

## A. ATLANTIC SURFLAM ASSESSMENT SUMMARY FOR 2013

**State of Stock:** The Atlantic surfclam resource in the US EEZ is not overfished and overfishing is not occurring in 2011.

The surfclam EEZ resource is summarized by six regions and two stock assessment areas. From north to south, the regions are: Georges Bank (GBK), Southern New England (SNE), Long Island (LI), New Jersey (NJ), Delmarva (DMV) and southern Virginia (SVA) (Figure A1) and the two stock assessment areas are northern (GBK) and southern (remaining regions). Surfclams and fisheries in state waters are not included in this assessment. Stock assessment results from the two areas were combined to evaluate the status of the stock for the entire EEZ resource. The resource is defined as a single stock.

Estimated biomass of the entire resource during 2011 (approximately 120+ mm shell length, SL) was 1,060 thousand mt (2,337 million lbs), with a 95% confidence interval of 802 – 1401 thousand mt meats. The 95% confidence interval overlaps the  $B_{Target} = \frac{1}{2} B_{1999} = 972$  thousand mt meats (2142 million lbs) but is entirely above  $B_{Threshold} = \frac{1}{2} B_{Target} = 486$  thousand mt meats (1071 million lbs; Figure A2). Estimated annual fishing mortality during 2011 for the entire resource was  $F = 0.027$  (95% confidence interval 0.016 – 0.045), which is entirely below the overfishing threshold  $F_{MSY proxy} = M = 0.15$  (Figure A3).

Estimated biomass on Georges Bank during 2011 (ages 7+, approximately 120+ mm shell length, SL) was 357 thousand mt of meats (787 million lbs) with a 95% confidence interval 252 - 506 mt. Surfclams on Georges Bank were not fished from 1990 to 2008 due to the risk of paralytic shellfish poisoning (PSP). There was light fishing in years 2009-2011 under an exempted fishing permit. Fishing mortality on Georges Bank was close to zero ( $F_{2011} = 0.009$ ; 95% confidence interval 0.006 – 0.013) during 2011.

Estimated biomass of the southern area during 2011 (ages 6+, approximately 120+ mm shell length, SL) was 703 thousand mt (1,549 million lbs), with a 95% confidence interval of 481 – 1028 thousand mt meats (Figure A4). Estimated fishing mortality during 2011 for the southern area was  $F = 0.037$  (95% confidence interval 0.025 – 0.056) (Figure A5).

**Projections for 2012 - 2016:** Catch during 2012-2013 for all projections was assumed equal to mean catch during 2007 – 2011 (23,357 mt). However, in the status quo catch and quota scenarios 8,635 mt of catch was deducted from the south and taken in the north. Catches were landings plus a 12% allowance for incidental mortality. Discards were assumed to be zero since 1990 when the size limit was discontinued. Projections used three plausible assumptions about catches during 2013-2016 (see table below). The status quo catch is probably the most realistic. The  $F_{MSY proxy}$  (OFL) is the most aggressive in terms of total harvest, but fishing at the  $F_{MSY proxy}$  level is not allowed under the FMP. The quota is the maximum level of landings allowed under the FMP.

**Projection Table**

Year	Southern area			GBK area			Southern + GBK		
	F=0.15 (M)	Status-quo catch	Quota	F=0.15 (M)	Status-quo catch	Quota	F=0.15 (M)	Status-quo catch	Quota
<b>Biomass (mt)</b>									
2011	704,366	704,366	704,366	370,217	370,217	370,217	1,074,583	1,074,583	1,074,583
2012	699,480	699,480	699,480	338,866	338,866	338,866	1,038,346	1,038,346	1,038,346
2013	690,839	690,839	690,839	308,580	308,580	308,580	999,419	999,419	999,419
2014	633,310	677,921	672,888	252,941	271,536	271,536	886,251	949,457	944,424
2015	604,667	686,541	676,966	208,410	238,833	238,833	813,077	925,374	915,799
2016	617,034	731,098	717,356	175,171	212,330	212,330	792,205	943,428	929,686
<b>Biomass / Bthreshold (Bthreshold=B1999/4)</b>									
1999	1,513,100			506,882			2,019,982		
Bthreshold	378,275			126,721			504,996		
2011	1.86	1.86	1.86	2.92	2.92	2.92	2.13	2.13	2.13
2012	1.85	1.85	1.85	2.67	2.67	2.67	2.06	2.06	2.06
2013	1.83	1.83	1.83	2.44	2.44	2.44	1.98	1.98	1.98
2014	1.67	1.79	1.78	2.00	2.14	2.14	1.75	1.88	1.87
2015	1.60	1.81	1.79	1.64	1.88	1.88	1.61	1.83	1.81
2016	1.63	1.93	1.90	1.38	1.68	1.68	1.57	1.87	1.84

Year	Southern area			GBK area			Southern + GBK		
	F=0.15 (M)	Status-quo catch	Quota	F=0.15 (M)	Status-quo catch	Quota	F=0.15 (M)	Status-quo catch	Quota
<b>Landings (mt, catch - 12% incidental mortality)</b>									
2011	16,089	16,089	16,089	2,127	2,127	2,127	18,216	18,216	18,216
2012	18,728	18,728	18,728	2,127	2,127	2,127	20,854	20,854	20,854
2013	60,767	13,145	18,504	28,352	7,710	7,710	89,119	20,854	26,213
2014	57,705	13,145	18,504	23,444	7,710	7,710	81,150	20,854	26,213
2015	55,609	13,145	18,504	19,570	7,710	7,710	75,178	20,854	26,213
2016	54,683	13,145	18,504	16,829	7,710	7,710	71,512	20,854	26,213
<b>Landings (bu, catch - 12% incidental mortality)</b>									
2011	2,086,796	2,086,796	2,086,796	275,848	275,848	275,848	2,362,644	2,362,644	2,362,644
2012	2,429,011	2,429,011	2,429,011	275,848	275,848	275,848	2,704,859	2,704,859	2,704,859
2013	7,881,636	1,704,882	2,399,944	3,677,240	999,977	999,977	11,558,875	2,704,859	3,399,921
2014	7,484,494	1,704,882	2,399,944	3,040,787	999,977	999,977	10,525,280	2,704,859	3,399,921

2015	7,212,525	1,704,882	2,399,944	2,538,250	999,977	999,977	9,750,776	2,704,859	3,399,921
2016	7,092,540	1,704,882	2,399,944	2,182,694	999,977	999,977	9,275,234	2,704,859	3,399,921

Year	Southern area			GBK area			Southern + GBK		
	F=0.15 (M)	Status-quo catch	Quota	F=0.15 (M)	Status-quo catch	Quota	F=0.15 (M)	Status-quo catch	Quota
<b>Fully recruited fishing mortality</b>									
2011	0.037	0.037	0.037	0.009	0.009	0.009	0.028	0.028	0.028
2012	0.044	0.044	0.044	0.010	0.010	0.010	0.033	0.033	0.033
2013	0.150	0.031	0.044	0.150	0.039	0.039	0.150	0.034	0.042
2014	0.150	0.031	0.044	0.150	0.044	0.044	0.150	0.035	0.043
2015	0.150	0.031	0.044	0.150	0.050	0.050	0.150	0.035	0.044
2016	0.150	0.030	0.043	0.150	0.055	0.055	0.150	0.035	0.044
<b>Exploitation rate (catch/biomass)</b>									
2011	0.026	0.026	0.026	0.006	0.006	0.006	0.019	0.019	0.019
2012	0.030	0.030	0.030	0.007	0.007	0.007	0.022	0.022	0.022
2013	0.099	0.021	0.030	0.103	0.028	0.028	0.100	0.023	0.029
2014	0.102	0.022	0.031	0.104	0.032	0.032	0.103	0.025	0.031
2015	0.103	0.021	0.031	0.105	0.036	0.036	0.104	0.025	0.032
2016	0.099	0.020	0.029	0.108	0.041	0.041	0.101	0.025	0.032

**Catch and Status Table**

Year	Whole stock										Min <sup>1</sup>	Max <sup>1</sup>	Mean <sup>1</sup>
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011			
Landings <sup>3</sup>	22016	25017	24197	21163	23573	24915	22519	20149	18102	18587	13186	25017	20851
Catch <sup>3</sup>	24658	28019	27100	23702	26401	27904	25221	22567	20274	20818	14768	28019	23353
Quota <sup>3</sup>	25061	25061	26218	26218	26218	26218	26218	26218	26218	26218	13880	26218	21850
Estimated biomass <sup>4</sup>	1823	1744	1714	1687	1591	1438	1308	1187	1100	1060	1060	2499	1902
Recruitment <sup>5</sup>	1163	1085	1757	2596	2407	2206	1750	2286	3257	2089	906	6717	3481
F <sup>6</sup>	0.022	0.024	0.024	0.022	0.025	0.029	0.028	0.026	0.025	0.027	0.015	0.029	0.020

Year	Southern area										Min <sup>2</sup>	Max <sup>2</sup>	Mean <sup>2</sup>
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011			
Landings <sup>3</sup>	22016	25017	24197	21163	23573	24915	22519	20138	16800	16191	13186	25017	20241
Catch <sup>3</sup>	24658	28019	27100	23702	26401	27904	25221	22555	18817	18134	14768	28019	22670
Quota <sup>3</sup>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Estimated biomass <sup>4</sup>	1207	1128	1104	1079	1013	912	827	750	706	703	703	1974	1391
Recruitment <sup>5</sup>	849	851	1438	2240	2027	1906	1594	2115	3017	1704	552	4698	2454
F <sup>6</sup>	0.032	0.036	0.036	0.034	0.040	0.046	0.045	0.043	0.038	0.037	0.019	0.046	0.028

Year	Northern area										Min <sup>1</sup>	Max <sup>1</sup>	Mean <sup>1</sup>
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011			
Landings <sup>3</sup>	0	0	0	0	0	0	0	11	1302	2397	0	2766	375
Catch <sup>3</sup>	0	0	0	0	0	0	0	12	1458	2684	0	3097	420
Quota <sup>3</sup>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Estimated biomass <sup>4</sup>	616	616	610	608	578	526	481	437	394	357	357	616	511
Recruitment <sup>5</sup>	314	234	319	356	380	300	156	171	240	385	156	3597	1027
F <sup>6</sup>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.009	0.000	0.009	0.001

1 - Min, max and mean are calculated based on the years 1982 - 2011

2 - Min, max and mean are calculated based on the years 1979 - 2011

3 - Landing, catch and quota units are metric tons of meats

4 - Biomass units are thousands of metric tons of meat

5 - Recruitment units are millions of age zero clams

6 - Note that F depends on commercial selectivity and the selectivity used in this assessment covers a smaller subset of the available clams than the selectivity used in previous assessments. Thus, the F estimates given here are not directly comparable to the F estimates from previous assessments.

**Stock Distribution and Identification:** Atlantic surfclams are distributed along the coast from Maine through North Carolina at depths ranging from the sub-tidal zone in state waters to about 50 m in the EEZ. All Atlantic surfclams in the EEZ are currently assessed and managed as a single unit stock, although there are differences between regions in biological characteristics and fishing activity.

**Landings:** Annual landings from the EEZ have been stable since the mid 1980s (Figure A6), ranging between 19 and 25 thousand mt. Landings in 2011 were 19 thousand mt (41 million lbs). The EEZ landings have been at or below the quota due to the ITQ tag system. Landings were less than the quota during 2004-2011 due to market limitations.

Areas of highest landings have shifted from DMV north to NJ over time (Figure A7). Since 1979, 85-100% of landings have been taken from the Mid-Atlantic Bight (SVA, DMV and NJ). About 15% of landings were taken from SNE and LI in 2011. Fishing on GBK has recently begun after 20 years of closure due to paralytic shellfish poisoning (PSP). Landings on GBK accounted for about 5% of the total in 2011.

The regional distribution of fishing effort (Figure A8) is similar to that of landings. Fishing effort in NJ and SNE has increased in recent years, while landings have declined in NJ and increased in SNE. LPUE trends since the early 2000's are generally downward for the southern area (Figure A9). LPUE in the GBK experimental fishery was about five times higher than elsewhere. There has been a doubling of effort over the previous ten years while catches have remained stable; effort has shifted into LI and SNE from NJ (Figure A8). LPUE values by region in the most recent years were at or among the lowest since the ITQ began in 1990 except on GBK (Figure A9).

**Data and Assessment:** The updated assessment includes a number of improvements relative to the SAW-49 assessment (NEFSC 2010) including: updated survey gear efficiency estimates based on new cooperative depletion experiments, a new estimate of survey gear size selectivity, new growth curves, new shell length-meat weight relationships, and a new approach to assessing the stock where the northern and southern areas are assessed separately, with parameters in the north borrowed from the south due to data limitations in GBK.

A statistical catch at age and length model called Stock Synthesis (SS3) (Methot and Wetzel. *In press*) replaced the biomass dynamic model used previously (KLAMZ). The new model incorporates age and length structure. Age composition data from the 1982 to 2011 NEFSC clam surveys, and commercial length composition from port samples (when available) were utilized in this assessment for the first time. Evaluation of cooperative research data indicates that survey capture efficiency is more uncertain than portrayed in previous assessments. Uncertainty about capture efficiency increased uncertainty about biomass levels substantially. However, conclusions about stock status are robust to this uncertainty.

**Biological Reference Points:** By definition, overfishing occurs whenever the annual fishing mortality rate on the entire stock is higher than  $F_{MSY}$  or the  $F_{MSY}$  proxy. The stock is defined as overfished if biomass (ages 6+ in the south and ages 7+ in the north) falls below  $B_{Threshold}$  (estimated as  $\frac{1}{2} B_{MSY}$  proxy).

The current proxy for  $F_{MSY}$  is  $F = M$  where  $M$  is assumed to be  $0.15 y^{-1}$ . The proxy for  $B_{MSY}$  is one-half of the estimated biomass (ages 6+ in the south and ages 7+ in the north) during 1999 (Figure A2). The 1999 biomass and related biomass biological reference points, as well as  $MSY$ , were re-estimated in this assessment. The previous and revised reference point values are shown in the table below.

## Previous and revised reference points<sup>1</sup>

Reference Point	Last assessment	Revised
$F_{MSY}$	$M=0.15 \text{ y}^{-1}$	Same
$B_{1999}$	1086 thousand mt meats	1944 thousand mt meats
$B_{MSY \text{ proxy}} = \frac{1}{2} B_{1999}$ (target)	543 thousand mt meats	972 thousand mt meats
$B_{Threshold} = \frac{1}{2} B_{MSY \text{ proxy}}$	272 thousand mt meats	486 thousand mt meats
$MSY$	NA	98 thousand mt meats

1 – Biomass based reference points from the previous assessment are for animals > 120 mm SL, while those from the current assessment are for animals aged 6+ in the south and 7+ in the north. The two different measures are comparable because the ages were chosen to match the lengths used last assessment.

**Fishing Mortality:** Fishing mortality for surfclams during 2011 was  $F = 0.027$  over the whole stock (90% confidence interval 0.016-0.045). It has remained low during the entire time series and never approached the threshold (Figure A3). The F for the southern area during 2011 was 0.037 (0.025-0.056), while the F for GBK during 2011 was 0.009 (0.006-0.013).

**Recruitment:** Recruitment (age 0) has been below average for the whole stock since 1999 (Figure A10).

**Stock Biomass:** Biomass increased from 1330 thousand mt meats (2932 million lbs) and peaked at 2500 thousand mt meats (5512 million lbs) between 1982 and 1988 (Figure A2). During 1989-2011, biomass declined at a rate of about 3.5% per year. Stock biomass during 2011 was 1060 thousand mt meats (2337 million lbs) with a 95% confidence interval 802-1401 thousand mt, which was slightly less than the previous low of 1100 thousand mt (2425 million lbs) during 2010.

Biomass in the south during 2011 was 703 thousand mt (481-1028 thousand mt). Biomass in GBK during 2011 was 357 thousand mt (252-506 thousand mt).

### Special Comments:

Fishing mortality rates for surfclams in the southern region during 2011 were estimated to be low in this assessment despite decades of steady fishing and declines in LPUE. Low model estimates of fishing mortality are supported by the presence of old surfclams (30+ y) and because survey age and size composition data resemble the expected age and size composition in an unexploited population. The catches are low relative to minimum swept area biomass estimates. The explanation for the low estimated F is that the fishery is concentrated in small areas for economic reasons. Most of the stock is not impacted by the fishery. Low F estimates agree with previous assessment results.

Estimates of biomass in both the northern and southern areas were uncertain in terms of absolute biomass (scale) but estimated trends in biomass were relatively certain. This is important in considering reference points for surfclams. For example, point estimates of  $B_{MSY \text{ proxy}}$  and  $B_{2011}$  are uncertain for surfclams due to difficulties in estimating both scale and  $B_{MSY}$  in a stock where fishing mortality has always been light. However, the ratio  $B_{2011} / B_{1999}$ , where  $B_{1999}$  is a  $B_{MSY \text{ proxy}}$ , is stable because estimates of  $B_{2011}$  and  $B_{1999}$  are correlated (correlation coefficient = 0.90). Fishing mortality estimates for surfclams, in contrast, are not robust because they compare the scale of catch against the absolute but uncertain scale of biomass. Despite scale uncertainty, the overfishing status determination is relatively certain because the overall fishing mortality rate is low and almost certainly less than  $F_{Threshold} = M = 0.15$  based on sensitivity testing, survey size and age data and various other model calculations. Similarly, quota catch projections indicate the probability of overfishing or overfished conditions are <1% even at the extremes of a large range of biomasses.

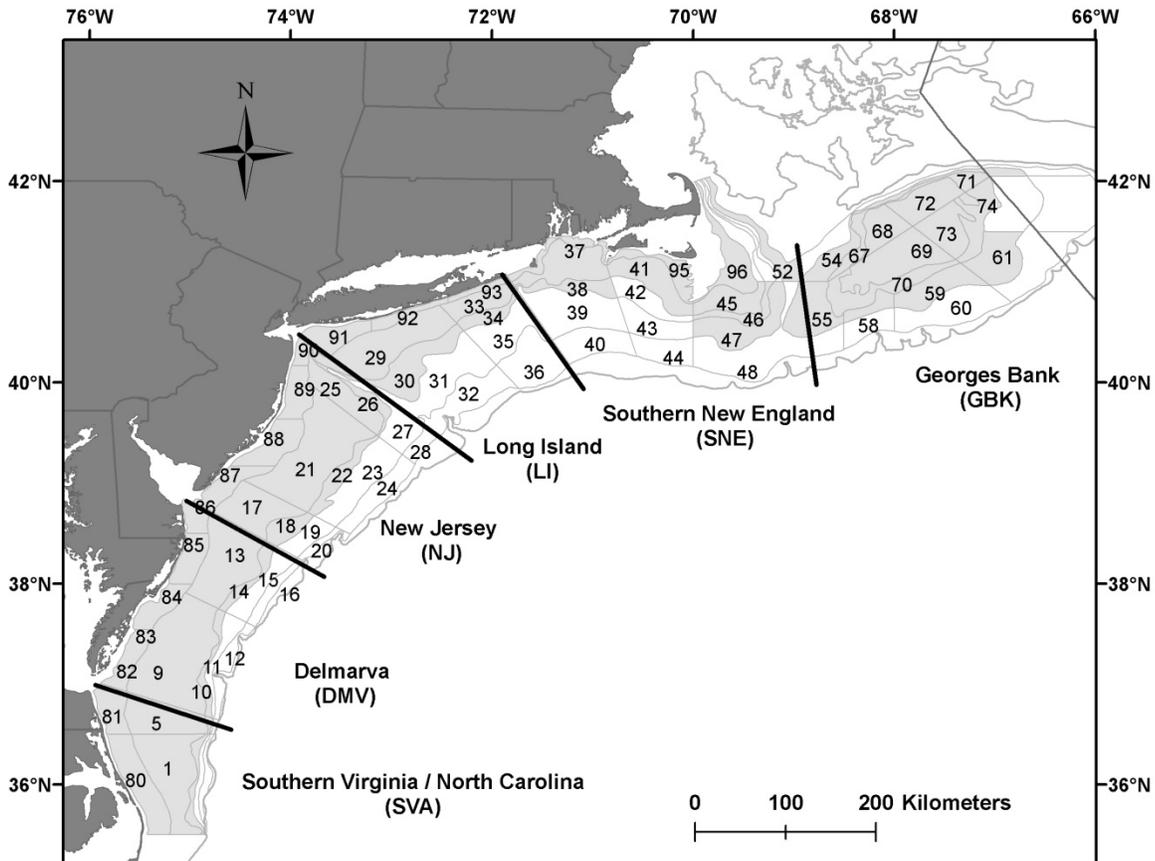
The size-selectivity of the fishery is an important factor in this assessment and tends to buffer the resource from the effects of fishing to some degree. The fishery does not begin to select clams until they reach relatively large sizes. Surfclams are reproductive at very small sizes and thus are sexually mature for several years before becoming available to the fishery (Cargnelli et al. 1999).

A term of reference for this assessment was to address stock structure. The SAW Working Group (WG) considered the alternative of splitting GBK from the southern area, but failed to reach a consensus. The WG provided a summary of its arguments in the report for the SARC panel to consider. The SARC Panel concluded the material presented did not contain sufficient information to allow it to reach a decision on stock definition. The Panel notes this decision does not prevent the stock assessment from being conducted by subareas, nor does it preclude area-based management.

## References

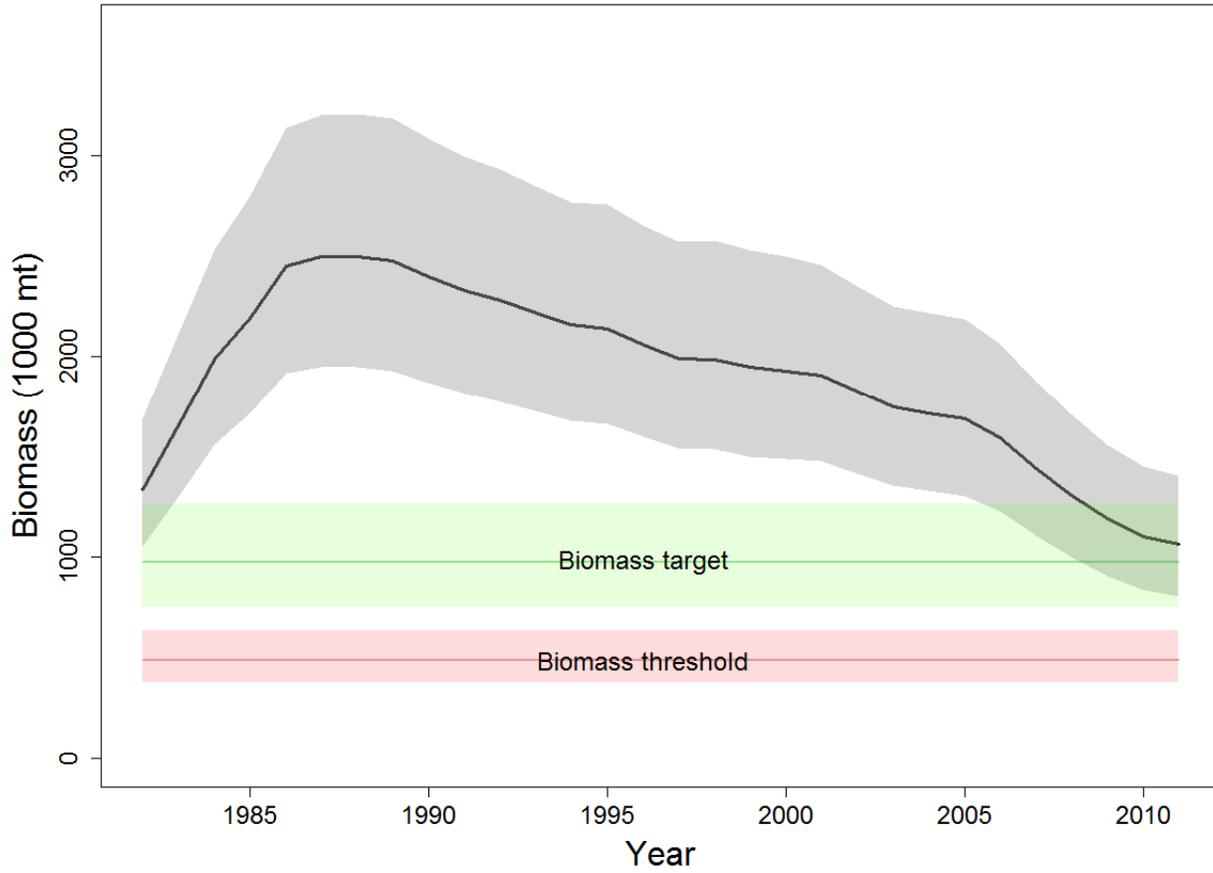
- Cargnelli LM, Griesbach SJ, Packer DB, Weissberger W. 1999. Essential fish habitat source document: Atlantic surfclam, *Spisula solidissima*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-142.
- Methot RD, Wetzel CR. In Press. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research. In Press.
- NEFSC. 2010. Atlantic surfclam stock assessment. In: 49th Northeast Regional Stock Assessment Workshop (49th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 10-03; 383 p.

## Atlantic Surfclam - Figures

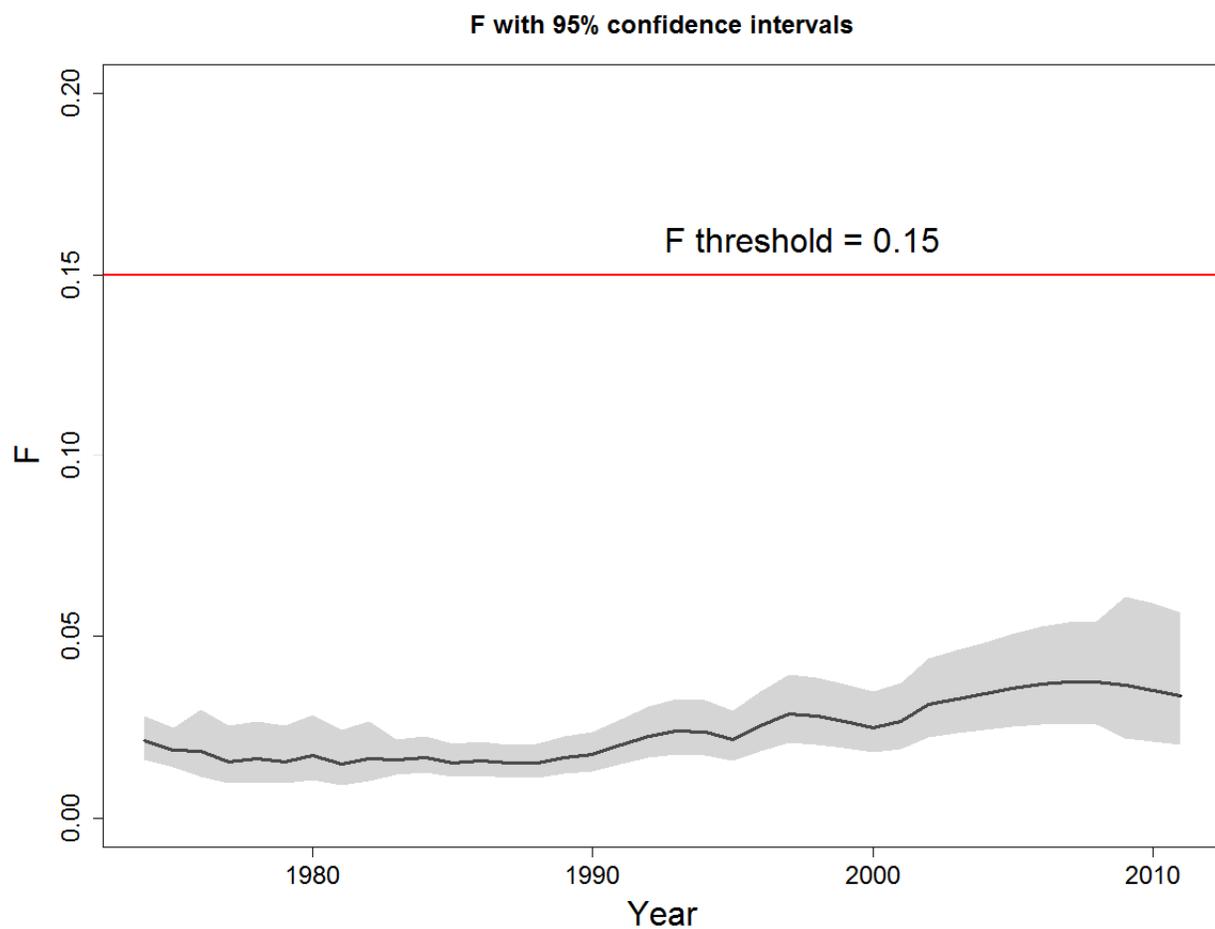


**A1.** Assessment regions for the Atlantic surfclam stock in the US Exclusive Economic Zone (EEZ). NEFSC shellfish strata with potential surfclam habitat are shown in grey and identified by stratum ID numbers.

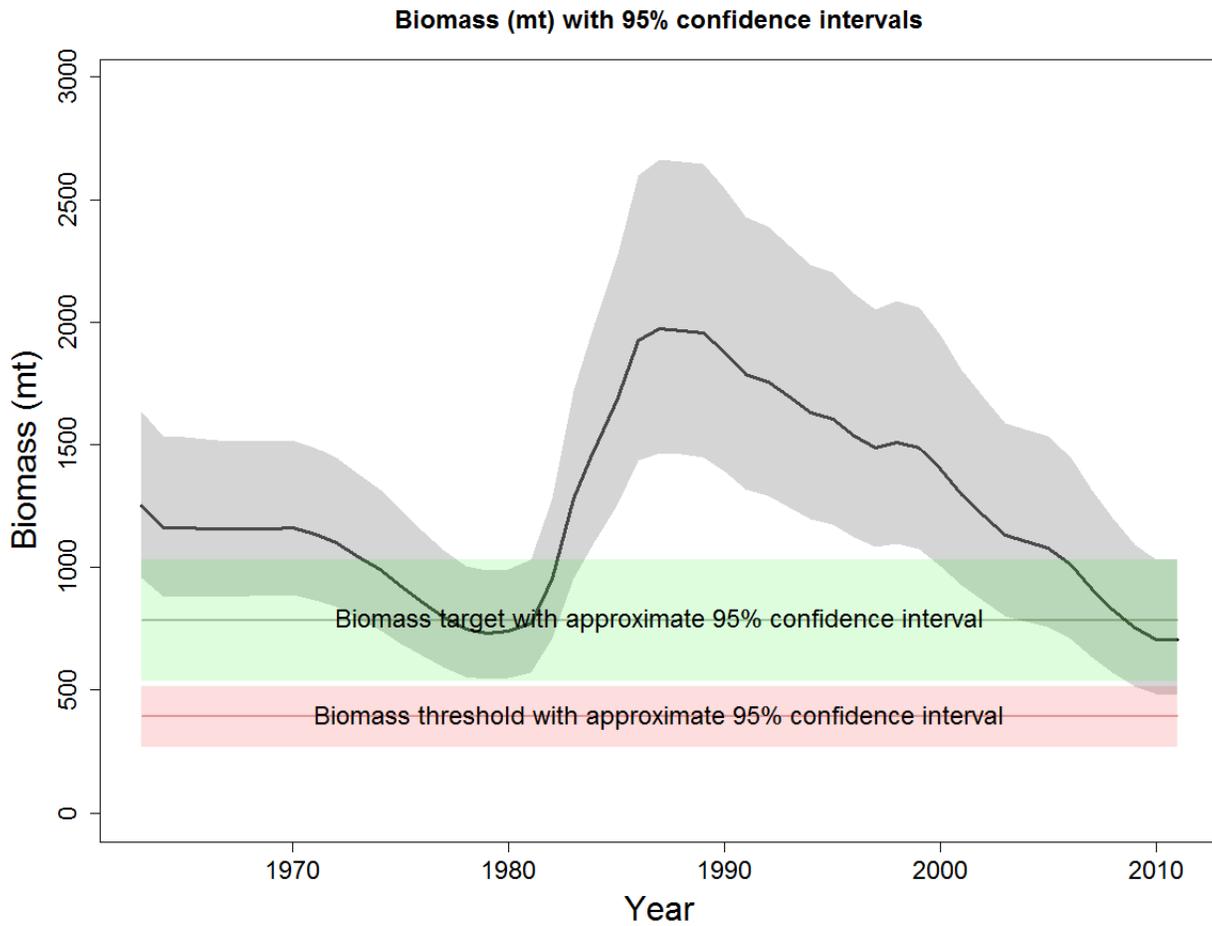
Whole stock biomass status with 95% confidence intervals



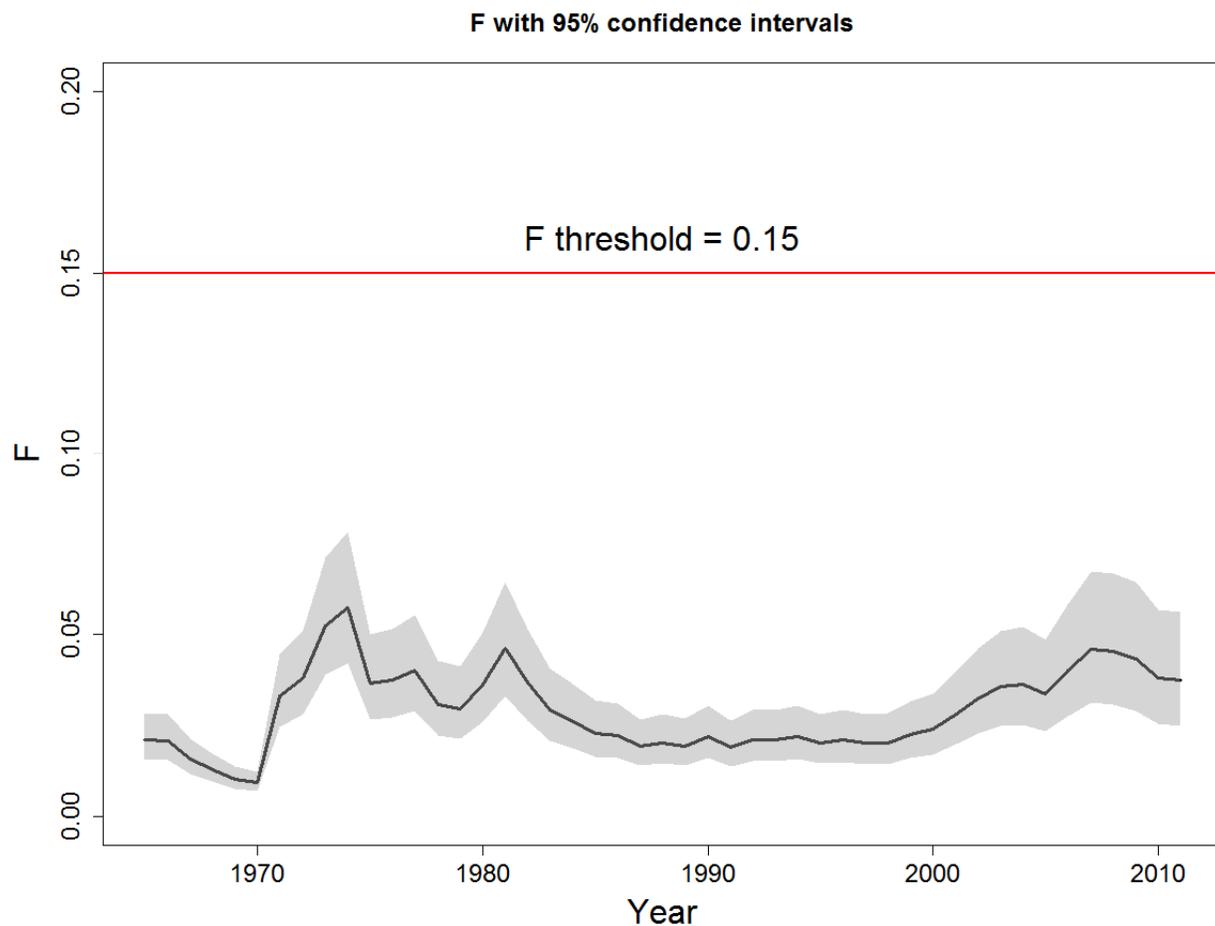
A2. Atlantic surfclam. Whole stock biomass status estimates with approximate 95% confidence intervals on the estimates and reference points.



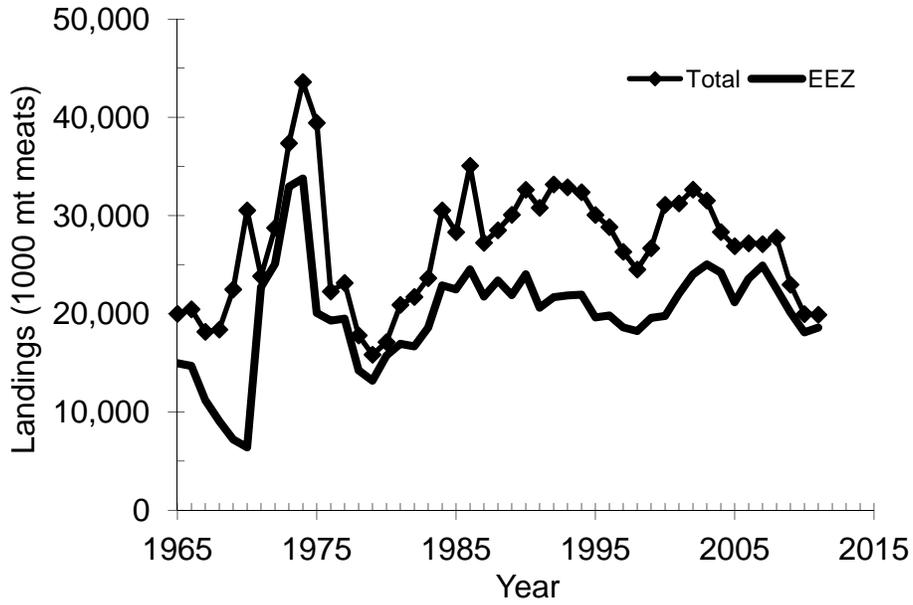
**A3.** Atlantic surfclam. Whole stock fishing mortality estimates with approximate 95% confidence intervals, and the overfishing threshold.



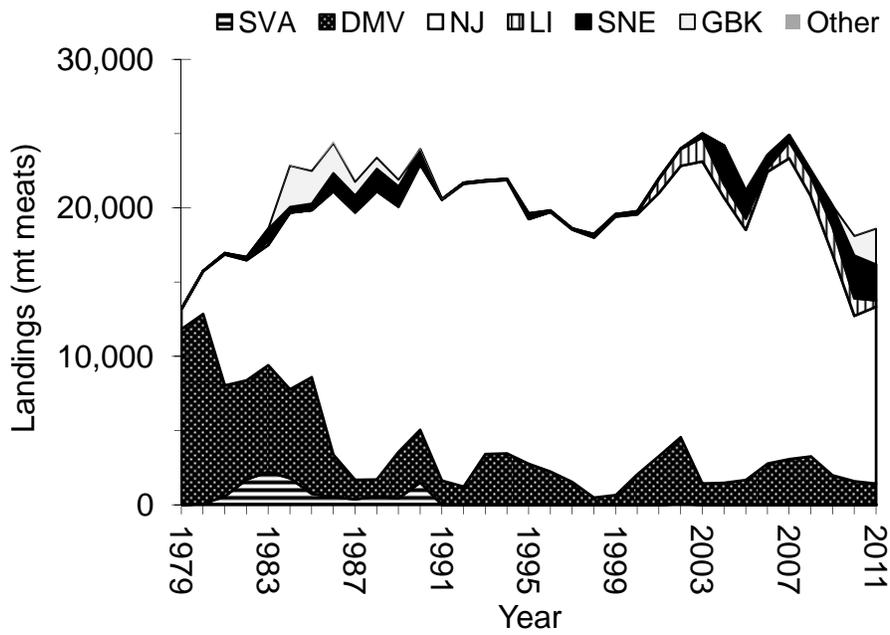
**A4.** Atlantic surfclam. Southern area biomass estimates, and biomass reference points with approximate 95% confidence intervals.



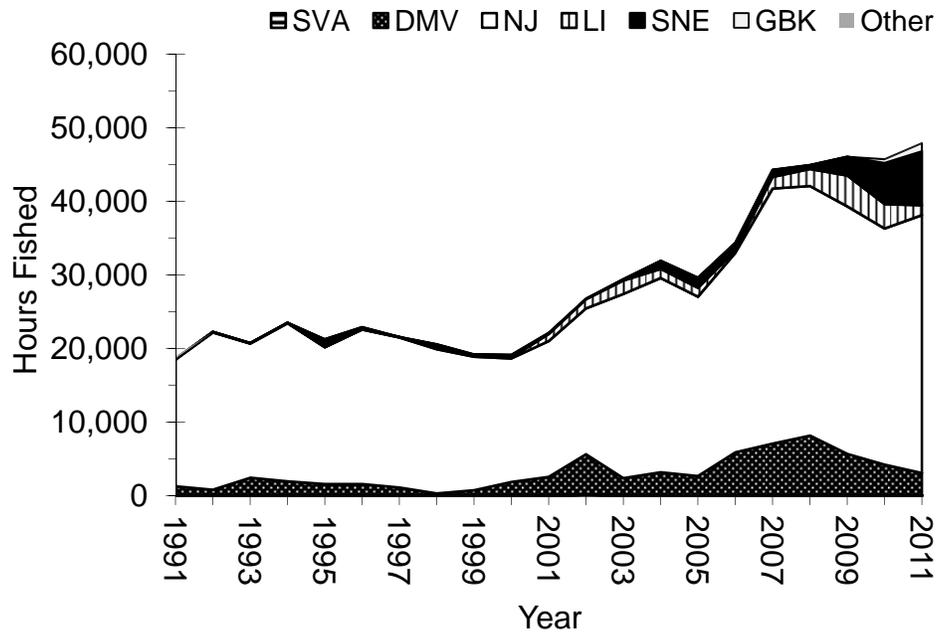
**A5.** Atlantic surfclam. Southern area fishing mortality estimates with approximate 95% confidence intervals, and the overfishing threshold.



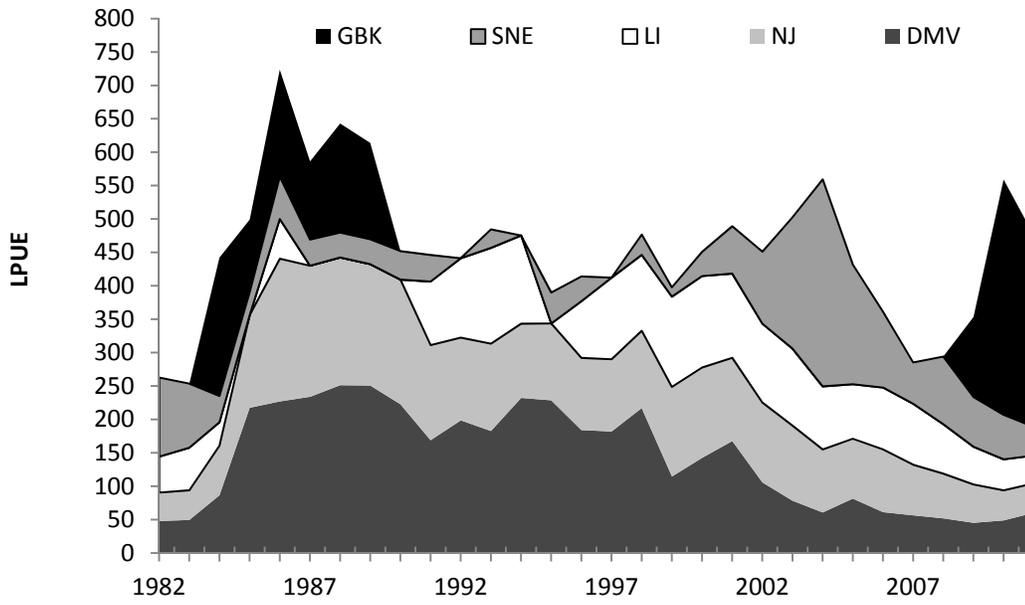
A6. Surfclam landings (total and EEZ) during 1965-2011.



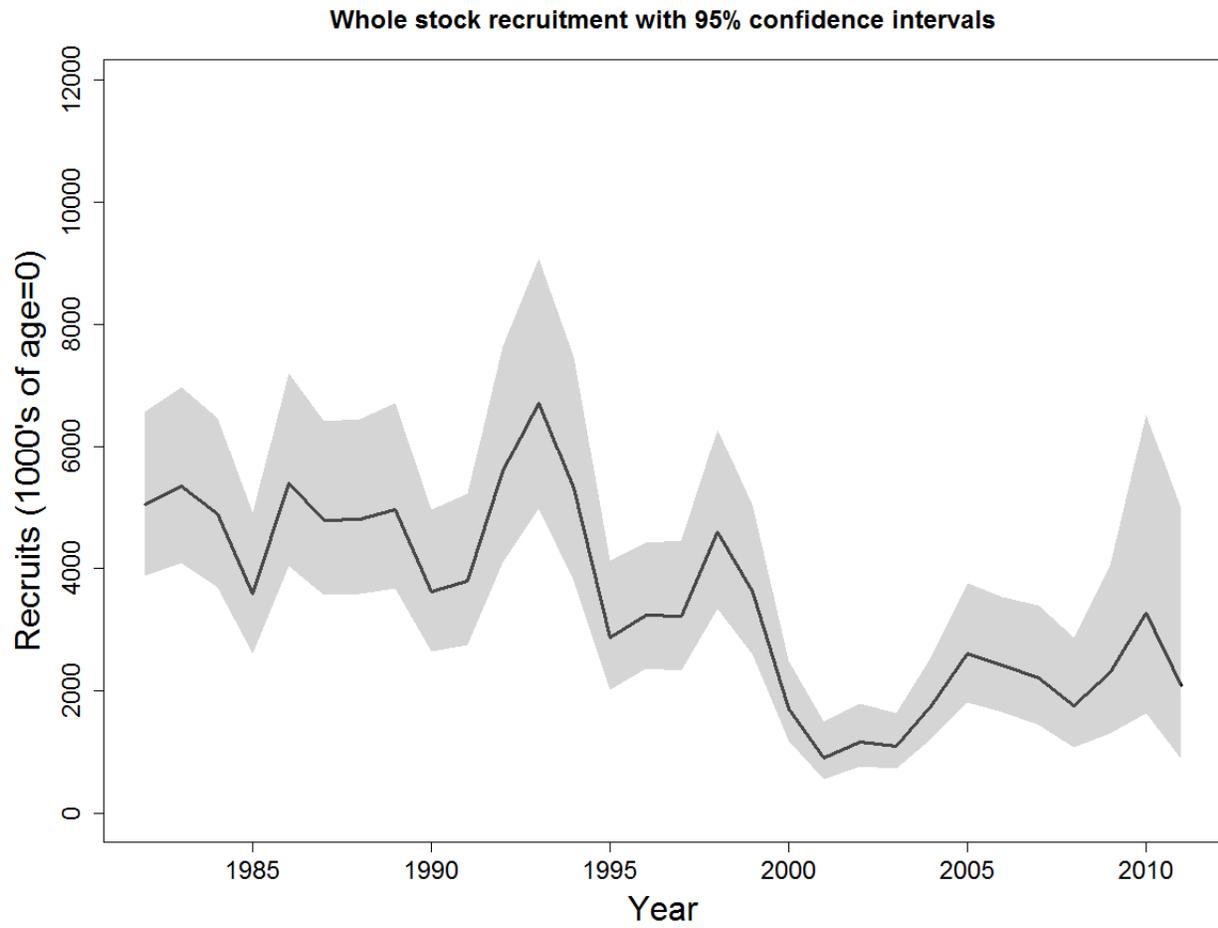
A7. Surfclam landings from the US EEZ during 1979-2011, by stock assessment region.



**A8.** Surfclam hours fished from the US EEZ during 1991-2011, by stock assessment region.



**A9.** Nominal landings per unit effort (LPUE, bushels landed per hour fished) for surfclam, by region



**A10.** Atlantic surfclam. Whole stock recruitment estimates with approximate 95% confidence intervals.