Inland Bays Volunteer Horseshoe Crab Spawning Survey

Annual Report 2014

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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

2014 marked the seventh 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 April 13th and July 12th, for a total of 66 individual spawning surveys.

Activity for a given night ranged between zero crabs, and 2,083 horseshoe crabs. A total of 9,697 crabs were counted in 2014 with an average sex ratio across all five sites of 6.05 males for every female. No significant differences existed for either total crabs, or sex ratios between full and new moon cycles.

In general, as total crab numbers increased, sex ratios increased as well. Tower Rd had the lowest average sex ratio for 2014, 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 2014, which corresponds to the spawning period of the crabs.

Methods

Five different sandy beaches found throughout the Delaware Inland Bays (Figure 1) were surveyed a minimum of 12 times, 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). Additional surveys were conducted, using the same clustering of three surveys on the new and full moon cycle to identify the first and last spawning occurrences during the year. The additional surveys take place in late April and early August.

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. The end of the beach that the survey begins at was determined using a coin flip for each night of the survey. Starting at the randomly selected end of the beach, the team extends an 8 meter long pull rope, with 1 meter markings. Using a random number generator, the team determines which two meters are sampled that night. The $1m^2$ quadrat is placed at the first random number, with one end at the high tide line, and the far end facing 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 number and repeats the counting process. Once the two quadrats are completed, the 8 meter pull rope is extended further down the beach and the same two random numbers are sampled. This process is repeated until the entire length of the beach has been sampled. The 'horseshoe crab line' that was followed is not a straight line, and it may be above or below the water line, however, it is never more than $1m^2$ 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.

Results

In 2014 a total of 9,687 horseshoe crabs were counted on five beaches. The average total horseshoe crab count was 135.53 crabs, and the average sex ratio for 2014 was 6.05 males for every female.

Total crab count ranged from zero to 2,083 crabs for a single night. The peak spawning day for 2014 was June 15th. Out of all five beaches surveyed, James Farm had the highest average total crabs, and Tower Rd had the lowest average sex ratio (Table 1).

No significant differences were observed between moon cycles for either total crabs or sex ratios.

Discussion

The sex ratio of 6.05 was markedly higher than the sex ratio of 4.38 reported by the Delaware Bay survey (Swann et al. 2015). Since 2011, the Inland Bays survey has reported a higher sex ratio than the Delaware Bay survey for 3 of the 4 years (Swann et al 2015). It is unclear why this is the case. The peak spawning day in 2014 was June 15th. This was almost a full month before the peak spawning day reported by the Delaware Bay survey (May 16th, Swann et al. 2015).

Similar to the Delaware Bay survey, as the total number of crabs increases, sex ratios also increase (Figure 2). This relationship has been demonstrated each of the previous three years this survey has taken place.

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. Since 2011, James Farm has had the highest median number of total crabs out of the five beaches currently surveyed. Likewise, Coastal Kayak and Peninsula have had the lowest and second lowest median number of crabs every year since 2011. Physical characteristics of all three beaches may explain the consistent patterns in total crabs seen. James Farm has a very gradual beach profile, with a firm, flat, sandy bottom. Furthermore, it is relatively well sheltered from wave action, which is a preferred physical dynamic for horseshoe crabs (Smith et al. 2002b; Lathrop et al., 2006). These physical factors may increase the suitability of James Farm for spawning horseshoe crabs, and may also facilitate easier beach access for crabs on windy or stormy nights. Oppositely, Coastal Kayak receives relatively high wave energy during stormy or windy nights, and may therefore be inaccessible to crabs. Furthermore, Coastal Kayak is located in Little Assawoman Bay, and is a considerable distance from either the Indian River Inlet (15 km in linear distance) or Ocean City Inlet (16.5 km). Crabs traveling from either inlet are forced into a shallow and narrow canal to reach Little Assawoman bay, and ultimately Coastal Kayak. All of these factors may limit the number of crabs that reach and are able to remain on the Coastal Kayak beach. Lastly, Peninsula has several curved rock jetties which create horseshoe shaped sandy beaches protected from wave energy. While this protection may increase the number of crabs that can spawn once they reach the beach, the jetties themselves may act as a barrier for crabs searching for a beach, thereby limiting the overall number of crabs that arrive at Peninsula. Furthermore, while Peninsula has sand close to shore, approximately 30 feet from the high tide line the sediment changes to a softer substrate (mud/peat). This sediment is utilized significantly less than sandy sediments (Botton et al. 1988). This combination of jetties and muddy substrate mean that any crabs using Peninsula's beach need to navigate through the center of two rock jetties, and traverse over a less preferred substrate to arrive at the suitable sand.

No significant differences were observed between moon cycles for total crabs, or sex ratios. This indicates that both lunar cycles were utilized equally by the crabs in 2014 (Figure 5,6).

Acknowledgements

We would like to thank all the volunteers who helped in gathering data for this study. Without them this study would be impossible. A special thanks to our 2014 team leaders, Pat Drizd, Charlie Taylor, Dennis Bartow, Robert Collins, and Val Ellenberger. Dennis Bartow continues to be the life blood of this survey and deserves special recognition for his diligent work and efforts.

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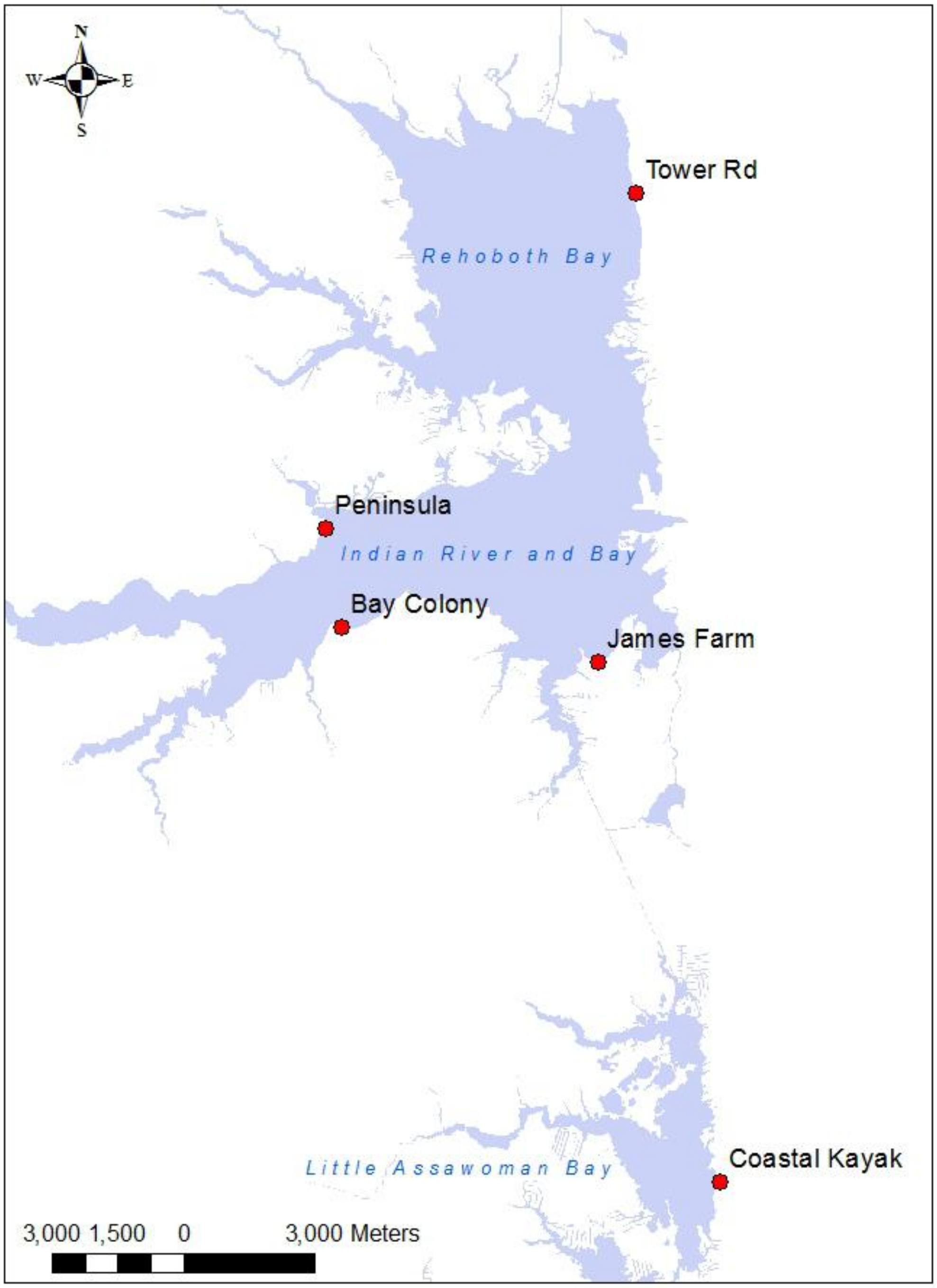

Figure 1. The five Inland Bays survey sites for 2014.

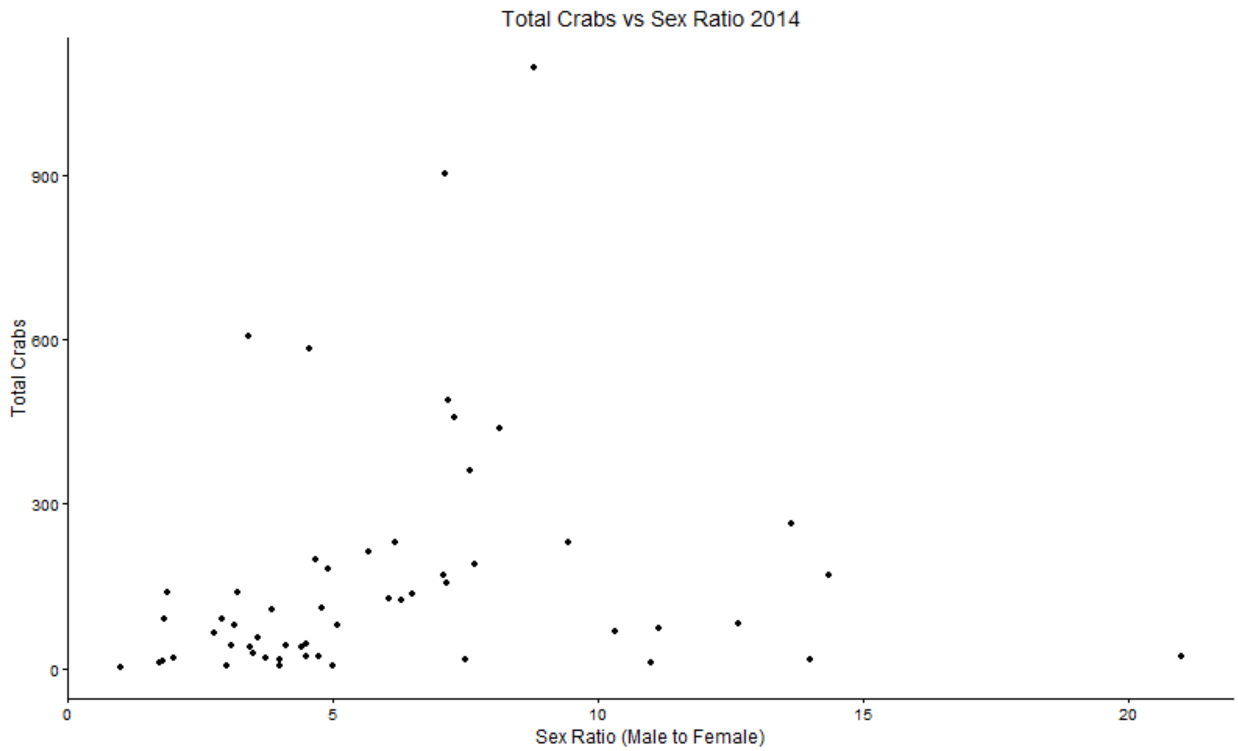

Figure 2. Total crabs vs sex ratio. As the total crabs increase, sex ratios generally increase.

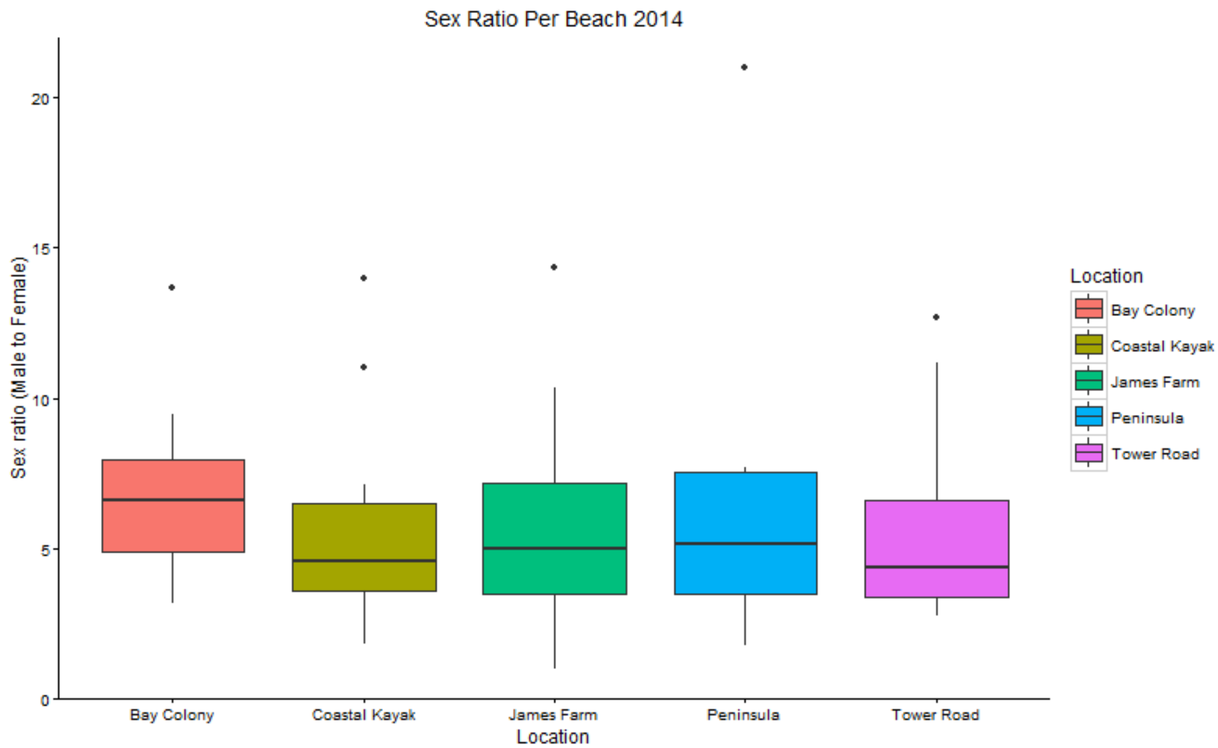

Figure. 3. Sex ratio for each beach surveyed in 2014. Coastal Kayak had the lowest median sex ratio.

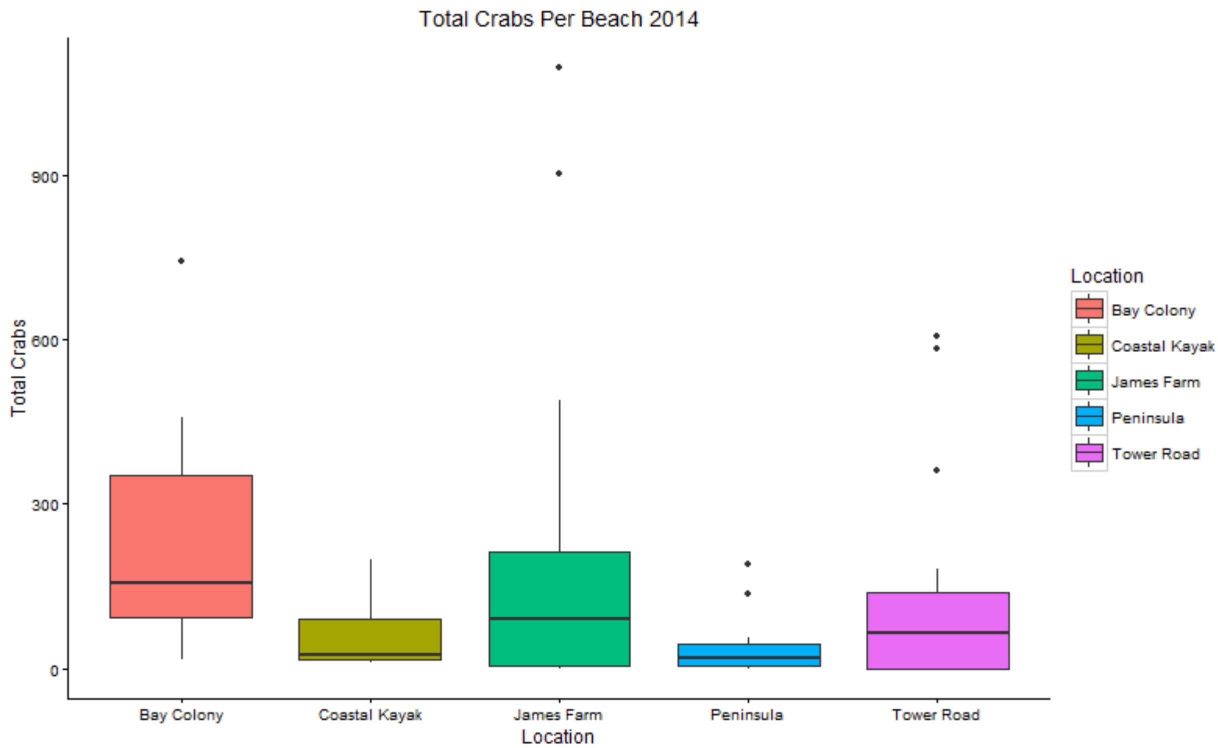

Figure 4. Total crabs for each beach surveyed in 2014.

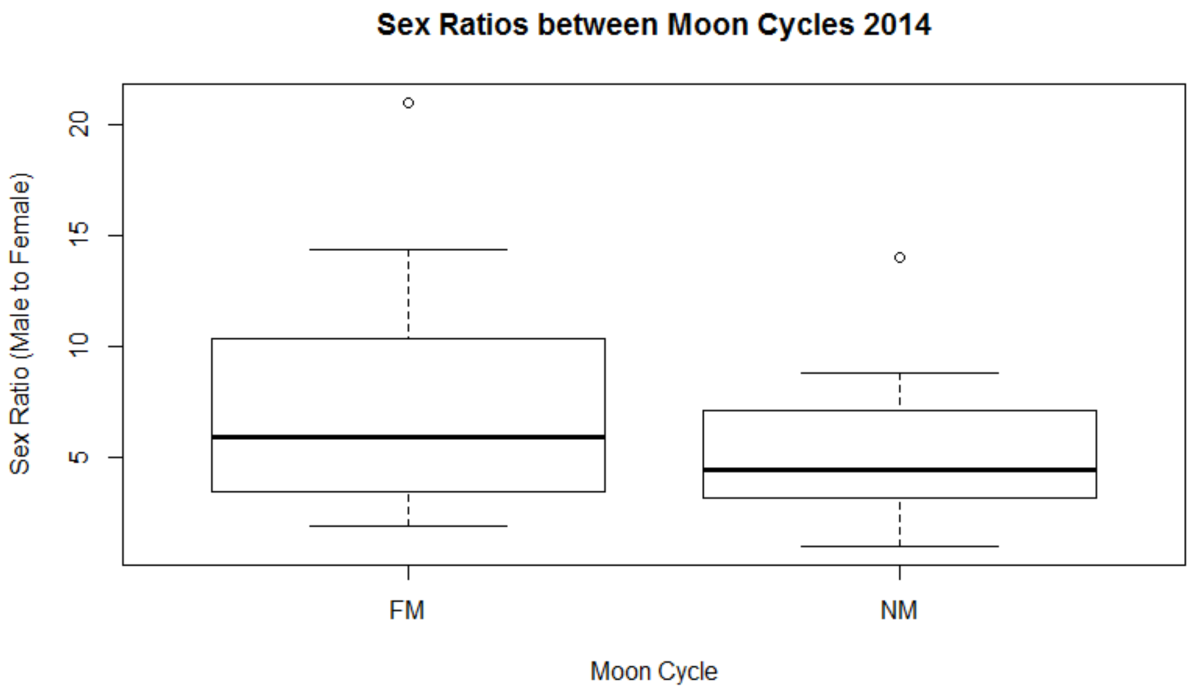

Figure 5. Sex ratios for each moon cycle. FM = full moon, NM = new moon. No significant differences were present as assessed by a two tailed Wilcox test (α = 0.05).

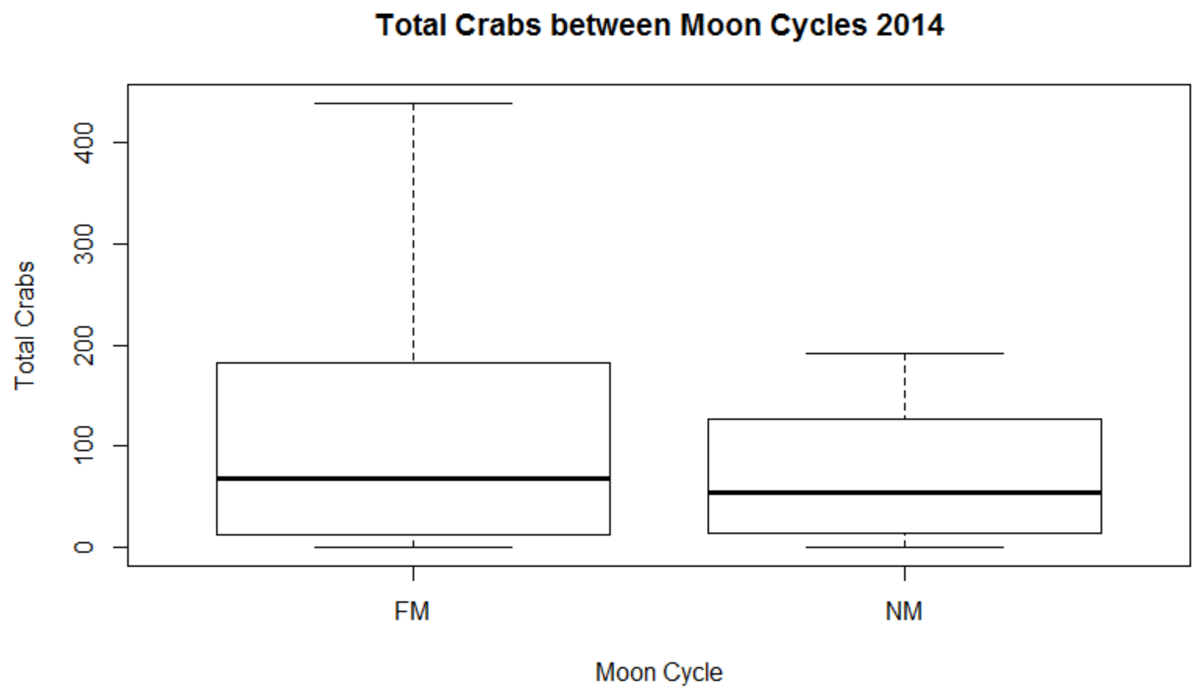

Figure 6. Total crabs for each moon cycle. FM = full moon, NM = new moon. No significant differences were present as assessed by a two tailed Wilcox test (α = 0.05).

Table 1. Average sex ratio and total crabs per beach for 2014.

Beach	Average Sex Ratio (M:F)	Average Total Crabs
Bay Colony	6.88	195.5
Coastal Kayak	5.71	62.3
James Farm	5.68	209.88
Peninsula	6.85	41.3
Tower Rd	5.59	135.4