and observed spawning (Fig. 1). I recorded the position of 45 spawning groups in a single transect (Fig.2A). Of these, 10 were doubles, and 3 were triples. Spawning groups always occurred within the wave zone. No group moved higher onto the beach. Crabs were observed only from the southern edge of the marsh to the lighthouse. Several of the cores taken the following week contained eggs (Fig. 3A). Positions of egg-containing cores are shown in Figure 3B. Most cores contained single eggs, and no cores contained more than three eggs.

June 22 – Third survey
We were accompanied on this survey by Sheila Ehler. We recorded the position of 42 spawning crabs in single transect survey. Of these, 7 were doubles, and 1 was a triple. The waves along the beach that night were higher than previously. The majority of spawning groups were flipped over, and many had become detached. Several single animals, some upturned, were observed on the beach. They were presumably the result of recently broken groups. Locations of spawning crabs are shown in Figure 2B. Once again, crabs were only observed on the southern part of the beach. Two of the cores taken the following week contained two eggs each. Their positions are marked in Figure 3B.

Summary

1. Horseshoe crabs utilize Cove Point beach for spawning, albeit at lower densities than those observed in Delaware Bay. Along one kilometer of beach, 45 groups were observed on June 7 and 42 observed on June 22.

2. Spawning began after the May 22 high tide. This was later than was observed previously. It is possible that the 2005 cold Spring contributed to this later spawning period. Spawning was occurring by June 7, and continued at least through June 22.

3. Spawning groups consisted primarily of single males. Double or triple males constituted only 29% and 19% of spawning groups on June 7 and June 22, respectively.

This suggests that in this population the male/female ratio is lower compared with Delaware Bay.

4. Our method of collecting sand cores did detect horseshoe crab eggs. These eggs were found only in areas where spawning groups were observed. This suggests that spawning was successful and that the other areas of beach were not being utilized on other nights. The eggs were rare, however, and some cores within the spawning area did not contain eggs. It is appears that these narrow diameter cores (2 cm), which were based in design on Delaware Bay egg densities, were not sufficient to detect the lower egg densities that the Cove Point spawning efforts likely produced.

5. Spawning groups were entirely restricted to the southern kilometer of beach, with the vast majority (97%) found along the southernmost 730 meters. The area of beach in which spawning occurred is shown in Figure 4.

This differential use of Cove Point beach by spawning groups is interesting and perhaps important for horseshoe crab conservation. Our observations suggest that spawning is restricted to the southernmost kilometer of beach. Some areas of the northern beach are clearly unsuitable, with little beach before *Phragmites australis* stands begin. However, the beach in many areas is apparently suitable, with a modest slope and an adequate depth of sand for spawning.

We hypothesize that differential utilization of Cove Point beach is related to both erosion and the marsh behind the beach. Botton et al. (1988) suggested that reduced sediment and hydrogen sulfide from underlying peat layers may prevent horseshoe crabs from utilizing some beaches in Delaware Bay. We believe this may be occurring at Cove Point beach. Beach erosion in the northern beaches may bring underlying vegetation closer to the surface, even where none is exposed. This, combined with the marsh behind the northern beach, could lead to reduced sediments and hydrogen sulfide production in beach pore water. These conditions present both toxicity and hypoxia problems for developing horseshoe crab eggs. Botton et al (1988) suggest that spawning groups avoid such beaches. Sand is accreting on the southern beaches, burying vegetation. The land behind the southern beaches is also higher, with less marsh water working into the beach sediments. Thus differential beach conditions could lead to differential utilization by spawning groups.

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