

## Summary of the 1998 Spawning Survey of Horseshoe Crabs Along the Delaware Bay Shore

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

The spawning survey of horseshoe crabs was conducted along the shores of Delaware Bay for the ninth year. Counts of spawning horseshoe crabs was performed by trained volunteers on the Saturdays closest to the new and full moon dates in May and June. Counts were conducted on May 9th, May 23rd, June 6th and June 20th on Delaware and New Jersey beaches (Table 1A). Of the four dates, the highest number of horseshoe crabs was observed on the May 23rd date, the Saturday closest to the new moon date of May 25th with an estimate of 528,006 individuals (Table 3). An estimate of 361,602 spawners was calculated for 7 beaches in Delaware (Table 2A.). The New Jersey estimate of spawning individuals was 166,404 for 12 surveyed beaches (Table 2B.). An estimate of 32,318 on the May 23rd survey date was obtained for the creeks and back marsh areas in New Jersey (Table 2C.). The weather conditions during the May 23rd survey were favorable for spawning activity during the P.M. count (1924 hr predicted time of high water at the reference station, Breakwater Harbor, Delaware) (Table 1B.). Windy conditions on May 22nd, however, may have adversely affected the May 23rd A.M. spawning activity (0654 hr predicted time).

The 1998 spawning estimate of adult horseshoe crab was slightly lower than the 1997 estimate of 703,846 individuals (Table 3). The lower estimate may be due to the low count during the A.M. survey due to adverse weather conditions for spawning. The 1998 P.M. count of 464,934 individuals is comparable to the 1997 P.M. estimate of 475,810 spawners. The estimate is lower than previous estimates in the early years, but higher than years with adverse weather conditions for spawning (Table 3 and Tables 4A. and 4B.).

The Atlantic States Marine Fisheries Council recently mandated the States of Delaware and New Jersey to conduct the spawning survey of horseshoe crabs as a means of assessing the crab population. Plans are underway to improve the existing survey with the assistance of the States and the Council.

Legend 1 for Table 1A. and 1B.

Table 1A. 1998 Spawning Survey Data (Pages 1 -8)

Column A Beach - Delaware or New Jersey

Column B Date the Survey was Conducted

Column C Time the count was taken

Column D Number of 5 m segments counted or if different sampling was used, the length surveyed is listed with "m" (meters) noted.

Column E Total number of crabs counted within the segments

Column F Column E divided by Column D

$$\frac{\text{Total number of crabs counted}}{\text{Number of 5 m segments}} = \text{Average number of crabs per 5 m segment}$$

Column G Estimate of Spawning Length based on 7.5' USGS topographic quadrangles in kilometers. Spawning length is divided by 5m to obtain a multiplication factor for calculations. Creeks were roughly estimated to have a spawning length of 0.5 kilometers.

Column H Estimate of total individuals spawning during AM or PM tide using random sampling method. The total number of crabs on a particular beach was determined by taking the average number of crabs per 5 m multiplied by the spawning length of the beach (km).

Column I Total number of males counted

Column J Total number of females counted

Column K Male to Female Ratio - Column I divided by Column J

Column L Young males counted within the segments

Table 1B. 1998 Survey Weather Data (Pages 1 -8)

Column A Beach - Delaware or New Jersey

Column B Date the Survey was Conducted

Column C Time the count was taken

Column M Air Temperature at the Time of the Survey

Column N Wind Direction at the Time of the Survey

Column O Wind Velocity at the Time of the Survey

Column P Wave Height at the Time of the Survey

Column Q Weather at the Time of the Survey

Column R Notes at the Time of the Survey

Table 1. A. 1998 Spawning Survey Data

A	B	C	D	E	F	G	H	I	J	K	L
Beach	Date	Time	Seg	Total	Crabs per 5m	Length	Estimate	M	F	M/F	Y M
Delaware											
Fowlers	5/9/98	AM	18	2	0.11	3.00	67	1	1	1.00	
Fowlers	5/9/98	PM	18	0	0.00	600.00	0	0	0		
Fowlers	5/23/98	8:20AM	18	15	0.83	600.00	500	6	9	0.67	
Fowlers	5/23/98	7:40-8:50PM	18	47	2.61	600.00	1,567	39	8	4.88	26
Fowlers	6/6/98	7:00-9:00AM	18	8	0.44	600.00	267	7	1	7.00	6
Fowlers	6/6/98	7:35-8:30PM	18	14	0.78	600.00	467	8	6	1.33	2
Fowlers	6/20/98	6:25AM	18	66	3.67	600.00	2,200	47	19	2.47	23
Fowlers	6/20/98	6:30PM	18	28	1.56	600.00	933	21	7	3.00	14
Slaughter											
Slaughter	5/22/98	5:30PM	18	1,546	85.89	3.00	51,533	1327	219	6.06	168
Slaughter	5/23/98	7:00-7:30AM	18	97	5.39	600.00	3,233	76	21	3.62	2
Slaughter	5/30/98	12:50-1:45AM	18	1,790	99.44	600.00	59,667	1469	321	4.58	134
Slaughter	5/30/98	2:30-3:40PM	11	417	37.91	600.00	22,745	305	112	2.72	50
Slaughter	6/6/98	7:00-8:10AM	18	4	0.22	600.00	133	3	1	3.00	0
Slaughter	6/6/98	7:15-9:00PM	18	549	30.50	600.00	18,300	471	78	6.04	33
Slaughter	6/19/98	PM	18	127	7.06	600.00	4,233	108	19	5.68	11
Slaughter	6/20/98	6:00-6:30AM	18	156	8.67	600.00	5,200	119	37	3.22	15
Big Stone											
Big Stone	5/8/98	7:30-9:00PM	18	0	0.00	1520.00	0				
Big Stone	5/9/98	8:00-8:45AM	18	0	0.00	1520.00	0				
Big Stone	5/22/98	6:30PM	18	1,480	82.22	1520.00	124,978	1,189	291	4.09	139
Big Stone	5/23/98	7:15-9:00AM	18	3	0.17	1520.00	253	1	2	0.50	
Big Stone	6/5/98	6:00-8:00PM	18	506	28.11	1520.00	42,729	414	92	4.50	40
Big Stone	6/6/98	6:30-7:30AM	18	0	0.00	1520.00	0	0	0		
Big Stone	6/19/98	4:30-5:35PM	18	44	2.44	1520.00	3,716	34	10	3.40	0
Big Stone	6/20/98	4:50-8:00AM	18	288	16.00	1520.00	24,320	242	46	5.26	
South Bowers											
South Bowers	5/23/98	8:15-8:45AM	18	506	28.11	2.30	12,931	431	75	5.75	
South Bowers	5/23/98	8:45-9:15PM	18	2,345	130.28	460.00	59,928	2,055	290	7.09	

Table 1. A. 1998 Spawning Survey Data

A	B	C	D	E	F	G	H	I	J	K	L
Beach	Date	Time	Seg	Total	Crabs per 5m	Length	Estimate	M	F	M/F	YM
Delaware											
North Bowers	5/23/98	6:10AM-12:00PM	18	345	19.17	1.30	4,983	286	59	4.85	165
North Bowers	5/23/98	7:05-9:30PM	18	2,532	140.67	260.00	36,573	2,013	519	3.88	1182
North Bowers	5/30/98	1:50AM	18	2,038	113.22	260.00	29,438	1,779	259	6.87	135
North Bowers	6/6/98	6:30-10:30AM	18	5	0.28	260.00	72	2	3	0.67	0
North Bowers	6/6/98	6:00-9:10PM	18	152	8.44	260.00	2,196	122	30	4.07	37
North Bowers	6/20/98	6:10-7:05AM	18	52	2.89	260.00	751	44	8	5.50	10
North Bowers	6/20/98	5:30-8:30PM	18	45	2.50	260.00	650	35	10	3.50	14
Kitts Hummock						1.00					
Kitts Hummock	5/23/98	9:30-9:45AM	3	146	48.67	200.00	9,733	112	34	3.29	
Kitts Hummock	5/23/98	11:00PM	3	147	49.00	200.00	9,800	99	48	2.06	
Kitts Hummock	5/23/98	9:00-9:45AM	9	350	38.89	200.00	7,778	222	128	1.73	
Kitts Hummock	5/23/98	9:20-10:20PM	9	871	96.78	200.00	19,356	628	243	2.58	
Pickering						1.00					
Pickering	5/8/98	7:00PM	18	0	0.00	200.00	0	0	0		
Pickering	5/9/98	8:25-9:50AM	18	11	0.61	200.00	122	6	5	1.20	0
Pickering	5/22/98	7:30-9:00PM	18	2,460	136.67	200.00	27,333	1,978	482	4.10	290
Pickering	5/23/98	7:45AM	18	1,301	72.28	200.00	14,456	1,107	194	5.71	71
Pickering	5/30/98	1:15-2:15AM	18	2,386	132.56	200.00	26,511	2,007	379	5.30	
Pickering	5/30/98	2:00-3:15PM	18	2,271	126.17	200.00	25,233	1,921	350	5.49	109
Pickering	5/31/98	2:40-3:30AM	18	2,696	149.78	200.00	29,956	2,231	465	4.80	110
Pickering	6/5/98	7:30 PM	18	1,712	95.11	200.00	19,022	1,466	246	5.96	128
Pickering	6/6/98	7:30-8:15AM	18	16	0.89	200.00	178	7	9	0.78	2
Pickering	6/7/98	8:30-10:00AM	18	359	19.94	200.00	3,989	310	49	6.33	
Pickering	6/19/98	6:20-7:45PM	18	955	53.06	200.00	10,611	834	121	6.89	98
Pickering	6/20/98	7:00AM	18	425	23.61	200.00	4,722	356	69	5.16	32
Totals				31,313			723,363	25,938	5,375	4.83	3,046

Table 1. A. 1998 Spawning Survey Data

A Beach	B Date	C Time	D Seg	E Total	F Crabs per 5m	G Length	H Estimate	I M	J F	K M/F	L Y M
New Jersey											
Higbees	5/23/98	6:45-7:50PM	18	14	0.78	0.98	152	8	6	1.33	6
Higbees	6/6/98	6:00-7:15AM	18	1	0.06	196.00	11	1	0		1
Higbees	6/6/98	6:15PM	18	0	0.00	196.00	0	0	0		
Higbees	6/20/98	5:15-6:15AM	18	34	1.89	196.00	370	20	14	1.43	7
Higbees	6/20/98	5:15PM	18	15	0.83	196.00	163	8	7	1.14	5
Norbury's						2.43					
Norbury's	5/23/98	6:41-7:40AM	18	5	0.28	486.00	135	2	3	0.67	0
Norbury's	5/23/98	6:30-8:31PM	18	550	30.56	486.00	14,850	396	154	2.57	19
Norbury's	6/6/98	6:15-7:20AM	18	0	0.00	486.00	0	0	0		
Norbury's	6/6/98	6:00PM	18	0	0.00	486.00	0	0	0		
Norbury's	6/20/98	5:30-6:45AM	18	61	3.39	486.00	1,647	47	14	3.36	6
Norbury's	6/20/98	5:50PM	18	14	0.78	486.00	378	8	6	1.33	
Norbury's	6/23/98	8:40PM	18	10	0.56	486.00	270	5	5	1.00	1
Norbury's	7/9/98	7:45PM	18	7	0.39	486.00	189	4	3	1.33	
Rutgers South						2.20					
Rutgers South	5/23/98	6:00-7:32AM	18	0	0.00	440.00	0	0	0		
Rutgers South	5/23/98	7:19-8:25PM	18	1,083	60.17	440.00	26,473	906	177	5.12	62
Rutgers South	6/6/98	6:00-7:05AM	18	0	0.00	440.00	0	0	0		
Rutgers South	6/6/98	7:15-7:49PM	18	0	0.00	440.00	0	0	0		
Higgs						0.80					
Higgs	5/9/98	AM		0		160.00	0				
Higgs	5/9/98	PM		0		160.00	0				
Higgs	5/23/98	AM	100m	0		160.00	0				
Higgs	5/23/98	7:30-8:30PM	100m	660	33.00	160.00	5,280	598	62	9.65	
Higgs	5/24/98	8:10PM	100m	716	35.80	160.00	5,728	665	51	13.04	
Higgs	6/6/98	AM		0		160.00	0				
Higgs	6/6/98	PM		0		160.00	0				
Higgs	6/20/98	AM		0		160.00	0				
Higgs	6/20/98	PM		0		160.00	0				

Table 1. A. 1998 Spawning Survey Data

A	B	C	D	E	F	G	H	I	J	K	L
Beach	Date	Time	Seg	Total	Crabs per 5m	Length	Estimate	M	F	M/F	YM
New Jersey											
Kimblies	5/9/98	8:00-9:15AM		0		1.00	0				
Kimblies	5/9/98	8:30-9:10PM		0		200.00	0				
Kimblies	5/23/98	7:15-8:15AM	18	107	5.94	200.00	1,189	87	20	4.35	
Kimblies	5/23/98	7:30-9:45PM	18	1330	73.89	200.00	14,778	1147	183	6.27	
Kimblies	6/6/98	7:00-7:20AM	18	0	0.00	200.00	0				
Kimblies	6/6/98	PM	18	0	0.00	200.00	0				
Kimblies	6/20/98	6:00-6:30AM	18	0	0.00	200.00	0				
Kimblies	6/20/98	6:30-7:00PM	18	0	0.00	200.00	0				
Kimblies/Pierces Ck											
Kimblies/Pierces Ck	5/23/98	AM	6	132	22.00	100.00	2,200	110	22	5.00	
Kimblies/Pierces Ck	5/23/98	8:30-8:50PM	6	1153	192.17	100.00	19,217	1035	118	8.77	
Kimblies/Pierces Ck	6/6/98	AM	6	3	0.50	100.00	50	2	1	2.00	
Kimblies/Pierces Ck	6/6/98	PM	6	0	0.00	100.00	0				
Kimblies/Pierces Ck	6/20/98	AM+PM	6	0	0.00	100.00	0				
Kimblies/Cooks Ck						0.50					
Kimblies/Cooks Ck	5/23/98	AM	6	114	19.00	100.00	1,900	108	6	18.00	
Kimblies/Cooks Ck	5/23/98	9:15-9:40PM	6	346	57.67	100.00	5,767	310	36	8.61	
Kimblies/Cooks Ck	6/6/98	AM+PM	6	0	0.00	100.00	0				
Kimblies/Cooks Ck	6/20/98	AM+PM	6	0	0.00	100.00	0				
Cooks						3.00					
Cooks	5/11/98	8:10-9:35AM	21	73	3.48	600.00	2,086	38	35		9
Cooks	5/11/98	PM				600.00					
Cooks	5/23/98	6:30-8:00AM	21	36	1.71	600.00	1,029	20	16		
Cooks	5/23/98	6:30-9:00PM	21	1,210	57.62	600.00	34,571	948	262		151
Cooks	5/25/98	8:10-9:30AM	21	117	5.57	600.00	3,343	55	62		5
Cooks	5/25/98	7:45-9:15PM	21	1,481	70.52	600.00	42,314	1,162	319		183
Cooks	6/9/98	8:15-9:15AM	21	4	0.19	600.00	114	3	1		
Cooks	6/9/98	8:20-9:10PM	21	6	0.29	600.00	171	5	1		

Table 1. A. 1998 Spawning Survey Data

A	B	C	D	E	F	G	H	I	J	K	L
Beach	Date	Time	Seg	Total	Crabs per 5m	Length	Estimate	M	F	M/F	Y M
New Jersey											
Reeds	5/9/98	8:20-9:30AM	18	28	1.56	1.53	476	20	8		
Reeds	5/9/98	8:10-9:50PM	18	145	8.06	306.00	2,465	114	31		
Reeds	5/23/98	7:00-8:00AM	18	42	2.33	306.00	714	27	15	1.80	5
Reeds	5/23/98	7:45-8:30PM	18	1,566	87.00	306.00	26,622	1,092	474	2.30	2
Reeds-South BC	6/6/98	6:45-7:15AM	18	0	0.00	306.00	0	0	0		
Reeds-South BC	6/6/98	7:25-7:45PM	18	0	0.00	306.00	0	0	0		
Moores											
Moores	5/9/98	10:15-11:30AM	6	198	33.00	600.00	19,800	163	35	4.66	
Moores	5/23/98	8:40-9:10AM	15	163	10.87	600.00	6,520	139	24		
Moores	5/23/98	PM				600.00					
Moores	6/6/98	7:45-8:10AM	18	0		600.00	0	0	0		
Moores	6/6/98	8:25-8:45PM	18	8	0.44	600.00	267	7	1	7.00	
Moores-Creek											
Moores-Creek	5/23/98	AM				0.50					
Thompsons-Marsh											
West Bank Channel 2											
West Bank Channel 2	5/9/98	9:15-9:40AM	2	143	71.50	8.00	572	134	9	14.89	
West Bank Channel 2	5/23/98	9:00-9:10AM	1	68	68.00	8.00	544	65	3	21.67	
Adler's Ditch											
Adler's Ditch	5/9/98	9:50-10:00AM	3	92	30.67	0.05	307	83	9	9.22	
Adler's Ditch(1 mile)	5/23/98	8:45-8:55AM	1	199	199.00	10.00	1,990	148	51	2.90	
Adler's Ditch	6/20/98	7:35-7:55AM	6	57	9.50	10.00	95				
Adler's Ditch-South	6/20/98	7:10-7:30AM	2	79	39.50	10.00	395	74	5		
Other Sites											
Thompson Beach Rd.	5/6/98	12:30-1:30PM		100		1,070 m					
East Bank Channel 2	5/9/98	10:15AM		200-300		25m-peat					
Riggins Ditch	5/9/98	10:15AM		100-200		peatw/sand					
Channel 3	5/9/98	10:15AM		0							
Channel 1 (North)	5/23/98	8:10-8:30AM	2	59	29.50	100m		47	12	3.92	

Table 1. A. 1998 Spawning Survey Data

A	B	C	D	E	F	G	H	I	J	K	L
Beach	Date	Time	Seg	Total	Crabs per 5m	Length	Estimate	M	F	M/F	Y M
New Jersey Other Sites											
Channel 1 (North)	6/5/98	8:45AM		4		3600 sq.ft	4	3	1		
Channel 1 (South)	6/5/98	9:35AM		2		1200 sq.ft	2	1	1		
Channel 2	6/6/98	7:31AM		0			0				
East West+Butchers	6/6/98	8:00AM		0			0				
Riggins Ditch-East	6/6/98	8:15AM		4			4				
Plug Channel 4	6/6/98	8:30AM		2			2				
South side of Plug	6/6/98	8:57AM		5			5				
Riggins Ditch-West	6/6/98	9:30AM		4			4				
Channel 1	6/6/98	10:30AM		0			0				
Thompsons-Beach						1.00					
Thompsons-Beach	5/9/98	9:15AM		15		200.00	15				
Thompsons-Beach	5/23/98	8:10-8:30AM		75		200.00	75				
Thompsons-Beach	6/6/98	7:45AM		4		200.00	4				
Thompsons-Beach	6/20/98	8:00-8:10AM	3	37	12.33	200.00	2,467	33	4	8.25	
Commercial Township											
	5/13/98	12:30-6:30PM		0			0				
	5/29/98			125			125				
Channel 2E	6/12/98	1:00-1:45PM	2	13	6.50	100m	130	7	6		
Channel 3C	6/12/98	2:00-2:30PM		40		91.4 m	40	23	17		
	6/29/98	1:30-3:05PM		0			0				
East Point						0.95					
East Point	5/10/98	10:42-11:15PM	14	443	31.64	190.00	6,012	376	67	5.61	est.20%
East Point	5/11/98	10:24AM	18	233	12.94	190.00	2,459	184	49		est.0%
East Point	5/23/98	8:40PM	15	1543	102.87	190.00	19,545	1346	197		
East Point	5/24/98	9:25-10:30AM	18	681	37.83	190.00	7,188	567	114	4.97	
East Point	6/6/98	6:51-7:45PM	18	2	0.11	190.00	21	1	1	1.00	
East Point	6/7/98	7:55AM	18	0	0.00	190.00	0	0	0		
East Point	6/20/98	7:30AM	18	167	9.28	190.00	1,763	129	38	3.39	
East Point	6/21/98	7:40PM	14	35	2.50	190.00	475	32	3	10.67	
East Point-South Ck	5/11/98										
East Point-North Ck	Various										



Table 1. A. 1998 Spawning Survey Data

A	B	C	D	E	F	G	H	I	J	K	L
Beach New Jersey	Date	Time	Seg	Total	Crabs per 5m	Length	Estimate	M	F	M/F	Y M
Fortescue	6/6/98	6:45-7:55AM	18	0	0.00	2.60	0	0	0		
Fortescue	6/6/98	7:30-8:30PM	18	0	0.00	520.00	0	0	0		
Fortescue	6/20/98	6:00-8:00AM	18	102	5.67	520.00	2,947	69	33	2.09	
Fortescue	6/20/98	7:10-8:30PM	12	144	12.00	520.00	6,240	118	26	4.54	
Fortescue-Creek						0.50					
Oyster Creek	6/20/98	7:00-7:20AM	6	92	15.33	100.00	1,533	61	31	1.97	
OysterCk Mouth	6/20/98	7:30-7:40PM	3	132	44.00	100.00	4,400	107	25	4.28	
Fortescue Creek	6/6/98					100.00					
Fortescue Creek	6/20/98					100.00					
Gandys						1.20					
Gandys	5/10/98	10:23-12:15PM	25	29	1.16	240.00	278	21	8	2.63	12
Gandys	5/10/98	10:25-11:35PM	25	102	4.08	240.00	979	82	20	4.10	
Gandys	5/24/98	9:10-10:20AM	25	56	2.24	240.00	538	43	13	3.31	6
Gandys	5/24/98	9:25-10:00PM	25	643	25.72	240.00	6,173	496	147	3.37	
Gandys	5/25/98	10:25AM-noon	25	34	1.36	240.00	326	20	14	1.43	4
Gandys	5/25/98	10:05PM-Midnight	25	853	34.12	240.00	8,189	686	167	4.11	
Gandys	6/7/98	9:00-11:00AM	25	10	0.40	240.00	96	9	1	9.00	1
Gandys	6/7/98	9:20-10:30PM	25	4	0.16	240.00	38	3	1	3.00	
Gandys	6/8/98	9:40-11:05AM	25	1	0.04	240.00	10	1	0		1
Gandys	6/8/98	9:40-11:00PM	25	78	3.12	240.00	749	60	18	3.33	
Gandys	6/21/98	8:15-9:45AM	25	314	12.56	240.00	3,014	269	45	5.98	48
Gandys	6/21/98	8:25-9:40PM	25	103	4.12	240.00	989	85	18	4.72	
Gandys-Creek											
Beach Creek	5/10/98	10:23-12:15PM		31			31				
Beach Creek	5/24/98	9:10-10:20AM		110			110				
Beach Creek	5/25/98	10:25AM-noon		195			195				
Beach Creek	6/7/98	9:00-11:00AM		0			0				
Beach Creek	6/8/98	9:40-11:05AM		0			0				
Beach Creek	6/21/98	8:15-9:45AM		22			22				

Table 1. A. 1998 Spawning Survey Data

A	B	C	D	E	F	G	H	I	J	K	L
Beach	Date	Time	Seg	Total	Crabs per 5m	Length	Estimate	M	F	M/F	Y M
New Jersey											
Sea Breeze	5/9/98	10:00-10:20AM	18	1	0.06	1.65	18	0	1	0.00	
Sea Breeze	5/23/98	8:30-9:30AM	15	26	1.73	330.00	572	17	9	1.89	5
Sea Breeze	6/6/98	AM and PM		0		330.00	0				
Sea Breeze	6/20/98	5:40AM		61		330.00	61	48	13	3.69	
Sea Breeze	6/20/98	6:05PM		71		330.00	71	49	22	2.23	
Totals				18,806			322,991	14,708	3,349	4.39	

Table 1. B. 1998 Survey Weather Data

A	B	C	M	N	O	P	Q	R
Beach	Date	Time	Air Temp	Wind Dir	Wind Vel	Wave Hgt	Weather	Notes
Delaware	5/9/98	AM						
Fowlers	5/9/98	AM						
Fowlers	5/9/98	PM						
Fowlers	5/23/98	8:20AM	70	SW	3mph	1-1.5'	clear	partial sunlight, dusk, calm
Fowlers	5/23/98	7:40-8:50PM	60	NE	5-10mph	1-1.5'	cloudy	
Fowlers	6/6/98	7:00-9:00AM	65	NW	<5mph	<1'	clear	
Fowlers	6/6/98	7:35-8:30PM					clear	
Fowlers	6/20/98	6:25AM					partialcloud	
Fowlers	6/20/98	6:30PM	80	E	<5mph	<1'	clear	
Slaughter	5/22/98	5:30PM	68	N	10-15mph	1ft.	clear	full sunlight
Slaughter	5/23/98	7:00-7:30AM	65				clear	full sunlight
Slaughter	5/30/98	12:50-1:45AM	80		5-7mph	<1ft.	full dark	slight haze to cloudy
Slaughter	5/30/98	2:30-3:40PM	70	ESE	4-8mph	minimal	clear	full sunlight, hot, mild breeze
Slaughter	6/6/98	7:00-8:10AM	80	NE	5-10mph	minimal	partialclouds	high thin clouds breaking up
Slaughter	6/6/98	7:15-9:00PM	82	W	5-10mph	calm	clear	nearly dusk, beautiful evening
Slaughter	6/19/98	PM					partialclouds	partial sunlight, high clouds
Slaughter	6/20/98	6:00-6:30AM					clear	sunny
Big Stone	5/8/98	7:30-9:00PM	58	E	10-15mph	2-3'	cloudy	dusk
Big Stone	5/9/98	8:00-8:45AM	53	NE	15-20mph	3'	cloudy	light rain, water dirty
Big Stone	5/22/98	6:30PM	70	N	5mph		full sun	water temp. 70 degrees
Big Stone	5/23/98	7:15-9:00AM	55	N	5-10mph	<1'	full sun	
Big Stone	6/5/98	6:00-8:00PM	68	NW	5mph	flat	cloudy	dusk
Big Stone	6/6/98	6:30-7:30AM	53	NW	10mph	1'	cloudy	
Big Stone	6/19/98	4:30-5:35PM	80	W	10mph	<1'	cloudy	lots of eggs on beach+water
Big Stone	6/20/98	4:50-8:00AM	72	WSW	5mph	<1'	cloudy	dawn
South Bowers	5/23/98	8:15-8:45AM	78	N	4mph		partialcloud	calm
South Bowers	5/23/98	8:45-9:15PM					partialcloud	lots of no see ums

Table 1. B. 1998 Survey Weather Data

A	B	C	M	N	O	P	Q	R
Beach	Date	Time	Air Temp	Wind Dir	Wind Vel	Wave Hgt	Weather	Notes
North Bowers Delaware	5/23/98	6:10AM-12:00PM	80	NE	10mph	1.5'	partialcloud	full sunlight
North Bowers	5/23/98	7:05-9:30PM	62	none	0	1.5'	dusk	moonlight
North Bowers	5/30/98	1:50AM						
North Bowers	6/6/98	6:30-10:30AM	26C	none	0	1.5-2'	partialcloud	partial sunlight
North Bowers	6/6/98	6:00-9:10PM	30C	NE	5mph	2.5'	clear	partial sunlight
North Bowers	6/20/98	6:10-7:05AM	28C	NE	3mph	1.5'	clear	full sunlight, 62% humidity
North Bowers	6/20/98	5:30-8:30PM	28C	variable	5mph	2.5'	clear	partial sunlight, 40% humidity
Kitts Hummock	5/23/98	9:30-9:45AM	78	N	4mph	<1ft.	partialcloud	
Kitts Hummock	5/23/98	11:00PM			1mph	<6"	full dark	
Kitts Hummock	5/23/98	9:00-9:45AM	62	N	5mph	calm	partialcloud	full sunlight
Kitts Hummock	5/23/98	9:20-10:20PM		SE	calm	6"	full dark	clear
Pickering	5/8/98	7:00PM						full darkness, rain in day
Pickering	5/9/98	8:25-9:50AM	58	SE		2-4ft.	cloudy	locals lots of crabs 5/7PM
Pickering	5/22/98	7:30-9:00PM	60	NE		calm	clear	dusk, count 1m, but 2.5m deep
Pickering	5/23/98	7:45AM						
Pickering	5/30/98	1:15-2:15AM	79	WSW	15mph	2.5'	partialcloud	moonlight, full darkness
Pickering	5/30/98	2:00-3:15PM	90	W	3-5mph	minimal	full sun	lots of crabs
Pickering	5/31/98	2:40-3:30AM	warm		5-7mph	nowaves	fulldark	
Pickering	6/5/98	7:30 PM	70	W	light		cloudy	count 1m, but 1.5m
Pickering	6/6/98	7:30-8:15AM	16C	E	10mph	0.5'	partialcloud	dawn
Pickering	6/7/98	8:30-10:00AM	78	NW	5-10mph	minimal	full sun	partial sunlight
Pickering	6/19/98	6:20-7:45PM	25C	SE		0.5'	cloudy	hazy, full sunlight
Pickering	6/20/98	7:00AM	29C	SE	2-4mph	0-0.5'	clear	

Table 1. B. 1998 Survey Weather Data

A	B	C	M	N	O	P	Q	R
Beach New Jersey	Date	Time	Air Temp	Wind Dir	Wind Vel	Wave Hgt	Weather	Notes
Higbees	5/23/98	6:45-7:50PM	60	S	light	no waves	clear	full sunlight, water calm
Higbees	6/6/98	6:00-7:15AM	75	N	1.5mph	1ft.	cloudy	overcast,windy, partial sun
Higbees	6/6/98	6:15PM	65	NW	10mph	2.5ft.	clear	dusk, partial sun
Higbees	6/20/98	5:15-6:15AM	80	NW	5mph	0.5ft.	partialcloud	overcast, partial sun
Higbees	6/20/98	5:15PM	80	SW	1.5mph	0.5ft.	partialcloud	warm, humid, partial sun
Norbury's	5/23/98	6:41-7:40AM	57	W	5-10mph	none	clear	dawn, full sun, light breeze
Norbury's	5/23/98	6:30-8:31PM	68	W	5-10mph	0	clear	partial sun, dusk
Norbury's	6/6/98	6:15-7:20AM	chilly	W	strong	1/3m	partialcloud	dawn, overcast
Norbury's	6/6/98	6:00PM	72	W	strong	1-2ft.	clear	full sunlight, dusk
Norbury's	6/20/98	5:30-6:45AM	70	SW	2-3knots	4-6"	clear	dawn, nice!
Norbury's	6/20/98	5:50PM	80	SW	light	4-6"	clear	dusk,hazy
Norbury's	6/23/98	8:40PM	80	nobreeze	0	no waves	overcast	full darkness
Norbury's	7/9/98	7:45PM	72	SW	light	6"	clear	dusk,moonlight,pleasant
Rutgers South	5/23/98	6:00-7:32AM	55	WNW	8-10mph	12-18"	clear	full sunlight
Rutgers South	5/23/98	7:19-8:25PM	70	SW	5 knots	6"	clear	full sun,ASA 64, E, 5.6/8,S 8
Rutgers South	6/6/98	6:00-7:05AM	55	W	10-15 kts	15-18"	cloudy	ASA 64, N 4, E 4/5,6
Rutgers South	6/6/98	7:15-7:49PM		W	10-15 kts	1-2'	clear	ASA 64, E 11, S 11
Higgs	5/9/98	AM		NW	very windy			
Higgs	5/9/98	PM						
Higgs	5/23/98	AM	79.5	W	5-7mph	6"	clear	full sun,dusk, 1m in
Higgs	5/23/98	7:30-8:30PM						
Higgs	5/24/98	8:10PM						
Higgs	6/6/98	AM						
Higgs	6/6/98	PM						
Higgs	6/20/98	AM						
Higgs	6/20/98	PM						

Table 1. B. 1998 Survey Weather Data

A	B	C	M	N	O	P	Q	R
Beach	Date	Time	Air Temp	Wind Dir	Wind Vel	Wave Hgt	Weather	Notes
New Jersey								
Kimblies								
Kimblies	5/9/98	8:00-9:15AM			windy		clear	full sun, pleasant morning
Kimblies	5/9/98	8:30-9:10PM			windy		dusk	moonlight, full dark, pleasant
Kimblies	5/23/98	7:15-8:15AM						
Kimblies	5/23/98	7:30-9:45PM						
Kimblies	6/6/98	7:00-7:20AM			windy	rough	cloudy	partial sun
Kimblies	6/6/98	PM						
Kimblies	6/20/98	6:00-6:30AM						
Kimblies	6/20/98	6:30-7:00PM						
Kimblies/Pierces Ck								
Kimblies/Pierces Ck	5/23/98	AM						
Kimblies/Pierces Ck	5/23/98	8:30-8:50PM						Right angle to shoreline Width 14-15 ft.
Kimblies/Pierces Ck	6/6/98	AM						
Kimblies/Pierces Ck	6/6/98	PM						sand bar with spawning occurri
Kimblies/Pierces Ck	6/20/98	AM+PM						
Kimblies/Cooks Ck								
Kimblies/Cooks Ck	5/23/98	AM						Right angle to shoreline Width 10-12 ft.
Kimblies/Cooks Ck	5/23/98	9:15-9:40PM						
Kimblies/Cooks Ck	6/6/98	AM+PM						sand bar with spawning occurri
Kimblies/Cooks Ck	6/20/98	AM+PM						
Cooks								
Cooks	5/11/98	8:10-9:35AM	50	NE	20-30mph	1-1.5ft.	cloudy	Dawn
Cooks	5/11/98	PM						Heavy Rain and Wind
Cooks	5/23/98	6:30-8:00AM	48	SW	20mph	1ft.	clear	Dawn
Cooks	5/23/98	6:30-9:00PM	65	NE	10-15mph	<1ft.	clear, sunny	Full sun-Dusk-Full Darkness
Cooks	5/25/98	8:10-9:30AM	63	SW	5mph	<1ft.	overcast	Dawn
Cooks	5/25/98	7:45-9:15PM	68	SW	5-10mph	<1ft.	cloudy	Dusk-Full Darkness
Cooks	6/9/98	8:15-9:15AM	60	S	5mph	6"	clear	Dawn, light breeze
Cooks	6/9/98	8:20-9:10PM	65	S	5mph	6"	cloudy	Dusk

Table 1. B. 1998 Survey Weather Data

A	B	C	M	N	O	P	Q	R
Beach	Date	Time	Air Temp	Wind Dir	Wind Vel	Wave Hgt	Weather	Notes
New Jersey								
Reeds	5/9/98	8:20-9:30AM	59	N	15-20mph	1ft.	cloudy	light rain, windy
Reeds	5/9/98	8:10-9:50PM	57	NNE	20mph	<1ft.	cloudy	windy, dusk-full darkness
Reeds	5/23/98	7:00-8:00AM	60	N	0-5mph	<1ft.	Full sunlight	
Reeds	5/23/98	7:45-8:30PM	60	SW	5-10mph	<1ft.	clear	Full sun-dusk
Reeds-South BC	6/6/98	6:45-7:15AM	52	NW	10-15mph	1ft. swells	cloudy	Dawn
Reeds-South BC	6/6/98	7:25-7:45PM	70	NW	10-15mph	2ft. swells	clear	windy, 2-3 ft. swells
Moores								
Moores	5/9/98	10:15-11:30AM	59	N	15-20mph	0	cloudy	light rain
Moores	5/23/98	8:40-9:10AM	60	N	0-5mph	<1ft.	Full sun	water-flat
Moores	5/23/98	PM	50	S	5-10mph	1ft.	clear	flooded access road, no count
Moores	6/6/98	7:45-8:10AM	57	NW	5-10mph	1ft. swell	cloudy	
Moores	6/6/98	8:25-8:45PM	60	NW	10-15mph	2ft. swell	clear	windy, 2-3ft. swells
Moores-Creek								
Moores-Creek	5/23/98	AM	60	N	0-5mph	<1ft.	clear	SW, strong, no sandbars, sand+
Thompsons-Marsh								
West Bank Channel 2								
West Bank Channel 2	5/9/98	9:15-9:40AM	54	NNW	windy	<0.5ft.	cloudy	sand with peat at ends
West Bank Channel 2	5/23/98	9:00-9:10AM	65	NE	mild wind	none	partialcloud	drizzle
Adler's Ditch								
Adler's Ditch	5/9/98	9:50-10:00AM	54	NNW	windy	<0.5ft.	cloudy	sandy, small clumps Spartina
Adler's Ditch(1 mile)	5/23/98	8:45-8:55AM	65	NE	mild wind	none	partialcloud	200mlength, 3m into water
Adler's Ditch	6/20/98	7:35-7:55AM	mid60-70's	NE	0-5mph	N/A	Full sun	Hazy, humid
Adler's Ditch-South	6/20/98	7:10-7:30AM	mid60-70's	NE	0-5mph	N/A	Full sun	Hazy, humid
Other Sites								
Thompson Beach Rd.	5/6/98	12:30-1:30PM						
East Bank Channel 2	5/9/98	10:15AM	cool	windy			overcast	damp with occasional rain
Riggins Ditch	5/9/98	10:15AM	cool	windy			overcast	damp with occasional rain
Channel 3	5/9/98	10:15AM	cool	windy			overcast	damp with occasional rain
Channel 1 (North)	5/23/98	8:10-8:30AM	65	NE	mild wind	none	partialcloud	cool





Table 1. B. 1998 Survey Weather Data

A	B	C	M	N	O	P	Q	R
Beach	Date	Time	Air Temp	Wind Dir	Wind Vel	Wave Hgt	Weather	Notes
New Jersey								
Fortescue	6/6/98	12:45-1:40PM	59	NW	20knots	1ft.	cloudy	
Fortescue	6/6/98	11:35PM-12:05AM	68	NW	25knots	1ft.	partialcloud	
Fortescue	6/20/98	10:30AM-12:30PM	76	WNW	5knots	<1ft.	partialcloud	
Fortescue	6/20/98		76	W	light	moderate	cloudy	near dusk
Fortescue-creek								
Oyster Creek	6/20/98	7:00-7:20AM						RightAngle,40ft.,moderate,sand
OysterCk Mouth	6/20/98	7:30-7:40PM						
Fortescue Creek	6/6/98							
Fortescue Creek	6/20/98							100ft.width,sandy
Gandys								
Gandys	5/10/98	10:23-12:15PM	60	ENE	5mph	6"	overcast	no sun
Gandys	5/10/98	10:25-11:35PM	60	NE	5mph	6"	overcast	no moon
Gandys	5/24/98	9:10-10:20AM	70	calm	calm	6"	bright sun	
Gandys	5/24/98	9:25-10:00PM	70	SW	5mph	1ft.	dark	no moon, no stars
Gandys	5/25/98	10:25AM-noon	68	SW	10mph	1ft.	overcast	
Gandys	5/25/98	10:05PM-Midnight	72	WSW	7mph	8"	overcast	no stars
Gandys	6/7/98	9:00-11:00AM	65	SW	5mph	6"	full sun	no clouds
Gandys	6/7/98	9:20-10:30PM	65	W	10mph	1ft.	full moon	
Gandys	6/8/98	9:40-11:05AM	65	W	10mph	1ft.	sunny	spotty clouds
Gandys	6/8/98	9:40-11:00PM	72	calm	calm	6"	full moon	no clouds
Gandys	6/21/98	8:15-9:45AM	82	calm	calm	6"	clear	low sun
Gandys	6/21/98	8:25-9:40PM	75	S	5mph	8"	dusk	
Gandys-creek								
Beach Creek	5/10/98	10:23-12:15PM	60	ENE	5mph	6"	overcast	no sun
Beach Creek	5/24/98	9:10-10:20AM	70	calm	calm			east bank 40m, west bank
Beach Creek	5/25/98	10:25AM-noon	68	SW	10mph			
Beach Creek	6/7/98	9:00-11:00AM	65	SW	5mph	6"	full sun	
Beach Creek	6/8/98	9:40-11:05AM	65	W	10mph	1ft.	sunny	spotty clouds
Beach Creek	6/21/98	8:15-9:45AM	82	calm	calm	6"	clear	low sun

Table 1. B. 1998 Survey Weather Data

A	B	C	M	N	O	P	Q	R
Beach	Date	Time	Air Temp	Wind Dir	Wind Vel	Wave Hgt	Weather	Notes
New Jersey								
Sea Breeze	5/9/98	10:00-10:20AM	59	NNE	15-20knots	1ft.	cloudy	rain
Sea Breeze	5/23/98	8:30-9:30AM	65	N	10knots	1ft.	clear	sunny, cirrus clouds
Sea Breeze	6/6/98	AM and PM	65	S	moderate	calm		High Ceiling-Good
Sea Breeze	6/20/98	5:40AM			breezy		clear	
Sea Breeze	6/20/98	6:05PM			calm		clear	

Table 2. Summary of 1998 Survey Data  
A. Delaware Beaches

	Estimate 5/9/98 AM	Estimate 5/9/98 PM	Estimate 5/23/98 AM	Estimate 5/23/98 PM	Estimate 6/6/98 AM	Estimate 6/6/98 PM	Estimate 6/20/98 AM	Estimate 6/20/98 PM	Beach Totals
Fowlers	67	0	500	1,567	267	467	2,200	933	6,001
Slaughter			3,233	51,533 (5/22/98)	133	18,300	5,200	4,233 (6/19/98)	82,632
Big Stone	0	0 (5/8/98)	253	124,978 (5/22/98)	0	42,729 (6/5/98)	24,320	3,716 (6/19/98)	195,996
South Bowers			12,931	59,928					72,859
North Bowers			4,983	36,573	72	2,196	751	650	45,225
Kitts Hummock			8,756	14,578					23,334
Pickering	0	122	14,456	27,333	178	19,022 6/5/98	4,722	10,611	76,444
AM and PM Totals	67	122	45,112	316,490	650	82,714	37,193	20,143	502,491
Daily Total		189		361,602		83,364		57,336	502,491

Table 2. Summary of 1998 Survey Data  
B. New Jersey Beaches

	Estimate 5/9/98 AM	Estimate 5/9/98 PM	Estimate 5/23/98 AM	Estimate 5/23/98 PM	Estimate 6/6/98 AM	Estimate 6/6/98 PM	Estimate 6/20/98 AM	Estimate 6/20/98 PM	Beach Totals
Higbees				152	11	0	370	163	696
Norbury's			135	14,850	0	0	1,647	378	17,010
Rutgers South			0	26,473	0	0			26,473
Hights	0	0	0	5,280	0	0	0	0	5,280
Kimbles	0	0	1,189	14,778	0	0	0	0	15,967
Cooks	2,086 (5/11/98)		1,029	34,571	114 (6/9/98)	171 (6/9/98)			37,971
Reeds	476	2,465	714	26,622	0	0			30,277
Moore's	19,800		6,520		0	267			26,587
Thompsons-Beach	15		75		4		2,467		2,561
East Point	2,459 (5/11/98)	6,012	7,188 (5/24/98)	19,545	0 (6/7/98)	21	1,763	475 6/21/98	37,463
Fortescue					0	0	2,947	6,240	9,187
Gandys	278	979	538	6,173	96 (6/7/98)	38 (6/7/98)	3,014 (6/21/98)	989 (6/21/98)	12,105
Sea Breeze	18		572		0		61	71	722
AM and PM Totals	23,046	11,542	17,960	148,444	225	497	12,269	8,316	222,299
Daily Totals		34,588		166,404		722		20,585	222,299

Table 2. Summary of 1998 Survey Data  
C. Tidal Creek and Marsh Areas

	Estimate 5/9/98 AM	Estimate 5/9/98 PM	Estimate 5/23/98 AM	Estimate 5/23/98 PM	Estimate 6/6/98 AM	Estimate 6/6/98 PM	Estimate 6/20/98 AM	Estimate 6/20/98 PM	Totals
New Jersey Kimbles/Pierces Ck			2,200	19,217	50	0	0	0	21,467
Kimbles/Cooks Ck			1,900	5,767	0	0	0	0	7,667
Thompsons-Marsh West Bank Channel 2	572		544						1,116
Adler's Ditch	307		1,990		15		490		2,787
Other Sites	500		590						1,105
Fortescue-Creek							1,533	4,400	5,933
Gandys-Creek	31 (5/10/98)		110 (5/24/98)		0 (6/7/98)		22 (6/21/98)		163
Sea Breeze-Creek									
AM and PM Totals	1,410		7,334	24,984	65	0	2,045	4,400	40,238
Daily Totals		1,410		32,318		65		6,445	40,238

Table 3. Comparison of Data on Horseshoe Crabs Spawning on Delaware Bay Shores on Pre-Selected Dates\*.

	9-May-98	23-May-98	6-Jun-98	20-Jun-98
Estimation of Spawning Individuals	34,777	528,006	84,086	77,921
Percentage of DE Spawning Individuals	1	68	99	74
Percentage of NJ Spawning Individuals	99	32	1	26
Individuals During AM High Tide	23,113	63,072	875	49,462
Individuals During PM High Tide	11,664	464,934	83,211	28,459
Ratio of Individuals PM vs. AM Tide	0.50	7.37	95.10	0.58
Beaches Surveyed in Delaware	3	7	5	5
Beaches Surveyed in New Jersey	9	12	12	9
Ratio of Male Individuals to Female		4.66		
Ratio Male to Female Delaware		4.83		
Ratio Male to Female New Jersey		4.39		
Main Spawning Beaches in Delaware		Slaughter Big Stone		
Main Spawning Beaches in New Jersey		Rutgers South Reeds Cooks		

\* Each Year, at least two months prior to the expected spawning season, a "census" date is selected.

Table 3. Comparison of Data on Horseshoe Crabs Spawning on Delaware Bay Shores on Pre-Selected Dates\*.

	10-May-97	24-May-97	7-Jun-97	21-Jun-97
Estimation of Spawning Individuals	140,121	703,846	33,599	453,818
Percentage of DE Spawning Individuals	99	79	14	75
Percentage of NJ Spawning Individuals	1	21	86	25
Individuals During AM High Tide	93,631	228,036	23,002	140,202
Individuals During PM High Tide	46,490	475,810	10,597	313,616
Ratio of Individuals PM vs. AM Tide	0.5	2.09	0.46	2.24
Beaches Surveyed in Delaware	7	7	6	7
Beaches Surveyed in New Jersey	9	12	10	9
Ratio of Male Individuals to Female		3.48		
Ratio Male to Female Delaware		3.37		
Ratio Male to Female New Jersey		3.78		
Main Spawning Beaches in Delaware		Slaughter Big Stone		
Main Spawning Beaches in New Jersey		Norburys Rutgers South		

\* Each Year, at least two months prior to the expected spawning season, a "census" date is selected.

Table 3. Comparison of Data on Horseshoe Crabs Spawning on Delaware Bay Shores on Pre-Selected Dates\*.

	4-May-96	18-May-96	1-Jun-96	15-Jun-96
Estimation of Spawning Individuals	163,239	209,976	466,124	182,193
Percentage of DE Spawning Individuals	95	88	79	88
Percentage of NJ Spawning Individuals	5	12	21	12
Individuals During AM High Tide	59,003	27,953	67,834	25,229
Individuals During PM High Tide	104,236	182,023	398,290	156,964
Ratio of Individuals PM vs. AM Tide	1.77	6.51	5.87	6.22
Beaches Surveyed in Delaware	6	6	7	5
Beaches Surveyed in New Jersey	4	8	10	8
Ratio of Male Individuals to Female			avg. 2.45	
Ratio Male to Female Delaware			avg. 2.82	
Ratio Male to Female New Jersey			avg. 2.52	
Main Spawning Beaches in Delaware			Slaughter Big Stone South Bowers	
Main Spawning Beaches in New Jersey			Norburys Rutgers South Highs East Point	

\* Each Year, at least two months prior to the expected spawning season, a "census" date is selected.



Table 3. Comparison of Data on Horseshoe Crabs Spawning on Delaware Bay Shores on Pre-Selected Dates\*.

	27-May-95	10-Jun-95	21-May-94	11-Jun-94
Estimation of Spawning Individuals	91,864	112,912	104,000	342,884
Percentage of DE Spawning Individuals	97	96	74	91
Percentage of NJ Spawning Individuals	3	4	26	9
Individuals During AM High Tide	2,609	38,080	52,694	44,651
Individuals During PM High Tide	89,255	74,832	51,306	298,233
Ratio of Individuals PM vs. AM Tide	34.21	1.96	0.97	6.68
Beaches Surveyed in Delaware	7	5	8	4
Beaches Surveyed in New Jersey	3	9	15	3
Ratio of Male Individuals to Female		2.74	2.46	3.74
Ratio Male to Female Delaware		3.39	2.16	3.52
Ratio Male to Female New Jersey		2.74	3.14	3.62
Main Spawning Beaches in Delaware	Slaughter Pickering	Slaughter Pickering	Kitts Hummock Pickering	Big Stone Bowers Pickering
Main Spawning Beaches in New Jersey	Highs East Point	Highs East Point	Highs Moore's East Point	Moore's

\* Each Year, at least two months prior to the expected spawning season, a "census" date is selected.

Limuli Laboratories  
 7 Bay Avenue, Dias Creek  
 Cape May Court House, NJ 08210  
 609-465-6552

Table 3. Comparison of Data on Horseshoe Crabs Spawning on Delaware Bay Shores on Pre-Selected Dates\*.

	5-Jun-93	16-May-92	25-May-91	8-Jun-90
Estimation of Spawning Individuals	394,039	399,147	1,224,771	1,240,679
Percentage of DE Spawning Individuals	88	28	43	19
Percentage of NJ Spawning Individuals	12	72	57	81
Individuals During AM High Tide	16,846	133,952	318,153	317,399
Individuals During PM High Tide	377,193	265,195	906,618	923,280
Ratio of Individuals PM vs. AM Tide	22.39	2.04	2.85	2.91
Beaches Surveyed in Delaware	9	13	13	21
Beaches Surveyed in New Jersey	9	11	8	13
Ratio of Male Individuals to Female	2.49	3.13	2.64	2.19
Ratio Male to Female Delaware	2.77	2.12	2.78	1.76
Ratio Male to Female New Jersey	2.29	4.14	2.51	2.62
Main Spawning Beaches in Delaware	Big Stone South Bowers Kitts Hummock Pickering Port Mahon	Pickering	North Bowers Kitts Hummock Pickering Port Mahon Kelly Island	Cedar Beach South Bowers Kitts Hummock Pickering
Main Spawning Beaches in New Jersey	Kimbles Highs	Kimbles Highs	Fortescue Moores Beach East Point	Cooks Beach Highs Beach Moores Beach Thompsons East Point

\* Each Year, at least two months prior to the expected spawning season, a "census" date is selected.

Limuli Laboratories  
7 Bay Avenue, Dias Creek  
Cape May Court House, NJ 08210  
609-465-6552

Table 4. Spawning Estimates Survey Dates 1990-1998  
A. Delaware Beaches

Beach	1990	1991	1992	1993	1994	1995	1996	1997	1998
Cape Henlopen	2,375	6,250							
Roosevelt Inlet	18,400	61,120							
Broadkill	450			2,782					
Primehook		9,399	0	975	0		0		
Fowler Beach		0	0		0	120			2,067
Slaughter Beach	72,165	14,583	28,398		120	38,298	122,628	126,833	54,766
Big Stone Beach	33,000		3,773	243,792	0	2,888	152,760	185,186	125,231
South Bowers	72,163	32,085	10,102	27,264	338	12,498	37,182	71,658	72,859
North Bowers	7,280	56,420	13,000	11,677		11,362	28,510	53,733	41,556
St. Jones Neck							3,534	44,956	
Kitts Hummock	19,300	18,266*	10,212	29,874	67,000	0		22,800	23,334
Pickering Beach	21,075*	34,677	27,022	13,318	9,240	36,934	24,190	48,133	41,789
Port Mahon	8,406*	30,957*	8,298	10,617	47				
Kelly Island	70,266*	165,130*	9,046	6,095					
Kent Island	820*								
Bombay Hook Is	1,550*								
Woodland Beach	0	775	0						
Augustine Beach	0								
Collins Beach	no beach								
Totals	327,250	429,662	109,851	346,394	76,745	102,100	368,804	553,299	361,602

\* Changed from Original Data

Table 4. Spawning Estimates Survey Dates 1990-1998  
 B. New Jersey Beaches

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Beach									
Sunset Beach	0				0			22	152
Higbees				53	0	0	305		
North Cape May									
Cox Hall Creek	38,849								
Villas	4,270	4,791	28,000		425				
Norbury's Landing	7,946	8,644		13,556	535		14,687	30,348	14,985
South CSL	200		32,240	7,588	320	4,740	19,517	37,468	26,473
Higgs Beach	82,991	3,179	19,880	7,718	896	2,425	8,968	10,107	5,280
Pierces Pt.					1,854	183			
Kimbles			160,980	11,732	270	224	3,256	12,278	15,967
Cooks Beach	358,020		33,348*	2,412*	360	105	4,932		35,600
Reeds Beach		16,818	18,868*	4,667*	2,601	459	3,552	27,999	27,336
Moores Beach	198,505	481,754			3,636		7,368	15,200	6,520
Thompsons Beach	65,626							3,356	75
East Point	25,802	58,541*			13,146	1,705	15,420	9,542	26,733
Raybins					20				
Fortescue	13,564	145,195	14,872	390	2,808		8,840		
Gandy's Beach	7,875	3,420	14,179		384		10,475	4,227	6,711
Sea Breeze	8,760			1,664		30			572
Totals	812,408	722,342	322,367	49,780	27,255	10,812	97,320	150,547	166,404

\*Changed from original data