

The 2009 Delaware Bay Horseshoe Crab Spawning Survey

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Abstract

Each May and June, the shores of Delaware Bay play host to hundreds of spawning horseshoe crabs. In this time frame, on 12 nights coinciding with the new and full moon phases, the yearly Delaware Bay horseshoe crab survey is conducted. All systematic counts are taken in or near darkness at high tides along 26 beaches – 13 in New Jersey and 13 in Delaware.

The scheduled 312 survey dates resulted in 255, or 82 percent, of the dates completed. Cancellations were due to: flooding (31), weather (7), volunteer unavailability (1), or miscellaneous reasons (18).

Both New Jersey and Delaware reached their single day peak estimate of 586,298 on May 24, 2009, the day of the new moon. Delaware's 2009 peak estimate was 340,854 similar to the 2007 estimate but considerably higher than previous years of 1999-2008. New Jersey's estimate was 245,444, comparable to the 2006 and 2005 estimates, but 4 times as great as last year's estimate of 69,669 and considerably higher than previous years' estimates dating from 1999-2008.

The 2009 male to female sex ratio of 5.04 was slightly higher than the 2008 and 2007 ratios of 4.90. Previous years' ratios ranged from 3.67 in 2000 to 3.38 in 2001, 3.48 in 2002, 3.61 in 2003, 3.85 in 2004, 3.89 in 2005, and 4.53 in 2006.

The aggregate total of seasonal activity for New Jersey and Delaware was 2,049,200 (339,271 females and 1,709,929 males). As with the previous numbers, the seasonal activity was higher than last year's total of 1,578,618 horseshoe crabs (267,562 females and 1,311,054 males) but comparable to the 2007 and 2006 estimates of 1,947,372 and 1,885,355 individuals respectively.

Introduction

Since its inception in 1999, our survey has made tremendous strides and is now 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 to 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 2009 along the shores of the Delaware Bay. Twenty-six beaches were represented in this year's count (13 along the state of Delaware's coast and 13 along the Delaware Bay 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 Sea Breeze, Fortescue, Gandys, Reeds, Kimbles, Pierces Point, Highs, South Cape Shore Lab, Norburys Landing, Villas, North Cape May, Higbees, and Sunset Beach.

Counts were taken simultaneously on both New Jersey and Delaware beaches coinciding the peak high tides and following the new and full moons. The dates of counting were: May 7, 9, 11, 22, 24, 26 and June 5, 7, 9, 20, 22, and 24. High tide times ranged from 7:22 p.m. to 11:11 p.m. allowing adjustments for tidal flow entering the bay.

Results

Coverage by the volunteers accounted for 82 percent, or 255, of the entire 312 scheduled counts. In New Jersey, 38 dates were not staffed, 17 in May and 21 in June. Only one date was canceled due to weather, the remaining cancellations were due to no access (19) and miscellaneous reasons (18). Kimbles beach proved inaccessible on eight of the 12 scheduled dates. Sea Breeze counting was canceled on three dates for no access. The last three survey dates in June were missed at Norburys Landing due to no access. (Table 1A).

Nineteen cancellations occurred in Delaware during the 2009 spawning season. Of these, one was canceled for volunteer unavailability, six due to weather, and the majority (12) for no access. During the May 26th date, access problems prevented the count at Slaughter, Bennetts, South Bowers, Ted Harvey, Kitts Hummock and Woodland. On June 22nd, four beach counts were canceled due to access problems at Fowler, Bennetts, South Bowers and Woodland. (Table 1B).

This year's (2009) survey produced an increase in the estimated number of spawners along Delaware and New Jersey's shores when compared to 2008. The peak activity was recorded during the May 24th date with 586,298 individuals estimated. This was the highest count of the 12 nights in both New Jersey and Delaware. Delaware spawners were calculated to be 340,854 on this date and New Jersey spawners 245,444. Additionally, good spawning numbers were observed on May 9th, May 22nd, June 7th and 9th.

In New Jersey, 58% of the seasonal spawning occurred during 2 days, May 22nd and May 24th with 229,664 and 245,444 spawners respectively. Spawning activity in New Jersey for the overall season was the highest at South Cape Shore Lab with 167,508 individuals, comparable to the 2007 estimate of 162,316 horseshoe crabs. Additional good seasonal numbers were observed at Norburys

Landing (132,751), Reeds Beach (107,926) and Fortescue (88,816). The highest density was achieved at Pierces Point with 34.78 horseshoe crabs per square meter on May 24th, the peak survey date. (Table 1A and Figure 1).

These results were mirrored in Delaware, with almost 50% (48%) of the seasonal activity observed May 22nd and May 24th with 247,696 and 341,026 animals respectively. The highest seasonal activity occurred on Big Stone beach and was estimated to be 284,500 spawners. Estimates at South Bowers (154,698), Slaughter (154,560) and Pickering (143,560) contributed to overall good seasonal spawning activity. Pickering, as in the past, had the highest density during the entire season with 28.73 and 29.21 crabs per square meter on May 22nd and May 24th respectively. (Table 1B and Figure 1).

The 2009 male to female ratio was 5.04 – slightly higher than the 2008 and 2007 ratio of 4.90. Previous year's estimates were lower with ratios of 3.72, 3.67, 3.38, 3.48, 3.61, 3.85, 2.89 and 4.53 during the years 1999 to 2006 respectively. (Sex ratios are computed by averaging the total number of males and females counted throughout the entire season.) The ratio of males to females continues to be high and should be an area of concern to managers. Estimating the number of males and females by utilizing the 5.04 ratio and the 2009 seasonal estimate resulted in 1,709,929 males and 339,271 females spawning. (Table 5 and Figure 5).

The seasonal estimate of 2,049,200 is showed an increase over the previous two years. In fact, New Jersey's was the highest seasonal estimate since 1999, when the sampling methodology was standardized. (Table 4 and Figure 4).

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 dates and/or beaches may change yearly. As in previous years, the majority of the dates surveyed (51 percent in DE and 50 percent in NJ) showed horseshoe crabs densities lower than five crabs per meter. In New Jersey, high densities were noted on 14% of the survey dates, the greatest percentage since 1999. Crabs in high densities were not observed at all in 2008. High and moderate densities of horseshoe crabs were observed in Delaware at comparable percentages to other years (Table 3 and Figure 3).

Dates with zero crabs (15 in Delaware and 6 in New Jersey) were few in number this year. Delaware's most northern beach, Woodland Beach rendered zero counts during seven of the 10 dates surveyed. Zero crabs were observed on New Jersey's most southern beaches, Sunset and Higbees beaches during four of the survey counts.

Discussion

This year's peak count was notable with 586,298 spawning individuals during the May 24th count, the new moon date. The beaches of New Jersey hosted the greatest estimate of spawners (245,444) since 1999. This estimate was coupled with the greatest percentage (14%) of high density counts (greater than 10 crabs per meter) since 1999 and the highest density of 34.78 crabs per square meter.

The 2009 peak estimate for Delaware of 340,854 spawners is comparable to the 2007 estimate of 351,090 and moderately higher than previous years. Due to its expansive length, Big Stone Beach is the main spawning beach in Delaware and its 2009 seasonal estimate was 284,500.

This year's seasonal spawning estimate of 2,049,200 was higher than the 10 previous years. Delaware's seasonal spawning activity was similar to the previous three years' estimates. In contrast, New Jersey's estimate greatly increased, resulting in an estimate double or almost double the estimated number from 7 of the last 10 years.

This appreciable increase in spawners during the 2009 season, however didn't translate into a comparable increase of female spawners. Unfortunately, the 2009 sex ratio of 5.04 translates into, 339,271 females, similar to the 2006 and 2007 estimates. These years had a lower sex ratio and lesser seasonal activity

Acknowledgements

It can be said that Mother Nature "keeps us on our toes" and that has proven true for our survey in recent years. Conducting the survey has become more difficult due to flooding problems with more and more counts canceled each season. However, despite the missed counts, the spawners have increased, forcing us to pick up our pace a little and really bend down and count.

To our volunteers, thank you for "keeping on your toes" - your perseverance, efforts and diligence in performing the counts.

And thank you to the States of New Jersey and Delaware and Dave Smith of the US Geological Survey as well.

Table 1. 2009 Survey Results- Densities and Estimates
 B. 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	7-May	9-May	11-May	22-May	24-May	26-May	5-Jun	7-Jun	9-Jun	20-Jun	22-Jun	24-Jun	Totals
Sunset Beach (2.02 km)													
Density of HSC, Crabs/m	cancel	0	0	cancel	0.03	0.02	0.05	0	0.12	cancel	0.08	3.78	
Estimated Number of HSC	0	0	0	0	61	40	101	0	242	0	162	7636	8,242
Higbees Beach (0.98 km)													
Density of HSC, Crabs/m	cancel	0	0.03	cancel	0.39	0.03	0.26	0.43	1.73	0.16	0.72	1.4	
Estimated Number of HSC	0	0	29	0	382	29	255	421	1695	157	706	1372	5,047
North Cape May * (3 km)													
Density of HSC, Crabs/m	cancel	cancel	cancel	0.03	0.01	cancel	0.02	0.25	0.9	0.16	cancel	cancel	
Estimated Number of HSC	0	0	0	90	30	0	60	750	2700	480	0	0	4,110
Villas (2 km)													
Density of HSC, Crabs/m	0.04	0.23	0.02	7.76	11.13	2.02	0.27	3.81	cancel	1.88	1.59	cancel	
Estimated Number of HSC	80	460	40	15520	22260	4040	540	7620	0	3760	3180	0	57,500
Norburys Landing (2.43 km)													
Density of HSC, Crabs/m	1.03	7.02	0.02	18.28	18.26	cancel	0.08	5.76	4.18	cancel	cancel	cancel	
Estimated Number of HSC	2503	17059	49	44420	44372	0	194	13997	10157	0	0	0	132,751
South CSL * (2.2 km)													
Density of HSC, Crabs/m	4.5	14.31	0.07	14.66	16.25	4.69	0.41	11.31	8	0.15	0.95	0.84	
Estimated Number of HSC	9900	31482	154	32252	35750	10318	902	24882	17600	330	2090	1848	167,508
Highs * (0.8 km)													
Density of HSC, Crabs/m	4.17	10.21	0.09	12.54	18.6	0.06	1.26	7.79	0.2	0.12	0.58	0.13	
Estimated Number of HSC	3336	8168	72	10032	14880	48	1008	6232	160	96	464	104	44,600
Pierces Point (0.7 km)													
Density of HSC, Crabs/m	6.51	8.51	cancel	22.52	34.78	cancel	1.99	7.72	cancel	0.35	0.36	cancel	
Estimated Number of HSC	4557	5957	0	15764	24346	0	1393	5404	0	245	252	0	57,918
Kimbles (1 km)													
Density of HSC, Crabs/m	2.05	cancel	cancel	18.79	21.41	cancel	cancel	0.76	cancel	cancel	cancel	cancel	
Estimated Number of HSC	2050	0	0	18790	21410	0	0	760	0	0	0	0	43,010
Reeds * (1.53 km)													
Density of HSC, Crabs/m	3.29	10.49	0.04	20.5	20.89	4.11	0.32	3.93	5.38	0.12	0.05	1.42	
Estimated Number of HSC	5034	16050	61	31365	31962	6288	490	6013	8231	184	77	2173	107,926
Gandys * (1.2 km)													
Density of HSC, Crabs/m	0.08	0.44	0	19.76	13.32	4.43	1.49	cancel	10.57	1.27	cancel	0.71	
Estimated Number of HSC	96	528	0	23712	15984	5316	1788	0	12684	1524	0	852	62,484
Fortescue (2.6 km)													
Density of HSC, Crabs/m	0.6	1.11	0.66	11.22	13.08	1.68	0.35	1.14	2.67	0.39	0.2	1.06	
Estimated Number of HSC	1560	2886	1716	29172	34008	4368	910	2964	6942	1014	520	2756	88,816
Sea Breeze * (1.65 km)													
Density of HSC, Crabs/m	0.06	0	cancel	5.18	cancel	cancel	cancel	cancel	7.73	cancel	cancel	6.31	
Estimated Number of HSC	99	0	0	8547	0	0	0	0	12755	0	0	10412	31,812
Totals													
	29,215	82,589	2,121	229,664	245,444	30,448	7,641	69,043	73,167	7,789	7,450	27,152	811,724

Table 1. 2009 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	
Date	7-May	9-May	11-May	22-May	24-May	26-May	5-Jun	7-Jun	9-Jun	20-Jun	22-Jun	24-Jun	Totals
Cape Henlopen (1.5 km)													
Density of HSC, Crabs/m	0.14	cancel	0.02	1.09	2.54	4.48	0.08	2.66	4.42	cancel	1.12	5.46	
Estimated Number of HSC	210	0	30	1635	3810	6720	120	3990	6630	0	1680	8190	33,015
Broadkill (1.5 km)													
Density of HSC, Crabs/m	0	0.04	0.25	0.24	2.01	0	0	2.08	2.77	0.24	0.93	1.4	
Estimated Number of HSC	0	60	375	360	3015	0	0	3120	4155	360	1395	2100	14,940
Primehook * (2.0 km)													
Density of HSC, Crabs/m	0.07	1.33	0.82	6.87	10.43	0.18	0.01	1.31	4.99	0.48	1.3	1.4	
Estimated Number of HSC	140	2660	1640	13740	20860	360	20	2620	9980	960	2600	2800	58,380
Fowler * (3 km)													
Density of HSC, Crabs/m	0	2.77	0	0.74	1.69	0.02	cancel	0.23	0.59	cancel	cancel	0.79	
Estimated Number of HSC	0	8310	0	2220	5070	60	0	690	1770	0	0	2370	20,490
Slaughter * (3 km)													
Density of HSC, Crabs/m	2.26	9.29	1.92	9.02	19.76	cancel	cancel	3.85	3.29	0.73	0.71	0.69	
Estimated Number of HSC	6780	27870	5760	27060	59280	0	0	11550	9870	2190	2130	2070	154,560
Big Stone * (5.0 km)													
Density of HSC, Crabs/m	0.05	10.13	0.88	14.03	17.05	0.32	cancel	3.33	4.79	1.24	2.74	2.34	
Estimated Number of HSC	250	50650	4400	70150	85250	1600	0	16650	23950	6200	13700	11700	284,500
Bennetts Pier (2.6 km)													
Density of HSC, Crabs/m	0.03	5.98	0.44	6.16	9.69	cancel	0	2.79	3.16	3.89	cancel	2.76	
Estimated Number of HSC	78	15548	1144	16016	25194	0	0	7254	8216	10114	0	7176	90,740
South Bowers (2.3 km)													
Density of HSC, Crabs/m	0.55	9.53	2.1	16.88	19.65	cancel	cancel	9.09	6.15	3.31	cancel	cancel	
Estimated Number of HSC	1265	21919	4830	38824	45195	0	0	20907	14145	7613	0	0	154,698
North Bowers * (1.3 km)													
Density of HSC, Crabs/m	2.27	9.37	5.79	10.47	15.55	cancel	0	6.6	9.65	0.69	0.69	1.48	
Estimated Number of HSC	2951	12181	7527	13611	20215	0	0	8580	12545	897	897	1924	81,328
Ted Harvey WMA (1.0 km)													
Density of HSC, Crabs/m	3.57	19.88	11.54	13.12	19.15	cancel	0.01	6.85	9.21	0.85	1.97	3.21	
Estimated Number of HSC	3570	19880	11540	13120	19150	0	10	6850	9210	850	1970	3210	89,360
Kitts Hummock * (1.0 km)													
Density of HSC, Crabs/m	0.97	14.38	12.8	22.1	24.39	cancel	0	10.59	9.11	3.76	8.56	4.88	
Estimated Number of HSC	970	14380	12800	22100	24390	0	0	10590	9110	3760	8560	4880	111,540
Pickering (1 km)													
Density of HSC, Crabs/m	5.87	21.65	9.15	28.73	29.21	0.04	0.01	16.16	22.26	2.08	3.59	4.81	
Estimated Number of HSC	5870	21650	9150	28730	29210	40	10	16160	22260	2080	3590	4810	143,560
Woodland * (0.5 km)													
Density of HSC, Crabs/m	0	0.04	0	0.26	0.43	cancel	0	0	0	0	cancel	0	
Estimated Number of HSC	0	20	0	130	215	0	0	0	0	0	0	0	365
Totals	22,084	195,128	59,196	247,696	340,854	8,780	160	108,961	131,841	35,024	36,522	51,230	1,237,476

**Table 2. Comparison of Data on Horseshoe Crabs Spawning on Delaware Bay Shores
Years 1999-2009**

	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
Estimated Number of HSC	586,298	346,319	463,587	503,435	527,520	356,739	259,957	333,553	216,929	272,770	422,775
Estimated Number of HSC - NJ	245,444	69,669	112,497	222,653	222,168	105,973	60,272	130,164	19,726	70,293	141,720
Estimated Number of HSC - DE	340,854	276,650	351,090	280,782	305,352	250,766	199,685	203,389	197,203	202,477	281,055
Beaches Surveyed in DE	13	13	13	13	13	13	13	13	13	11	9
Beaches Surveyed in NJ	13	12	11	11	11	11	10	10	10	11	13
Main Spawning Beaches in DE	Big Stone	Big Stone	Big Stone	Big Stone	Big Stone	Big Stone	Big Stone	S. Bowers	Slaughter	Slaughter	Slaughter
	Slaughter	Slaughter	Slaughter	Slaughter	S. Bowers	Slaughter	Slaughter	Slaughter	Big Stone	Big Stone	Big Stone
	S. Bowers	Pickering	S. Bowers	S. Bowers	Bennets	Pickering	Pickering	Big Stone			
	Pickering			Pickering	Slaughter		Ted Harvey	Pickering			
					Pickering						
Main Spawning Beaches in NJ	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	South CSL	Townbank
	Norburys	Norburys		Norburys	Norburys	Fortescue	Fortescue	Gandys			Norburys
	Reeds			Fortescue	Villas	Norburys	Norburys	Sea Breeze			South CSL

Table 3. Percentages of Horseshoe Crab Densities 1999-2009

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

Table 4. Seasonal Estimates of Horseshoe Crabs 1999-2009

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

Table 5. Seasonal Estimates of Male and Female Horseshoe Crabs 2000-2009

Year	Females	Males
1999	270,664	1,006,869
2000	283,658	1,041,026
2001	277,335	937,391
2002	290,167	1,009,781
2003	261,718	944,803
2004	307,842	1,185,191
2005	267,368	1,040,061
2006	340,932	1,544,423
2007	330,064	1,617,308
2008	267,562	1,311,054
2009	339,271	1,709,929

Figure 1. New Jersey and Delaware Spawning Estimates During 2009 Survey

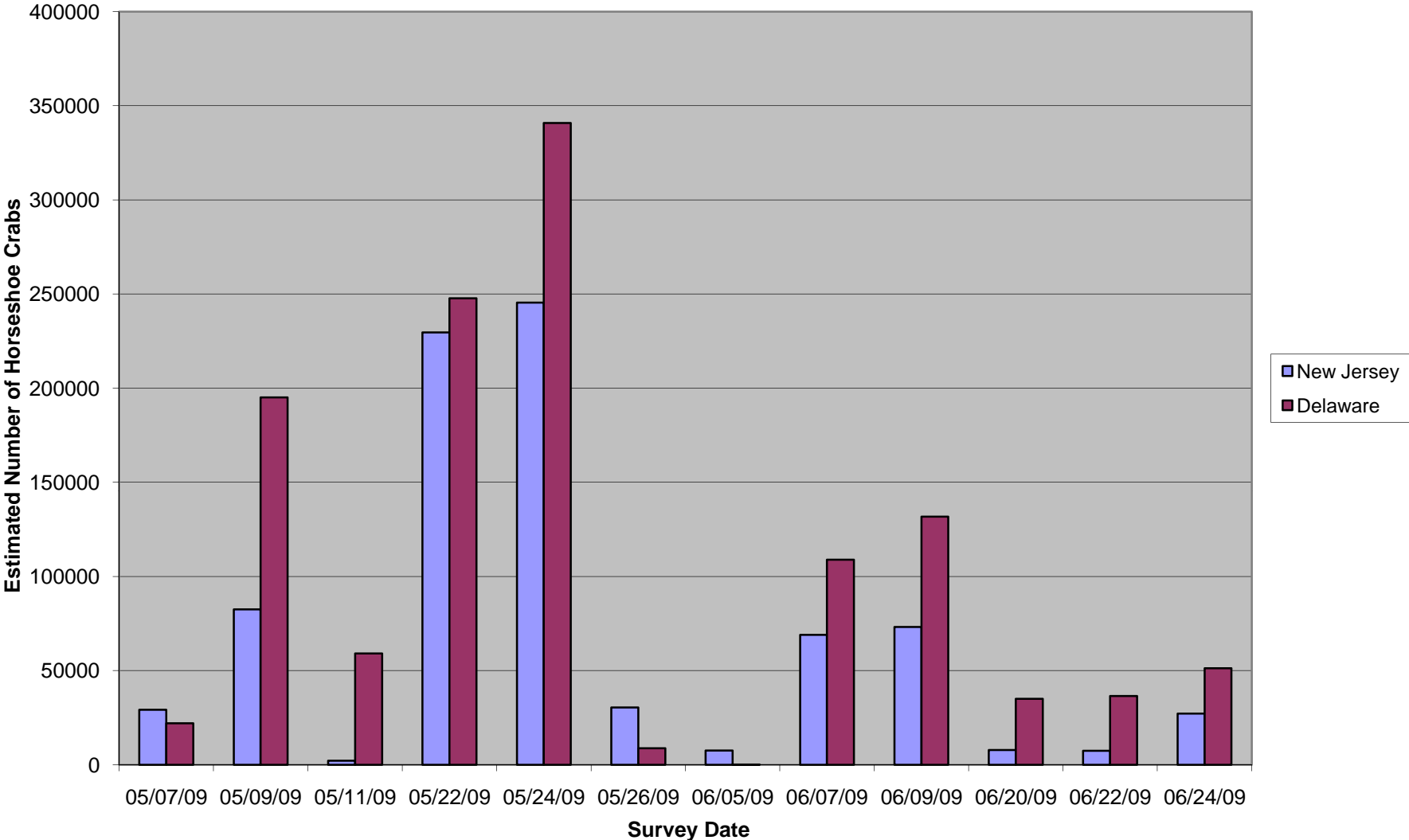


Figure 2. Peak Estimates of Spawning Horseshoe Crabs 1999-2009

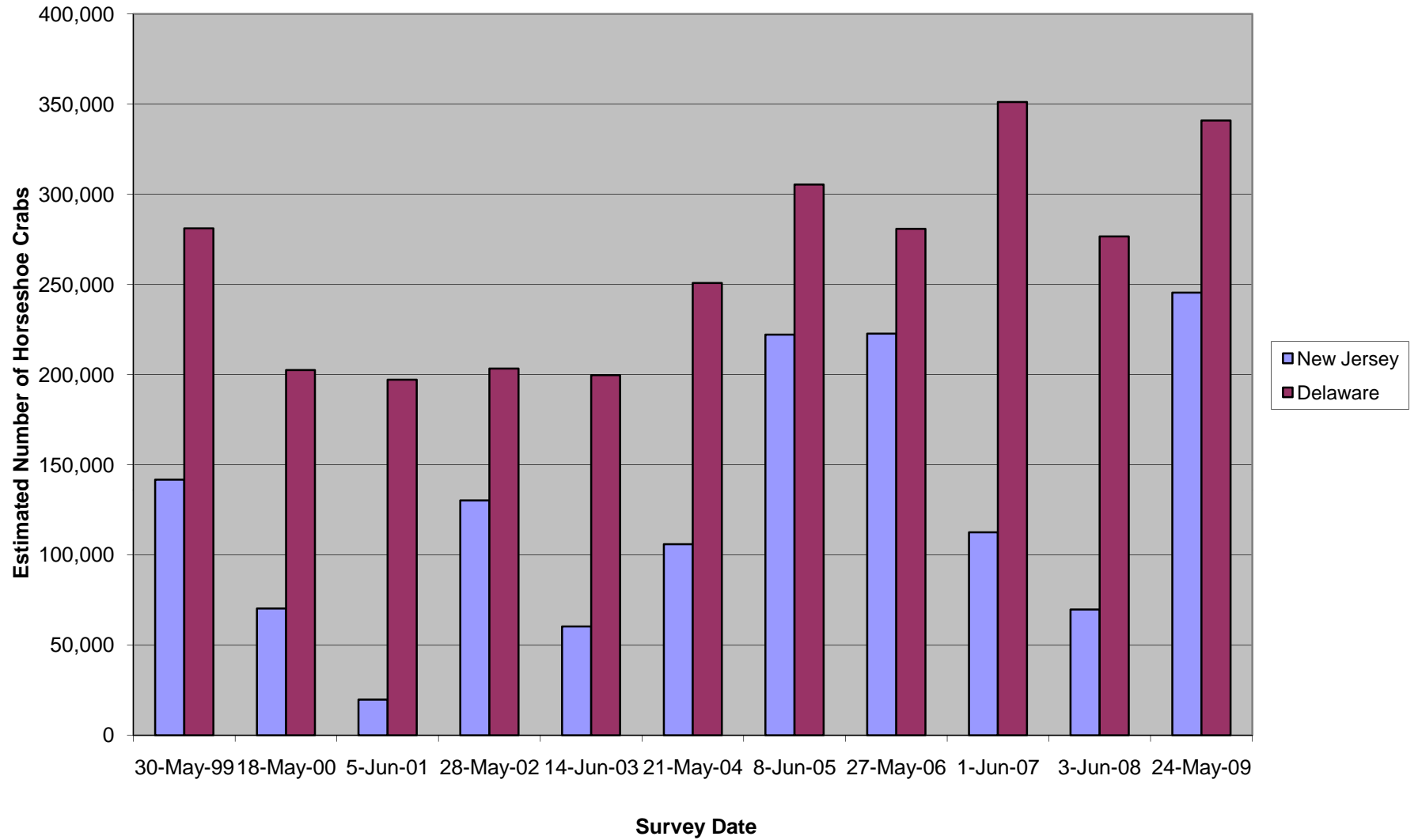


Figure 3. Percentages of Densities of Horseshoe Crabs 1999-2009

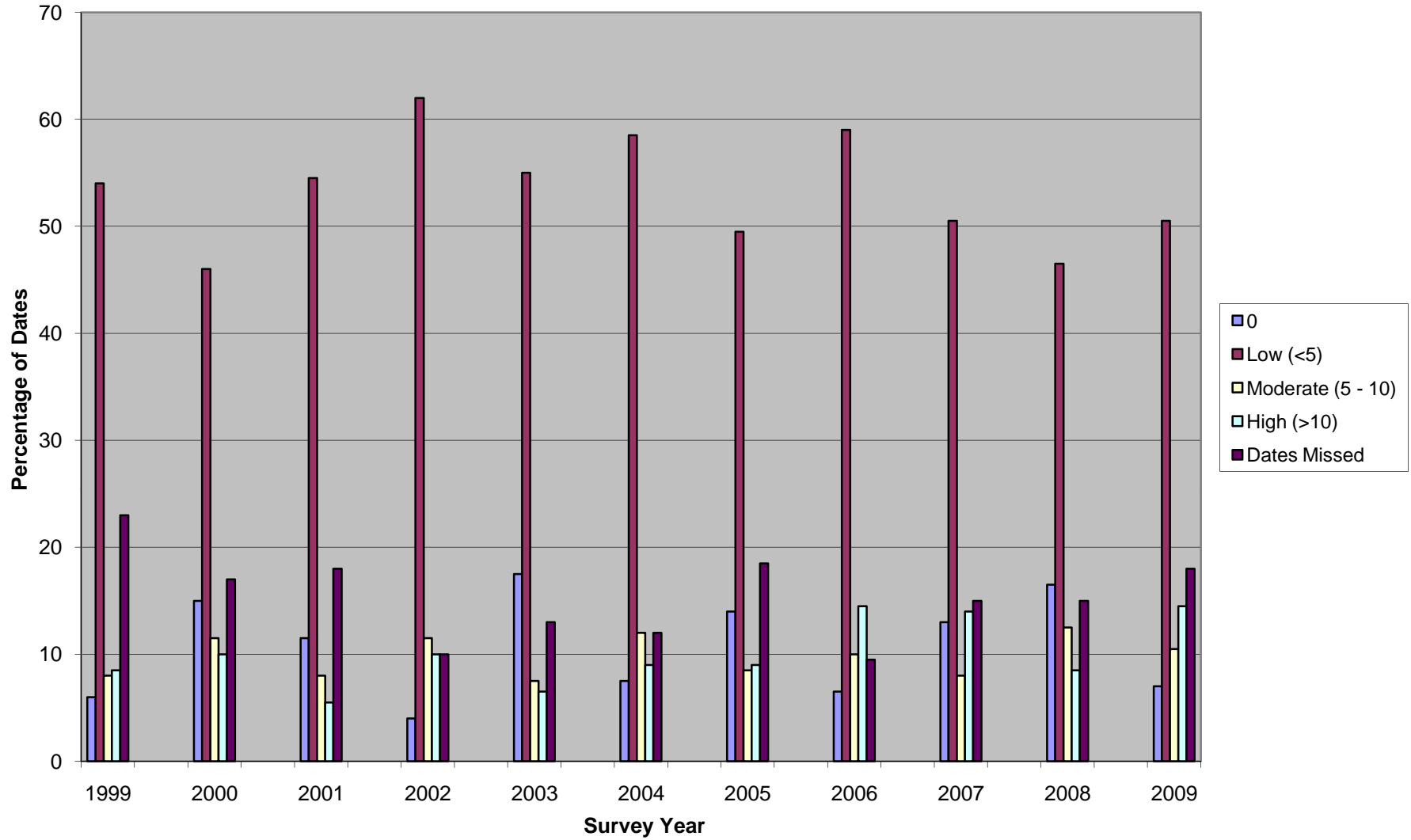


Figure 4. Seasonal Estimates of Spawning Horseshoe Crabs

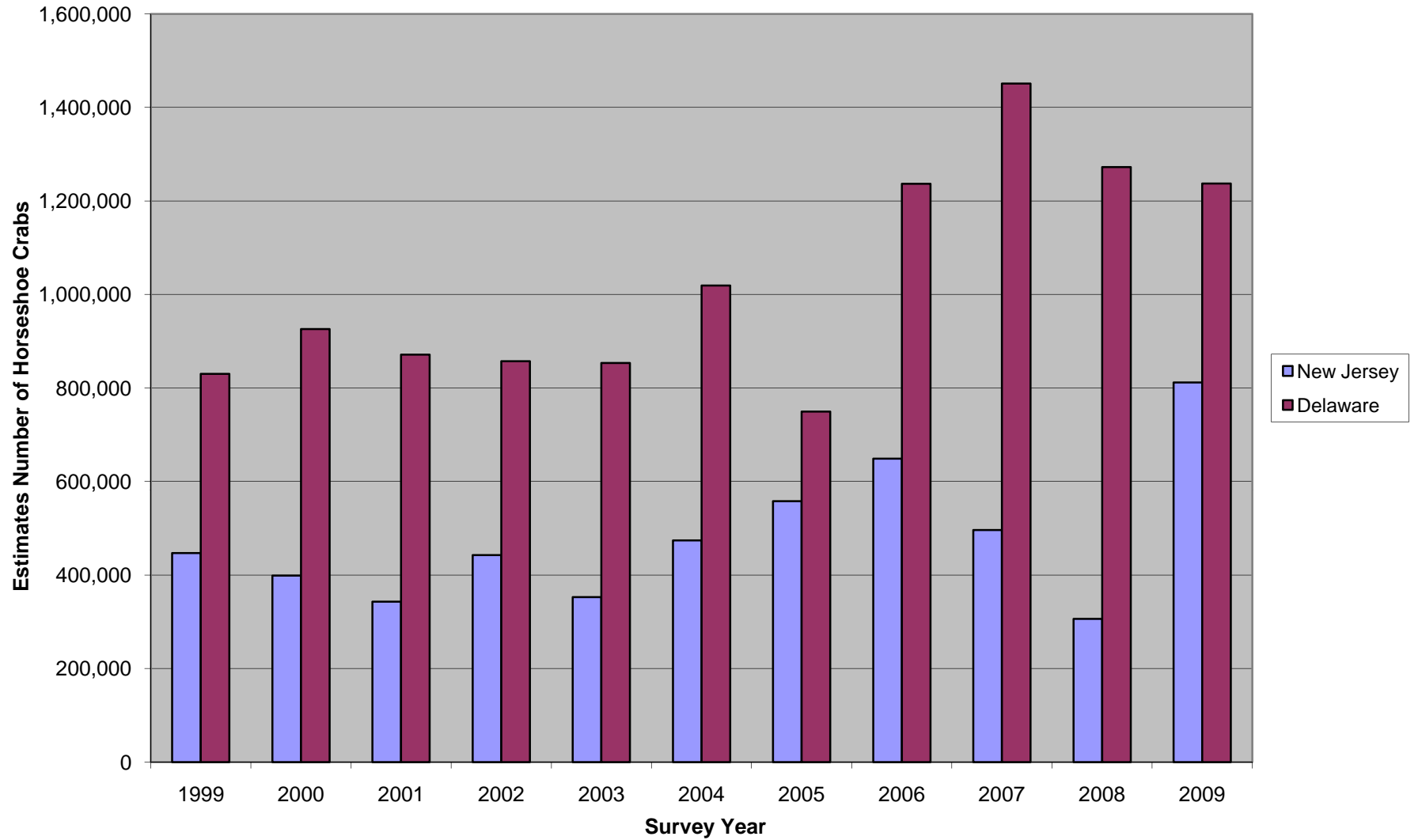


Figure 5. Seasonal Estimates of Male and Female Horseshoe Crabs 1999-2009

