

2013 Horseshoe Crab Stock Assessment Update

Presentation to the Horseshoe Crab Management Board
St. Simons Island, GA
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Regulatory History

- Pre-1998: Unregulated harvest in most states
- 1998: Horseshoe Crab FMP approved
- Addendum I approved April 2000
 - Recommended the creation of the Cral N. Shuster Horseshoe Crab Reserve
- Addendum II approved May 2001
 - Criteria for quota transfers between states
- Addendum III approved May 2004
 - Reduced harvest quotas and implemented seasonal bait closures in DE Bay region
 - Revised monitoring components for all jurisdictions
- Addendum IV approved May 2006
 - Further bait harvest limits in NJ and DE – 100,000 male only
 - Delayed harvest in MD and VA

Regulatory History

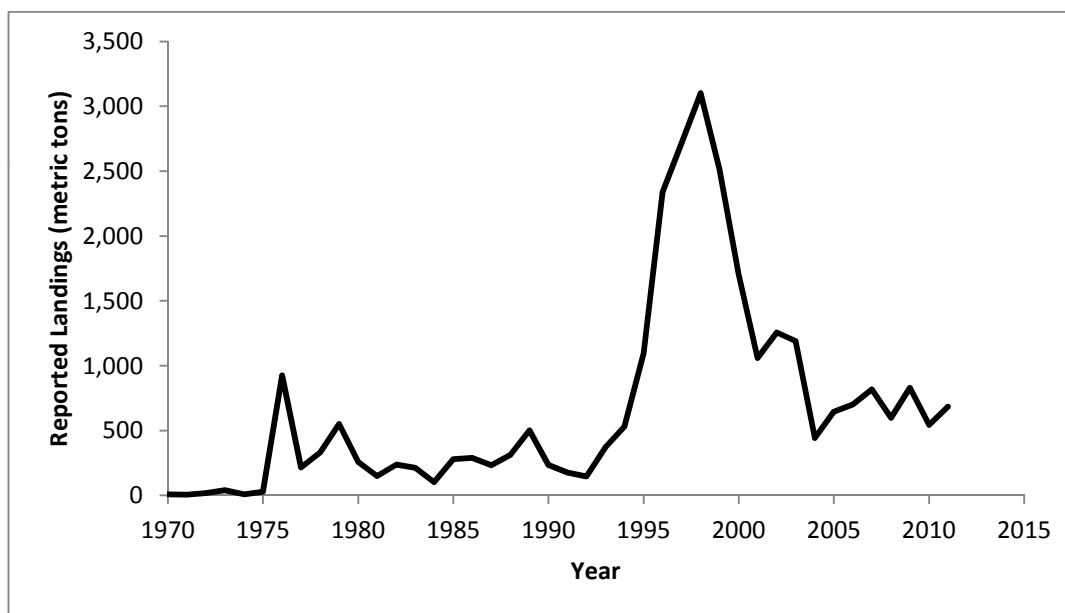
- Addendum V approved September 2008
 - Extended provisions of Addendum IV through October 31, 2009 and then through October 31, 2010
- Addendum VI approved August 2010
 - Further extended Addendum IV through April 30, 2013
 - Prohibited directed harvest and landing of all HSC in NJ and DE from Jan. 1 – June 7 and female HSC from June 8 – Dec. 31
 - No more than 40% of VA quota could be harvested east of COLREGS line
 - Male:Female ratio of 2:1
- Addendum VII approved February 2012
 - Implementation of the Adaptive Resource Management (ARM) Framework for DE, NJ, MD, and VA

Assessment History

- 1998 – Initial Stock Assessment
- 2004 – Next stock assessment
 - Analysis of trends
- 2009 – Latest stock assessment
 - Analysis of trends
 - Autoregressive Integrated Moving Average (ARIMA) models
 - Surplus Production Model – DE Bay Region
 - Catch Survey Model – DE Bay Region
 - Adaptive Resource Management (ARM) Framework – DE Bay Region

Reported Atlantic coast horseshoe crab landings and value, 1970 - 2011 (NMFS Commercial Fishery Landings Database, accessed on 8/5/2013)

Year	Metric tons	Pounds	Value (\$)	value/pound
1970	7	15,900	2,383	0.15
1971	5	11,900	970	0.08
1972	19	42,000	880	0.02
1973	40	88,700	1,960	0.02
1974	8	16,700	2,656	0.16
1975	29	62,800	7,974	0.13
1976	927	2,043,100	28,524	0.01
1977	215	473,000	7,859	0.02
1978	330	728,500	23,251	0.03
1979	551	1,215,630	81,977	0.07
1980	257	566,447	47,731	0.08
1981	148	326,695	36,885	0.11
1982	239	526,700	46,647	0.09
1983	213	468,600	37,901	0.08
1984	102	225,112	22,834	0.10
1985	279	614,939	54,903	0.09
1986	288	635,823	69,773	0.11
1987	232	511,758	77,058	0.15
1988	313	688,839	86,706	0.13
1989	502	1,106,645	140,889	0.13
1990	235	519,057	61,878	0.12
1991	175	385,487	39,674	0.10
1992	146	321,995	34,730	0.11
1993	373	821,205	85,808	0.10
1994	531	1,171,571	131,175	0.11
1995	1,096	2,416,168	309,467	0.13
1996	2,340	5,159,326	1,542,092	0.30
1997	2,714	5,983,033	1,182,375	0.20
1998	3,101	6,835,305	2,109,723	0.31
1999	2,514	5,542,506	1,397,354	0.25
2000	1,704	3,756,475	960,117	0.26
2001	1,060	2,336,645	667,018	0.29
2002	1,257	2,772,010	540,037	0.19
2003	1,190	2,624,248	695,338	0.26
2004	442	974,425	432,702	0.44
2005	645	1,421,957	514,418	0.36
2006	703	1,548,900	821,017	0.53
2007	819	1,804,968	1,147,833	0.64
2008	597	1,315,963	837,330	0.64
2009	830	1,830,506	1,126,440	0.62
2010	543	1,197,883	723,263	0.60
2011	684	1,508,615	924,469	0.61



State by state Atlantic coast horseshoe crab landings reported through ASMFC, 1998 - 2012.

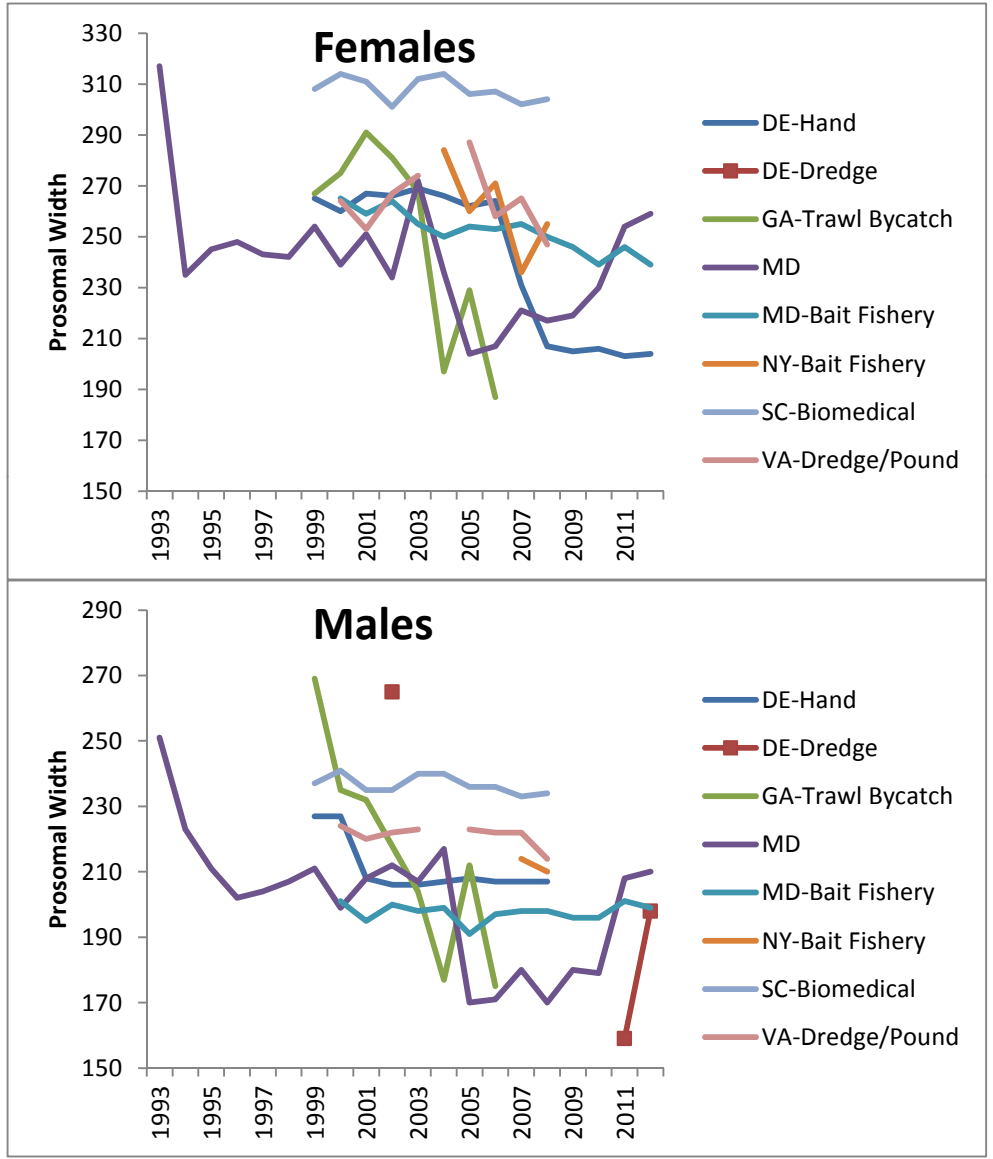
	ME	NH	MA	RI	CT	NY	NJ	PA	DE	MD	VA	NC	SC	GA	FL	Total
RPL	13,500	350	440,503	26,053	64,919	488,362	604,049		482,401	613,225	203,326	24,036		29,312	9,455	2,999,491
Addendum IV Quota	13,500	350	330,377	26,053	48,689	366,272	100,000	0	100,000	170,653	152,495	24,036	0	29,312	9,455	1,371,192
1998	13,500	200	400,000		34,583	352,462	241,456	70,000	479,634	114,458	1,015,700	21,392			200	2,743,585
1999	1,500	350	545,715	26,053	45,050	394,026	297,680	0	428,980	134,068	650,640	28,094	0	29,312	19,446	2,600,914
2000	1,391	180	272,930	13,809	15,921	628,442	398,629	0	2,490	152,275	145,465	14,973	0	0	10,462	1,656,967
2001	100	0	134,143	3,490	12,175	129,074	261,239	0	244,813	170,653	48,880	9,130	0	0	0	1,013,697
2002	150	120	138,613	3,886	32,080	177,271	281,134	0	298,319	278,211	42,954	12,988	0	0	200	1,265,926
2003	98	0	125,364	5,824	15,186	134,264	113,940	0	356,380	168,865	106,577	24,367	0	0	1,628	1,052,493
2004	0	0	69,436	6,030	23,723	142,279	46,569	0	127,208	161,928	94,713	9,437	0	0	0	681,323
2005	0	0	73,740	8,260	15,311	155,108	87,250	0	154,269	169,821	97,957	7,713	0	0	0	769,429
2006	0	0	171,906	15,274	26,889	172,381	3,444	0	147,813	136,733	155,704	10,331	0	0	469	840,944
2007	0	5	150,829	15,564	25,098	298,222	0	0	76,663	172,117	79,570	9,300	0	0	186	827,554
2008	0	0	103,963	15,549	32,565	148,719	0	0	102,113	163,495	68,338	26,191	0	0	50	660,983
2009	0	41	98,332	18,729	27,065	123,653	0	0	102,659	165,434	248,327	33,025	0	0	0	817,265
2010	0	0	54,782	12,502	30,036	124,808	0	0	61,751	165,344	145,357	9,938	0	0	993	605,511
2011	0	0	67,087	12,632	24,466	146,995	0	0	95,663	167,053	121,650	27,076	0	0	0	662,622
2012	0	0	106,821	19,306	18,958	167,723	0	0	100,255	169,087	124,048	22,902	0	0	0	729,100

Commercial catch rates (CPUE) of horseshoe crabs in Delaware and Georgia

Year	Delaware						Georgia		
	Hand Harvest	Trips	Hand CPUE	Dredge Harvest	Trips	Dredge CPUE	Bycatch	Net Hrs	CPUE
1991	17,457	62	281.6	22,158	16	1384.9			
1992	24,355	71	343	16,665	9	1851.7			
1993	29,867	44	678.8	20,466	17	1203.9			
1994	74,899	93	805.4	26,173	12	2181.1			
1995	133,586	172	776.7	38,515	30	1283.8			
1996	245,889	211	1165.4	50,470	14	3605.0			
1997	374,379	318	1177.3	53,052	33	1607.6			
1998	389,566	629	619.3	90,068	137	657.4			
1999	336,232	393	855.6	92,748	84	1104.1			
2000	192,993	301	641.2	55,945	51	1097.0	293	20.86	14.05
2001	160,028	420	381	84,785	157	540.0	543	55.89	9.72
2002	191,343	403	474.8	101,387	172	589.5	147	42.23	3.48
2003	302,101	845	357.5	54,279	220	246.7	13	36.45	0.36
2004	66,210	197	336.1	60,244	152	396.3	133	40.95	3.25
2005	96,832	161	601.4	57,437	117	490.9	754	89.49	8.43
2006	72,477	160	450.5	75,336	94	801.4	561	42	2.73
2007	59,429	124	566	17,234	19	907.1	0		
2008	102,113	150	680.8	0	0		0		
2009	102,659	202	508.2	0	0		0		
2010	55,329	146	379	6,422	19	338.0	40	79.2	0.51
2011	78,204	154	507.8	17,459	21	831.4	43	23.25	1.85
2012	45,274	170	266.3	54,981	74	743.0	0		

Trends in female and male horseshoe crab prosomal width (mm) from fishery dependent surveys

Year	DE-Hand		DE-Dredge		GA-Trawl Bycatch			MD			MA-Bait Fishery		NY-Bait Fishery (Trawl)		SC-Biomedical		VA-Dredge/Pound	
	Female*	Male*	Female	Male	TEDs?	Female*	Male*	Source	Female*	Male*	Female*	Male	Female	Male	Female	Male	Female	Male
1993								COMM	317	251								
1994								COMM	235	223								
1995								COMM	245	211								
1996								COMM	248	202								
1997								COMM	243	204								
1998								COMM	242	207								
1999	265	227			w/o TEDs	267	269	COMM	254	211					308	237		
2000	260	227			w/o TEDs	275	235	COMM	239	199	265	201			314	241	264	224
2001	267	208			w/ TEDs	291	232	COMM	251	208	259	195			311	235	253	220
2002	266	206		265	w/ TEDs	281	218	COMM	234	212	264	200			301	235	267	222
2003	269	206			w/ TEDs	268	204	COMM	272	207	255	198			312	240	274	223
2004	266	207			w/ TEDs	197	177	COMM	236	217	250	199	284	219	314	240		
2005	262	208			w/ TEDs	229	212	BIO	204	170	254	191	260		306	236	287	223
2006	264	207			w/ TEDs	187	175	BIO	207	171	253	197	271		307	236	258	222
2007	231	207						BIO	221	180	255	198	236	214	302	233	265	222
2008	207	207						BIO	217	170	250	198	255	210	304	234	247	214
2009	205							BIO	219	180	246	196						
2010	206							BIO	230	179	239	196						
2011	203			159	w/ TEDs		216	BIO	254	208	246	201						
2012	204			198				BIO	259	210	239	199						



Biomedical Harvest

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Number of crabs brought to biomedical facilities (bait and biomedical crabs)	343,126	323,149	367,914	500,251	511,478	512,552	548,751	628,476	611,827
Number of biomedical-only crabs harvested (not counted against state bait quotas)	292,760	283,720	309,289	428,872	423,614	402,202	482,704	545,164	530,797
Number of bait crabs bled	50,366	39,429	58,625	71,379	87,864	110,350	66,047	83,312	81,030
Estimated mortality of biomedical-only crabs prior to bleeding	4,391	4,256	4,639	3,599	2,973	6,298	9,665	6,917	6,891
Number of biomedical-only crabs bled	275,194	270,496	296,958	398,844	402,080	362,291	438,417	492,734	485,965
Estimated mortality of biomedical-only crabs during or after bleeding	41,279	40,574	44,543	59,833	60,312	54,344	65,763	73,910	72,895
Total estimated mortality on biomedical crabs not counted against state bait quotas	45,670	44,830	49,182	63,432	63,285	60,642	75,428	80,827	79,786

- Increasing biomedical harvest since 2004
- Biomedical harvest represented 10% of coast wide harvest in 2012 (bait and biomedical combined)
- 1998 FMP – *“If horseshoe crab mortality associated with collecting, shipping, handling, or use by the biomedical industry exceeds 57,500 horseshoe crabs per year, the Commission would reevaluate potential restrictions on horseshoe crab harvest by the biomedical industry.”*

Assessment Approach

- Analysis of trends via Autoregressive Integrated Moving Average (ARIMA) Models
- Surplus Production and Catch Survey Models not conducted
 - 2009 Stock Assessment did not include Biomedical Harvest
 - SAS felt these data needed to be included
 - Could not include because this was an Update

Fisheries-independent surveys included in the stock assessment update

Survey	Metric	N	First year	Last year
New England Region				
Massachusetts Inshore Bottom Trawl (Fall)	number per tow	35	1978	2012
Massachusetts Inshore Bottom Trawl (Spring)	number per tow	35	1978	2012
New Hampshire Spawning Survey (Spring)	number per distance (ft)	12	2001	2012
New Hampshire Spawning Survey (Spring - Summer)	number per distance (ft)	9	2001	2009
Rhode Island - Marine Research Inc.	arithmetic mean catch per tow	25	1988	2012
Rhode Island - Marine Research Inc. Providence River Impingement	number of crabs impinged	21	1992	2012
Rhode Island - Stout Survey	number of crabs	28	1975	2002
Rhode Island DFW Trawl	arithmetic mean catch per tow	15	1998	2012
University of Rhode Island - Graduate School of Oceanography	arithmetic mean catch per tow	54	1959	2012
New York Region				
CT Long Island Sound Trawl (Fall)	geometric mean kg per tow	21	1992	2012
CT Long Island Sound Trawl (Spring)	geometric mean kg per tow	21	1992	2012
NY Peconic Bay Trawl Survey	delta mean CPUE	26	1987	2012
NY Western Long Island Beach Seine - Jamaica Bay	geometric mean catch per haul	26	1987	2012
NY Western Long Island Beach Seine - Little Neck Bay	geometric mean catch per haul	26	1987	2012
NY Western Long Island Beach Seine - Manhasset Bay	geometric mean catch per haul	26	1987	2012
Delaware Bay Region				
Northeast Area Monitoring and Assessment Program (Fall)	geometric mean per tow	6	2007	2012
Northeast Area Monitoring and Assessment Program (Spring)	geometric mean per tow	5	2008	2012
Delaware 16 ft trawl (Juvenile)	geometric mean catch per tow	21	1992	2012
Delaware 16 ft trawl (YOY)	geometric mean catch per tow	21	1992	2012
Delaware 30 ft trawl (all HSC)	geometric mean catch per tow	23	1990	2012
Delaware 30 ft trawl (Female)	geometric mean catch per tow	23	1990	2012
Delaware 30 ft trawl (Male)	geometric mean catch per tow	23	1990	2012
Delaware Bay Spawning Survey (Female)	index of spawning activity	14	1999	2012
Delaware Bay Spawning Survey (Male)	index of spawning activity	14	1999	2012
Maryland Coastal Bay	geometric mean catch per tow	24	1989	2012
NJ Delaware Bay Trawl (Female)	geometric mean catch per tow	15	1998	2012
NJ Delaware Bay Trawl (Male)	geometric mean catch per tow	15	1998	2012
NJ Delaware Bay Trawl (all HSC)	geometric mean catch per tow	15	1998	2012
NJ Delaware Bay Trawl (Juvenile)	geometric mean catch per tow	15	1998	2012
NJ Ocean Trawl	stratified geometric mean	25	1988	2012
NJ Surf Clam Dredge	geometric mean per dredge	15	1998	2012
NMFS bottom trawl survey (Fall)	geometric mean catch per tow	21	1988	2008
NMFS bottom trawl survey (Spring)	geometric mean catch per tow	21	1988	2008
Virginia Tech Trawl (all HSC)	catch per tow	10	2002	2011
Virginia Tech Trawl (Female)	catch per tow	10	2002	2011
Virginia Tech Trawl (Male)	catch per tow	10	2002	2011
Southeast Region				
Florida Seahorse Key (Gulf) Spawning Survey	mean number per tide	11	1993	2010
Georgia Shrimp Trawl	arithmetic mean catch per tow	14	1999	2012
NC Pamlico Sound Neuse River Gill Net	geometric mean catch per set	12	2001	2012
SEAMAP Trawl Survey (Fall)	Geometric mean catch per tow	18	1995	2012
South Carolina Trawl	number per tow	18	1995	2012

Autoregressive Integrated Moving Average (ARIMA) Models

Fishery independent indices of HSC abundance can be quite variable

Variation in time series represents

- True changes in abundance
- Within survey sampling variability
- Varying catchability over time

ARIMA Models

- Minimizes measurement error
- Derives fitted estimates of abundance over the entire time series
- Commonly used when not enough data are available for size or age-structured assessment models (Pennington 1986)

Autoregressive Integrated Moving Average Models

Helser and Hayes (1995)

- Extended application of ARIMA models to survey data to infer population status relative to some index-based reference point
- Bootstrap techniques to calculate the probability of being below the reference point in a given year
- The choice of a reference point is rather arbitrary
- q25 reference point – lower quartile of fitted index values

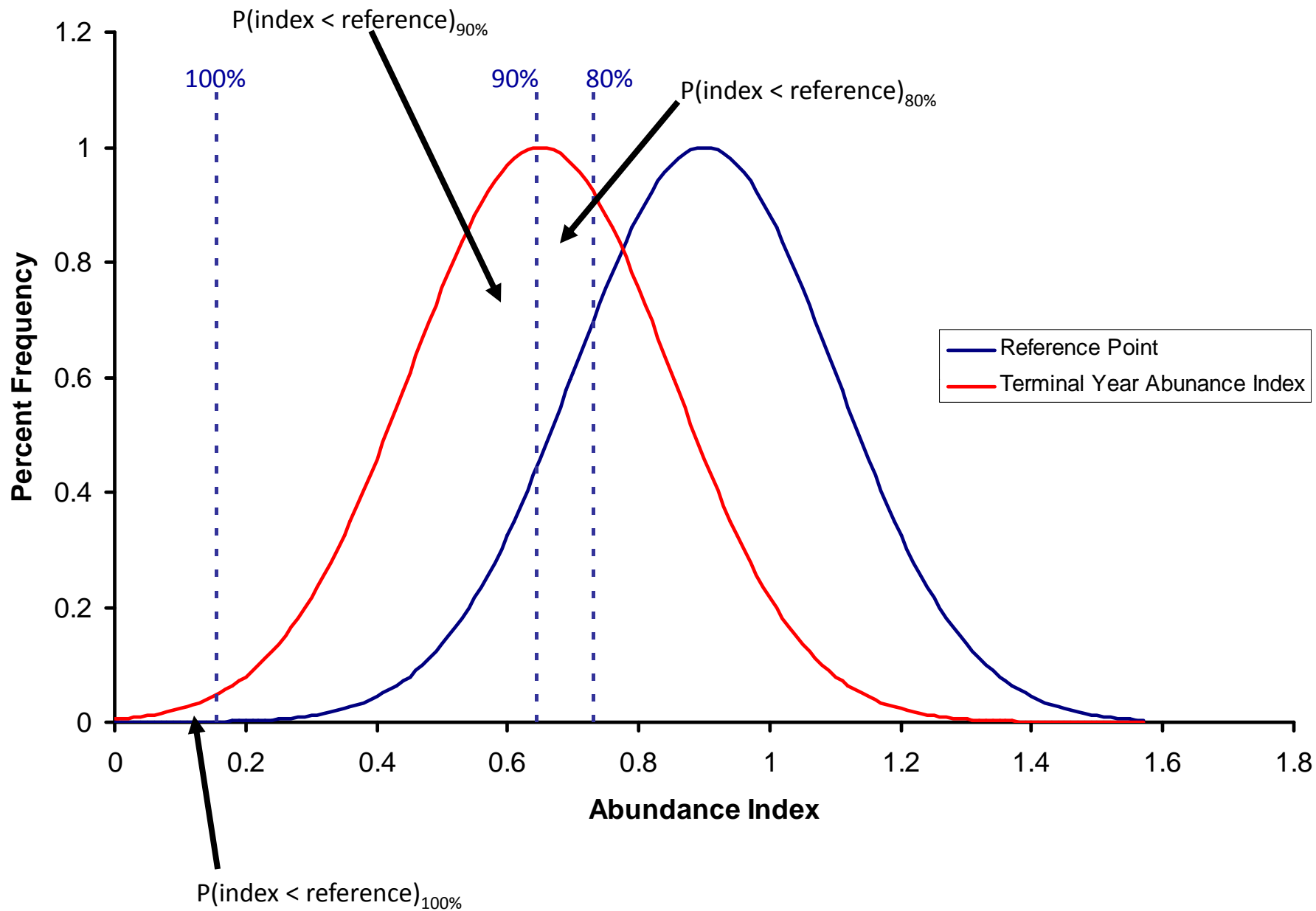
Autoregressive Integrated Moving Average Models

Helser et al. (2002)

Two-tiered decision approach for comparison to reference points

1. Estimate $P(\text{index} < \text{reference})$
2. Estimate statistical level of confidence of $P(\text{index} < \text{reference})$

Accounts for uncertainty in both the index value and the reference point



Autoregressive Integrated Moving Average Models

- Fit ARIMA models to time series of HSC abundance indices
- Estimate the probability that 2011/2012 indices were less than reference points with **80%** confidence levels
- Reference points:
 - Q_{25} – lower quartile of fitted index values
 - 1998 – fitted index value for 1998, when harvest restrictions implemented

[NOTE: the Q_{25} reference point can change through time as the length of the time series of abundance estimates increases]

ARIMA Summary Statistics

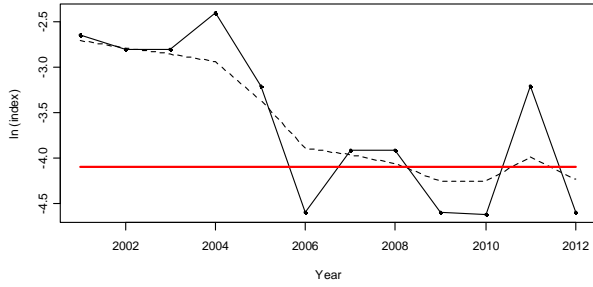
Survey	Years	n	W	p	r ₁	r ₂	r ₃	θ	SE	σ ² _c
New England Region										
Massachusetts Inshore Bottom Trawl (Fall)	1978-2012	35	0.97	0.52	-0.42	-0.06	-0.16	0.78	0.11	0.72
Massachusetts Inshore Bottom Trawl(Spring) ¹	1978-2012	35	0.95	0.08	-0.44	0.02	-0.12	0.75	0.16	0.69
New Hampshire Spawning Survey (Spring)	2001-2012	12	0.95	0.68	-0.22	-0.4	0.14	0.46	0.24	0.57
New Hampshire Spawning Survey (Spring - Summer)	2001-2009	9	0.98	0.96	-0.29	-0.54	0.37	0.49	0.29	0.33
Rhode Island - Marine Research Inc.	1988-2012	25	0.98	0.96	-0.51	0.57	-0.55	0.35	0.16	0.57
Rhode Island - Marine Research Inc. Providence River Impingment	1992-2012	25	0.98	0.96	-0.51	0.57	-0.55	0.35	0.16	0.57
Rhode Island - Stout Survey	1975-2002	28	0.91	0.02	-0.32	-0.02	0.33	0.27	0.16	0.24
Rhode Island DFW Trawl	1998-2012	15	0.96	0.61	-0.17	-0.27	0.17	0.16	0.38	0.21
University of Rhode Island - Graduate School of Oceanography	1959-2012	54	0.98	0.37	-0.38	0.31	-0.16	0.34	0.11	1.07
New York Region										
CT Long Island Sound Trawl (Fall)	1992-2012	20	0.90	0.04	-0.17	-0.24	-0.17	0.68	0.25	0.2
CT Long Island Sound Trawl (Spring)	1992-2012	21	0.88	0.02	-0.4	-0.03	-0.14	0.74	0.21	0.29
NY Peconic Bay Trawl Survey	1987-2012	26	0.99	0.96	-0.35	0.29	0.06	0.2	0.16	0.22
NY Western Long Island Beach Seine - Jamaica Bay	1987-2012	26	0.99	0.98	-0.51	-0.17	0.48	1	0.74	0.38
NY Western Long Island Beach Seine - Little Neck Bay	1987-2012	26	0.99	0.99	-0.53	0.2	-0.29	0.71	0.17	0.4
NY Western Long Island Beach Seine - Manhasset Bay	1987-2012	26	0.99	0.99	-0.53	0.26	-0.41	0.76	0.18	0.7
Delaware Bay Region										
Delaware 16 ft trawl (Juvenile)	1992-2012	21	0.94	0.23	-0.23	0.03	-0.14	0.26	0.23	0.59
Delaware 16 ft trawl (YOY) ¹	1992-2012	21	0.96	0.53	-0.29	-0.19	0.04	1	0.17	2.13
Delaware 30 ft trawl (all HSC)	1990-2012	23	0.92	0.07	-0.15	-0.16	0.13	0.61	0.18	1.04
Delaware 30 ft trawl (Female)	1990-2012	23	0.95	0.29	-0.19	-0.13	0.15	0.6	0.16	1.11
Delaware 30 ft trawl (Male)	1990-2012	23	0.91	0.05	-0.18	-0.29	0.14	0.66	0.17	1.52
Delaware Bay Spawning Survey (Female)	1999-2012	14	0.98	0.94	-0.42	-0.12	0.16	0.61	0.34	0.03
Delaware Bay Spawning Survey (Male)	1999-2012	14	0.96	0.79	-0.6	0.21	-0.06	0.78	0.27	0.05
Maryland Coastal Bay ²	1990-2012	23	0.94	0.18	-0.5	-0.13	0.43	0.83	0.49	0.21
Maryland Coastal Bay ³	1989-2012	24	0.91	0.04	-0.14	-0.09	0.13	0.79	0.18	0.34
NJ Delaware Bay Trawl (Female)	1998-2012	15	0.94	0.42	-0.65	0.23	0.11	1	0.56	0.3

ARIMA Summary Statistics (continued)

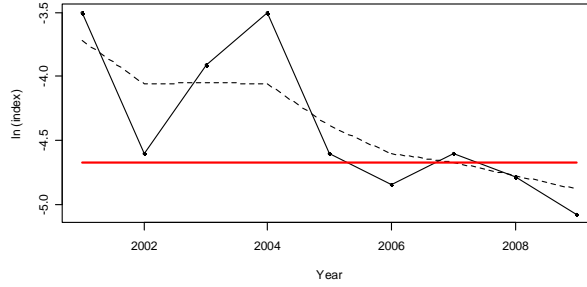
Survey	Years	n	W	p	r ₁	r ₂	r ₃	θ	SE	σ ² _c
Delaware Bay Region										
NJ Delaware Bay Trawl (Male)	1998-2012	15	0.95	0.52	-0.58	0.03	0.26	0.75	0.18	0.26
NJ Delaware Bay Trawl (all HSC)	1998-2012	15	0.95	0.50	-0.54	-0.17	0.43	0.79	0.18	0.5
NJ Delaware Bay Trawl (Juvenile)	1998-2012	15	0.96	0.61	-0.49	-0.16	0.34	0.77	0.26	1.2
NJ Ocean Trawl	1988-2012	25	0.97	0.67	0.01	-0.28	-0.14	0.21	0.31	0.14
NJ Surf Clam Dredge	1998-2012	15	0.94	0.34	-0.24	0.48	-0.17	0.29	0.17	0.4
NMFS bottom trawl survey (Fall)	1988-2008	21	0.93	0.16	-0.55	0.03	0.15	1	0.36	0.14
NMFS bottom trawl survey (Spring)	1988-2008	21	0.89	0.02	-0.62	0.2	0.1	1	0.16	0.92
Virginia Tech Trawl (all HSC)	2002-2011	10	0.85	0.06	0.13	-0.42	-0.49	0.1	0.42	0.19
Virginia Tech Trawl (Female)	2002-2011	10	0.95	0.69	0.03	-0.17	-0.44	0.01	0.41	0.19
Virginia Tech Trawl (Male)	2002-2011	10	0.90	0.23	0.17	-0.52	-0.5	0.18	0.39	0.2
Southeast Region										
Florida Seahorse Key (Gulf) Spawning Survey	1993-2010	11	0.95	0.66	0.02	-0.43	-0.01	0.14	0.38	0.45
Georgia Shrimp Trawl	1999-2012	14	0.98	0.95	-0.14	-0.34	0.04	0.55	0.3	0.21
NC Pamlico Sound Neuse River Gill Net	2001-2012	12	0.97	0.90	-0.28	-0.09	0.02	0.15	0.24	0.05
SEAMAP Trawl Survey	1995-2012	18	0.90	0.06	-0.18	0.06	-0.3	0.43	0.24	1.44
South Carolina Trawl	1995-2012	18	0.98	0.91	-0.13	-0.27	-0.12	0.09	0.34	0.24

New England Region

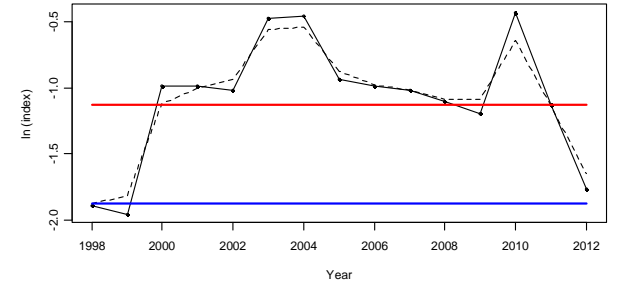
New Hampshire Spawning Survey (May - June)



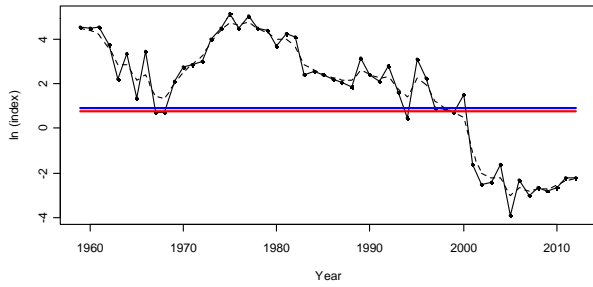
New Hampshire Spawning Survey (May - Sept)



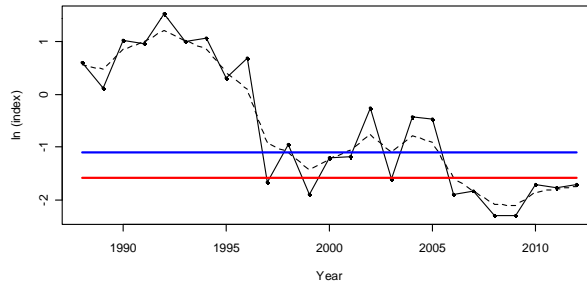
Rhode Island Division of Fish and Wildlife



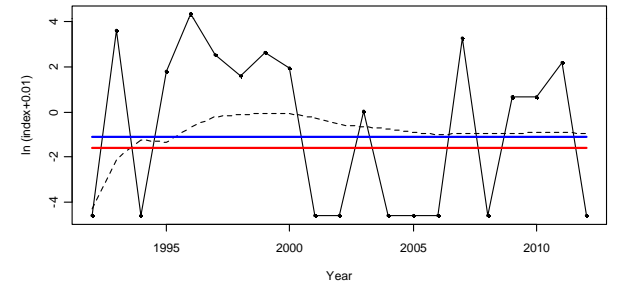
Unv. of Rhode Island - Grad School of Oceanography



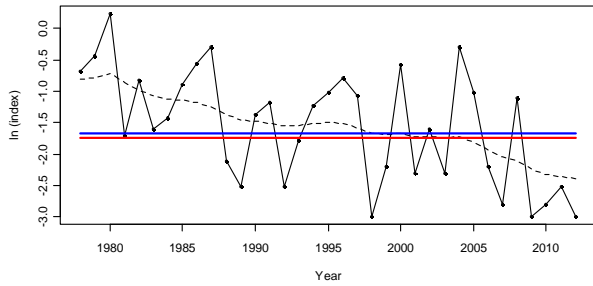
Rhode Island - Marine Research Inc.



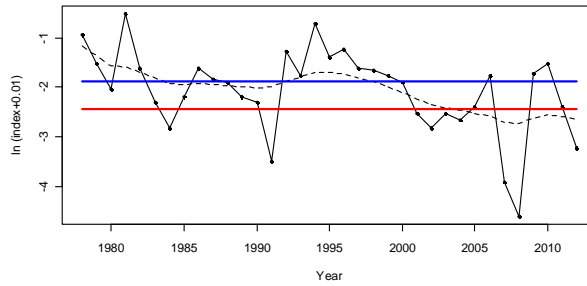
Rhode Island - Providence River Impingement



Massachusetts DMF Botom Trawl - Fall

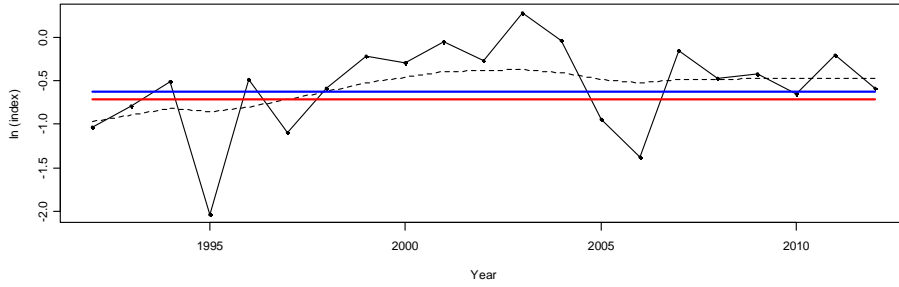


Massachusetts DMF Botom Trawl - Spring

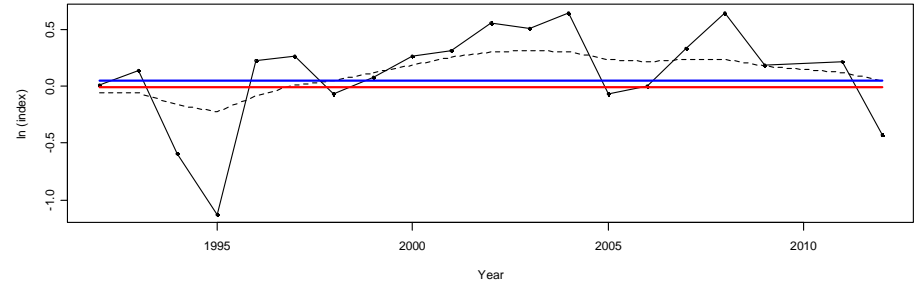


New York Region

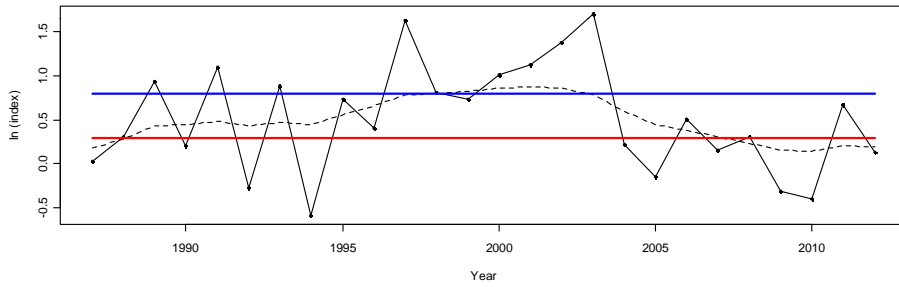
Connecticut Long Island Sound Trawl - Spring



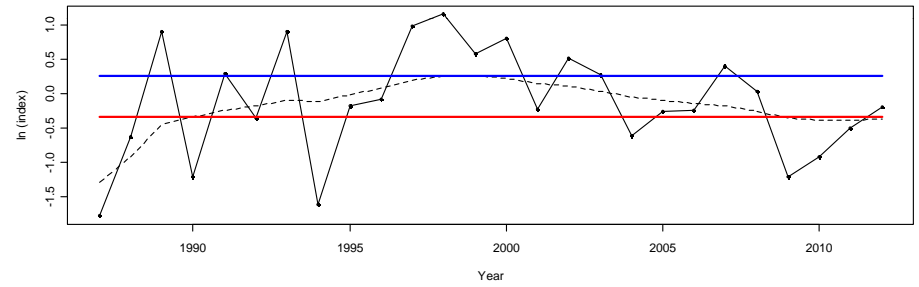
Connecticut Long Island Sound Trawl - Fall



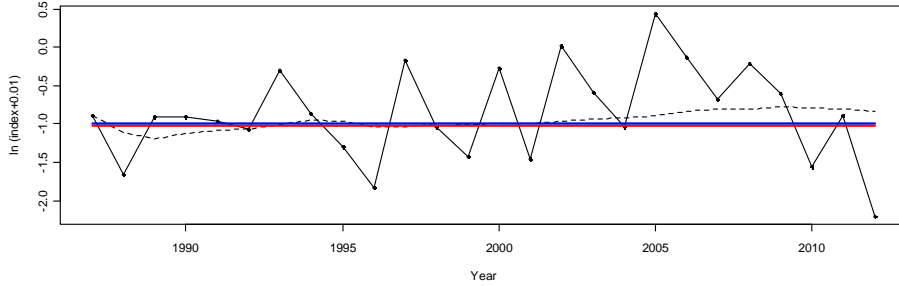
NYSDEC Long Island Sound Seine - Little Neck Bay



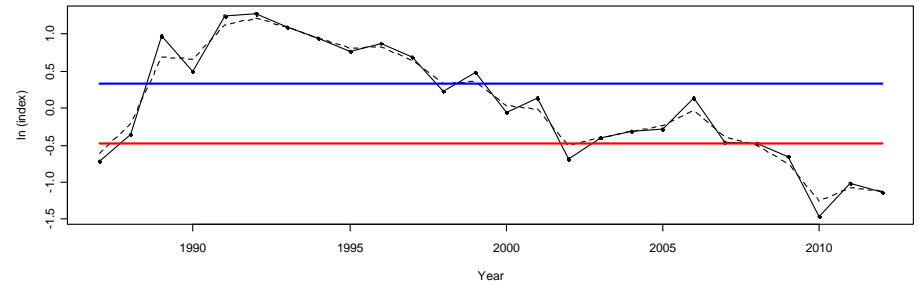
NYSDEC Long Island Sound Seine - Manhasset Bay



NYSDEC Long Island Sound Seine - Jamaica Bay

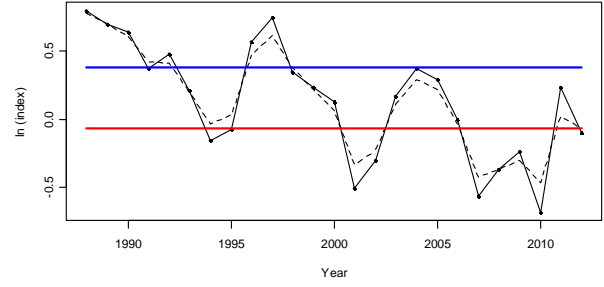


NYSDEC Peconic Bay Trawl

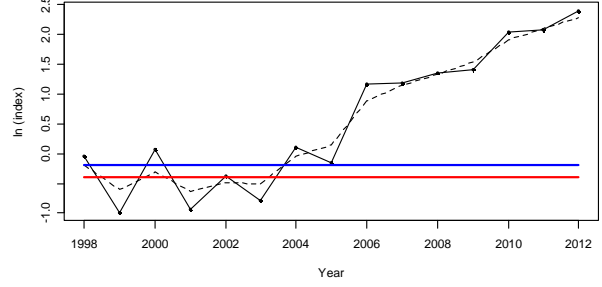


Delaware Bay Region

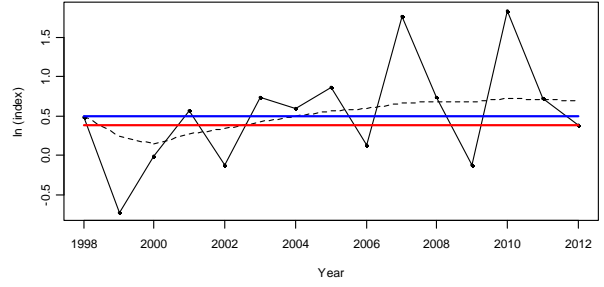
New Jersey Ocean Trawl



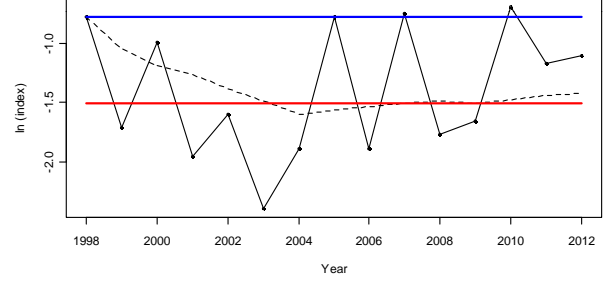
New Jersey Surf Clam



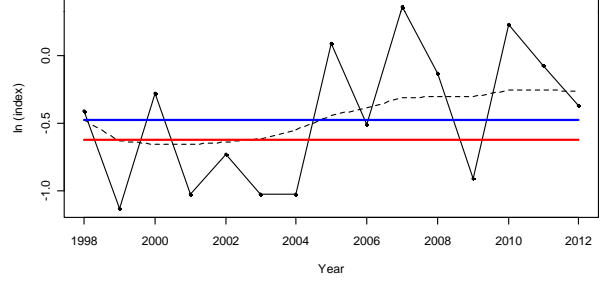
New Jersey Delaware Bay Trawl - All



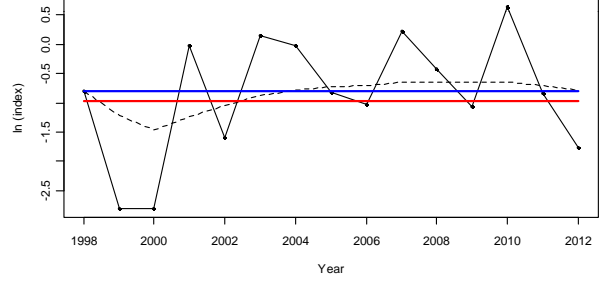
New Jersey Delaware Bay Trawl - Females



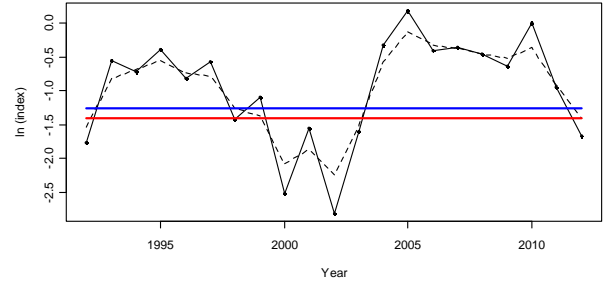
New Jersey Delaware Bay Trawl - Males



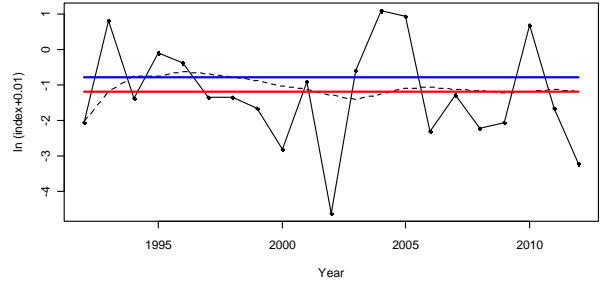
New Jersey Delaware Bay Trawl - Juveniles



Delaware Bay 16 ft. Trawl - Juveniles

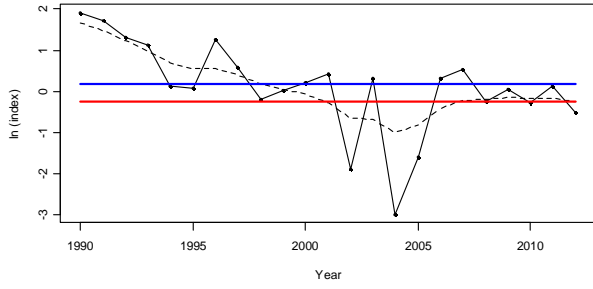


Delaware Bay 16 ft. Trawl - YOY

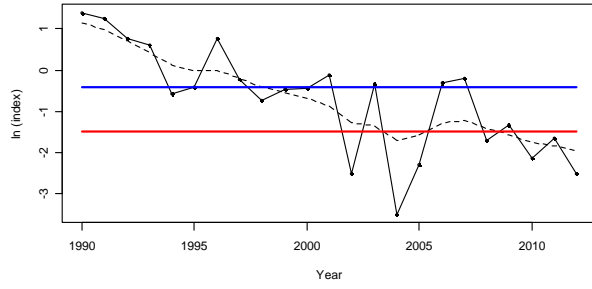


Delaware Bay Region (Continued)

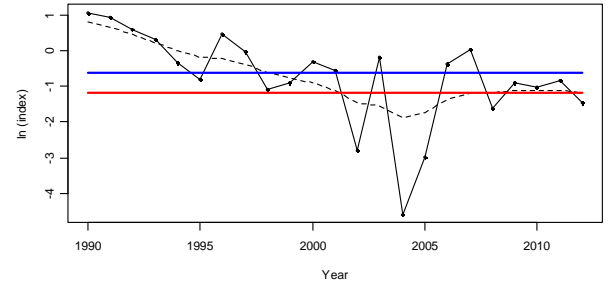
Delaware Bay 30 ft. Trawl - Combined Sexes



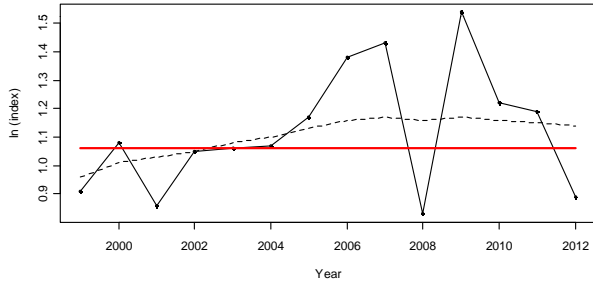
Delaware Bay 30 ft. Trawl - Females



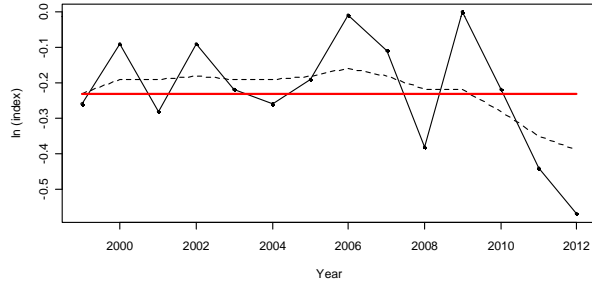
Delaware Bay 30 ft. Trawl - Males



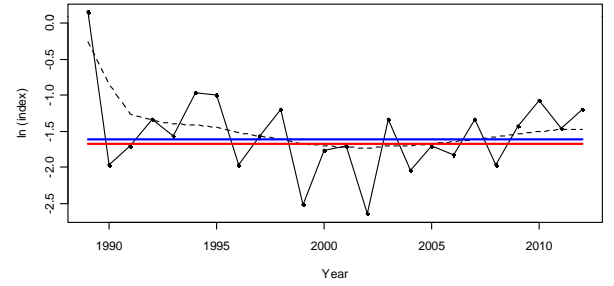
Delaware Bay Spawning Survey - Males



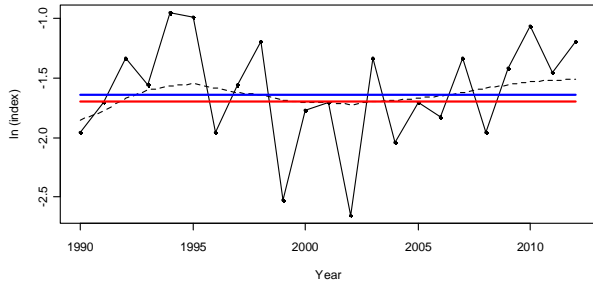
Delaware Bay Spawning Survey - Females



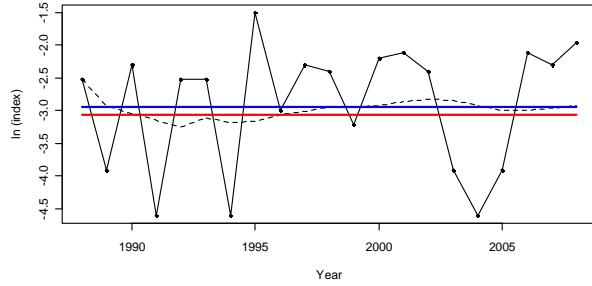
Maryland Coastal Bay Trawl



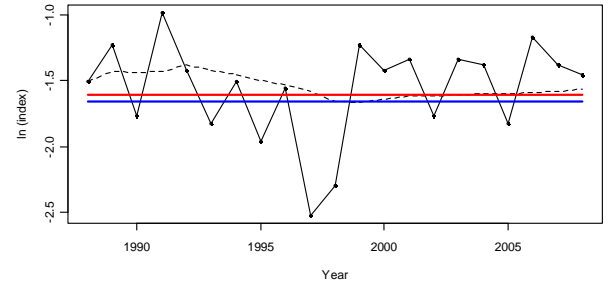
Maryland Coastal Bay Trawl



NMFS Bottom Trawl - Spring

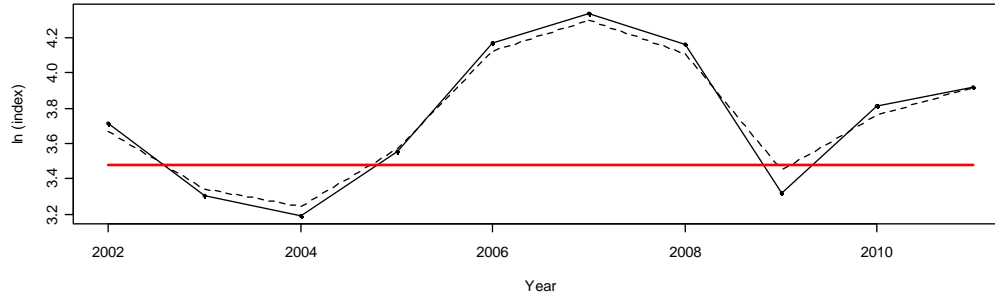


NMFS Bottom Trawl - Fall

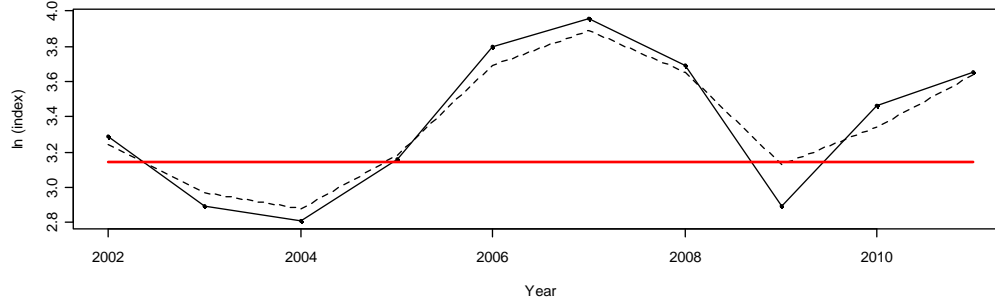


Delaware Bay Region (Continued)

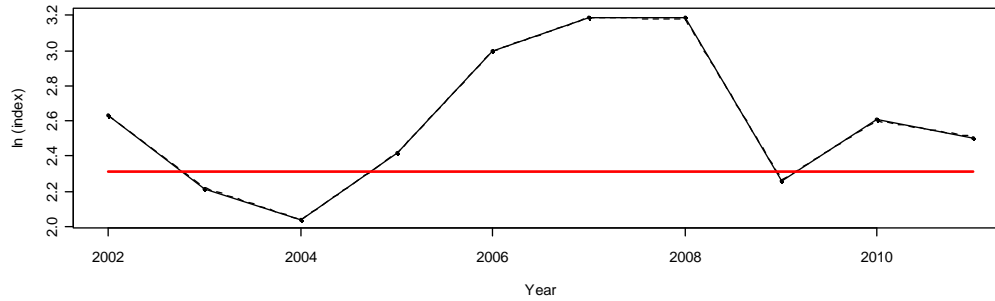
Virginia Tech Trawl Survey - All HSC



Virginia Tech Trawl Survey - Males

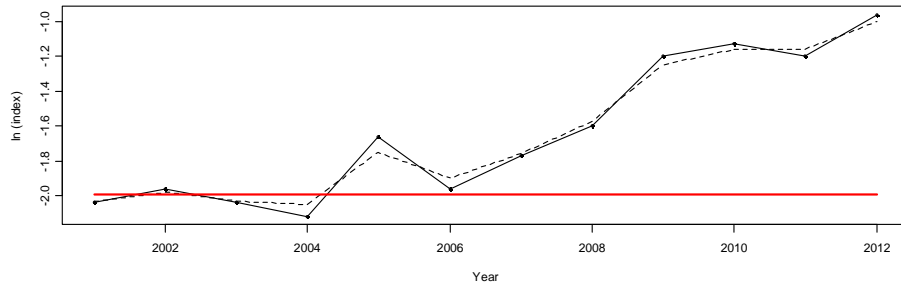


Virginia Tech Trawl Survey - Females

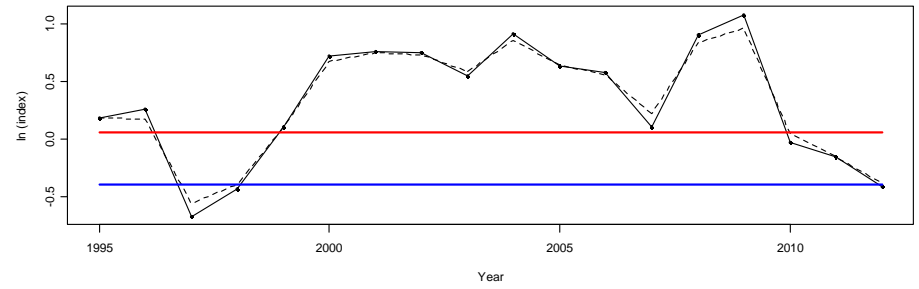


Southeast Region

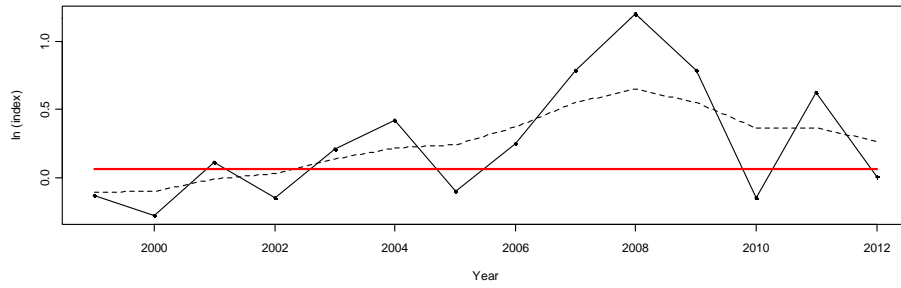
NC Pamlico Sound Neuse River Gill Net



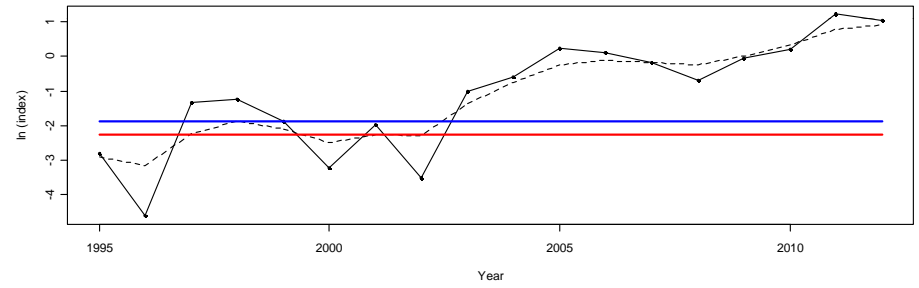
South Carolina Trawl



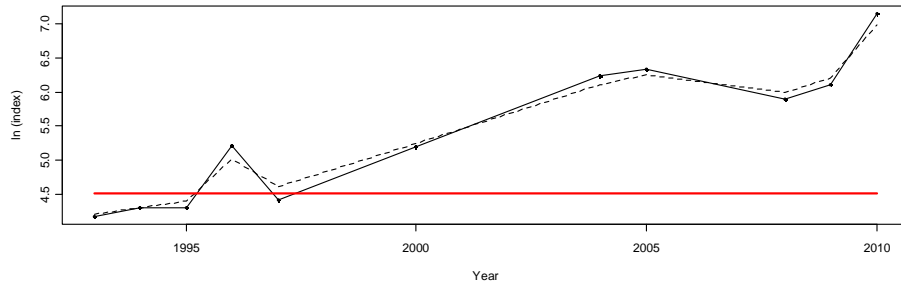
Georgia Shrimp Trawl



SEAMAP Trawl



FL Seahorse Key Spawning Survey



Delaware Bay Region (Continued)

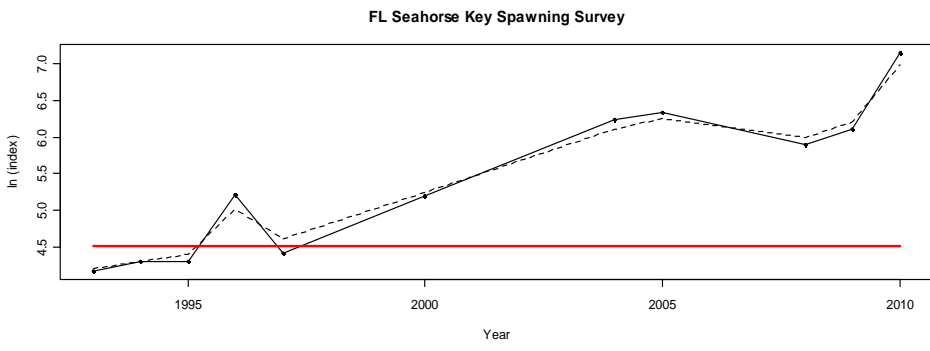
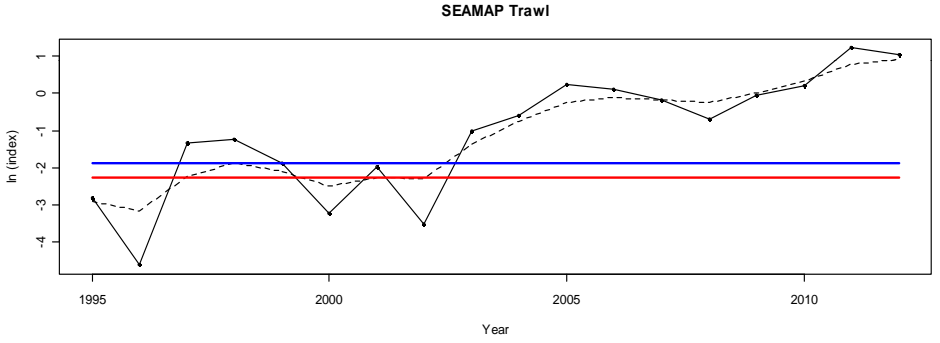
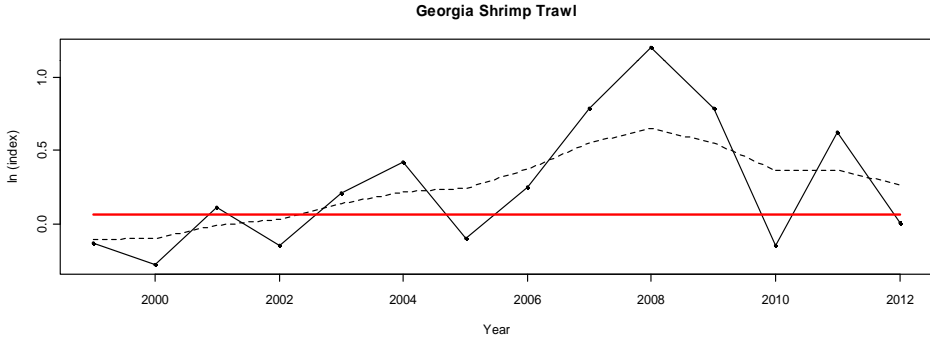
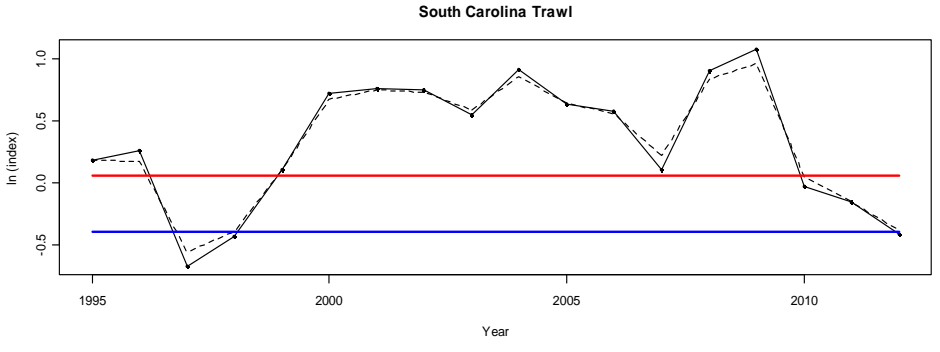
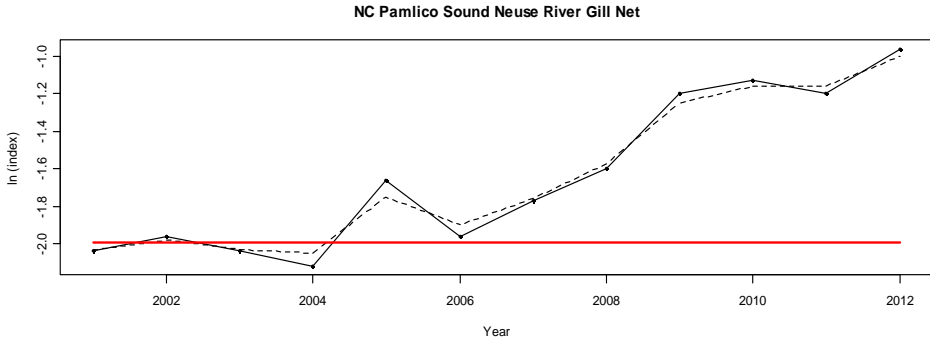


Figure 8: Southeast Region

ARIMA Results

Survey	i_t	i_{1998}	$P(i_t < i_{1998})$	Q_{25}	$P(i_t < Q_{25})$
New England Region					
Massachusetts Inshore Bottom Trawl (Fall)	-2.41	-1.68	0.91	-1.75	0.72
Massachusetts Inshore Bottom Trawl (Spring)	-2.64	-1.88	0.96	-2.45	0.55
New Hampshire Spawning Survey (Spring)	-4.23			-4.11	0.34
New Hampshire Spawning Survey (Spring - Summer)	-4.89			-4.67	0.47
Rhode Island - Marine Research Inc.	-1.75	-1.10	0.87	-1.57	0.53
Rhode Island - Marine Research Inc. Providence River Impingment	-0.94	-1.10	0.86	-1.57	0.52
Rhode Island - Stout Survey	1.91	1.20	0.01	1.89	0.25
Rhode Island DFW Trawl	-1.66	-1.88	0.18	-1.13	0.69
University of Rhode Island - Graduate School of Oceanography	-2.27	0.93	1.00	0.76	1.00
New York Region					
CT Long Island Sound Trawl (Fall)	0.05	0.06	0.22	-0.01	0.11
CT Long Island Sound Trawl (Spring)	-0.49	-0.63	0.11	-0.73	0.08
NY Peconic Bay Trawl Survey	-1.13	0.34	1.00	-0.48	0.93
NY Western Long Island Beach Seine - Jamaica Bay	-0.84	-0.99	0.03	-1.03	0.01
NY Western Long Island Beach Seine - Little Neck Bay	0.19	0.81	0.93	0.29	0.44
NY Western Long Island Beach Seine - Manhasset Bay	-0.37	0.27	0.82	-0.35	0.24
Delaware Bay Region					
Delaware 16 ft trawl (Juvenile)	-1.42	-1.26	0.42	-1.42	0.26
Delaware 16 ft trawl (YOY) ¹	-1.20	-0.77	0.38	-1.20	0.04
Delaware 30 ft trawl (all HSC)	-0.24	0.17	0.76	-0.26	0.20
Delaware 30 ft trawl (Female)	-1.99	-0.42	1.00	-1.49	0.61
Delaware 30 ft trawl (Male)	-1.17	-0.62	0.77	-1.18	0.21
Delaware Bay Spawning Survey (Female)	-0.40			-0.23	0.54
Delaware Bay Spawning Survey (Male)	1.14			1.06	0.05
Maryland Coastal Bay ²	-1.51	-1.65	0.15	-1.70	0.08
Maryland Coastal Bay ³	-1.47	-1.62	0.22	-1.68	0.16
NJ Delaware Bay Trawl (Female)	-1.42	-0.78	0.99	-1.52	0.19
NJ Delaware Bay Trawl (Male)	-0.26	-0.47	0.08	-0.63	0.02
NJ Delaware Bay Trawl (all HSC)	0.70	0.51	0.09	0.39	0.04
NJ Delaware Bay Trawl (Juvenile)	-0.78	-0.80	0.15	-0.97	0.08
NJ Ocean Trawl	-0.07	0.38	0.87	-0.07	0.28
NJ Surf Clam Dredge	2.29	-0.20	0.00	-0.39	0.00
NMFS bottom trawl survey (Fall)	-1.58	-1.67	0.05	-1.62	0.14
NMFS bottom trawl survey (Spring)	-2.93	-2.95	0.17	-3.06	0.05
Virginia Tech Trawl (all HSC)	3.92			3.48	0.10
Virginia Tech Trawl (Female)	2.51			2.31	0.19
Virginia Tech Trawl (Male)	3.64			3.15	0.06

ARIMA Results (continued)

Survey	i_f	i_{1998}	$P(i_f < i_{1998})$	Q_{25}	$P(i_f < Q_{25})$
Southeast Region					
Florida Seahorse Key (Gulf) Spawning Survey	7.00			4.51	0.00
Georgia Shrimp Trawl	0.27			0.06	0.06
NC Pamlico Sound Neuse River Gill Net	-1.00			-2.00	0.00
SEAMAP Trawl Survey	0.89	-1.90	0.00	-2.26	0.00
South Carolina Trawl	-0.39	-0.39	0.29	0.07	0.69

Regional summary of ARIMA results

Region	Current Update		2009 Stock Assessment	
	$P(i_f < i_{1998}) > 0.50$	$P(i_f < Q_{25}) > 0.50$	$P(i_f < i_{1998}) > 0.50$	$P(i_f < Q_{25}) > 0.50$
New England	5 out of 6	6 out of 7	2 out of 3	2 out of 5
New York	3 out of 5	1 out of 5	1 out of 5	1 out of 5
Delaware Bay	4 out of 11	2 out of 16	5 out of 11	1 out of 19
Southeast	0 out of 2	0 out of 5	0 out of 5	0 out of 3
Coast wide	12 out of 24	9 out of 33	8 out of 24	4 out of 32

Stock Status

- No overfished/overfishing definitions have been adopted
- Population indices show unique trends between some regional populations
- *Management regulations and population assessment should be implemented on a regional scale. Monitoring and research should reflect the regional differences.*
- Positive trends were observed in the Southeast
- Relatively stable trends in Delaware Bay (Exception is the NJ Surf Clam Dredge which continues to increase)
- Continued declining abundance was evident in the New York and New England regions
- *Continued precautionary management is therefore recommended coastwide to anticipate effects of redirecting harvest from Delaware Bay to outlying populations.*

Stock Status (continued)

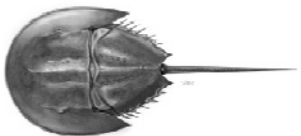
- Catch survey model will be continued to be developed for Delaware Bay area – not included in this update because of need to include biomedical harvest that wasn't in the original version.
- ARM framework for Delaware Bay is now implemented and will continue
- Assessment approaches to make informed management decisions are lacking in the New York and New England region where trends in abundance indices continue to suggest exploitation in these regions is not sustainable
- Monitoring and management in the New York and New England areas should be given a higher priority to reverse or at least stabilize abundance trends in these areas
 - Need better assessment of biomedical harvest regionally
 - Data confidentiality issues
- There is a need for a better assessment of the impacts of biomedical harvest coast wide
 - Partition coast wide biomedical harvest regionally
 - Issues with data confidentiality

Questions?



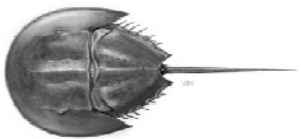
**Horseshoe Crab Technical
Committee Report**
P. Howell

**Presented to Horseshoe Crab
Management Board**
October 31, 2013



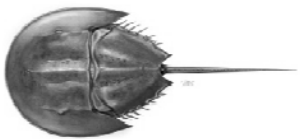
Overview

- **Three parts to presentation**
 - Asian HSC ban update
 - USFWS Red Knot Listing
 - Alternative Bait in Eel/Conch Fisheries
- **No action required**
- **Questions taken at end**



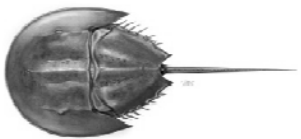
Asian HSC Ban Update

- **DE, MD, SC have taken action to ban the importation and use of Asian HSC**
- **MA is moving forward, but unclear when the ban will be completed**
- **All other states have not taken action due to a variety of reasons (lack of HSC fishery, lack of authority, etc.)**



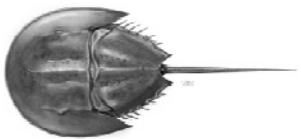
US FWS Red Knot Listing Proposal

- **September 30, 2013, US FWS published a Proposed Rule to list red knots as threatened**
- **TC held a conference call to discuss concerns or impacts to the states**
- **Recommend writing a comment letter clarifying certain aspects of management**
- **No other concerns, as there is not expected to be much impact on the HSC fishery**

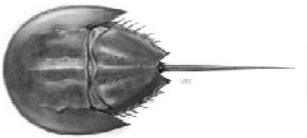


Alternative Bait in Eel/Conch Fisheries

- Studies at UDel isolated a chemical cue which attracts eel and conch to horseshoe crab
- Recently UDel researchers successfully manufactured a workable alternative bait product
- Mixing it with as little as 1/16 of a female horseshoe crab is as successful in attracting eels as using the entire horseshoe crab.
- Investigating the cost effectiveness of the alternative bait since it is now commercially available.



Questions?





**Delaware Bay Ecosystem Technical
Committee Report**
G. Breese

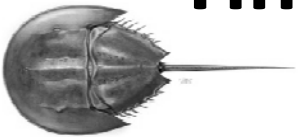
**Presented to Horseshoe Crab
Management Board**
October 31, 2013





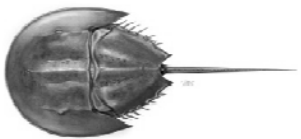
Overview

- **Three topics:**
 - **ARM-based harvest recommendations**
 - **Shorebird and horseshoe crab survey summary**
 - **Delaware Bay Egg Survey Review Report**
- **Time for questions after each topic**



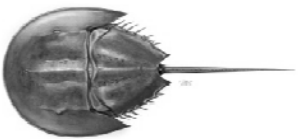
ARM Harvest Recommendations

- Model is based on estimates of red knot and horseshoe crab abundance
 - HSC abundance data from Virginia Tech 2012 Trawl Survey
 - Shorebird Abundance from 2013 Mark-Unmarked Survey
- ARM Model recommends the same harvest package as for 2013



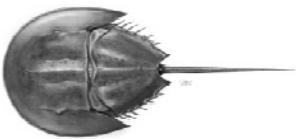
ARM Harvest Recommendations

- HSC abundance data from Virginia Tech 2012 Trawl Survey:
 - Because of only partial funding in 2012, historical data was used to develop a ratio that allowed extrapolating from 2012 data to the historic area surveyed:
 - Mature male estimate: 18,635,078
 - Mature female estimate: 7,243,669



ARM Harvest Recommendations

- **Red Knot Abundance from 2013 Mark-Unmarked Surveys:**
 - **This is a new method for estimating stopover populations**
 - **48,955 estimated stopover population**
 - **Previously used the Peak Population Count, 25,596)**

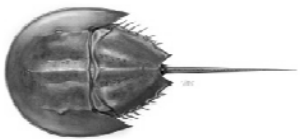


ARM Harvest Recommendations

- Red Knot Abundance Threshold Changed:

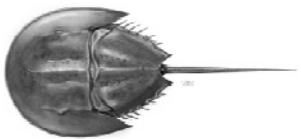
- 81,900 will be the new Threshold Value

- Previous threshold was 45,000



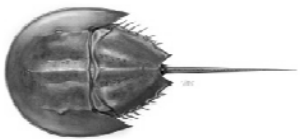
ARM Harvest Monitoring Issue

- Due to lack of funding the Vtech Trawl Survey will **not** be conducted in 2013
- Loss of this survey threatens the viability of the ARM
- Working with NEAMAP for an alternative that looks promising



ARM Optimum Harvest Packages

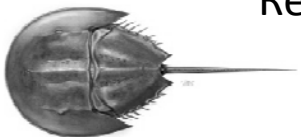
Harvest package	Male harvest (×1,000)	Female harvest (×1,000)
1	0	0
2	250	0
3	500	0
4	280	140
5	420	210



HSC Quota By State

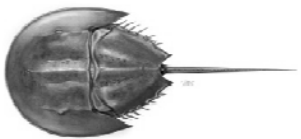
<i>State</i>	Delaware Bay Origin HSC Quota		Total Quota	
	<i>Male</i>	<i>Female</i>	<i>Male</i>	<i>Female</i>
Delaware	162,136	0	162,136	0
New Jersey	162,136	0	162,136	0
Maryland	141,112	0	255,980	0
Virginia	34,615*	0	81,331*	0

*Refers to harvest east of the COLREGS line.



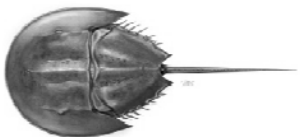
Questions?

State	Total Quota	
	Male	Female
Delaware	162,136	0
New Jersey	162,136	0
Maryland	255,980	0
Virginia	81,331	0



Horseshoe Crab Survey Summary

- **Data sources:**
 - Six HSC trawl surveys
 - Two HSC spawning surveys
 - One egg survey (will be discussed later in presentation)

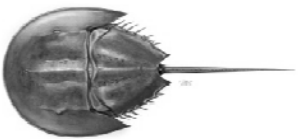




Trawl Surveys

- **No clear trend apparent in recent data**
- **Confident that the population has at least stabilized**
- **High variability among surveys**

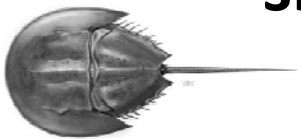
Note: No figures presented in slides as they were presented in the stock assessment update





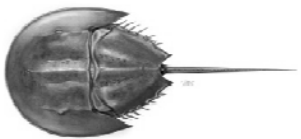
Spawning Surveys

- **Delaware Bay Spawning Survey**
 - No trend in male or female spawning density
 - Sex ratios (M:F) have ranged from 3.2 to 5.2 over 14 years; past 5 of 6 years have been > 4.0
- **Maryland Coastal Bays Spawning Survey**
 - Recent changes to survey design make it too short to evaluate trends



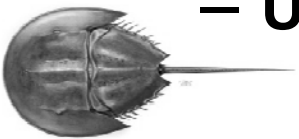
Shorebird Counts

- **Shorebird counts were not provided to the DBETC, so the committee was unable to summarize data from the past year**
- **Anecdotal information for 2013 suggests bird abundance similar to last year, with most birds staying on the NJ side of the bay, suggesting egg supply is not a limiting factor for the current population**



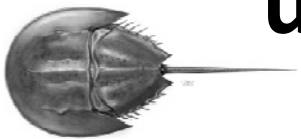
Summary and Questions

- Surveys reflect little change in the status of horseshoe crabs in the Delaware Bay region
- High variability of the surveys, makes it difficult to discern any trends
- Recommended factors to examine for a better understanding of how soon to expect population increases include:
 - First year survivorship
 - Changing conditions leading to new population baseline
 - Unreported losses due to bait/biomedical



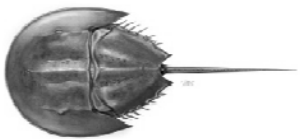
Delaware Bay Egg Survey Review

- **Due to limited funds and uncertainty in the utility for management, DE requested a review of the egg survey**
- **Addendum III made the egg survey a mandatory compliance requirement for Delaware and New Jersey**
 - **Goal: to determine if egg survey has utility for ASMFC management**



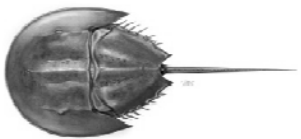
Egg Survey Background

- **NJ has consistently had lower egg counts than DE, even when counting the same sample (studies conducted in 2008 and 2011/2012)**
- **The data has not been used directly for ASMFC management decisions, in part due to this disparity.**



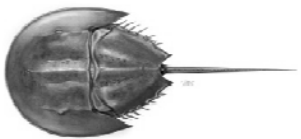
Egg Survey Working Group

- **The Egg Survey Working Group (WG) was formed to investigate the utility of the survey currently, and in the future**
- **Horseshoe crab interests, shorebird interests and Delaware Bay states participated**



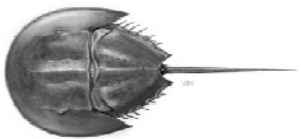
WG Recommendations

- **Confirmed that current management decisions do not rely on the egg survey**
 - ARM Framework relies on horseshoe crab and red knot abundance, more direct measures of what is important for management
- **Methodological issues are problematic and reduce confidence in the results**
- **Surface Eggs are ephemeral and hard to measure due to extreme variation**



WG Recommendations

- **WG recommends that the egg survey be discontinued as a compliance element for the states of New Jersey and Delaware**
- **WG is willing to help improve the survey and recognizes that individual states may wish to continue the survey, ex. New Jersey where it is a state mandated survey**



Questions?

