

# *Limulus polyphemus* Spawning Survey 2012

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## **Introduction**

An eight-year study of horseshoe crab reproduction at Cove Point suggested that the number of spawning females had declined. The beach had undergone considerable changes during this period, and it was unclear whether the observed decline represented a real change in population numbers or indicated a degradation of the beach as a spawning area. A study was thus conducted in the Spring and Summer of 2012 in order to better characterize spawning activity. Specifically, the study was conducted with the following objectives:

1. Determine which tide cycle was associated with the greatest spawning activity.
2. Determine which day within a tide cycle was associated with the greatest spawning activity.
3. Compare spawning activity at Cove Point with Flag Ponds, a nearby spawning beach.
4. Use these data to better evaluate the observed decline in spawning activity at Cove Point beach.

## **Methods**

Cove Point beach was surveyed during four lunar tide cycles: late May, two cycles in June and the beginning of July. Based upon a Maryland DNR tide table, a day was chosen as the highest tide for that cycle. This day, designated as day “zero”, was surveyed, as well as two days before and after day zero. Thus five days were surveyed for each tide cycle. Each of these surveys consisted of a single pass down the beach from the lighthouse to the stone rip-rap within one hour of the nighttime highest tide. Spawning females, associated males, and any single males were marked with GPS and their locations plotted using Google Earth. A spawning female with any associated males was considered a spawning group. Surveys were conducted by technicians Stephanie Siemek or Deborah Smith, with two additional student workers each night.

The remaining work was conducted by the PI. Cove Point beach was surveyed for spawning activity during the daytime high tide just before the day zero nighttime survey. Flag Ponds beach, a spawning beach north of Cove Point, was surveyed on day zero at night, within one hour of the high tide. Within a few days of the last survey in a cycle, Cove Point beach was sampled for eggs or egg clusters. For this, ten stations were established by GPS. Stations 1-5 began at the beach access point and continued north, each station about 10 meters apart. Stations 6-10 were placed similarly, south of the access point. This area contained the highest spawning

activity in the surveys. Surveys occurred during the day near low tide. At each station, two 18cm x 18cm x 18cm sand cores were taken, one at the high tide line and another one meter seaward. Sand cores were passed through a 1 mm screen, washed with seawater, and searched for horseshoe crab eggs or egg clusters.

## Results

### I. Spawning Activity at Cove Point

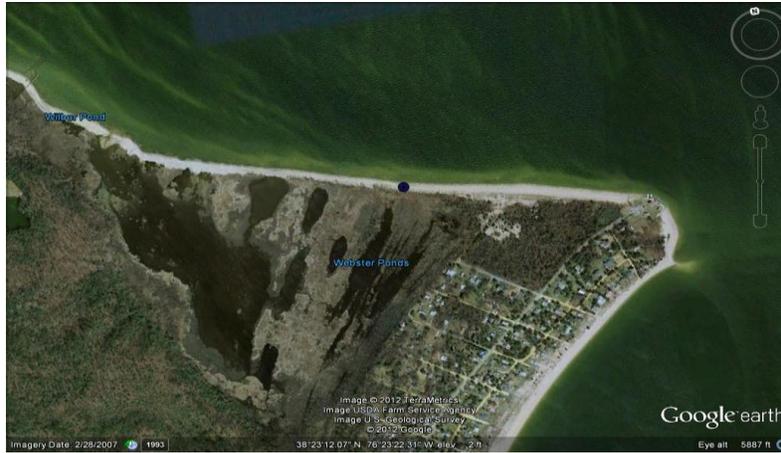


Figure 1. Surveys were conducted at the nighttime high tide during the period May 20-24, with the highest tide (day zero) on May 22. This tide cycle was considered the earliest likely period to observe spawning activity. May 22 was a new moon. No spawning groups were seen outside of a single pair, on May 22. This group is shown above.

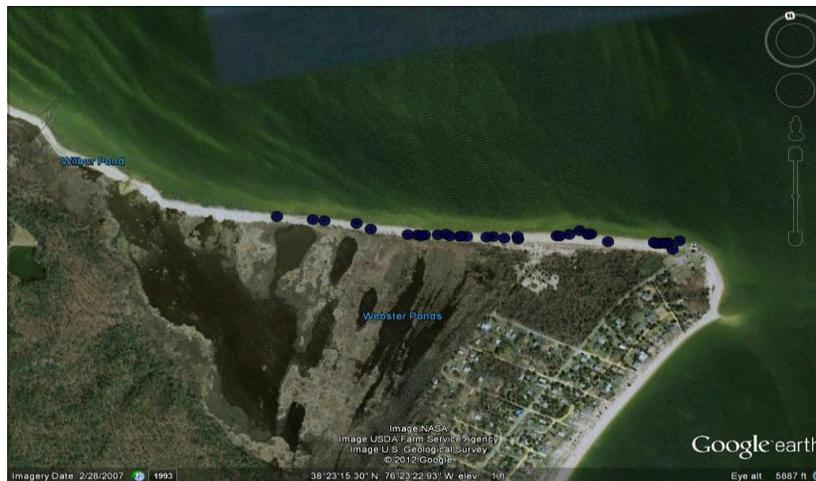


Figure 2. The second set of surveys was conducted June 2-6, with the highest tide (day zero) on June 4. This was a full moon. A total of 49 spawning groups were observed over the period.

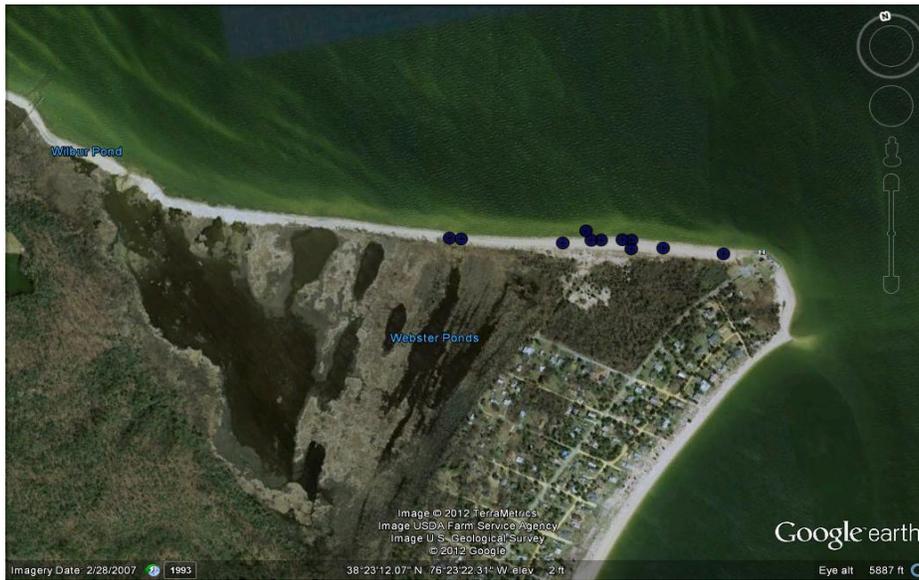


Figure 3. The third survey set was conducted on June 17-21, with the highest tide (day zero) on June 19. This was a new moon. A total of 11 spawning groups were observed during this period.

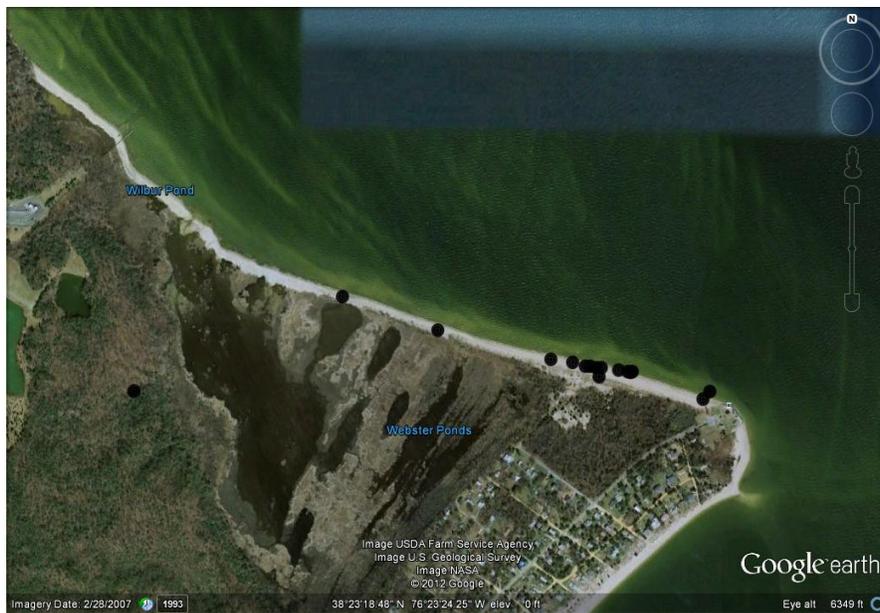
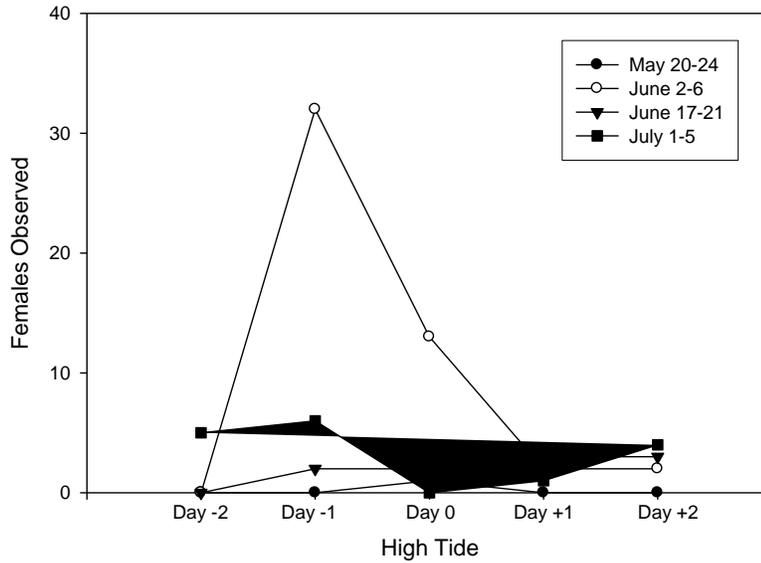
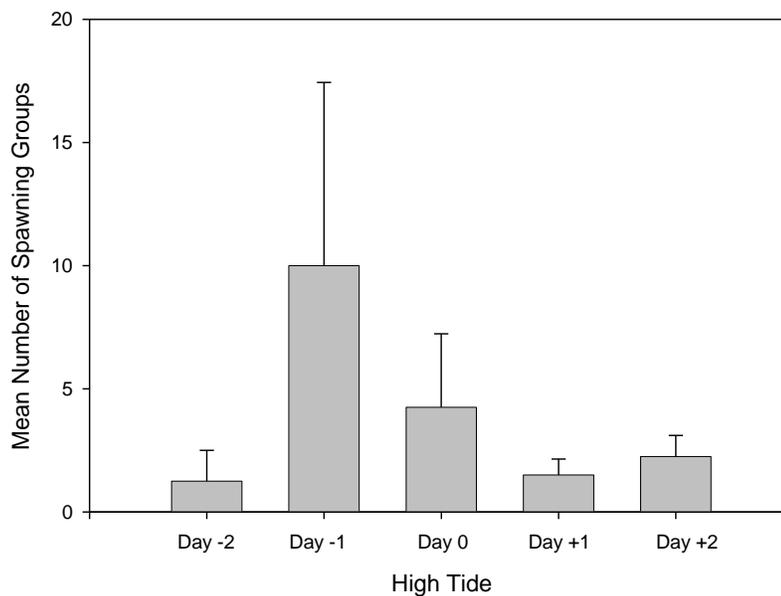


Figure 4. The last survey set occurred during the period July 1-5, with the highest tide (day zero) on July 3. This was a full moon. A total of 16 spawning groups were observed.



**Figure 5.** This graph shows the number of spawning groups for each survey day and tide cycle. The June 2-6 period had by far the greatest activity, followed by the July 1-5 period. Full moon tide cycles were thus more active than new moon tide cycles. For the two full moon cycles, spawning reached a peak the day before day zero. The new moon cycles did not show this trend.



**Figure 6.** This graph shows the mean number of spawning groups observed, across all tide cycles, at each day in the cycle. It illustrates the peak in spawning activity observed on the day prior to the highest tide on day zero.

## II. Comparison of Cove Point with Flag Ponds

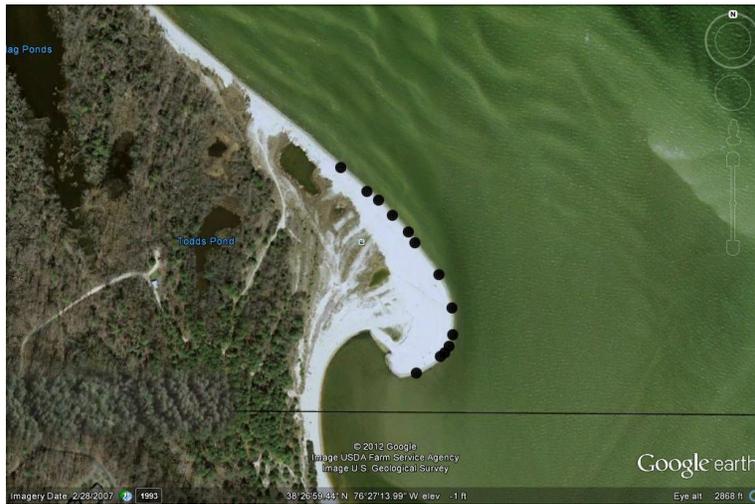


Figure 7. The beach at Flag Ponds was surveyed for horseshoe crab spawning on the nighttime high tides occurring June 4, June 19 and July 3. The June 19 survey is plotted as an example in Figure 7. This spawning map was typical; crabs were observed only along the sandy spit in the area shown. Spawning counts for the three surveys (June 4, 19 and July 3) were 30, 15 and 16 spawning groups, respectively.

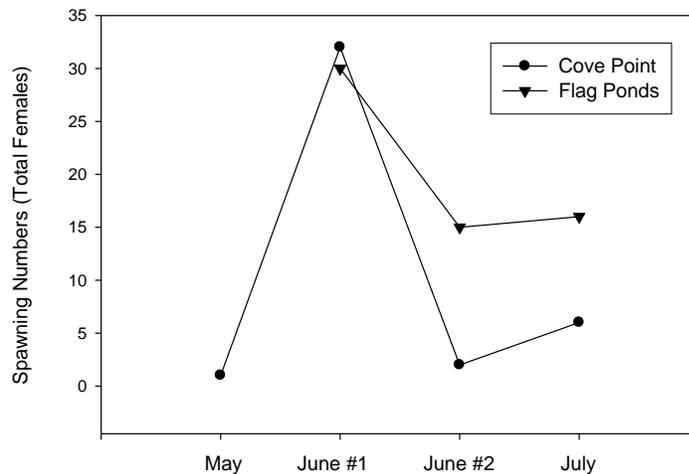


Figure 8. This graph shows a comparison of total spawning group numbers between Cove Point and Flag Ponds. Because Flag Ponds was surveyed on day zero rather than an entire tide cycle, Cove Point data from only day zero were used in the comparison. Flag Ponds was not surveyed in May. The early June survey showed similar total numbers between the two beaches. For both beaches, this tide cycle had the highest number of spawning groups. For the later June survey and the July survey, spawning group counts at Flag Ponds exceeded those from Cove Point.

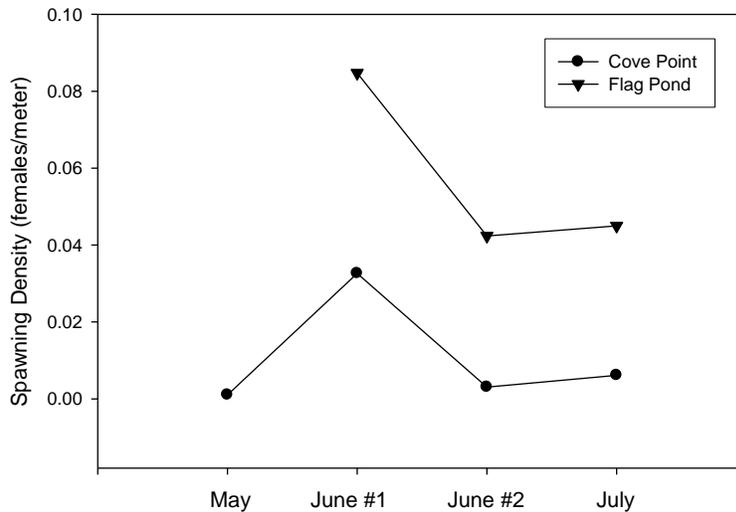


Figure 9. When total counts from Cove Point and Flag Ponds are compared in Figure 8, the early June survey appears similar. However, the distances surveyed at these two beaches differ. The distance along each beach where spawning occurred was measured for Cove Point and Flag Ponds maps. For Cove Point, there were 980 meters of beach, stretching from the lighthouse to the most distant spawning group shown in Figure 2, that were utilized for spawning. For Flag Ponds that distance was 354 meters. A spawning density could thus be calculated, expressed as females/meter. When these densities were compared, spawning groups at Flag Ponds were denser for both June surveys and the July survey.

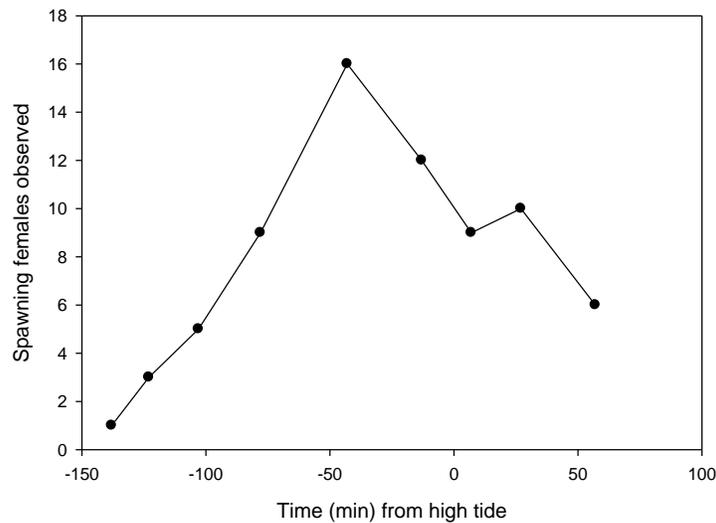


Figure 10. During the July Flag Ponds survey, spawning groups were counted every 20 minutes, beginning about 140 minutes before the time of highest tide and continuing for about an hour afterward. On this night, very few females arrived on the beach prior to about 2 hours before high tide. Within this two hour period, female spawning density steadily increased and peaked about an hour before high tide. Spawning groups had declined from 16 to six by one hour after

high tide. If the decline is extrapolated, it suggests that spawning ended by two hours after high tide. Spawning thus occurred within a four hour window surrounding high tide, with highest activity about an hour before high tide.

### III. Male to Female Ratios at Cove Point

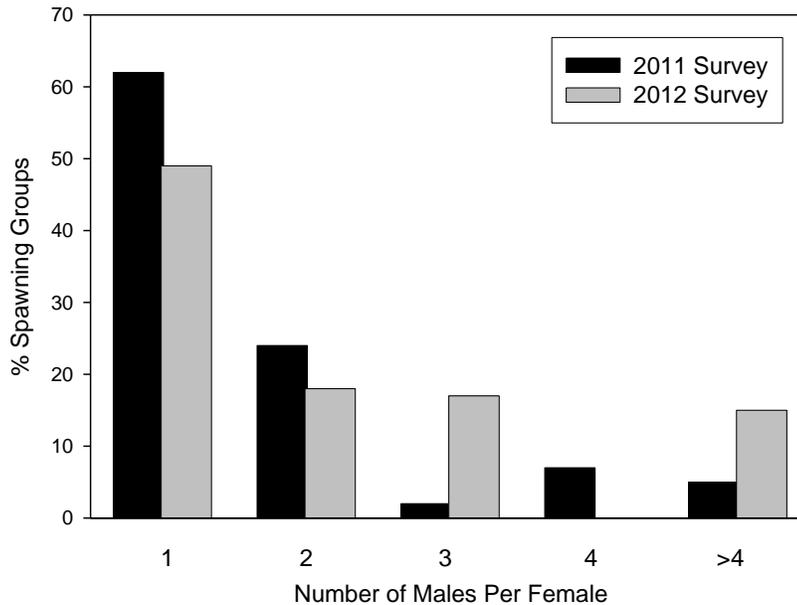


Figure 11. This graph shows the number of males associated with the female in a spawning group at Cove Point. It compares last year's survey, 2011, with this year, 2012. For both years, the most common group size consisted of a female with a single male. However, in the 2012 survey several workers noticed that there were occasional groups consisting of a very large number of males. Some groups at Cove Point contained more than 10 males, and one group observed at Flag Ponds contained 25 males, all centered on a single female. At both sites, there were also a large number of unattached males observed in shallow water or on the beach. For example, we counted 15 spawning groups for the late June Flag Ponds survey, with an additional 73 single, unattached males. A shift toward a higher male:female ratio is shown in this figure, where spawning groups containing larger numbers of males became more prevalent in 2012. In 2011, 62% of all observed spawning groups contained a single male, while 38% contained multiple males. In 2012, the percentages were 49 and 54%, respectively. The ratio of single:multiple male percentages was significantly different between the two years (chi-square = 7.173,  $p = 0.01$ ).

### IV. Egg Survey

Cove Point beach was surveyed for horseshoe crab eggs immediately after the June and July tide cycles. These surveys were not successful. No eggs or egg clusters were found in any sand core.

## V. Daytime Surveys at Cove Point

The day before each highest nighttime tide survey, Cove Point beach was surveyed for spawning activity during the daytime high tide. No crab, male or female, was observed on the beach or in the water during any survey.

## VI. Long-term Population Trend

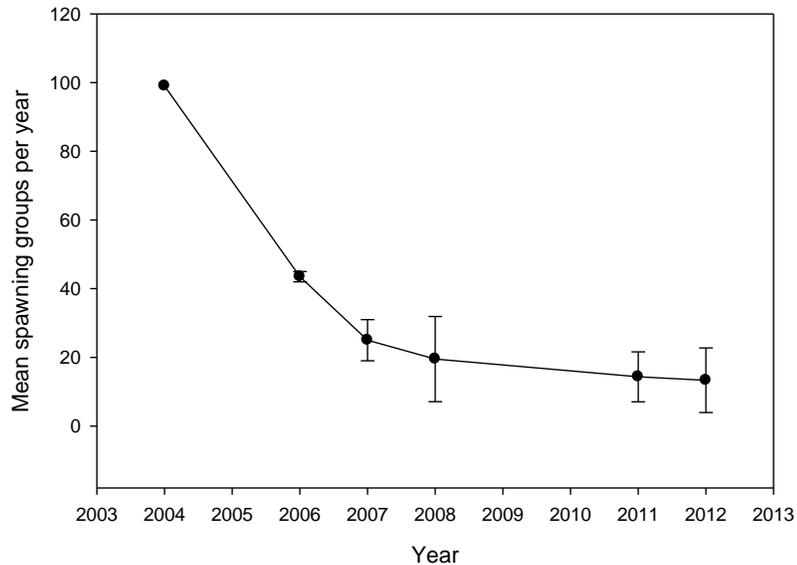


Figure 12. This graph shows mean spawning groups observed, each year, since the first survey in 2004. There was only a single survey that year. Studies in subsequent years involved either three or four surveys. When data from 2012 are added, the result is unchanged: a rapid decline in spawning until about 2007, and a slow decline thereafter.

### Summary and Discussion

1. In 2012, horseshoe crabs spawned in the same area of the beach described in previous surveys. The area of Cove Point beach utilized stretches from the lighthouse about halfway to the pier. Spawning ends just prior to that section of the beach that is eroding, with exposed vegetation and a short, steep beach. The restored beach nearer the pier seems conducive for spawning, but so far no spawning groups have been observed in this area. For horseshoe crabs, at least, the restoration work has not resulted in an increase in spawning or greater utilization of the beach.

2. The 5-day survey period for each tide cycle seemed to encompass the majority of spawning activity for that cycle. While some level of spawning was observed throughout, 74% of spawning groups were observed on the highest tide night, or the night before.

3. Spawning groups were more numerous on full moons, peaking with the June full moon cycle for both Cove Point and Flag Ponds. For full moon cycles spawning groups were most numerous the night before the highest tide and fullest moon.
4. Based on a Flag Ponds survey, almost all spawning activity occurred within two hours of high tide. The peak activity in that survey was observed about one hour before the highest tide.
5. There was no evidence that any spawning occurred during daytime high tides. This is different from observations of Delaware Bay populations.
6. Spawning was generally higher at Flag Ponds than Cove Point. Although counts for the peak night in the early June survey were similar between the two sites, spawning densities (females/meter) were higher for Flag Ponds in all surveys.
7. There seemed to be a shift toward a greater male:female ratio during spawning periods. While female numbers did not increase from previous years, there were greater numbers of single males. There were also greater numbers of spawning groups with multiple males, in some cases more than ten males per female.
8. No eggs or egg clusters were found in any sand core. Cores were taken in the area of Cove Point beach most utilized for spawning, and seemed an appropriate size to detect eggs. It is possible that spawning behavior in this area was not producing eggs in the sand. It is more likely, however, that spawning activity was low enough that a sand core sampling method was unable to detect the resulting eggs. In either case, it suggests a low level of reproduction.
9. Overall spawning group numbers were similar to those observed in 2011. The data for 2012 seem to fit well into the long-term downward trend in spawning activity.

A major purpose of the present study was to evaluate spawning at Cove Point more extensively, in order to better evaluate the apparent spawning decline. Specifically, we wished to determine if spawning activity was fully described by the previous single-night surveys. The current study suggests that spawning activity is greatest the night before the highest tide, so it is possible that earlier studies underestimated spawning. However, when the current day -1 data are compared with previous years in Figure 12, they fit well into the trend line. Based on day zero data, spawning activity would be even lower. Therefore, while spawning peaks can evidently be missed with a single-night survey, these data are still consistent with a long-term downward trend in spawning activity.

We also wished to compare Cove Point spawning with a second beach. Cove Point beach had been eroding in the middle and northern sections, resulting in restoration work to stabilize the

northern section. A decline in spawning activity may thus represent beach degradation or a population decline. The current study supports both hypotheses. Densities of spawning females were consistently higher at Flag Ponds, suggesting that this beach is more attractive than Cove Point. However, conversations with the park superintendant, Connie Sutton, suggest that spawning has declined at Flag Ponds as well, over a similar time frame. If true, similar declines at both beaches point to population declines in addition to any habitat degradation.

The picture that emerges is a Chesapeake horseshoe crab population that is very likely in decline. To our knowledge, there are no larger population studies, such as mark/recapture surveys, to confirm this. These spawning surveys may be indirectly detecting larger changes occurring in the mid-Chesapeake population. Given increasing beach erosion and dead zones throughout the Chesapeake, it would not be surprising to find that horseshoe crabs are suffering population declines along with many other species. Population studies should be conducted to determine the status of Chesapeake Bay horseshoe crabs.