



## Inland Bays Volunteer Horseshoe Crab Spawning Survey

### Annual Report 2015



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The Delaware Center for the Inland Bays is a non-profit organization and a National Estuary Program. It was created to promote the wise use and enhancement of the Inland Bays watershed by conducting public outreach and education, developing and implementing restoration projects, encouraging scientific inquiry and sponsoring needed research, and establishing a long-term process for the protection and preservation of the Inland Bays watershed.

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## ABSTRACT

2015 marked the eighth year in which horseshoe crab spawning activity has been formally surveyed in the Inland Bays watershed, and the fourth year in which sites have been examined throughout the entire spawning period of the horseshoe crab. Five beaches were sampled two nights prior to, the night of, and two nights following the full and new moons between May 1<sup>st</sup> and June 18<sup>th</sup>, for a total of 49 individual spawning surveys.

Activity for a given night ranged between zero crabs, and 2,310 horseshoe crabs. A total of 15,418 crabs were counted in 2015 resulting in a sex ratio of 6.89 males for every female.

In general, as total crab numbers increased, sex ratios increased as well. Coastal Kayak had the lowest average sex ratio for 2015, and James Farm had the highest average total number of crabs.

## INTRODUCTION

Increases in the harvest of Atlantic horseshoe crabs (*Limulus polyphemus*) for bait and medical uses, and the loss of spawning habitats, have raised questions about this species current status throughout the Mid-Atlantic (Botton and Ropes 1987; Berkson and Shuster 1999; Widener and Barlow 1999; Lathrop et al. 2006). Because migrating birds rely heavily on the eggs of horseshoe crabs (Myers 1986; Tsipoura and Burger 1999; Smith et al. 2002a), it is important to monitor horseshoe crab populations.

This study represents a long term monitoring effort to track Horseshoe crab populations within the Delaware Inland Bays (Rehoboth Bay, Indian River and Bay, and Little Assawoman Bay). The goals of this ongoing study are to assess current population levels and sex ratios, and to track any potential changes in these levels over time.

To accomplish these goals, horseshoe crabs were systematically counted at five sites during the spring and early summer of 2015, which corresponds to the spawning period of the crabs.

## METHODS

Five different sandy beaches found throughout the Delaware Inland Bays (Figure 1) were surveyed between May 1<sup>st</sup> and June 18<sup>th</sup>, on dates which coincide with the 12 primary spawning surveys conducted in the Delaware Bay by Delaware's Department of Natural Resources and Environmental Control (DNREC). These surveys usually fall in May and June, with occasional overlap into July. Because Horseshoe crabs appear to prefer beaches dominated by coarse sandy sediments and avoid beaches that have a high amount of peaty sediments or are adjacent to exposed peat banks (Botton et al. 1988; Smith et al. 2002a), all of the

beaches selected in this study were sandy beaches. These beaches were also selected because they were easily accessible for volunteers.

The spawning surveys were conducted two days prior to, the night of, and two nights following the new or full moon. The surveys were conducted at the highest of the lunar high tides during these periods, occurring at night (when the moon exerts the greatest pull on the tidal levels).

Each beach is surveyed by a team of volunteers, who have been trained in the protocol and how to determine the sex of horseshoe crabs. Teams begin surveys once the nightly high tide begins to recede. Teams begin by randomly selecting one end of the beach to start from using a coin flip. Once the end of the beach is determined, the team will walk to that end and extend a pull rope with markings every 1m, at the high tide line towards the opposite end of the beach. The length of the pull rope is dependent on the length of the beach, and is designed to systematically allow the placement of 100 1m<sup>2</sup> quadrats along the beach. The length of the rope is determined by dividing the overall length of the beach by 50. James Farm, Coastal Kayak, and Tower Road all use a 4 meter pull rope. Bay Colony uses a 6 meter pull rope. Peninsula does not use a pull rope because the length of the beach is only 100m; they count all quadrats along the beach. In addition to randomizing the direction of travel, the placement of the quadrats within each rope pull is randomized for a single night. Two quadrats are sampled per rope pull, for a total of 100 quadrats. The same two randomized locations along the pull rope are used for the duration of the night. Once the pull rope has been extended, the 1m<sup>2</sup> quadrat is placed at the first random quadrat location for that given night. The quadrat is positioned so that one end is even with the line of crabs, and the other end is towards the bay. All crabs which have at least half their body inside the quadrat are sexed and counted. Upon completion of the first quadrat, the team moves the quadrat to the second randomly selected location and repeats the counting process. Once the two quadrats have been counted for the first rope pull, the rope is extended along the next portion of the beach, and the same two random quadrat locations are sampled. This is repeated until 100 quadrats have been sampled. The 'horseshoe crab line' that is followed is not a straight line, and it may be above or below the water line, however, it is never more than 1m<sup>2</sup> away from the high tide line.

At each of the sites, salinity samples were also taken for each night. These samples are later tested for salinity using a YSI Pro 2030. Air and water temperature were also taken with a thermometer. Because weather conditions may not permit a survey to occur on a specific night for safety reasons, some surveys were cancelled. A total of 10 surveys were cancelled in 2015 as a result of storms or issues with scheduling enough volunteers.

## RESULTS

In 2015 a total of 15,418 horseshoe crabs were counted on five beaches. The average total horseshoe crab count was 314.65 crabs, and the cumulative sex ratio for 2015 was 6.89 males for every female. In general, as the total number of crabs increased, the sex ratio also increased (Figure 2).

Total crab count ranged from 0 to 2,310 crabs for a single night at a single beach. Out of all five beaches surveyed, James Farm had the highest average total crabs and Coastal Kayak had the lowest average total crab count (Figure 3). Bay Colony had the highest sex ratio, while Coastal Kayak had the lowest sex ratio (Figure 4).

## DISCUSSION

The sex ratio of 6.89 was markedly higher than the sex ratio of 4.47 reported by the Delaware Bay survey (Swann et al. 2015). Since 2011, the sex ratio in the Inland Bays has exceeded the Delaware Bay sex ratio every year except 2012. It is unclear why this is the case. It may represent a bias in observers, or a possible difference in regional sub populations. Additional years with matching survey protocol are needed to confirm this pattern over a longer time period.

The peak spawning day in 2015 was May 20<sup>th</sup> (Figure 5). This was similar to the peak time period observed in the Delaware Bay survey (Swann et al. 2015). Unsurprisingly, May 20<sup>th</sup> was also the night with the highest mean sex ratio (Figure 6). Each of the previous four years an increase in sex ratio has been seen as the total number of crabs increases.

Out of the five beaches surveyed in this study, James Farm is in general the beach with the greatest number of crabs, and Coastal Kayak and Peninsula are generally the beaches with the fewest number of crabs. This pattern is likely due to the physical characteristics of the beaches themselves. Coastal Kayak is a considerable distance from both the Indian River Inlet (15 km in linear distance) or Ocean City Inlet (16.5 km), and crabs reaching Coastal Kayak must travel through one of two shallow mucky canals. Additionally, this site is also subject to fairly high wave energy. Peninsula has firm sandy substrate along the shoreline, but approximately 30ft off the shoreline the substrate changes to a mucky soft bottom (mud/peat). This sediment is utilized significantly less than sandy sediments (Botton et al. 1988). Crabs seeking a spawning beach would need to travel over the less preferred substrate as well as navigate their way in between two curved rock jetties to reach Peninsula's beach. Oppositely, James Farm has a gradual well protected shoreline, with minimal wave action, which is preferred by spawning crabs (Smith et al. 2002b; Lathrop et al., 2006).

2015 marked the first year that the protocol matched the Delaware Bay survey protocol. This switch was made to facilitate comparisons between the surveys. Unfortunately, this switch has negated our ability to create trends in the total crabs counted over the duration of the survey. However, we believe the

switch in protocols will be more beneficial to horseshoe crab monitoring as a whole over the long term.

#### ACKNOWLEDGEMENTS

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Figure 1. The five Inland Bays survey sites for 2015.

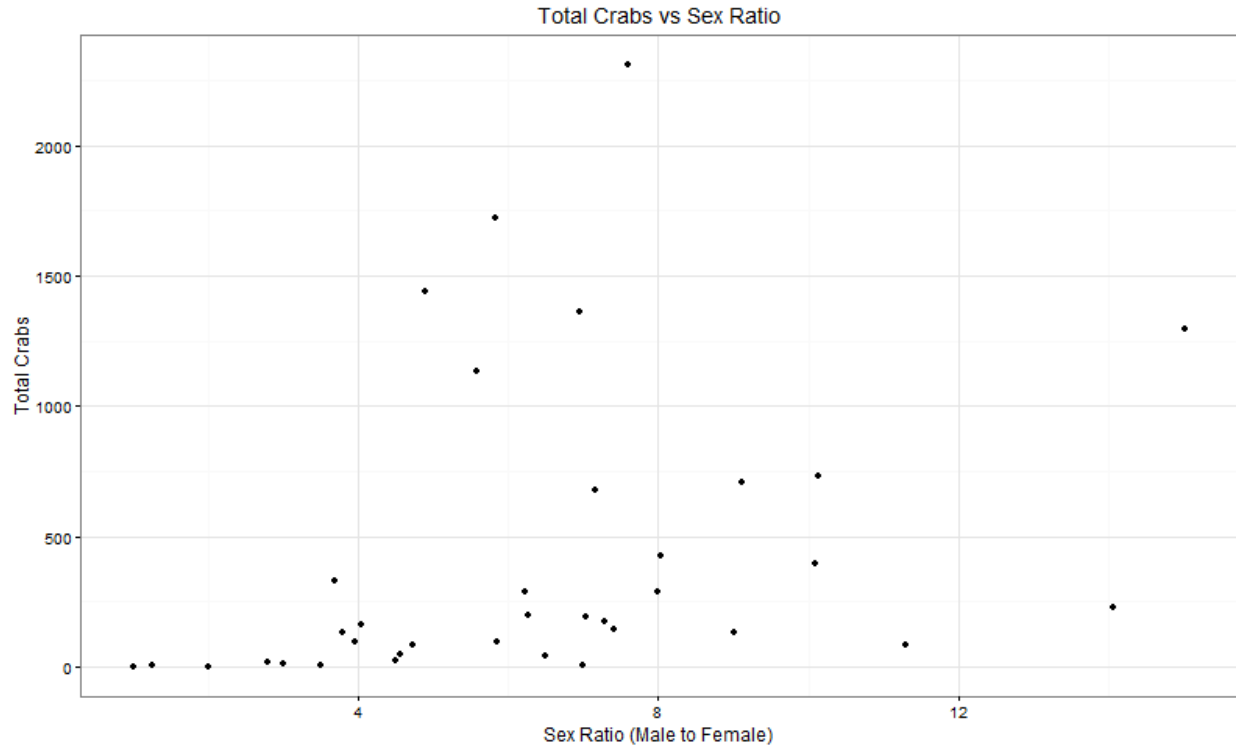
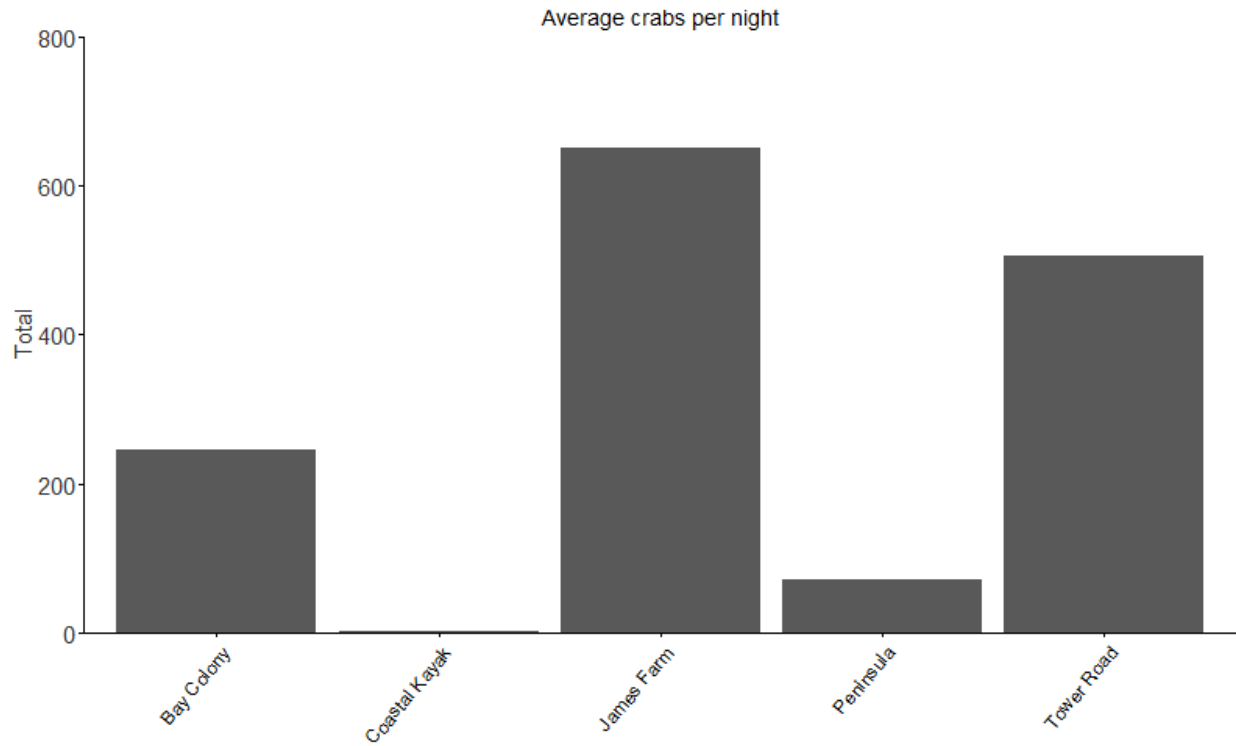
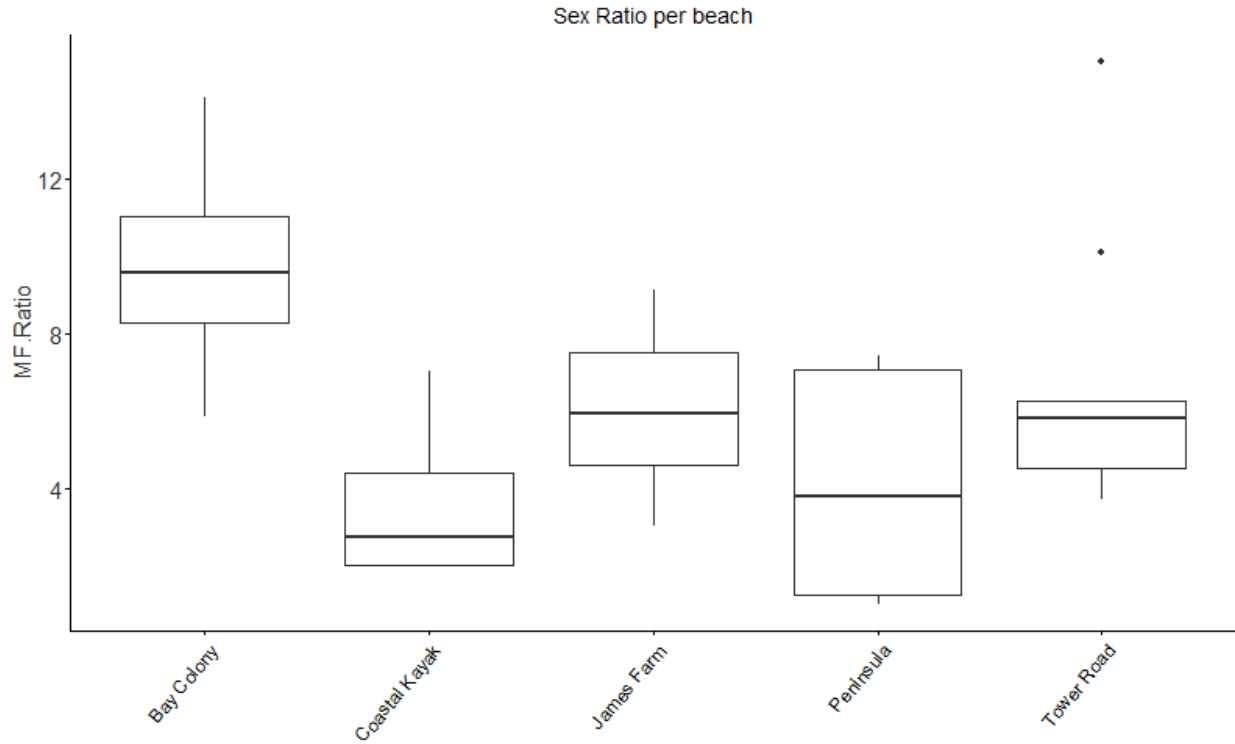


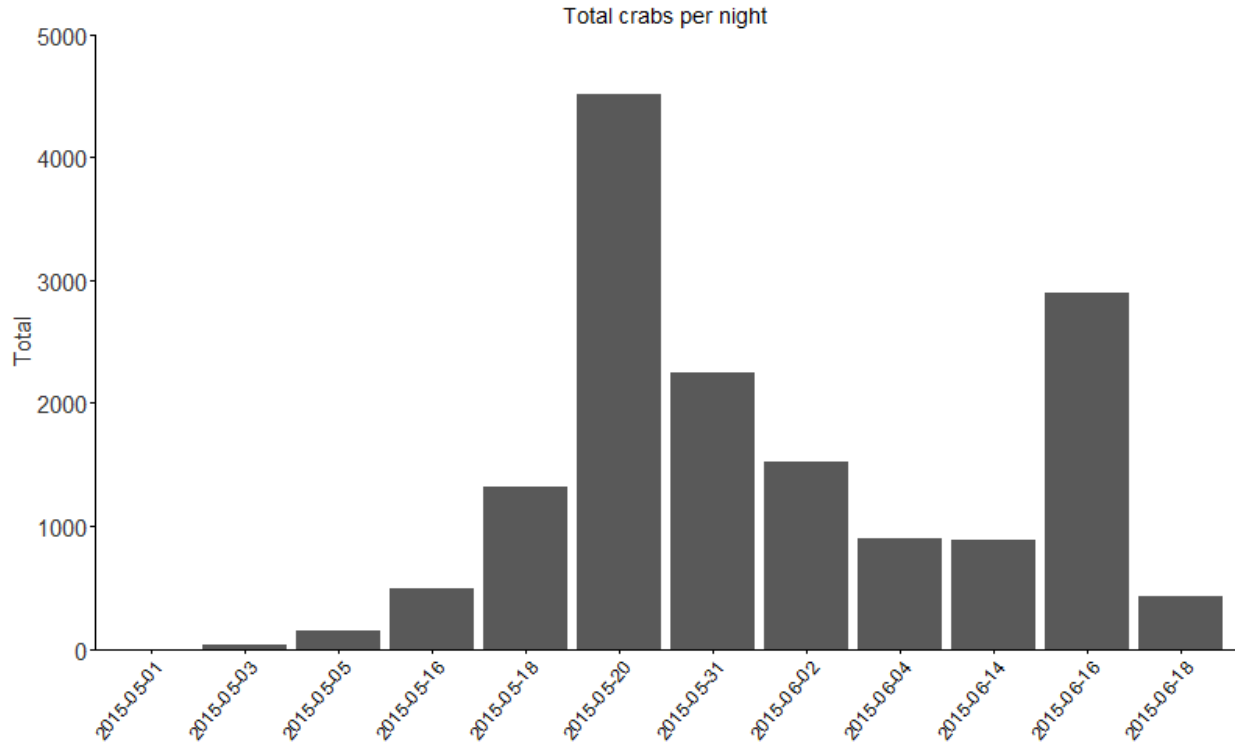
Figure 2. Sex ratio compared to total crabs for a given night per site. As the total number of crabs on a beach goes up, sex ratio generally increases.



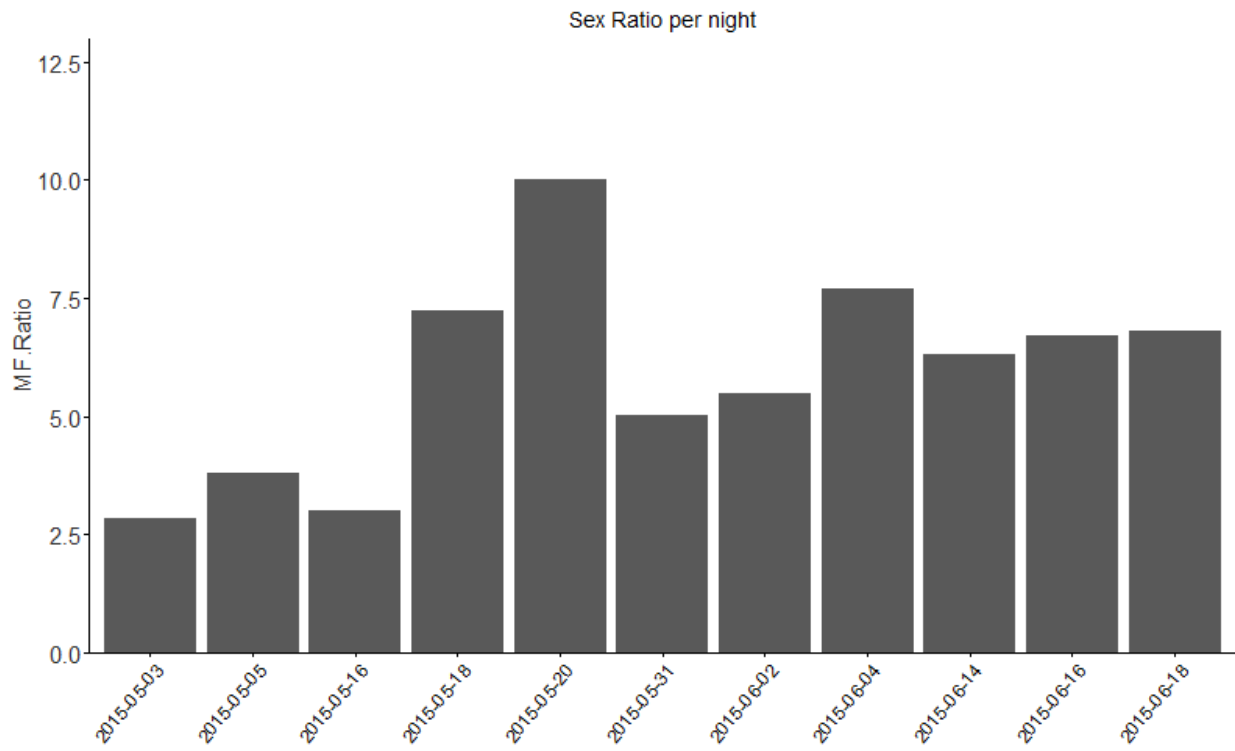
**Figure 3. Average total crabs per night for each beach in 2015. James Farm had the highest average crab count in 2015.**



**Figure 4. Sex ratio (males to females) per beach for 2015. Bay Colony had the highest median sex ratio, while Coastal Kayak had the lowest sex ratio.**



**Figure 5. Total number of crabs counted per night. May 20<sup>th</sup> was the peak night for 2015.**



**Figure 6. Sex ratio per night. Most sex ratios were above 5.**