

The 2012 Delaware Bay Horseshoe Crab Spawning Survey

Benjie Lynn Swan
William Hall
Carl N. Shuster, Jr.

Abstract

Spawning counts of horseshoe crabs were scheduled in advance for 25 beaches in New Jersey and Delaware during moon phases in May and June. The schedule included 300 events of which 255 counts were completed with the majority of the 45 dates cancelled due to flooding issues. Many of the cancellations in Delaware occurred during mid-May and early June, historically the peak period for horseshoe crabs spawning along the Delaware Bayshore.

The single day peak estimate of 341,062 horseshoe crabs was attained on May 22nd, two days following the new moon. This estimate fell short of the previous three years with Delaware's portion of 157,016 spawners, the lowest since 1999. New Jersey's estimate of 184,046 was similar to previous yearly estimates from the New Jersey shoreline and surpassed Delaware's record low estimate for the first time since 1999.

The grand total of seasonal activity for the Delaware Bay was 1,291,569 individuals, comprised of 668,950 for the New Jersey side and 622,619 for the Delaware side. While New Jersey's estimate was in the range of the previous few years, Delaware's estimate of 622,619 is the lowest estimate since the year 1999. The low Delaware estimate is largely due to the high number of cancellations during the peak period of horseshoe crab activity. The next lowest Delaware estimate was 749,473 spawners in the year of 2005 when again many cancellations occurred during the peak spawning time.

The average male to female sex ratio of 4.41 (3.99 for New Jersey and 4.84 for Delaware) was greatly improved from last year and was one of the lowest recorded in past years. The sex ratio is highly variable as the 2011 ratio was the highest on record with 5.36 males per female. The lower 2012 sex ratio translated into more females; however the drastic decrease in spawning estimates from Delaware negates the improved sex ratio. Thus, utilizing the sex ratio and the seasonal estimate, the 2012 female estimate (238,737 females) was the lowest since 1999.

In addition to the 12 counts conducted in May and June, a few beaches were surveyed during the new moon dates in late April. Counts during the early spring period were substantial and exceeded the late June counts from the same beaches. In New Jersey, the estimate from the three April dates was 7,844 spawners compared to 1,858 spawners during the three late June counts. In Delaware, the estimate for the late April dates was 52,276 compared to 18,457 spawners in the

late June counts. The April estimates were not used in the comparison of the 2012 data with the previous years, but are discussed in Table 6 and Figure 6.

Introduction

Since its inception in 1999, our survey has made tremendous strides and is considered the premier method of estimating the spawning population of horseshoe crabs. To continue with this undertaking each year we rely on many eager and energetic groups and volunteers who generously give of their time and their efforts to learn, count, enter and analyze the data reaped from the results of the survey.

Methods

Horseshoe crabs were enumerated in the months of May and June 2012 along the shores of the Delaware Bay. Twenty-five beaches were represented in this year's count (13 along the state of Delaware's coast and 12 along the coast of New Jersey). The Delaware beaches from north to south were Woodland, Pickering, Kitts Hummock, Ted Harvey Wildlife Management Area (WMA), North Bowers, South Bowers, Bennetts Pier, Big Stone, Slaughter, Fowler, Primehook, Broadkill, and Cape Henlopen. New Jersey beaches included Gandys, Fortescue, Reeds, Kimbles, Pierces Point, Highs, South Cape Shore Lab, Norburys Landing, Villas, Townbank, North Cape May and Higbees. The most northern beach in New Jersey, Sea Breeze, starting last year, will no longer be surveyed due to flooding and access problems.

Simultaneous counts coinciding with the change from peak high to ebb tide were taken on both New Jersey and Delaware beaches following the new and full moon periods in May and June. The dates of counting were: May 3, 5, 7, 18, 20, 22 and June 2, 4, 6, 18, 20 and 22. High tide times ranged from 7:12 p.m. to 11:07 p.m., allowing adjustments for tidal flow entering the bay. All counts initiate with the onset of the changing tide from peak high to beginning ebb on one kilometer of preset beach. Where one contiguous kilometer of beach is not available, adjustments are made to randomly place quadrats closer to each other to complete the count with 100 quadrats.

Results

Three hundred survey dates were scheduled and 255 dates completed or 85% of actual surveying. The remainder were canceled due to flooding (25), inclement weather (12), volunteer unavailability (7) or unspecified reason (1). In New Jersey, 20 dates were cancelled, due to no access and flooding (11), weather (4), no surveyors (4) and one unspecified reason (1). All the 11 cancellations due to flooding occurred during the full moon dates of June 2nd, June 4th and June 6th with Gandys beach and South Cape Shore Lab surveys missed on all three dates. (Table 1A)

Twenty-five cancellations occurred in Delaware during the 2012 spawning season due to flooding (14), weather (8) or no surveyors (3). Flooding canceled the May 18th, May 20th and June 4th counts at Bennetts Pier and Big Stone. Extensive flooding occurred during the full moon date of June 4th and subsequently, cancellations occurred in addition to Big Stone and Bennetts, at Broadkill, Cape Henlopen, South Bowers and Woodland. (Table 1B)

This year's (2012) peak estimate of spawners along Delaware and New Jersey's shores was much lower than the previous three years (Table 2). Delaware's estimate was the record lowest since 1999, allowing the New Jersey estimate for 2012 to surpass the Delaware estimate.

In New Jersey, 94% of the seasonal spawning activity occurred during the May dates with the greatest activity during May 18th and May 20th, 2 days before the new moon date and the new moon date. Very little activity was recorded during the full moon period in June due to cancellations caused by flooding issues. In New Jersey, the highest densities (26.72 and 34.58 crabs per meter) were observed along a small accessible section of beach (50-71 meters long) at Gandys. (Table 1A)

In Delaware, the spawning seasonal estimate was split between May dates (55%) and June dates (45%). Forty seven percent of the seasonal activity occurred on May 22nd and on June 6th with 157,016 spawners and 138,779 spawners, respectively. Very few horseshoe crabs were observed May 18th (845) and June 4th (356). All the beach estimates were considerably lower than last year's estimates with the exception of Woodland beach. The estimate for Woodland in 2011 was 125 and this year's estimate was 1,260. Broadkill, Primehook, Slaughter and Big Stone beach estimates were almost four times less than last year's estimates. The greatest density observed for the season was at Pickering beach on May 22nd with a density of 27.28 crabs per square meter. (Table 1B and Figure 1)

The male to female sex ratio of 4.41 was one of the lowest recorded in past years, and directly followed the highest ratio recorded in 2011 of 5.36 males per female. The sex ratio is highly variable among years, among beaches and within beaches. Average sex ratios in Delaware ranged from a low of 1.8 males per female at Fowlers (lowest number of horseshoe crabs counted, 154) to a high of 6.02 at South Bowers (3,785 horseshoe crabs counted). Pickering, the beach with the greatest number of horseshoe crabs counted (13,110), had a high sex ratio of 5.75 males per female. In New Jersey, the average sex ratios ranged from 1.67 at Higbees beach (lowest number of horseshoe crabs counted, 123) to a high of 4.97 at Gandys (4,500 horseshoe crabs counted). The New Jersey beach with the greatest number of horseshoe observed was Kimbles beach with a sex ratio of 4.73 and a total count of 5,259.

The seasonal estimate for both states of 1,291,569 was reminiscent of the years from 1999 to 2005. More recent counts (2006-2011) border the 2 million mark (Table 4 and Figure 4). The 2012 male to female ratio was 4.11 males per

female but coupled with the low seasonal estimate for Delaware resulted in the fewest number of females (238,737) estimated since 1999 (Table 5 and Figure 5).

We observe and utilize four levels of spawning activity to categorize the densities for each count. No spawning activity equals 0 crabs, low activity equals less than 5 crabs per meter, moderate activity equals 5 to 10 crabs per meter, and high activity equals greater than 10 crabs per meter. The data is then analyzed in percentages since the number of dates and/or beaches may change yearly. As in previous years, the majority of the dates surveyed (56% in both DE and NJ) showed horseshoe crabs densities lower than five crabs per meter. (Table 3 and Figure 3. Note that the data is presented in a new format figure).

Dates with zero crabs (20 in Delaware and 9 in New Jersey) were comparable to previous years, some years having fewer and others greater percentages of zero crabs (Table 3 and Figure 3). Many of the zero counts (7) in Delaware were recorded on May 18th and May 20th. Delaware's most northern beach, Woodland Beach rendered zero counts during seven of the 10 dates surveyed (Table 1B).

The April data collected was interesting in that more horseshoe crabs were observed during the April dates than the late June dates (Table 6 and Figure 6). Almost four times as many horseshoe crabs were observed during the three dates in April (April 19th, 21st and 23rd) compared to the June dates (June 18th, 20th and 22nd). The New Jersey beaches surveyed in April were North Cape May, Villas, Highs and Gandys and the Delaware beaches were Broadkill, Primehook, Fowler, North Bowers, Ted Harvey WMA, Kitts Hummock and Pickering. A few of the April dates were canceled due to weather or flooding issues (4 dates of 12 dates in New Jersey and 4 dates of 21 in Delaware). Only two June dates were canceled along the four beaches in New Jersey and none of the June dates were missed in Delaware.

Discussion

This year's peak count was 341,062 spawning individuals during the May 22nd count, two days after the new moon date. The 2012 peak estimate for New Jersey was 184,046 and comparable to previous years. Delaware's estimate of 157,016 was the lowest on record since 1999 (Table 2). Spawning estimates were higher on the northern beaches this year in contrast to greater spawning activity along the southern beaches in 2011. Both Gandys and Fortescue in New Jersey had significantly greater numbers of horseshoe crabs than previous years. The southern beaches that exhibited an upswing in spawning activity last year did not experience the same increased activity in 2012. (Table 1)

This year's seasonal spawning estimate of 1,291,569 was exceptionally low and resembled the seasonal counts in the years 1999-2005. Seasonal activity after 2006 was closer to 2 million individuals. This significant decrease can be attributed to Delaware's low seasonal activity of 630,091. For the first time in 14 years, the peak count and the seasonal count in New Jersey exceeded Delaware's counts (Table

4). Although the sex ratio was improved and considerably lower than previous years (Table 5), when it was coupled with the low seasonal activity, a record decrease in the number of females resulted.

Our concern for the survey beaches in regards to flooding was amplified during this year's survey and is a concern for the spawning horseshoe crabs. The beaches along both sides of the Delaware Bay have been significantly eroding over the last few years. The higher tides associated with the new and full moon phases create substantial flooding in the beach area. Both humans and horseshoe crab activities are adversely affected; the volunteers cannot access the beach due to road flooding and the beach area available for counting and spawning is non-existent during the periods of extreme high tide.

Gandys beach was closely examined this year prior to the start of the survey and a mere 66 meters was designated for the count. Every crab in this small area was counted by continually flipping the quadrat along the water's edge. The number of quadrats counted in 2012 ranged from 50-71 meters. Horseshoe crabs were observed in great densities in this area May 20th (26.72 crabs per meter) and May 22nd (34.58 crabs per meter). Unfortunately, the three counts surrounding the full moon in June were canceled due to the access road flooding.

Surveying at Kimbles beach has proved to be difficult and the United States Fish and Wildlife Service, owners of the beach parcel assisted in the survey this year. The area accessible for counting was a 200 meter section on the northern end; the first section (100 meters) was beach front and the end section (100 meters) was along the creek mouth where the horseshoe crabs congregated in great numbers. Nevertheless, the June 2nd and June 4th counts were canceled due to the access road flooding.

Unfortunately, the most productive beach in New Jersey at South Cape Shore Lab has been the site of severe erosion since 2007 making the beach length available for counting a small 100 meter section. Counting of all crabs within this section followed the protocol set by Gandys and Kimbles beaches by continually flipping the quadrat along the water's edge. However, even with the best strategic plan, counts were canceled during the three dates surrounding the full moon in June, June 2nd, 4th and 6th due to the access road flooding. Along with the erosion along the beachfront, an immense overwash area of several acres was created behind the dunes.

The three beaches in Delaware with the main flooding issues were Fowlers, Bennetts Pier and Big Stone. Both Bennetts and Big Stone had cancellations on May 18th, May 20th and June 4th due to flooding on the access road and the beach area. At Fowlers, surveying was canceled due to flooding on the dates of May 20th and May 22nd. The date of June 4th held the most cancellations; Cape Henlopen, Broadkill, South Bowers and Woodland, in addition to Bennetts and Big Stone.

Acknowledgements

As we are faced with deteriorating conditions along the Delaware Bayshore, the continued dedication and enthusiasm of our volunteers is visibly apparent and thoroughly appreciated. It is essential that the survey continues, not only to document the trends in the horseshoe crab spawning population but the general conditions of their spawning habitat. On the heels of the most devastating hurricane in 50 years for the Delaware Bayshore, the results from the 2013 survey will be immensely important and likely to be disconcerting in terms of beach area loss and more prevalent and pronounced flooding issues.

Listing of 2012 Figures and Tables

Figure 1. New Jersey and Delaware Spawning Estimates During 2012 Survey

Figure 2. Peak Estimates of Spawning Horseshoe Crabs years 1999-2012

Figure 3. Percentages of Horseshoe Crab Densities 2000-2012

Figure 4. Seasonal Estimates of Horseshoe Crabs 1999-2012

Figure 5. Seasonal Estimates of Male and Female Horseshoe Crabs 1999-2012

Figure 6. Comparison of Estimates from April versus June Dates 2012

Table 1A. 2012 Survey Results – Densities and Estimates -New Jersey Beaches

Table 1B. 2012 Survey Results – Densities and Estimates - Delaware Beaches

Table 2. Comparison of Data on Horseshoe Crabs Spawning on Delaware Bay Shores - Years 1999-2012

Table 3. Percentages of Horseshoe Crab Densities 1999-2012

Table 4. Seasonal Estimates of Horseshoe Crabs 1999-2012

Table 5. Seasonal Estimates of Male and Female Horseshoe Crabs 1999-2012

Table 6. 2012 Survey Results –Densities and Estimates - New Jersey and Delaware beaches – April Dates

Figure 1. New Jersey and Delaware Spawning Estimates During 2012 Survey

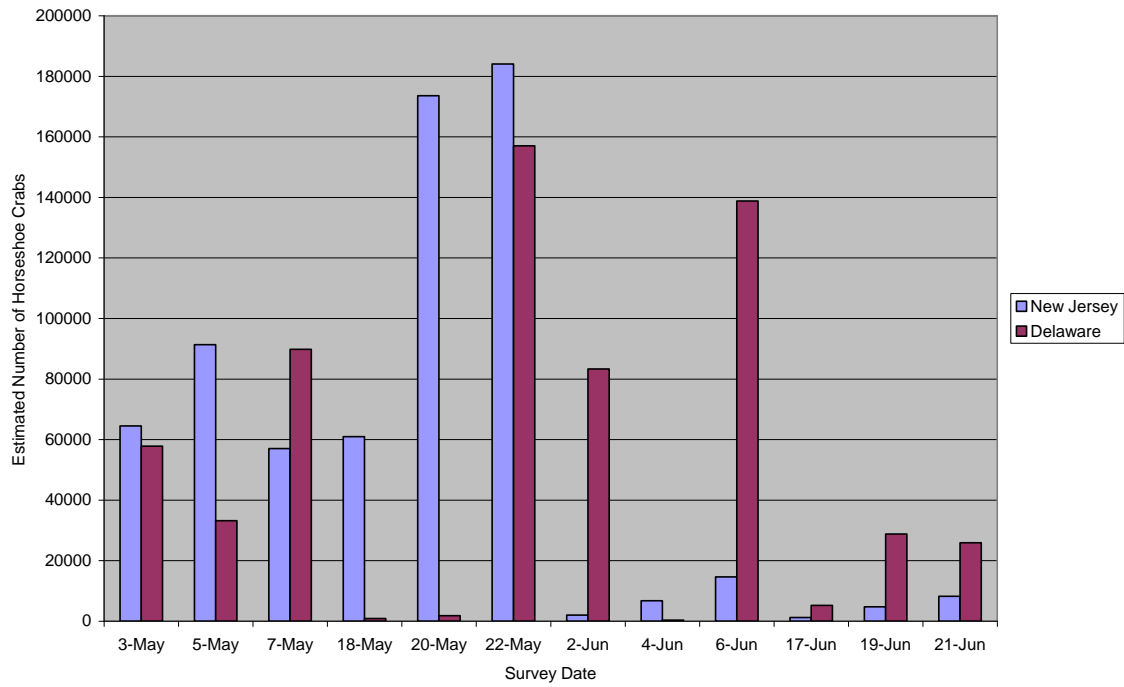


Figure 2. Peak Estimates of Spawning Horseshoe Crabs Years 1999-2012

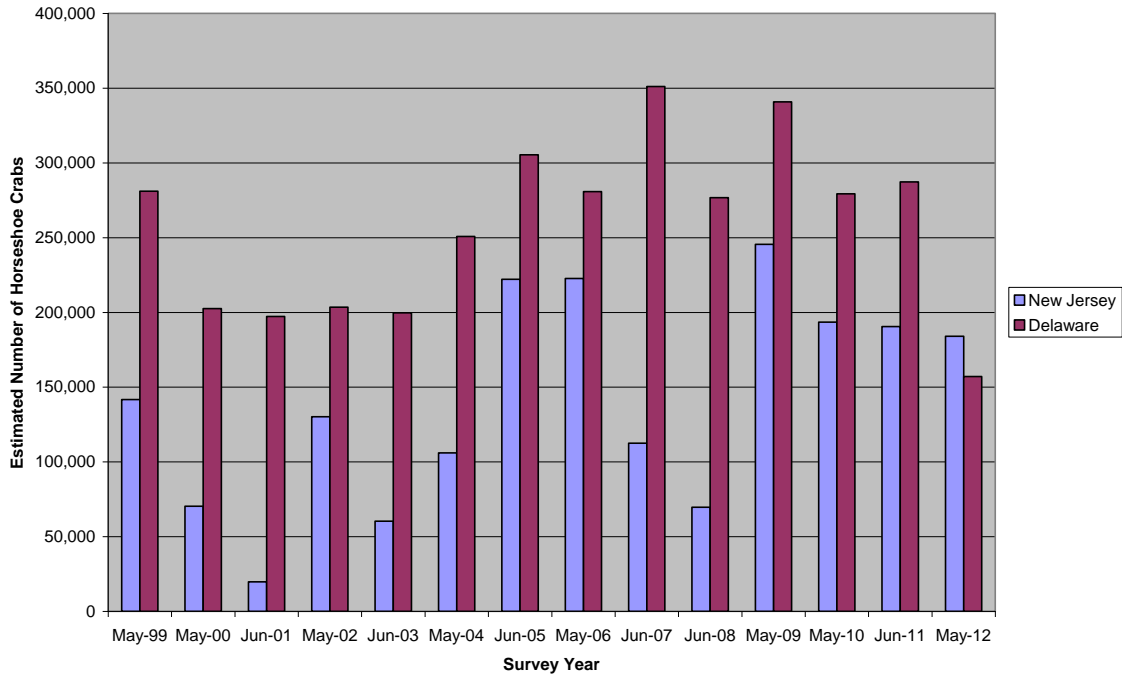


Figure 3. Percentages of Horseshoe Crab Densities 2000-2012

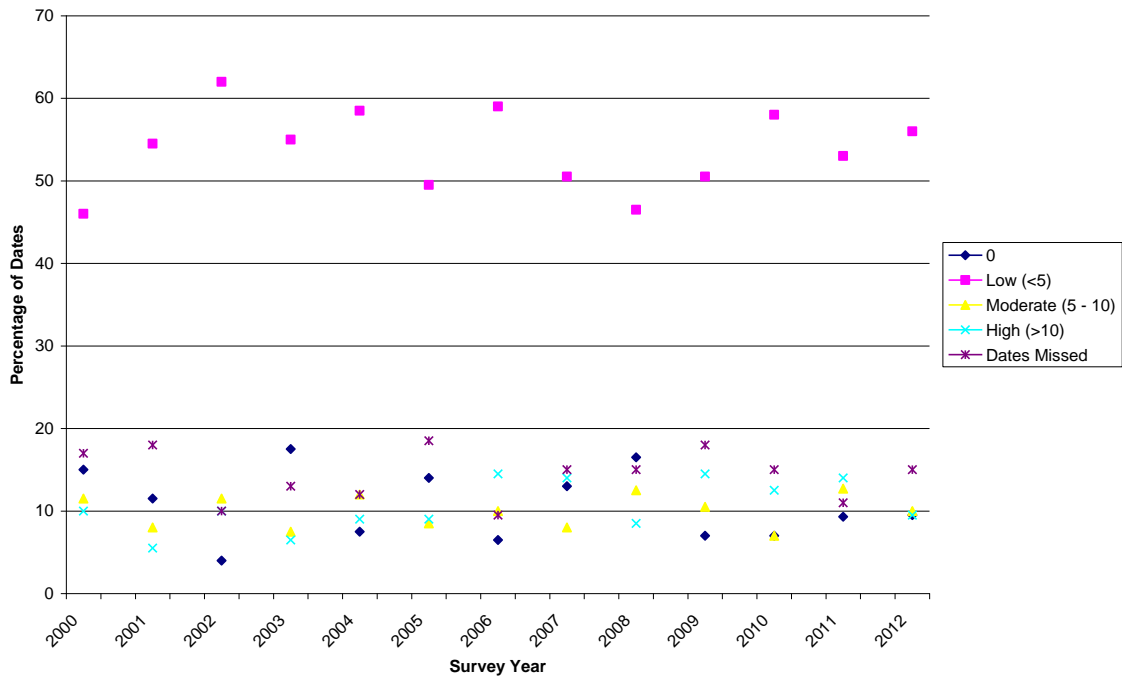


Figure 4. Seasonal Estimates of Horseshoe Crabs 1999-2012

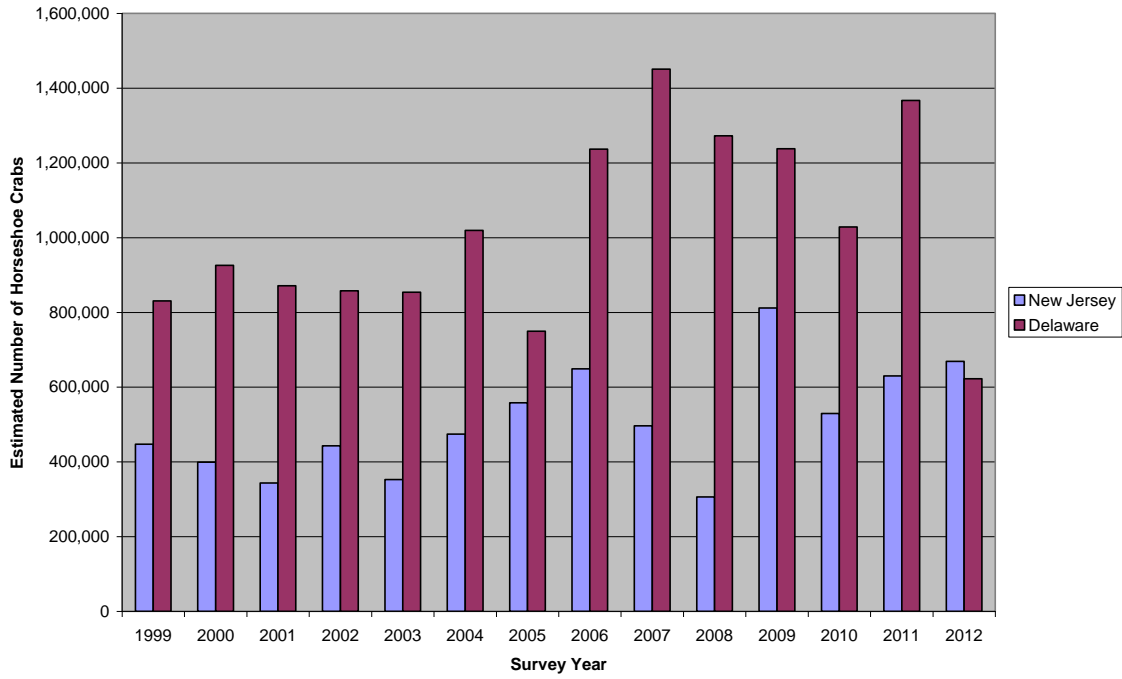


Figure 5. Seasonal Estimates of Male and Female Horseshoe Crabs 1999-2012

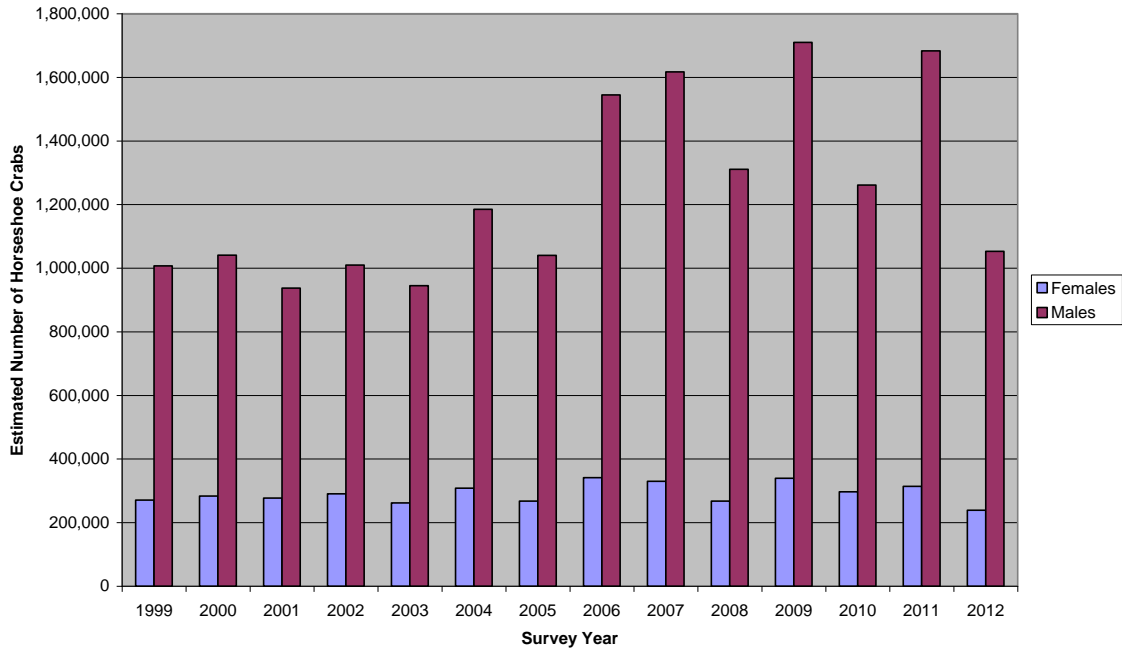


Figure 6. Comparison of Estimates from April versus June Dates 2012

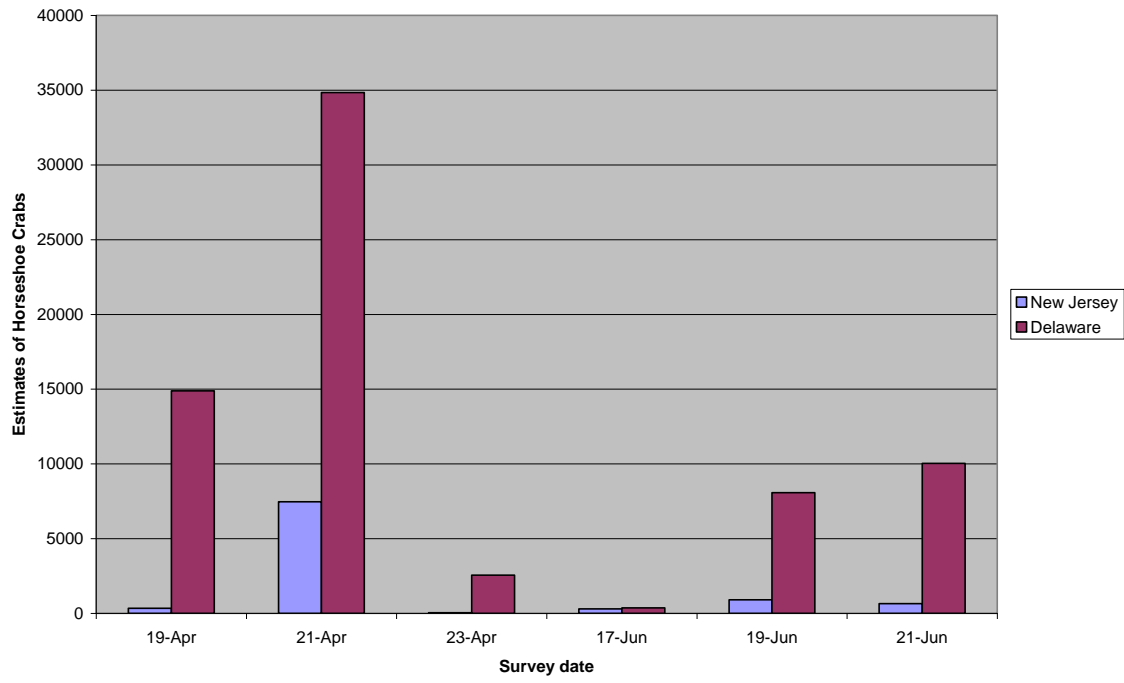


Table 1. 2012 Survey Results- Densities and Estimates
A. New Jersey Beaches (*Indicates beaches surveyed every year)

Moon Phase	Full-2	Full	Full+2	New-2	New	New+2	Full-2	Full	Full+2	New-2	New	New-2	
Date	3-May	5-May	7-May	18-May	20-May	22-May	2-Jun	4-Jun	6-Jun	17-Jun	19-Jun	21-Jun	Totals
Higbees * (0.98 km)													
Density of HSC, Crabs/m	0	0	0.12	0.02	cancel	0.3	cancel	0.1	0.65	cancel	0.04	cancel	
Estimated Number of HSC	0	0	118	20	0	294	0	98	637	0	39	0	1,205
North Cape May * (3 km)													
Density of HSC, Crabs/m	0	0.06	0	0.04	0.04	0.16	0.02	0.39	0.56	0.02	0.02	0.14	
Estimated Number of HSC	0	180	0	120	120	480	60	1,170	1,680	60	60	420	4,350
Villas (2 km)													
Density of HSC, Crabs/m	1.23	2.66	0.52	1.97	5.03	3.38	0.09	0.86	0.09	0.02	0.22	cancel	
Estimated Number of HSC	2,460	5,320	1,040	3,940	10,060	6,760	180	1,720	180	40	440	0	32,140
Townbank (2.3 km)													
Density of HSC, Crabs/m	0.53	2.29	2.14	0.35	1.5	cancel	0.15	0.57	1.7	0	0.13	0.18	
Estimated Number of HSC	1,219	5,267	4,922	805	3,450	0	345	1,311	3,910	0	299	414	21,942
Norburies Landing (2.43 km)													
Density of HSC, Crabs/m	5.04	5.35	2.15	1.1	6.37	7.75	cancel	cancel	1.83	0.04	0.47	0.58	
Estimated Number of HSC	12,247	13,001	5,225	2,673	15,479	18,833	0	0	4,447	97	1,142	1,409	74,552
South CSL * (2.2 km)													
Density of HSC, Crabs/m	5.37	8.28	2.4	2.81	16.82	14.11	cancel	cancel	cancel	0	0.48	0.76	
Estimated Number of HSC	11,814	18,216	5,280	6,182	37,004	31,042	0	0	0	0	1,056	1,672	112,266
Highs * (0.8 km)													
Density of HSC, Crabs/m	8.27	6.52	1.85	2.69	9.42	7.23	cancel	0	0.5	0	0.49	0.28	
Estimated Number of HSC	6,616	5,216	1,480	2,152	7,536	5,784	0	0	400	0	392	224	29,800
Pierces Point (0.7 km)													
Density of HSC, Crabs/m	6.47	5.89	8.79	8.06	16.38	10.88	0.03	1.75	1.84	0.04	cancel	1.92	
Estimated Number of HSC	4,529	4,123	6,153	5,642	11,466	7,616	21	1,225	1,288	28	0	1,344	43,435
Kimbles (1 km)													
Density of HSC, Crabs/m	3.3	9.27	11.63	4.82	7.33	15.64	cancel	cancel	0.89	0.02	0.14	0.6	
Estimated Number of HSC	3,300	9,270	11,630	4,820	7,330	15,640	0	0	890	20	140	600	53,640
Reeds * (1.53 km)													
Density of HSC, Crabs/m	6.05	7.81	6.54	7.08	12.86	11.67	0.01	cancel	0.71	0	0.33	0.21	
Estimated Number of HSC	9,257	11,949	10,006	10,832	19,676	17,855	15	0	1,086	0	505	321	81,503
Fortescue (2.6 km)													
Density of HSC, Crabs/m	3.52	5.42	3.55	7.34	11.3	14.71	0.54	0.48	0.05	0.28	0.26	0.7	
Estimated Number of HSC	9,152	14,092	9,230	19,084	29,380	38,246	1,404	1,248	130	728	676	1,820	125,190
Gandys * (1.2 km)													
Density of HSC, Crabs/m	3.23	3.89	1.6	3.9	26.72	34.58	cancel	cancel	cancel	0.17	0.015	cancel	
Estimated Number of HSC	3,876	4,668	1,920	4,680	32,064	41,496	0	0	0	204	18	0	88,926
Totals	64,470	91,302	57,003	60,950	173,565	184,046	2,025	6,772	14,648	1,177	4,767	8,225	668,950

Table 1. 2012 Survey Results - Densities and Estimates
 B. Delaware Beaches (*Indicates Beaches Surveyed Every Year)

Moon Phase	Full-2	Full	Full+2	New-2	New	New+2	Full-2	Full	Full+2	New-2	New	New-2	Totals
Date	3-May	5-May	7-May	18-May	20-May	22-May	2-Jun	4-Jun	6-Jun	17-Jun	19-Jun	21-Jun	
Cape Henlopen (1.5 km)													
Density of HSC, Crabs/m	0.13	0.17	1.95	0.16	0.85	5.02	0.96	cancel	4.48	1.34	2.94	2.1	
Estimated Number of HSC	195	255	2,925	240	1,275	7,530	1,440	0	6,720	2,010	4,410	3,150	30,150
Broadkill (1.5 km)													
Density of HSC, Crabs/m	0.04	0.03	1.17	0.03	0	0.35	2.22	cancel	3.48	0.00	0.45	1.09	
Estimated Number of HSC	60	45	1,755	45	0	525	3,330	0	5,220	0	675	1,635	13,290
Primehook * (2.0 km)													
Density of HSC, Crabs/m	0.13	0.13	3.39	0.17	cancel	2.32	1.88	cancel	2.04	0.03	0.1	0.1	
Estimated Number of HSC	260	260	6,780	340	0	4,640	3,760	0	4,080	60	200	200	20,580
Fowler * (3 km)													
Density of HSC, Crabs/m	0.02	0.11	1.17	0.03	cancel	cancel	0	0	0.21	0.00	0	0	
Estimated Number of HSC	60	330	3,510	90	0	0	0	0	630	0	0	0	4,620
Slaughter * (3 km)													
Density of HSC, Crabs/m	3.9	0.15	0.98	0.01	cancel	4.7	1.07	cancel	2.22	0.76	3.46	0.73	
Estimated Number of HSC	11,700	450	2,940	30	0	14,100	3,210	0	6,660	2,280	10,380	2,190	53,940
Big Stone * (5.0 km)													
Density of HSC, Crabs/m	0.02	0.07	1.8	cancel	cancel	4.4	2.01	cancel	8.4	cancel	cancel	cancel	
Estimated Number of HSC	100	350	9,000	0	0	22,000	10,050	0	42,000	0	0	0	83,500
Bennetts Pier (2.6 km)													
Density of HSC, Crabs/m	0.03	0.2	1.54	cancel	cancel	3.24	1.51	cancel	cancel	cancel	cancel	1.87	
Estimated Number of HSC	78	520	4,004	0	0	8,424	3,926	0	0	0	0	4,862	21,814
South Bowers (2.3 km)													
Density of HSC, Crabs/m	0.57	0	cancel	0	0	15.43	6.95	cancel	9.64	0.23	2.57	2.46	
Estimated Number of HSC	1,311	0	0	0	0	35,489	15,985	0	22,172	529	5,911	5,658	87,055
North Bowers * (1.3 km)													
Density of HSC, Crabs/m	3.38	1.01	5.85	0	0.02	12.31	1.33	0.02	1.29	0.13	1.63	1.33	
Estimated Number of HSC	4,394	1,313	7,605	0	26	16,003	1,729	26	1,677	169	2,119	1,729	36,790
Ted Harvey WMA (1.0 km)													
Density of HSC, Crabs/m	13.1	15.87	14.05	0	0.14	20.49	11.07	0	12.22	0.07	1.28	2.38	
Estimated Number of HSC	13,100	15,870	14,050	0	140	20,490	11,070	0	12,220	70	1,280	2,380	90,670
Kitts Hummock * (1.0 km)													
Density of HSC, Crabs/m	14.12	6.8	15.4	0.07	0.21	cancel	12.09	0.03	15.71	0.01	1.56	2.4	
Estimated Number of HSC	14,120	6,800	15,400	70	210	0	12,090	30	15,710	10	1,560	2,400	68,400
Pickering (1 km)													
Density of HSC, Crabs/m	12.41	6.86	21.2	0.03	0.12	27.28	16.69	0.3	21.69	0.05	2.24	1.68	
Estimated Number of HSC	12,410	6,860	21,200	30	120	27,280	16,690	300	21,690	50	2,240	1,680	110,550
Woodland * (0.5 km)													
Density of HSC, Crabs/m	0	0.25	1.2	0	0	1.07	0	cancel	cancel	0	0	0	
Estimated Number of HSC	0	125	600	0	0	535	0	0	0	0	0	0	1260
Totals	57,788	33,178	89,769	845	1,771	157,016	83,280	356	138,779	5,178	28,775	25,884	622,619

**Table 2. Comparison of Data on Horseshoe Crabs Spawning on Delaware Bay Shores
Years 1999-2012**

	22-May-12	3-Jun-11	29-May-10	24-May-09	3-Jun-08	1-Jun-07	27-May-06	8-Jun-05	21-May-04	14-Jun-03	28-May-02	5-Jun-01	18-May-00	30-May-99
Horseshoe Crabs	341,062	477,715	472,759	586,298	346,319	463,587	503,435	527,520	356,739	259,957	333,553	216,929	272,770	422,775
New Jersey Estimate	184,046	190,449	193,463	245,444	69,669	112,497	222,653	222,168	105,973	60,272	130,164	19,726	70,293	141,720
Delaware Estimate	157,016	287,266	279,296	340,854	276,650	351,090	280,782	305,352	250,766	199,685	203,389	197,203	202,477	281,055
Beaches in DE	13	13	13	13	13	13	13	13	13	13	13	13	11	9
Beaches in NJ	12	12	12	13	12	11	11	11	11	10	10	10	11	13
Beaches in DE	Pickering Ted Harvey	Big Stone Slaughter	Big Stone Slaughter	Big Stone Slaughter	Big Stone Slaughter	Big Stone Slaughter	Big Stone Slaughter	Big Stone S. Bowers	Big Stone Slaughter	Big Stone Slaughter	S. Bowers Slaughter	Slaughter Big Stone	Slaughter Big Stone	Slaughter Big Stone
	S. Bowers Big Stone	S. Bowers Pickering	S. Bowers Pickering	S. Bowers Pickering	Pickering	S. Bowers	S. Bowers Pickering	Bennets Slaughter Pickering	Pickering	Pickering Ted Harvey	Big Stone Pickering			
Beaches in NJ	Fortescue	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	Townbank
	South CSL Gandys	Norburys Fortescue	Norburys Gandys	Norburys Reeds			Norburys Fortescue	Norburys Villas	Fortescue	Norburys Norburys	Fortescue Gandys	Sea Breeze		Norburys South CSL

Table 3. Percentages of Horseshoe Crab Densities 1999-2012

Survey Year	State	Percentage				Dates Missed
		0	Low (<5)	Moderate (5-10)	High (>10)	
1999	New Jersey	4	65	10	6	15
	Delaware	8	43	6	11	31
2000	New Jersey	16	54	10	5	14
	Delaware	14	38	13	15	20
2001	New Jersey	10	63	5	5	17
	Delaware	13	46	11	6	19
2002	New Jersey	3	61	10	8	13
	Delaware	5	63	13	12	7
2003	New Jersey	17	60	7	3	13
	Delaware	18	50	8	10	13
2004	New Jersey	5	63	9	8	14
	Delaware	10	54	15	10	10
2005	New Jersey	14	48	6	10	21
	Delaware	14	51	11	8	16
2006	New Jersey	5	64	8	12	11
	Delaware	8	54	12	17	8
2007	New Jersey	16	58	1	10	15
	Delaware	10	43	15	18	15
2008	New Jersey	21	51	8	0	19
	Delaware	12	42	17	17	11
2009	New Jersey	4	50	8	14	24
	Delaware	10	51	13	15	12
2010	New Jersey	5	60	6	8	20
	Delaware	9	56	8	17	10
2011	New Jersey	10	58	15	7	10
	Delaware	8	49	10	21	12
2012	New Jersey	6	56	16	8	14
	Delaware	13	56	4	11	16

Table 4. Seasonal Estimates of Horseshoe Crabs 1999-2012

Year	New Jersey	Delaware	Total
1999	447,128	830,405	1,277,533
2000	398,847	925,837	1,324,684
2001	343,351	871,375	1,214,726
2002	442,586	857,362	1,299,948
2003	352,800	853,721	1,206,521
2004	474,019	1,019,014	1,493,033
2005	557,956	749,473	1,307,429
2006	648,728	1,236,627	1,885,355
2007	496,535	1,450,837	1,947,372
2008	306,306	1,272,312	1,578,618
2009	811,724	1,237,476	2,049,200
2010	529,606	1,028,611	1,558,217
2011	630,091	1,367,112	1,997,203
2012	668,950	622,619	1,291,569

Table 5. Seasonal Estimates of Male and Female Horseshoe Crabs 1999-2012

Year	Sex Ratio	Females	Males
1999	3.72	270,664	1,006,869
2000	3.67	283,658	1,041,026
2001	3.38	277,335	937,391
2002	3.48	290,167	1,009,781
2003	3.61	261,718	944,803
2004	3.85	307,842	1,185,191
2005	3.89	267,368	1,040,061
2006	4.53	340,932	1,544,423
2007	4.90	330,064	1,617,308
2008	4.90	267,562	1,311,056
2009	5.04	339,271	1,709,929
2010	4.25	296,803	1,261,414
2011	5.36	314,026	1,683,177
2012	4.41	238,737	1,052,832

Table 6. 2012 Survey Results- Densities and Estimates
 New Jersey and Delaware Beaches - April Dates (*Indicates beaches surveyed every year)

APRIL DATES				JUNE DATES					
Moon Phase	New-2	New	New+2		New-2	New	New-2		
Date	19-Apr	21-Apr	23-Apr		17-Jun	19-Jun	21-Jun		
New Jersey Beaches				New Jersey Beaches					
North Cape May * (3 km)				North Cape May * (3 km)					
Density of HSC, Crabs/m	cancel	0	cancel	Density of HSC, Crabs/m	0.02	0.02	0.14		
Estimated Number of HSC	flood	0	weather	Estimated Number of HSC	60	60	420		
Villas (2 km)				Villas (2 km)					
Density of HSC, Crabs/m	0	1.61	0	Density of HSC, Crabs/m	0.02	0.22	cancel		
Estimated Number of HSC	0	3,220	0	Estimated Number of HSC	40	440	0		
Highs * (0.8 km)				Highs * (0.8 km)					
Density of HSC, Crabs/m	0.43	5.3	0.05	Density of HSC, Crabs/m	0	0.49	0.28		
Estimated Number of HSC	344	4,240	40	Estimated Number of HSC	0	392	224		
Gandys * (1.2 km)				Gandys * (1.2 km)					
Density of HSC, Crabs/m	0	cancel	cancel	Density of HSC, Crabs/m	0.17	0.015	cancel		
Estimated Number of HSC	0	weather	flood	Estimated Number of HSC	204	18	0		
Totals	344	7,460	40	7,844	Totals	304	910	644	1,858
Delaware Beaches				Delaware Beaches					
Moon Phase	New-2	New	New+2		Moon Phase	New-2	New	New-2	
Date	19-Apr	21-Apr	23-Apr		Date	17-Jun	19-Jun	21-Jun	
Broadkill (1.5 km)				Broadkill (1.5 km)					
Density of HSC, Crabs/m	0.03	cancel	cancel	Density of HSC, Crabs/m	0	0.45	1.09		
Estimated Number of HSC	45	other	other	Estimated Number of HSC	0	675	1,635		
Primehook * (2.0 km)				Primehook * (2.0 km)					
Density of HSC, Crabs/m	0.14	cancel	0.06	Density of HSC, Crabs/m	0	0.1	0.1		
Estimated Number of HSC	280	weather	120	Estimated Number of HSC	60	200	200		
Fowler * (3 km)				Fowler * (3 km)					
Density of HSC, Crabs/m	0	0	0	Density of HSC, Crabs/m	0	0	0		
Estimated Number of HSC	0	0	0	Estimated Number of HSC	0	0	0		
North Bowers * (1.3 km)				North Bowers * (1.3 km)					
Density of HSC, Crabs/m	4.42	5.52	1.13	Density of HSC, Crabs/m	0	1.63	1.33		
Estimated Number of HSC	5,746	7,176	1,469	Estimated Number of HSC	169	2,119	1,729		
Ted Harvey WMA (1.0 km)				Ted Harvey WMA (1.0 km)					
Density of HSC, Crabs/m	5.33	9.91	0.62	Density of HSC, Crabs/m	0	1.28	2.38		
Estimated Number of HSC	5,330	9,910	620	Estimated Number of HSC	70	1,280	2,380		
Kitts Hummock * (1.0 km)				Kitts Hummock * (1.0 km)					
Density of HSC, Crabs/m	1.03	0	cancel	Density of HSC, Crabs/m	0.01	1.56	2.4		
Estimated Number of HSC	1,030	0	other	Estimated Number of HSC	10	1,560	2,400		
Pickering (1 km)				Pickering (1 km)					
Density of HSC, Crabs/m	2.45	17.75	0.35	Density of HSC, Crabs/m	0.05	2.24	1.68		
Estimated Number of HSC	2,450	17,750	350	Estimated Number of HSC	50	2,240	1,680		
Totals	14,881	34,836	2,559	52,276	Totals	359	8,074	10,024	18,457