

October 22, 2013

**Final Report for 2013 & 5-year project started in 2009**  
**Limulus polyphemus**  
**Horseshoe Crab Monitoring & Tagging Activity in Raritan Bay & Sandy Hook Bay,**  
**Monmouth County, New Jersey May & June 2009 - 2013**  
**Conducted by Volunteers with the Bayshore Regional Watershed Council**

Report to:  
American Littoral Society  
Brookdale Community College, Environmental Science Department  
M.A.S.T (Marine Academy of Science and Technology)  
Monmouth University  
National Park Service/Gateway National Recreation Area  
NJDEP/Fish & Wildlife Division  
US Fish & Wildlife



(Gathering of mating Horseshoe Crabs near the mouth of Whale Creek at Cliffwood Beach, Aberdeen Township, NJ)

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The full database is available for downloading from the Bayshore Regional Watershed Council's web site: <http://www.restoreourbay.org/current-projects/horseshoe-crab-monitoring/2>

## **Summary**

This is the final report of a 5-year study to monitor Horseshoe Crab mating activities at five estuarine sites along Sandy Hook Bay & Raritan Bay in Monmouth County, New Jersey. The project began in 2009 and concluded in 2013.

A Raritan Bay – Sandy Hook Bay, Monmouth County, New Jersey Horseshoe Crab spawning survey was implemented by volunteers with the Bayshore Regional Watershed Council, with cooperation from high school students with the Marine Academy of Science and Technology (M.A.S.T.), located at Sandy Hook. Volunteers with Monmouth County Parks & Bergen County Parks were also on hand. More than 100 volunteers in total were involved to implement this survey in an accurate manner. By collaborating with efforts of the general public, the benefits of citizen-based conservation activities become clear. Education and public involvement are key components to the most effective wildlife conservation programs.

### OLD BUSINESS for 2013

- The spawning survey by the Bayshore Regional Watershed Council was the fifth in a five-year project conducted in the Sandy Hook Bay-Raritan Bay region of Monmouth County, New Jersey.
- Volunteers at five (5) sites throughout the region conducted monitoring and tagging activities during periods of high tide on dates that coordinated with full or new moon phases.

### NEW BUSINESS for 2013

- Monitoring activities were diminished at all sites on Friday, May 24, 2013 due to higher than normal tides and wind gusts up to 30 mph resulting from an off-shore storm that washed out many beaches. As in the past four years, at least one monitoring event out of four during May & June was impacted negatively by a stormy weather event.
- Males out-numbered females again this year. The sex ratio continued to be considerable at 75:1, for every 75 males there were 1 female. This was a notable increase from last year's ratio of nearly 26:1.
- The total number of Horseshoe Crab populations in the study area was higher than last year, and continues to rise each year. Both single male populations and clusters of HSC were reported higher this year as well.
- The hot spot for HSC mating activity in 2013 was Cliffwood Beach in Aberdeen Township. For the past 5 years this site has been a significant and consistent location for peak HSC mating activities. Populations of crabs continue to be high at Cliffwood Beach, as well as Plum Island at Sandy Hook and the mouth of Many Mind Creek in Atlantic Highlands.

## **Background**

Horseshoe crabs are 'living fossils', the last survivors of a group of organisms that first appeared in the fossil record over 300 million years ago. Besides their extraordinary antiquity, horseshoe crabs are also of paramount importance to human health. Their blood contains a clotting agent, LAL (Limulus Amoebocyte Lysate), which provides a fast, reliable test for the presence of infectious bacteria in drugs, as well as prosthetic devices such as heart valves and hip replacements.

Horseshoe crabs play a vital role ecologically along the shores of the New York – New Jersey Harbor Estuary, including Sandy Hook Bay & Raritan Bay. Migratory shorebirds, including Ruddy Turnstones (*Arenaria interpres*), Dunlins (*Calidris alpina*), and Sanderlings (*Calidris alba*) rely on a certain amount of Horseshoe Crabs eggs to provide nourishment on their migrations from the tropics to northern Canada to breed. One bird in particular, the Red Knot (*Calidris canutus*) feeds primarily on Horseshoe Crab eggs during its stopover. Although Red Knots have a limited migratory population in Lower New York Bay, regular sightings by volunteers with the Bayshore Watershed Council have been seen of the bird by the dozens during spring migration at the tip of Sandy Hook peninsula and at Conaskonk Point in Union Beach. The Red Knot population in October 2013 was listed as a threatened species under the federal Endangered Species Act by the U.S. Fish and Wildlife Service.

In 2009, volunteer members of the Bayshore Regional Watershed Council approved a measure to conduct a five (5) year study to monitor and tag horseshoe crab (*Limulus polyphemus*) spawning populations at five (5) sites along Sandy Hook Bay & Raritan Bay in Monmouth County, New Jersey. The goal of the study is to obtain a better determination of the spawning population of this aquatic species, and to ascertain if the population is stable, increasing, or decreasing. In addition, by tagging horseshoe crabs, this study will help to better understand the migration patterns, abundance, and survival rates of recaptured tagged horseshoe crabs over the course of the program in the project area.

The five (5) monitoring sites along Raritan Bay & Sandy Hook Bay in Monmouth County, New Jersey include: 1) Plum Island at Sandy Hook Gateway National Recreation Area, 2) near the mouth of Many Mind Creek in the Borough of Atlantic Highlands, 3) Leonardo Beach in Middletown Township, 4) Conaskonk Point in the Borough of Union Beach, and 5) Cliffwood Beach in Aberdeen Township.

### **Field Methods**

Data was collected during full moon and new moon high tide event cycles in May and June. Monitoring activities by volunteers were divided into two activities: (1) counting spawning populations of Horseshoe Crabs and (2) tagging single adult Horseshoe Crabs in order to determine travel patterns during spawning . Both activities took place at the same time by watershed volunteers in May & June.

Field methods and activities for counting crab populations by watershed volunteers were similar to protocol described by the USGS in their volunteer information entitled, “SURVEYING HORSESHOE CRABS” (please see USGS web site: <http://www.lsc.usgs.gov/aeb/2065/protocol.asp>).

In brief, watershed volunteers first determined the tide height or water’s edge during high tide using a tide stick. When the height of the tide on the tide stick remained constant for approximately 10 minutes or began to decrease, volunteers would walk 1 meter (approx 3 feet) below the water’s edge to place the first meter stick for width. From this tide meter stick, a volunteer would walk one meter (approx 3 feet) from the water’s edge and place a second meter stick for width. There was a total of 2 meters or approximately 6 feet for width. For length, volunteers marked out exactly 1,000 feet of beach or as close to 1,000 feet as possible on certain

small, narrow beaches. Volunteers then began to walk towards one end of the beach, counting and recording on the tally sheets all Horseshoe Crabs within the 2 meter width transect along the entire 1,000 feet length of the survey area.

Field methods for tagging crab population were the same protocol as described by USFWS. Only single adult Horseshoe Crabs were tagged. Crabs that were in the process of mating were left alone so as not to interrupt the course of action. In brief, the protocol called for volunteers to attach a circular individual numbered disc to the left posterior (rear) of the prosoma (first section of body) by drilling a 5/32" hole through the side and then pushing the plastic pin (with tag) into the hole as far as it go. Data sheets recorded the tag number, sex, prosomal width (PW) in millimeters (widest point of the crab), the date tagged, beach name, waterbed name, and state. The watershed council received a total of 400 tags supplied by USFWS, nearly all were used.

## **RESULTS FOR 5<sup>th</sup> YEAR:**

Below are the results for the fifth (5) year out of a five year study of monitoring HSC at five sites along the edge of Sandy Hook Bay and Raritan Bay in Monmouth County, NJ.

### **DATES & TIMES**

#### **FIRST NIGHT**

Friday, May 10, 2013

8:30pm – 10:00pm.

Weather: Clear skies. Air temperature was in the upper 60s F. Winds were steady at 10-15 mph from the south. Surface water temperatures were in upper 50s F.

#### **SECOND NIGHT**

Friday, May 24, 2013

8:00pm – 9:00pm

Weather: Cloudy skies, drizzle, and scattered showers. Air temperatures were in low to mid 50s F. Winds were northerly at 15 to 25 mph gusting up to 35 mph. Waves were about two feet high. Surface water temperatures were in the low to mid 60s F.

#### **THIRD NIGHT**

Saturday, June 8, 2013

8:30pm – 10:00pm

Weather: Partly cloudy skies with air temperatures in the 70s F. Light westerly winds 10 mph or less. Calm seas. Surface water temperatures were the upper 60 to low 70s F.

#### **FOURTH NIGHT**

Sunday, June 23, 2013

8:00pm – 9:30pm

Weather: Partly cloudy and humid, with light showers. Air temperatures were in the 80s F. Light southwesterly winds 10 mph or less. Calm seas. Surface water temperatures were in the 70s F.

**Sandy Hook NRA/Plum Island:**

DATE	<b>Total Live crabs</b>	Total Live females	Total Live Males	Single Live Males	Single Live Females	Swimming Pairs	Burrowed Pairs	Clusters (3 or more crabs together)	Dead Crabs
May 10 <sup>th</sup>	<b>673</b>	189	484	229	27	65	30	67	3 m
May 24 <sup>th</sup>	<b>10</b>	3	7	4	0	3	0	0	4 m 1 f
June 8 <sup>th</sup>	<b>181</b>	35	146	87	0	16	10	9	3 m
June 23 <sup>rd</sup>	<b>55</b>	4	51	37	0	3	0	0	12 m 1 f
<b>Total</b>	<b>919</b>	<b>231</b>	<b>688</b>	<b>357</b>	<b>27</b>	<b>87</b>	<b>40</b>	<b>76</b>	<b>22 m 1f</b>

**Atlantic Highlands/Mouth of Many Mind Creek:**

DATE	<b>Total Live crabs</b>	Total Live females	Total Live Males	Single Live Males	Single Live Females	Swimming Pairs	Burrowed Pairs	Clusters (3 or more crabs together)	Dead Crabs
May 10 <sup>th</sup>	<b>218</b>	77	141	129	0	23	44	10	2 m
May 24 <sup>th</sup>	<b>0</b>	0	0	0	0	0	0	0	0
June 8 <sup>th</sup>	<b>178</b>	32	145	109	3	17	6	5	1 ?
June 23 <sup>rd</sup>	<b>127</b>	10	117	107	0	6	4	0	0
<b>Total</b>	<b>523</b>	<b>119</b>	<b>403</b>	<b>345</b>	<b>3</b>	<b>46</b>	<b>54</b>	<b>15</b>	<b>2m 1?</b>

**Middletown Township/ Leonardo Public Beach**

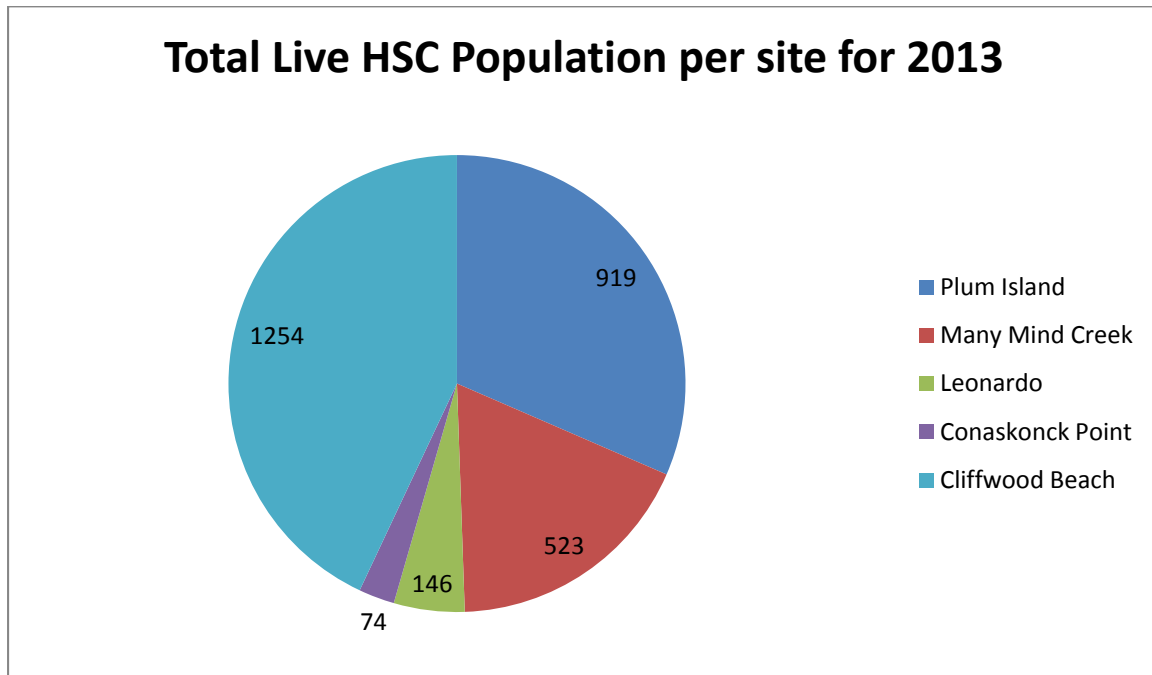
DATE	<b>Total Live crabs</b>	Total Live females	Total Live Males	Single Live Males	Single Live Females	Swimming Pairs	Burrowed Pairs	Clusters (3 or more crabs together)	Dead Crabs
May 10th	<b>107</b>	36	71	20	0	15	17	4	0
May 24 <sup>th</sup>	<b>2</b>	0	0	0	0	1	0	0	5 m 3 f
June 8 <sup>th</sup>	<b>1</b>	0	1	1	0	0	0	0	7 m 1 f
June 23 <sup>rd</sup>	<b>36</b>	7	29	22	0	1	6	0	1 f
<b>Total</b>	<b>146</b>	<b>43</b>	<b>101</b>	<b>43</b>	<b>0</b>	<b>17</b>	<b>23</b>	<b>4</b>	<b>12m 5f</b>

**Union Beach/ Conaskonck Point**

DATE	<b>Total Live crabs</b>	Total Live females	Total Live Males	Single Live Males	Single Live Females	Swimming Pairs	Burrowed Pairs	Clusters (3 or more crabs together)	Dead Crabs
May 10th	<b>50</b>	22	28	7	2	1	18	1	2 ?
May 24 <sup>th</sup>	<b>0</b>	0	0	0	0	0	0	0	16 ?
June 8 <sup>th</sup>	<b>7</b>	2	5	2	1	0	0	1	1 m
June 23 <sup>rd</sup>	<b>17</b>	2	15	15	0	2	0	0	3 m 1f
<b>Total</b>	<b>74</b>	<b>26</b>	<b>48</b>	<b>24</b>	<b>3</b>	<b>3</b>	<b>18</b>	<b>2</b>	<b>18? 4m 1f</b>

**Aberdeen Township/Cliffwood Beach**

DATE	<b>Total Live crabs</b>	Total Live females	Total Live Males	Single Live Males	Single Live Females	Swimming Pairs	Burrowed Pairs	Clusters (3 or more crabs together)	Dead Crabs
May 10th	<b>633</b>	224	409	129	0	70	117	37	1 f
May 24 <sup>th</sup>	<b>7</b>	3	4	2	1	2	0	0	15 m 10 f
June 8 <sup>th</sup>	<b>412</b>	79	333	210	1	35	19	24	0
June 23 <sup>rd</sup>	<b>202</b>	18	184	149	2	5	5	6	1 m 2 f
<b>Total</b>	<b>1,254</b>	<b>324</b>	<b>930</b>	<b>490</b>	<b>4</b>	<b>112</b>	<b>141</b>	<b>67</b>	<b>16m 13f</b>



### **Findings of the 5-year study from 2009 to 2013.**

After 5 years of monitoring and tagging adult Horseshoe Crabs at five sites along Raritan Bay and Sandy Hook Bay in Monmouth County, NJ, it seems clear at this stage the overall HSC population has been increasing since 2009. Perhaps the rapid decline in abundance during the 1990s has been halted and the crab population has stabilized or increasing. The total crab population in 2009 was 1,174. In 2013, the total crab population was 2,916. The overall HSC population approximately doubled within the study area over five years.

Other key findings over five years include:

- The female population has not remained stable over 5 years. Although there has been an increasing trend in male spawning density, female density has decreased. When the study began in 2009, there were 330 single females and a population ratio of 72:27, there were 72 single males for every 27 single females. In 2013, there were only 40 single females and the population ratio decreased dramatically to 96:3, there were 96 single males for every 3 females. This is not consistent with monitoring sites in Delaware Bay that report a ratio of 3:1 or 5:1, with males outnumbering females. While male Horseshoe crabs normally outnumber female Horseshoe Crabs on spawning beaches in the northeast, which usually corresponds to greater genetic diversity, the sizable difference in the sex ratio in Raritan Bay and Sandy Hook Bay appears atypical. The increase in mating pairs and clusters over five years suggests that adult sexually active females are being fought over quickly by single males.

The wide difference between male and female population puts the overall population in Raritan Bay and Sandy Hook Bay on a razor thin edge. Any disturbance to the female population will automatically cause a crash in the local Horseshoe crab population. More research needs to be done to see if a similar difference is occurring at other monitoring sites in New Jersey, New York, and the northeast

- Tagging activities suggest that the Horseshoe Crab population in Raritan Bay and Sandy Hook Bay is local to New York Harbor or the New York-New Jersey Harbor Estuary, including Jamaica Bay. Horseshoe crabs tagging efforts show no evidence of spawning site fidelity. In general, Horseshoe Crabs did not show up to the same sites every year. Some crabs that were tagged in Sandy Hook Bay one year were found in Jamaica Bay or Raritan Bay in other years. This action most likely has to do with improving genetic diversity.
- There is no evidence to support that Horseshoe Crabs in any great numbers travel from one major estuarine complex to another to spawn. Tagged Horseshoe crabs were never reported to be found from Delaware Bay or other estuarine sites in New Jersey or New York where monitoring/tagging activities are taking place. A majority of tagged Horseshoe crabs from this study were reported to be found in or near the New York- New Jersey Harbor Estuary. This would seem to suggest there are distinct populations of Horseshoe Crabs, with the Lower New York Bay population consisting of those spawning crabs from Jamaica Bay to Sandy Hook Bay and Raritan Bay.



- Cliffwood Beach and Plum Island at Sandy Hook NRA were consistently the top two spawning sites in Raritan Bay and Sandy Hook Bay. Both of these sites have wide natural beaches with little human disturbance nearby. Spawning Horseshoe crabs might have found these two sites optimal due to a variety of positive factors including the slope of the beach, the depth of the bay near the beach, and its location to water currents and food resources.
- Surprisingly, Conaskonck Point in the Borough of Union Beach was consistent over a five year period with low numbers of spawning Horseshoe Crabs. This was a surprise to many members of the watershed council who remember this site having one of the largest spawning populations of Horseshoe crabs in the Bayshore region of Monmouth County, NJ. The scarcity of spawning Horseshoe crabs here is interesting and puzzling.

The data for the five year study is located below. In 2013, the parameter known as “pairs” was divided into “swimming pairs” and “burrowed pairs” in order to better clarify HSC mating activity at each monitoring site. Other parameters are consistent over the five year study.

### **2013, 2012, 2011 & 2010 & 2009 TOTAL LIVE CRAB NUMBERS FOR EACH SITE**

#### **Sandy Hook NRA/Plum Island:**

YEAR	Total Crabs	Single Males	Single Females	Pairs	Swimming Pairs	Burrowed Pairs	Clusters
2009	319	191	124	123			1
2010	326	285	41	32			4
2011	269	186	6	17			7
2012	1136	452	10	189			53
2013	919	357	27		87	40	76
<b>Average</b>	<b>593.8</b>	<b>294.2</b>	<b>41.6</b>				<b>28.2</b>

#### **Atlantic Highlands/Mouth of Many Mind Creek:**

YEAR	Total Crabs	Single Males	Single Females	Pairs	Swimming Pairs	Burrowed Pairs	Clusters
2009	180	133	45	76			2
2010	146	123	26	21			1
2011	742	514	10	55			34
2012	410	194	8	87			13
2013	523	345	3		46	54	15
<b>Average</b>	<b>400.2</b>	<b>261.8</b>	<b>18.4</b>				<b>13</b>

**Middletown Township/ Leonardo Public Beach**

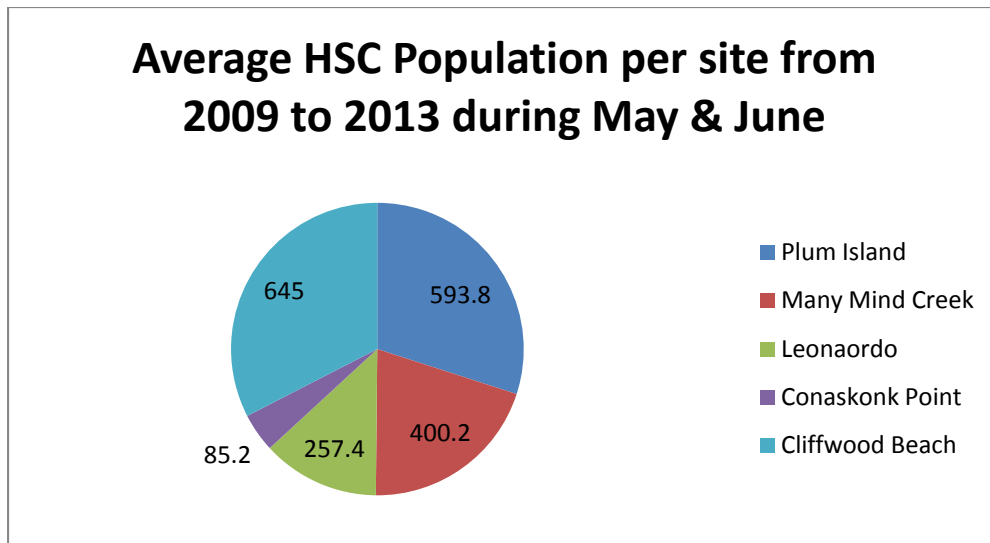
YEAR	Total Crabs	Single Males	Single Females	Pairs	Swimming Pairs	Burrowed Pairs	Clusters
2009	43	31	9	9			0
2010	235	176	68	20			21
2011	486	378	66	21			38
2012	377	84	9	127			23
2013	146	43	0		17	23	4
<b>Average</b>	<b>257.4</b>	<b>142.4</b>	<b>30.4</b>				<b>17.2</b>

**Union Beach/ Conaskonck Point**

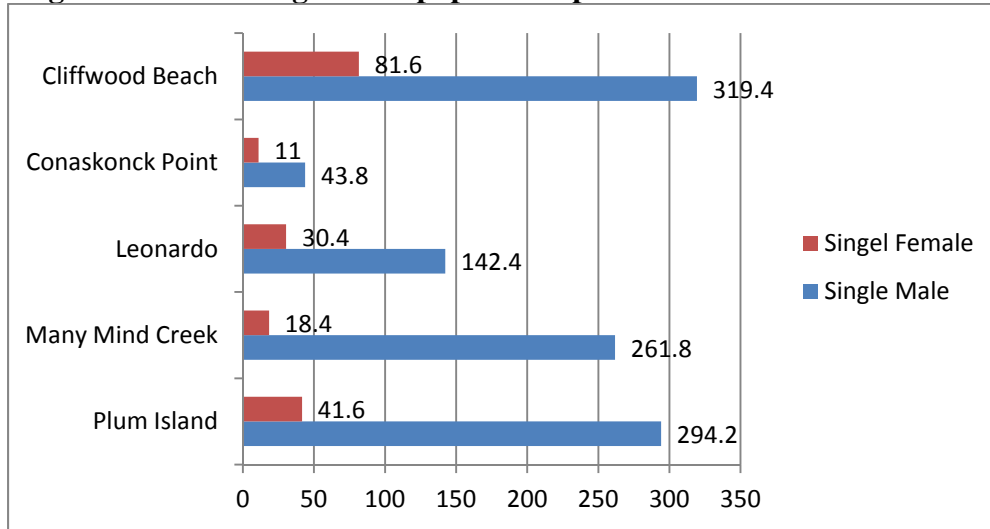
YEAR	Total Crabs	Single Males	Single Females	Pairs	Swimming Pairs	Burrowed Pairs	Clusters
2009	100	65	38	34			2
2010	48	34	10	10			0
2011	171	89	2	125			2
2012	33	7	2	9			0
2013	74	24	3		3	18	2
<b>Average</b>	<b>85.2</b>	<b>43.8</b>	<b>11</b>				<b>1.2</b>

**Aberdeen Township/Cliffwood Beach**

YEAR	Total Crabs	Single Males	Single Females	Pairs	Swimming Pairs	Burrowed Pairs	Clusters
2009	532	453	114	92			22
2010	428	230	198	148			50
2011	648	351	90	36			68
2012	363	73	2	95			30
2013	1,254	490	4		112	141	67
<b>Average</b>	<b>645</b>	<b>319.4</b>	<b>81.6</b>				<b>47.4</b>

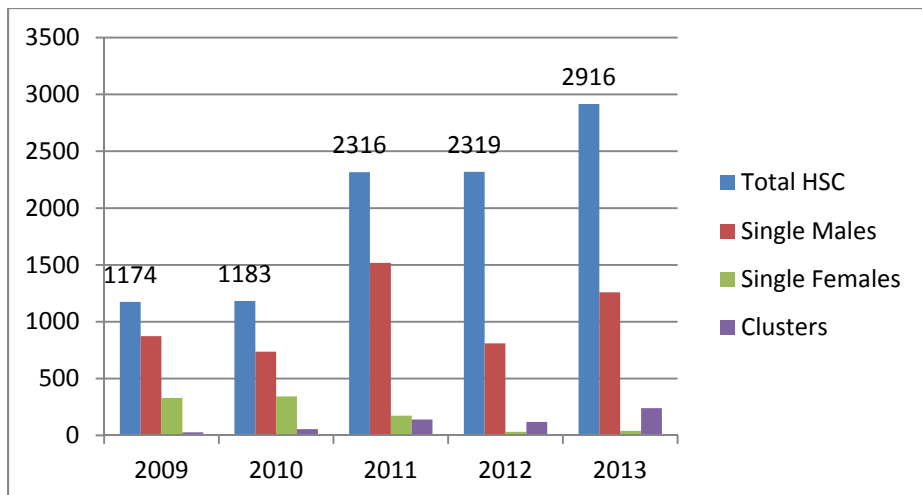


**Single Female vs. Single Male population per site from 2009 to 2013**



**\*\*\*TOTAL HSC ACTIVITY FOR THE REGION 2013, 2012, 2011, 2010 & 2009\*\*\***

YEAR	Total Crabs	Single Males	Single Females	Pairs	Swimming Pairs	Burrowed Pairs	Clusters
2009	1174	873	330	334			27
2010	1183	737	343	261			55
2011	2316	1518	174	245			139
2012	2319	810	31	507			119
2013	2916	1259	40		265	276	240
<b>Average</b>	<b>1,981.6</b>	<b>1,039.4</b>	<b>183.6</b>				<b>116</b>



## **RECOMMENDATIONS**

Management efforts for Horseshoe crabs by New York and New Jersey, and other states, and the Atlantic States Marine Fisheries Commission (ASMFC), need to include greater protection for female Horseshoe crabs. Some bait harvesters in New Jersey and New York prefer gravid females (those carrying eggs) to single male crabs. The overharvesting of female Horseshoe crabs by commercial fishermen, coupled with the loss of spawning habitat from overdevelopment of estuarine beaches and increasing beach erosion associated with sea level rise, has resulted in a precipitous decline in the female Horseshoe crab population in Raritan Bay and Sandy Hook Bay, and therefore the number of eggs available to feed migratory birds and continue a sustainable Horseshoe Crab population.

Unfortunately, if harvesting is not carefully managed, the risk of adversely affecting the Horseshoe crab population becomes a certainty. While the implementation of a harvest moratorium in New Jersey has helped to rebound the overall Horseshoe crab population within state waters, there needs to be special attention given to protecting female crabs with greater penalties for individuals that illegally harvest female species.

In addition, there needs to be greater protection for known mating sites in Raritan Bay and Sandy Hook Bay, including Cliffwood Beach in Aberdeen Township. Horseshoe crabs congregate inshore seasonally to spawn, which makes them especially vulnerable to exploitation, either intentionally or not, by local fishermen or beachgoers. There should be a public education campaign to inform people about the need to leave spawning Horseshoe crabs alone and their importance to local estuarine ecology.

Since Horseshoe crabs mature slowly, requiring nine to twelve years to attain sexual maturity, there is also a recommendation by the author of this study for the watershed council to continue this study for at least another 5 years. Population data in Delaware Bay indicate that after harvesting ceases, Horseshoe crabs do not rebound for approximately one decade, which corresponds to the time required for Horseshoe crabs to reach sexual maturity. Changes in abundance (increases or decreases) are not readily recognizable because they occur over a period of years. More time and data is needed to research the Horseshoe crab population in Raritan Bay and Sandy Hook Bay to determine if the population is sustainable.

## **APPRECIATION**

Appreciation and gratitude is given to the project partners. This study is a cooperative effort involving the U.S. Fish and Wildlife Service, National Park Service, Gateway National Recreation Area, New Jersey Division of Fish and Wildlife, Bayshore Regional Watershed Council, Brookdale Community College, Environmental Science Department, and the Marine Academy of Science and Technology, and Marine Academy of Science and Technology (M.A.S.T.) at Sandy Hook. In addition, appreciation is given to the more than 100 volunteers from the watershed council and local citizens who gave up a bit of their time in May and June to assist in this project, so that other people might gain a better understanding of Horseshoe crab activity in Raritan Bay & Sandy Hook Bay, Monmouth County, New Jersey. With the help of everyone involved, this project would have not been accomplished. Gratitude and appreciation to everyone.