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Sea Scallop Stock Assessment Update for 2005

by Deborah R. Hart

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Introduction

This report is an updated assessment of U.S. sea scallops, using data through the end of the 2005 calendar year. The methodology used here is identical to that used in the last fully peer-reviewed stock assessment (NEFSC 2004), but is updated to include two more calendar years of landings and fishery-independent survey data (2004-2005).

The Atlantic sea scallop, *Placopecten magellanicus,* occurs in continental shelf waters of the Northwest Atlantic between Cape Hatteras and Newfoundland. It supports one of the most valuable fisheries in the United States, with an ex-vessel value in 2005 of over $430 million, and is the most valuable wild scallop fishery in the world. Major commercial concentrations of sea scallops in U.S. waters occur in the Mid-Atlantic Bight (Virginia to Long Island), on Georges Bank and surrounding areas (including the Great South Channel and Nantucket Shoals), and near-shore areas in the Gulf of Maine.

The U.S. federal sea scallop fishery is managed by the New England Fishery Management Council, under Amendment 10 to the sea scallop management plan. The bulk of landings come from more than 300 vessels with limited access permits, but a growing percentage are being taken by vessels with open access general category permits. Limited access vessels are controlled by annual day at sea limits, crew size limits, and trip limits to special access areas. General category vessels are limited to 400 lbs of meats per day or trip, whichever is more restrictive. Gear restrictions (4" rings with a 10" twine top on dredges) apply to all permits.

Fishery closures have strongly influenced sea scallop population dynamics and fisheries in recent years. Three large areas on Georges Bank and Nantucket Shoals were closed to groundfish and scallop fishing in December 1994. Since then, scallop biomass in these areas has increased by about a factor of 25 (Hart and Rago 2006). Portions of these areas were reopened to limited scallop fishing from June-November 1999, June 2000-January 2001, and since November 2004, with seasonal closures during February through June 15. In the Mid-Atlantic, two areas were closed to scallop fishing for three years in April 1998, and a new rotational area (the "Elephant Trunk" closed area) was closed in July 2004. Substantial increases in biomass occurred in one of the two original rotational closures, from which considerable landings were derived after this area was reopened in May 2001. Considerable increases in biomass have also been observed in the Elephant Trunk area prior to its planned 2007 reopening.

Life History and Distribution

Sea scallops occur in the Northwest Atlantic Ocean from North Carolina to Newfoundland along the continental shelf, typically on sand and gravel bottoms (Hart and Chute 2004). In Georges Bank and the Mid-Atlantic, most are harvested at depths between 30 and 100 m, while the bulk of the landings from the Gulf of Maine are from near-shore relatively shallow waters (< 40 m). Sea scallops filter-feed on phytoplankton, microzooplankton, and detritus particles. Sexes are separate with external fertilization, and larvae are planktonic for 4-7 weeks before settling to the bottom. Scallops recruit to the NEFSC survey at about 2 years old (40-70 mm), and to the commercial fishery currently at around 4-5 years old, though historically most 3-year-olds were vulnerable to the commercial fishery.

According to Amendment 10 of the Atlantic Sea Scallop Fishery Management Plan (NEFMC 2003), all scallops in the US Exclusive Economic Zone (EEZ) belong to a single stock. The US sea scallop stock can be subdivided into Georges Bank, Mid-Atlantic, Southern New England, and Gulf of Maine regional components based on survey data, fishery patterns, and other information (NEFSC 2004). The stock is likely composed of smaller regional meta-populations with some movement of larvae from Georges Bank into Southern New England and from Southern New England to the Mid-Atlantic. The main regional components are Georges Bank (including the Great South Channel and Nantucket Shoals) and the Mid-Atlantic Region (Figure 1). However, relatively small but imprecisely known amounts of sea scallop biomass occur in areas outside regularly surveyed NEFSC shellfish strata. Landings from other regions have been comparatively minor. As in NEFSC (2004), abundance and fishing mortality estimates for Georges Bank and the Mid-Atlantic are estimated separately in this assessment and then combined to characterize the condition of the stock as a whole.

Growth in sea scallops is modeled using the von Bertalanffy growth equation $SH = L_\infty [1-\exp(-K(t-t_0))]$, where SH is shell height (in mm) and t is age (in years). The parameters L_∞ and K, based on Serchuk et al. (1979), are taken as $L_\infty = 152.46$, $K = 0.3374$ (Georges Bank), $L_\infty = 151.84$, $K = 0.2997$ (Mid-Atlantic). Since sea scallop assessments are not age-based, the value of t_0 is irrelevant for this assessment. Shell height to meat weight equations $\ln(MW) = a + b\ln(SH)$ are as given in NEFSC (2004): $a = 11.6038$, $b = 3.1221$ (Georges Bank), $a = 12.2484$, $b = 3.2641$ (Mid-Atlantic).

Landings

Total US landings of sea scallops averaged 26,639 mt meats during 2003-2005, nearly quadruple the amount typical during the mid-1990s (Table 1, Figure 2). The landings of 29,321 mt meats in 2004 was an all-time record. The recent increase in landings occurred primarily in the Mid-Atlantic area, where they were well above historical levels. Georges Bank landings remained around their long-term average from 1999-2004, but increased to a near-record 9711 mt meats in 2005, primarily due to reopening of portions of the closed area. The recent increases in landings were mainly due to increased recruitment in the Mid-Atlantic and improved management that has caused scallops to be landed at a much larger size. A majority of the landed meats from the mid-1980s through 1998 were in the smaller market categories (>30 meats per pound). Landings in more recent years have trended to much larger sizes; the mean weight of a landed scallop meat in 2005 was about twice that of a meat in the 1990s (Figure 3).

Surveys

Sea scallop surveys using a lined 8' dredge have been conducted by NEFSC since 1979, but the survey of Georges Bank was incomplete prior to 1982. Thus, survey data used for this assessment are for 1982-2005 for Georges Bank, and 1979-2005 in the Mid-Atlantic. Since 2004, rock chains have been used in four strata in the Great South Channel. In rocky areas, the rock chains increase the efficiency of the gear by about a factor of 1.56 (NEFSC 2004, Appendix 2). In order to be consistent with previous years, the catches in these four strata were reduced by a factor of 1.56 in 2004-2005. Further details regarding the surveys can be found in NEFSC (2004).

Survey biomass in both resource areas remained low through the mid-1990s (Table 2, Figure 4). The closure of three large areas on Georges Bank and Nantucket Shoals, combined with drastically reduced fishing effort (due to shifts of effort to the Mid-Atlantic and later to effort reduction measures) caused a rapid increase in biomass from 1994-2000, with biomass in this area remaining roughly stable since then. Mid-Atlantic biomass remained low until 1998, when the closure of two areas combined with effort reduction measures and very strong recruitment induced a rapid increase in biomass. The overall biomass index began increasing in the mid-1990s, and stood at 7.8 kg/tow in 2005, well above the biomass target of 5.6 kg/tow.

Fishing mortality estimates

Following NEFSC (2004), fishing mortality was estimated using the "rescaled catch-biomass" method. In summary, fishing mortality trends for Georges Bank and the Mid-Atlantic were estimated by the ratio of landings to survey biomass. These trends were scaled so that they averaged the long-term average fishing mortality estimated in each year by the "two-bin" method:

$$ {}^{s}F_t = -\ln\left(\frac{P_{t+1}}{R_t + P_t}\right) - M, $$

where R_t was the mean population number of scallops per standard survey tow in the first bin (new recruits) during survey year t, and P_t was the mean population number of scallops per standard survey tow in the second bin (plus group). Natural mortality M was estimated as 0.1 as in NEFSC 2004. The estimates from the two regions were combined using a number-weighed average. Further details on these calculations can be found in NEFSC (2004) and Hart and Rago (2006).

Georges Bank fishing mortality peaked at about 1.7 in 1991, but declined drastically starting in 1994 (Table 3 and Fig. 4). In recent years (2000-2005), fishing mortality has been around 0.1; the 2005 fishing mortality was slightly higher than the recent average (0.15) primarily due to reopenings of portions of the closed areas. Mid-Atlantic fishing mortality peaked at about 1.6 in 1992. Fishing mortality declined greatly between 1996 and 1999, and since then has modestly varied without trend. Fishing mortality in 2005 was the lowest in the time series (0.3); the recent decrease is primarily due to the rotational closure of the Elephant Trunk area. Fishing mortality for the overall resource peaked at 1.55 in 1991 and then declined considerably between 1991 and 1998. Since 1998, overall fishing mortality has varied between 0.18 and 0.34; it was 0.22 in 2005, slightly under the overfishing threshold of 0.24, but just over the fishing mortality target of 0.2.

Status determination for 2005

The overall NEFSC sea scallop survey index stood at 7.8 kg/tow for 2005, above the biomass target of 5.6 kg/tow (NEFMC 2003). Sea scallops were therefore not overfished. The point estimate for fishing mortality of the overall sea scallop resource was 0.22, below the overfishing threshold of 0.24. Thus, overfishing of sea scallops was not occurring. However, there are important caveats to this conclusion. First, the confidence interval for fishing mortality contains the overfishing threshold, so it cannot be concluded with statistical certainty that overfishing was not occurring. Perhaps more importantly, the fishing mortality estimate in 2005 is a spatial average over heavily fished areas and areas that are either closed (e.g., the Elephant Trunk Closed Area and the Nantucket Lightship Closed Area) or where fishing mortality was low (e.g., Georges Bank Closed Areas I and II). Because over half the scallop biomass is contained in the closed areas, fishing mortality in the remainder of the resource must be over the fishing mortality threshold, and localized overfishing of some areas must be continuing. There is a possibility that unless fishing effort elsewhere is reduced, overfishing of the overall resource may reoccur when the Elephant Trunk area is reopened and fishing mortality there is ramped up. Finally, there has been considerable growth in general category fishing effort in the last several years which also threatens to induce overfishing unless management action is taken to contain effort in this sector.

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Table 1. U.S. sea scallop landings (mt meats), 1964-2005.

	Gulf of Maine				Georges Bank				S. New England				Mid Atlantic Bight				Uncl.	Total			
Year	dredge	trawl	other	sum	dredge	trawl	other	sum	dredge	trawl	other	sum	dredge	trawl	other	sum	other	dredge	trawl	other	sum
1964		0	208	208		0	6,241	6,241		52	3	55		0	137	137			52	6,590	6,642
1965		0	117	117		3	1,478	1,481		2	24	26		0	3,974	3,974			5	5,592	5,598
1966		0	102	102		0	883	884		0	8	8		0	4,061	4,061			1	5,055	5,056
1967		0	80	80		4	1,217	1,221		0	8	8		0	1,873	1,873			4	3,178	3,182
1968		0	113	113		0	993	994		0	56	56		0	2,437	2,437			0	3,599	3,599
1969		1	122	123		8	1,316	1,324		0	18	19		5	846	851			14	2,302	2,317
1970		0	132	132		5	1,410	1,415		0	6	6		14	459	473			19	2,006	2,026
1971		4	358	362		18	1,311	1,329		0	7	7		0	274	274			22	1,949	1,971
1972		1	524	525		5	816	821		0	2	2		5	653	658			11	1,995	2,006
1973		0	460	460		15	1,065	1,080		0	3	3		4	245	249			19	1,773	1,792
1974		0	223	223		15	911	926		0	4	5		0	937	938			16	2,076	2,091
1975		6	741	746		13	844	857		8	42	50		52	1,506	1,558			80	3,132	3,212
1976		3	364	366		38	1,723	1,761		4	3	7		317	2,972	3,288			361	5,061	5,422
1977		4	254	258		27	4,709	4,736		1	10	11		27	2,564	2,591			58	7,536	7,595
1978	242	1	0	243	5,532	37	0	5,569	25	2	0	27	4,175	21	0	4,196		9,974	61	0	10,035
1979	401	5	1	407	6,253	25	7	6,285	61	5	0	66	2,857	29	1	2,888		9,572	64	9	9,645
1980	1,489	122	3	1,614	5,382	34	2	5,419	130	3	0	133	1,966	9	0	1,975	< 0.01	8,968	169	4	9,142
1981	1,225	73	7	1,305	7,787	56	0	7,843	68	1	0	69	726	5	0	731		9,806	135	7	9,948
1982	631	28	5	664	6,204	119	0	6,322	126	0	0	126	1,602	6	2	1,610		8,562	153	7	8,723
1983	815	72	7	895	4,247	32	4	4,284	243	1	0	243	3,081	18	10	3,109		8,386	124	21	8,530
1984	651	18	10	678	3,011	29	3	3,043	161	3	0	164	3,647	26	2	3,675		7,470	76	14	7,560
1985	408	3	10	421	2,860	34	0	2,894	77	4	0	82	3,227	47	1	3,276		6,572	88	11	6,672
1986	308	2	6	316	4,428	10	0	4,438	76	2	0	78	3,257	101	0	3,359		8,068	115	7	8,190
1987	373	0	9	382	4,821	30	0	4,851	67	1	0	68	7,488	315	1	7,803		12,749	346	10	13,104
1988	506	7	13	526	6,036	18	0	6,054	65	4	0	68	5,774	402	2	6,178		12,381	430	16	12,826
1989	600	0	44	644	5,637	25	0	5,661	127	11	0	138	7,549	422	2	7,973		13,913	458	45	14,416
1990	545	0	28	574	9,972	10	0	9,982	110	6	0	116	5,954	476	4	6,435		16,581	493	32	17,107
1991	527	3	75	605	9,235	77	0	9,311	55	16	0	71	6,195	808	9	7,011		16,012	903	84	16,999
1992	676	2	45	722	8,230	7	0	8,238	119	5	0	124	4,386	563	5	4,955		13,411	577	50	14,039
1993	763	2	32	797	3,637	18	0	3,655	65	1	0	66	2,382	392	3	2,778		6,848	413	36	7,296

Table 1 continued.

	Gulf of Maine				Georges Bank				S. New England				Mid Atlantic Bight				Uncl.	Total			
Year	dredge	trawl	other	sum	dredge	trawl	other	sum	dredge	trawl	other	sum	dredge	trawl	other	sum	other	dredge	trawl	other	sum
1994	519	3	3	525	1,133	3	1	1,137	0	1	0	1	5,176	688	9	5,872		6,827	693	13	7,534
1995	424	4	238	665	967	15	0	982	35	1	0	36	5,408	744	166	6,318		6,799	762	404	7,965
1996	632	20	121	773	2,040	6	0	2,045	74	0	0	74	4,335	656	9	4,999		7,006	682	130	7,818
1997	581	21	98	699	2,317	10	0	2,326	69	0	0	69	2,442	357	111	2,910		5,339	387	209	5,936
1998	443	10	1	455	1,990	27	0	2,016	95	6	0	102	2,359	574	15	2,948	44	4,792	610	17	5,565
1999	277	3	0	280	5,151	4	0	5,155	46	5	3	54	3,646	958	50	4,653	4	9,074	965	50	10,146
2000	182	8	1	191	5,412	25	0	5,437	84	2	0	86	7,707	1,142	10	8,860	49	13,301	1,175	11	14,623
2001	383	18	29	430	4,941	11	0	4,952	27	1	2	31	14,161	1,570	38	15,768		19,485	1,599	67	21,180
2002	533	7	2	542	5,653	40	0	5,694	41	3	0	43	16,016	1,591	5	17,612		22,202	1,639	7	23,891
2003	246	7	1	254	4,908	14	0	4,922	84	2	0	85	18,189	1,470	1	19,660	187	23,343	1,491	1	25,107
2004	126	7	1	134	4,301	48	4	4,353	106	20	22	148	23,212	1,453	21	24,686		27,639	1,508	26	29,321
2005	189	12	0	201	9,540	171	0	9,711	294	16	1	311	14,288	972	6	15,266		24,017	1,155	6	25,489

Table 2. NEFSC sea scallop survey stratified means for >40 mm scallops. Biomass is in meat weight.

Year	Num/Tow	CV	Num/tow Not Recruited	Num/Tow Fully Recruited	Biomass g/Tow	CV	Biomass Not Recruited g/Tow	Biomass Fully Recruited g/Tow	Mean Meat Weight (G)
Georges Bank									
1982	133	37%	100	33	869	18%	304	565	6.6
1983	61	21%	24	37	720	16%	97	623	11.9
1984	39	11%	15	23	544	9%	55	490	14.0
1985	65	14%	31	34	706	13%	126	579	10.8
1986	116	13%	79	37	917	9%	269	648	7.9
1987	126	15%	67	58	1,082	13%	245	837	8.6
1988	104	15%	56	48	904	12%	216	688	8.7
1989	111	36%	56	55	943	33%	248	695	8.5
1990	207	22%	129	78	1,340	20%	475	865	6.5
1991	251	30%	200	51	1,246	14%	551	695	5.0
1992	264	38%	185	79	1,638	29%	787	851	6.2
1993	70	28%	47	23	531	17%	204	327	7.6
1994	45	16%	20	25	457	13%	69	388	10.2
1995	120	18%	92	28	747	13%	285	462	6.2
1996	139	16%	70	69	1,332	14%	256	1,076	9.6
1997	100	13%	28	72	1,612	14%	98	1,514	16.1
1998	317	31%	145	172	4,000	37%	508	3,492	12.6
1999	246	17%	67	179	4,306	25%	158	4,148	17.5
2000	888	30%	542	346	8,131	21%	2,243	5,888	9.2
2001	473	13%	147	327	7,010	14%	616	6,394	14.8
2002	397	13%	33	364	8,051	13%	174	7,877	20.3
2003	311	12%	61	250	7,529	14%	231	7,299	24.2
2004	350	11%	43	307	9,289	11%	174	9,116	26.5
2005	275	12%	33	241	7,759	11%	133	7,626	28.3
Mid-Atlantic Bight									
1979	43	9%	11	32	728	10%	46	681	16.9
1980	51	12%	27	24	615	7%	62	553	12.1
1981	40	17%	18	22	488	11%	64	423	12.3
1982	40	11%	16	24	508	8%	64	444	12.8
1983	38	9%	20	19	472	8%	65	407	12.3
1984	39	10%	15	24	454	9%	49	406	11.8
1985	93	13%	58	35	734	9%	207	528	7.9
1986	152	8%	89	64	1,186	7%	323	863	7.8
1987	152	8%	94	58	1,039	6%	276	763	6.9
1988	179	10%	78	101	1,683	8%	302	1,381	9.4
1989	216	9%	129	87	1,525	7%	462	1,063	7.1
1990	264	22%	173	91	1,672	17%	702	970	6.3
1991	103	10%	48	55	963	10%	196	767	9.4
1992	53	10%	24	28	543	7%	82	461	10.3
1993	164	11%	138	26	753	8%	391	362	4.6
1994	162	10%	95	67	1,043	8%	326	717	6.4
1995	218	13%	125	94	1,547	11%	567	980	7.1
1996	77	8%	23	53	773	7%	116	657	10.1
1997	54	12%	28	26	533	6%	66	467	9.8

Table 2 continued.

Year	Num/Tow	CV	Num/tow Not Recruited	Num/Tow Fully Recruited	Biomass g/Tow	CV	Biomass Not Recruited g/Tow	Biomass Fully Recruited g/Tow	Mean Meat Weight (G)
Mid-Atlantic Bight *continued*									
1998	195	17%	145	50	1,101	15%	474	627	5.7
1999	309	21%	173	136	2,281	18%	640	1,641	7.4
2000	389	14%	131	257	4,005	13%	572	3,434	10.3
2001	398	12%	141	257	4,519	13%	523	3,995	11.3
2002	404	11%	112	292	5,122	12%	399	4,723	12.7
2003	864	15%	495	370	7,603	9%	1,297	6,306	8.8
2004	675	11%	303	372	6,700	7%	1,355	5,345	9.9
2005	507	9%	122	385	7,860	8%	351	7,509	15.5
Combined									
1982	83	28%	55	28	676	11%	176	500	8.1
1983	49	13%	22	27	587	10%	80	507	12.1
1984	39	8%	15	24	496	6%	51	445	12.8
1985	80	9%	46	35	721	8%	169	552	9.1
1986	135	7%	84	51	1,061	6%	298	763	7.8
1987	140	8%	82	58	1,059	7%	262	798	7.6
1988	144	8%	68	77	1,320	6%	262	1,058	9.2
1989	167	13%	95	72	1,254	12%	363	892	7.5
1990	237	16%	153	85	1,517	13%	596	921	6.4
1991	172	21%	119	53	1,095	9%	361	734	6.4
1992	151	31%	99	52	1,053	21%	410	643	7.0
1993	120	11%	96	24	650	8%	304	346	5.4
1994	108	9%	60	48	770	7%	206	564	7.2
1995	173	10%	110	63	1,175	9%	436	739	6.9
1996	106	11%	45	61	1,033	9%	181	852	10.3
1997	76	9%	28	48	1,035	10%	81	954	14.9
1998	251	20%	145	107	2,451	29%	490	1,961	10.5
1999	268	14%	124	144	1,978	16%	416	1,562	11.1
2000	621	21%	323	299	5,926	14%	1,350	4,576	10.0
2001	433	9%	144	290	5,678	10%	566	5,112	13.3
2002	401	8%	75	326	6,485	9%	294	6,192	16.2
2003	607	12%	293	314	7,569	8%	801	6,768	12.5
2004	524	8%	182	342	7,905	7%	805	7,100	15.1
2005	399	7%	81	318	7,813	7%	249	7,564	19.6

Table 3. Fishing mortality estimates for Georges Bank, Mid-Atlantic, and combined. The best estimates are given under the "Rescaled F" column in bold. Further details can be found in NEFSC 2004.

Georges Bank

	80-100	100+	SurveyF	*CV*	Landings	MinEBms	Ebms	*CV*	CBI	*CV*	RescaledF	*CV*	BH-F	MovAvg
1982	14.8	11.4			6322	3124	7811	*0.12*	0.81	*0.15*	**1.42**	*0.16*	0.62	0.64
1983	22.2	12.0	0.68		4284	3443	8608	*0.10*	0.50	*0.14*	**0.88**	*0.15*	0.81	0.66
1984	10.5	11.3	1.01		3043	2707	6767	*0.10*	0.45	*0.14*	**0.79**	*0.15*	0.48	0.59
1985	17.1	12.5	0.46		2894	3204	8011	*0.14*	0.36	*0.17*	**0.64**	*0.18*	0.70	0.77
1986	15.2	14.9	0.59		4438	3585	8964	*0.09*	0.50	*0.13*	**0.87**	*0.14*	0.58	0.87
1987	35.8	14.8	0.61		4851	4631	11578	*0.13*	0.42	*0.16*	**0.74**	*0.17*	1.03	1.14
1988	27.8	12.8	1.27		6054	3806	9515	*0.10*	0.64	*0.14*	**1.12**	*0.15*	0.99	1.42
1989	35.6	10.2	1.28		5661	3842	9605	*0.32*	0.59	*0.34*	**1.04**	*0.34*	1.38	1.43
1990	53.9	8.8	1.54		9982	4785	11962	*0.22*	0.83	*0.24*	**1.47**	*0.24*	1.89	1.37
1991	26.9	12.0	1.55		9311	3844	9611	*0.09*	0.97	*0.14*	**1.71**	*0.14*	1.02	0.98
1992	32.4	11.3	1.14		8238	4708	11770	*0.17*	0.70	*0.19*	**1.23**	*0.20*	1.21	0.97
1993	8.7	7.2	1.71		3655	1806	4514	*0.10*	0.81	*0.14*	**1.43**	*0.15*	0.72	0.77
1994	16.4	7.2	0.69		1137	2145	5363	*0.12*	0.21	*0.16*	**0.37**	*0.16*	0.96	0.81
1995	10.9	12.1	0.57		982	2554	6385	*0.12*	0.15	*0.15*	**0.27**	*0.16*	0.63	0.64
1996	37.9	23.5	-0.12		2045	5950	14874	*0.14*	0.14	*0.17*	**0.24**	*0.18*	0.83	0.59
1997	24.9	44.4	0.22		2326	8370	20926	*0.14*	0.11	*0.17*	**0.20**	*0.18*	0.45	0.46
1998	66.7	92.0	-0.38		2016	19308	48271	*0.39*	0.04	*0.40*	**0.07**	*0.41*	0.47	0.51
1999	59.3	84.7	0.53		5155	22937	57342	*0.31*	0.09	*0.32*	**0.16**	*0.33*	0.46	0.53
2000	133.5	135.6	-0.04		5437	32560	81401	*0.20*	0.07	*0.23*	**0.12**	*0.23*	0.58	0.53
2001	151.5	154.9	0.45		4952	35358	88396	*0.15*	0.06	*0.18*	**0.10**	*0.19*	0.55	0.40
2002	145.3	215.1	0.25		5694	43561	108903	*0.13*	0.05	*0.17*	**0.09**	*0.17*	0.45	0.32
2003	33.8	207.9	0.45		4922	40360	100901	*0.13*	0.05	*0.17*	**0.09**	*0.17*	0.18	0.18
2004	57.4	236.2	-0.08		4353	53546	133865	*0.11*	0.03	*0.15*	**0.06**	*0.15*	0.18	
2005	44.0	211.8	0.23		9711	45659	114146	*0.11*	0.09	*0.15*	**0.15**	*0.16*	0.15	
Mean8205	*45.1*	*65.2*	*0.63*	*0.04*	*4894*		*37062*		*0.36*		*0.63*		*0.72*	
Mean8294	*24.4*	*11.3*	*1.02*		*5375*		*8775*		*0.60*		*1.02*		*0.94*	
Mean9505	*72.1*	*120.6*	*0.19*		*4327*		*70492*		*0.08*		*0.14*		*0.45*	

Mid-Atlantic

	80-98.5	98.5+	SurveyF	*CV*	Landings	MinEBms	EBms	*CV*	CBI	*CV*	RescaledF	*CV*	BH-F	MovAvg
1979	10.9	19.1			2888	4326	7210	*0.10*	0.40	*0.14*	**0.65**	*0.15*	0.38	0.39
1980	7.0	16.2	0.52		1975	3512	5854	*0.07*	0.34	*0.12*	**0.55**	*0.12*	0.33	0.45
1981	9.0	10.1	0.73		731	2686	4476	*0.10*	0.16	*0.14*	**0.26**	*0.14*	0.47	0.46
1982	11.3	10.6	0.49		1610	2819	4698	*0.08*	0.34	*0.13*	**0.55**	*0.13*	0.55	0.55
1983	6.4	10.8	0.61		3109	2582	4304	*0.08*	0.72	*0.13*	**1.17**	*0.13*	0.36	0.61
1984	14.8	8.2	0.64		3675	2577	4295	*0.09*	0.86	*0.13*	**1.38**	*0.13*	0.73	0.85
1985	16.9	11.8	0.57		3276	3351	5584	*0.07*	0.59	*0.12*	**0.95**	*0.12*	0.75	0.99
1986	40.0	15.9	0.49		3359	5480	9133	*0.07*	0.37	*0.12*	**0.59**	*0.12*	1.06	1.10
1987	40.1	13.6	1.31		7803	4842	8071	*0.06*	0.97	*0.12*	**1.56**	*0.12*	1.16	1.16
1988	66.4	24.8	0.67		6178	8768	14613	*0.07*	0.42	*0.12*	**0.68**	*0.12*	1.10	1.24
1989	53.5	16.2	1.63		7973	6748	11247	*0.07*	0.71	*0.12*	**1.15**	*0.12*	1.22	1.21
1990	49.7	11.7	1.69		6435	6161	10268	*0.10*	0.63	*0.14*	**1.01**	*0.14*	1.41	1.05
1991	33.5	14.8	1.32		7011	4872	8120	*0.11*	0.86	*0.15*	**1.39**	*0.15*	1.01	0.85
1992	15.3	10.9	1.39		4955	2928	4880	*0.07*	1.02	*0.12*	**1.64**	*0.12*	0.73	1.13
1993	12.9	7.5	1.14		2794	2300	3833	*0.07*	0.73	*0.12*	**1.18**	*0.12*	0.83	1.38
1994	44.5	7.6	0.89		5872	4552	7587	*0.08*	0.77	*0.13*	**1.25**	*0.13*	1.84	1.58
1995	50.0	13.2	1.27		6318	6224	10373	*0.09*	0.61	*0.13*	**0.98**	*0.13*	1.48	1.17
1996	39.5	10.1	1.73		4999	4168	6947	*0.06*	0.72	*0.12*	**1.16**	*0.12*	1.43	1.04
1997	12.6	13.2	1.23		2910	2967	4944	*0.06*	0.59	*0.11*	**0.95**	*0.11*	0.61	1.00
1998	28.9	11.0	0.75		2948	3980	6633	*0.14*	0.44	*0.17*	**0.72**	*0.17*	1.10	1.16
1999	87.7	26.9	0.30		4653	10418	17363	*0.15*	0.27	*0.18*	**0.43**	*0.18*	1.30	1.05
2000	169.9	69.9	0.39		9691	21800	36334	*0.13*	0.27	*0.16*	**0.43**	*0.16*	1.09	0.86
2001	129.5	114.1	0.64		15812	25365	42274	*0.14*	0.37	*0.17*	**0.60**	*0.17*	0.76	0.69
2002	147.2	137.2	0.47		17233	29985	49976	*0.12*	0.34	*0.16*	**0.56**	*0.16*	0.72	0.66
2003	158.8	188.2	0.31		19822	40033	66721	*0.09*	0.30	*0.14*	**0.48**	*0.14*	0.60	0.60
2004	202.4	118.9	0.97		24530	36041	60068	*0.07*	0.41	*0.12*	**0.66**	*0.12*	0.85	
2005	150.0	232.5	0.22		15562	50789	84648	*0.08*	0.18	*0.13*	**0.30**	*0.13*	0.50	
Mean7905	*59.6*	*42.4*	*0.86*	*0.02*	*7190*		*18535*		*0.53*		*0.86*		*0.92*	
Mean7994	*27.0*	*13.1*	*0.94*		*4353*		*7136*		*0.62*		*1.00*		*0.87*	
Mean9505	*107.0*	*85.0*	*0.8*		*11316*		*35116*		*0.41*		*0.66*		*1.01*	

Table 3 continued.

Combined (number weighted)

	SurveyF	Landings	Ebms	CBI	RescaledF	CV	BH-F	MovAvg
1982		7933	12509	0.63	**1.09**	*0.08*	0.59	0.62
1983	0.66	7392	12912	0.57	**0.96**	*0.07*	0.68	0.67
1984	0.83	6718	11062	0.61	**1.07**	*0.07*	0.60	0.73
1985	0.51	6170	13595	0.45	**0.78**	*0.08*	0.72	0.89
1986	0.53	7797	18096	0.43	**0.70**	*0.07*	0.87	1.01
1987	0.94	12654	19648	0.64	**1.13**	*0.08*	1.09	1.15
1988	0.89	12232	24127	0.51	**0.84**	*0.07*	1.06	1.34
1989	1.48	13634	20851	0.65	**1.10**	*0.14*	1.29	1.32
1990	1.61	16417	22230	0.74	**1.25**	*0.11*	1.66	1.26
1991	1.44	16323	17731	0.92	**1.56**	*0.08*	1.01	0.96
1992	1.20	13192	16650	0.79	**1.32**	*0.09*	1.10	1.15
1993	1.43	6449	8347	0.77	**1.30**	*0.07*	0.77	1.20
1994	0.83	7009	12950	0.54	**0.98**	*0.08*	1.57	1.30
1995	1.09	7300	16758	0.44	**0.80**	*0.08*	1.27	0.93
1996	0.55	7045	21820	0.32	**0.58**	*0.08*	1.05	0.70
1997	0.43	5236	25870	0.20	**0.35**	*0.08*	0.48	0.62
1998	-0.20	4964	54904	0.09	**0.18**	*0.17*	0.57	0.72
1999	0.43	9808	74705	0.13	**0.27**	*0.15*	0.81	0.74
2000	0.12	15128	117735	0.13	**0.23**	*0.11*	0.77	0.65
2001	0.52	20764	130670	0.16	**0.28**	*0.09*	0.63	0.53
2002	0.34	22927	158878	0.14	**0.27**	*0.09*	0.55	0.49
2003	0.38	24744	167622	0.15	**0.30**	*0.08*	0.41	0.41
2004	0.42	28883	193933	0.15	**0.34**	*0.07*	0.50	
2005	0.23	25273	198794	0.13	**0.22**	*0.08*	0.32	
Mean8205	*0.72*		*57183*		*0.75*		*0.75*	
Mean8294	*1.03*		*16517*		*1.08*		*1.04*	
Mean9505	*0.39*		*105608*		*0.36*		*0.70*	

Figure 1. Sea scallop biomass (g/tow, meats) distribution from the 2005 NEFSC sea scallop survey. Dotted lines show closed/access area boundaries, including the Delmarva closure scheduled for 2007.

(a) Georges Bank

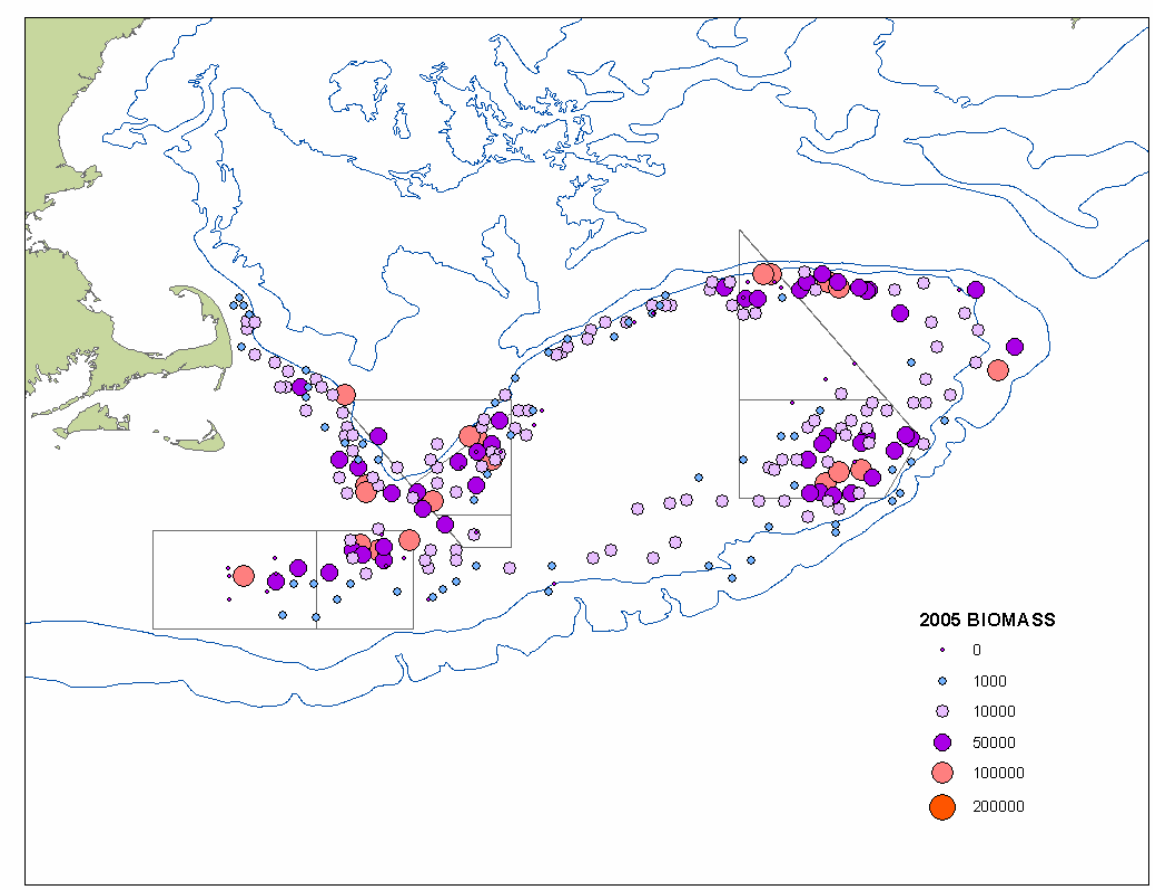


Figure 1 continued.

(b) Mid-Atlantic

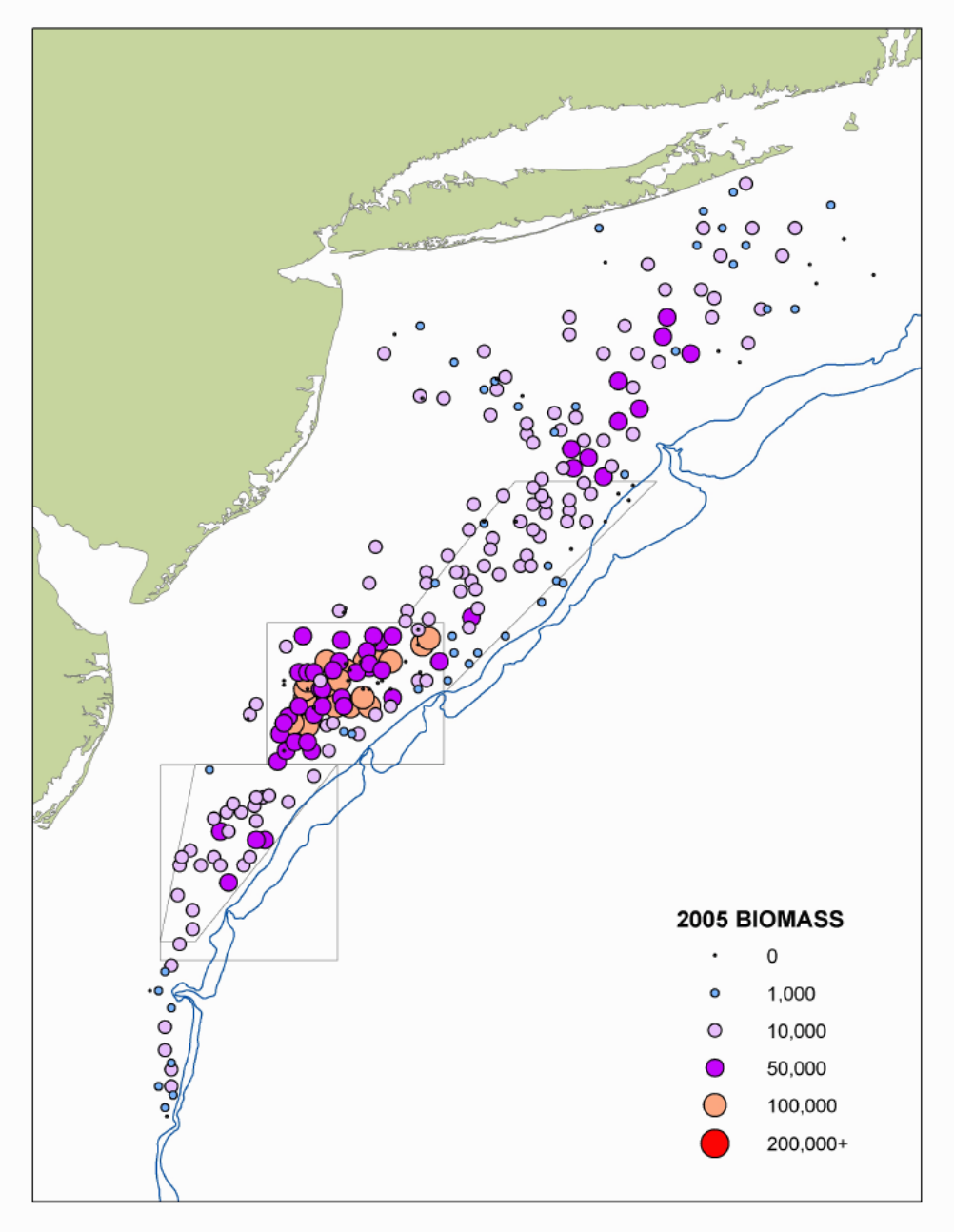


Figure 2. Sea scallop landings by region (mt meats), 1964-2005.

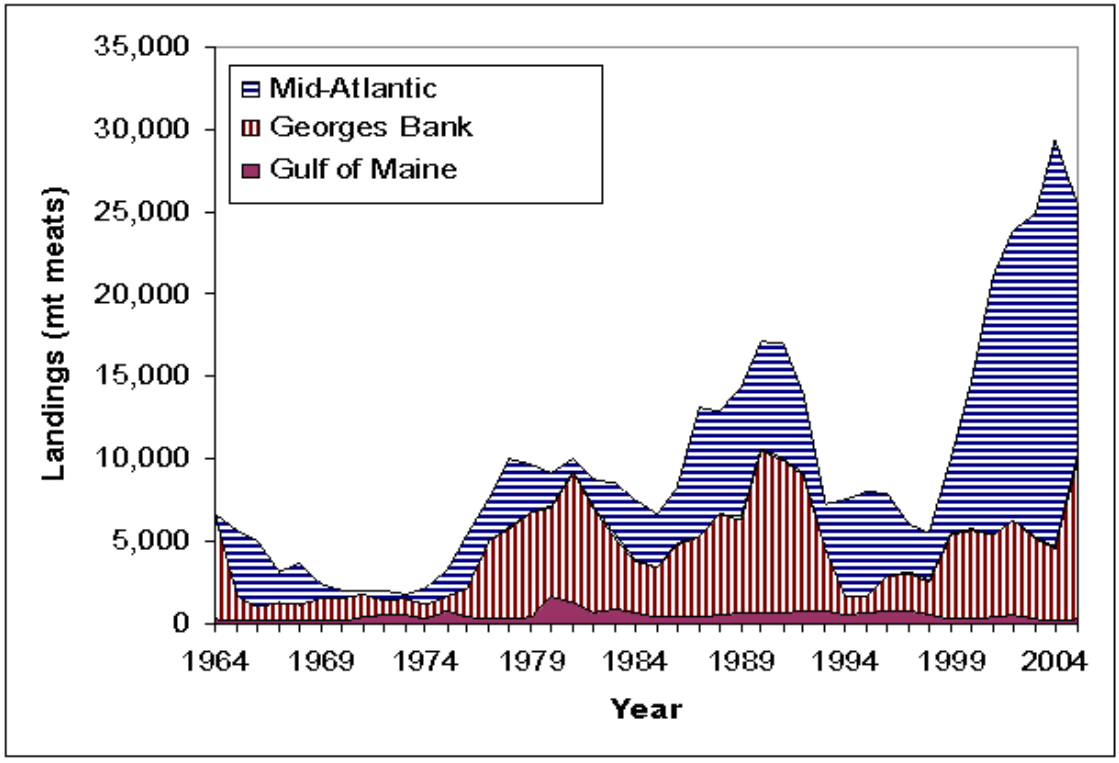


Figure 3. Sea scallop landings by meat count category, 1998-2005.

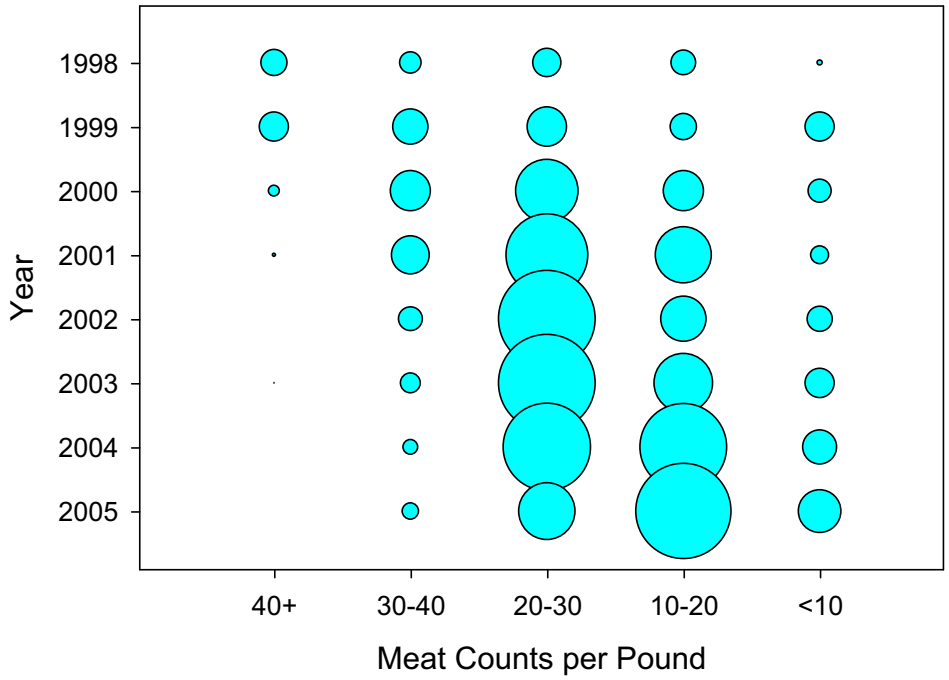
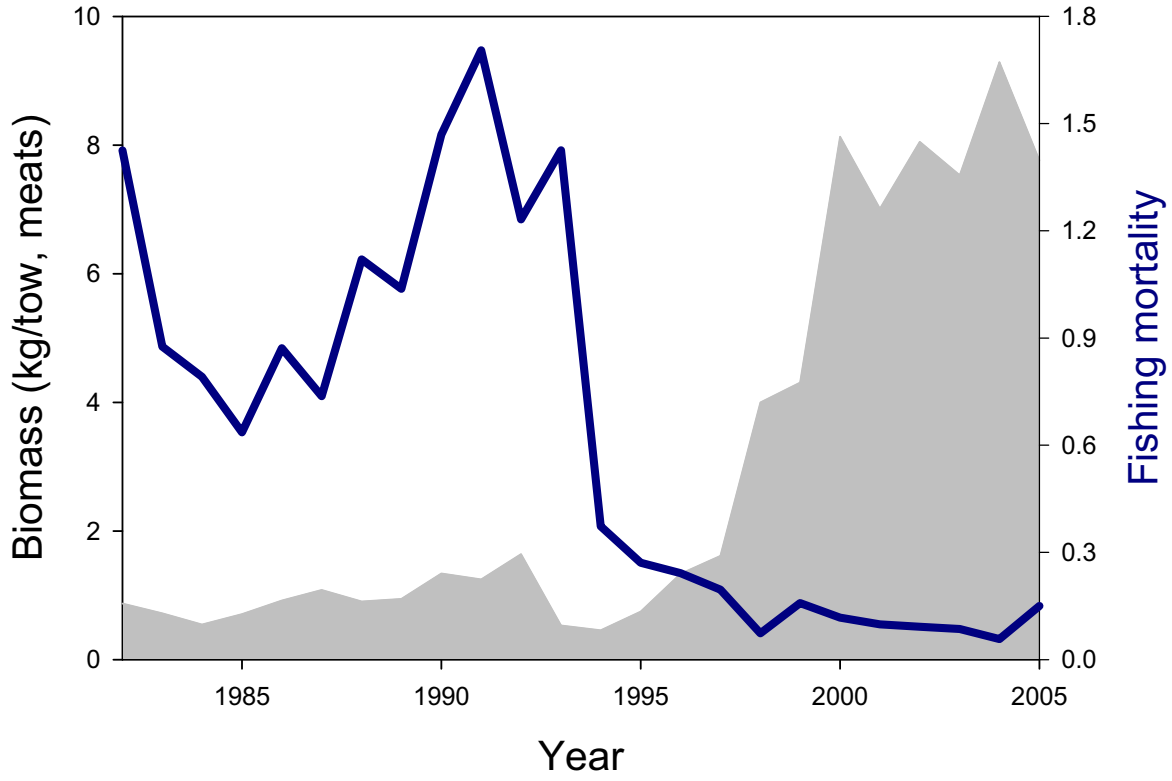
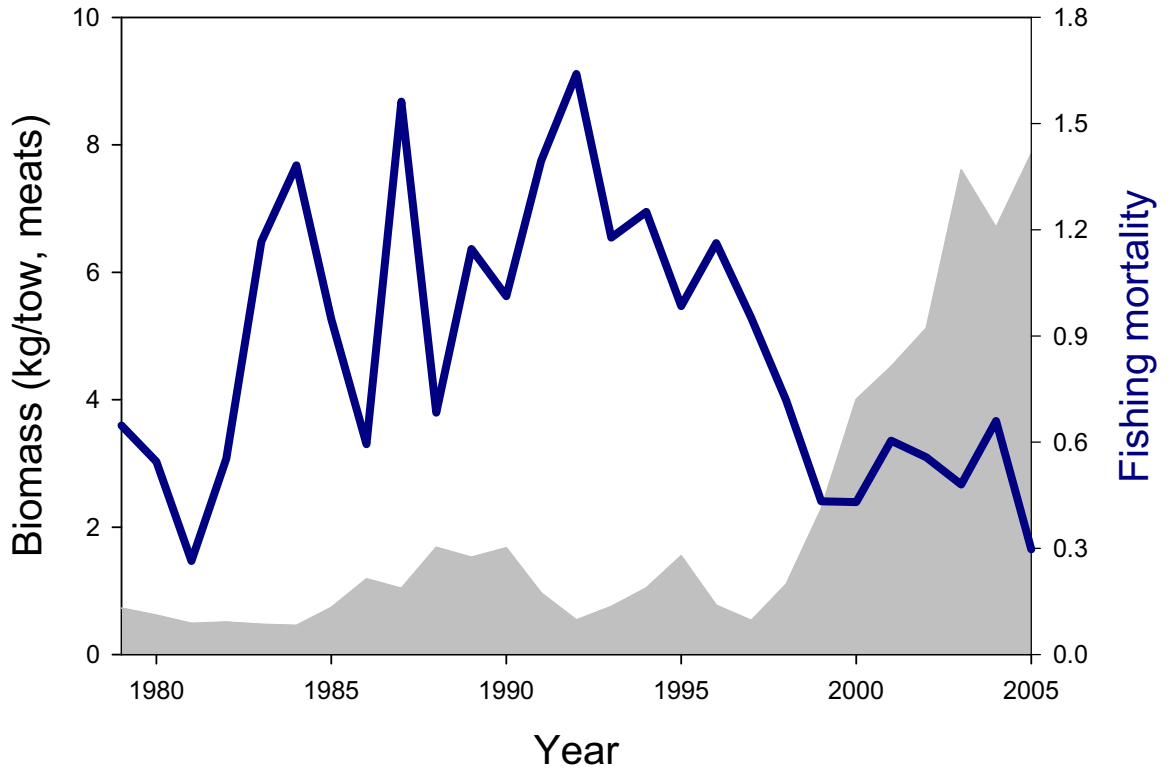


Figure 4. Sea scallop survey biomass and estimated fishing mortality for Georges Bank, Mid-Atlantic, and combined.

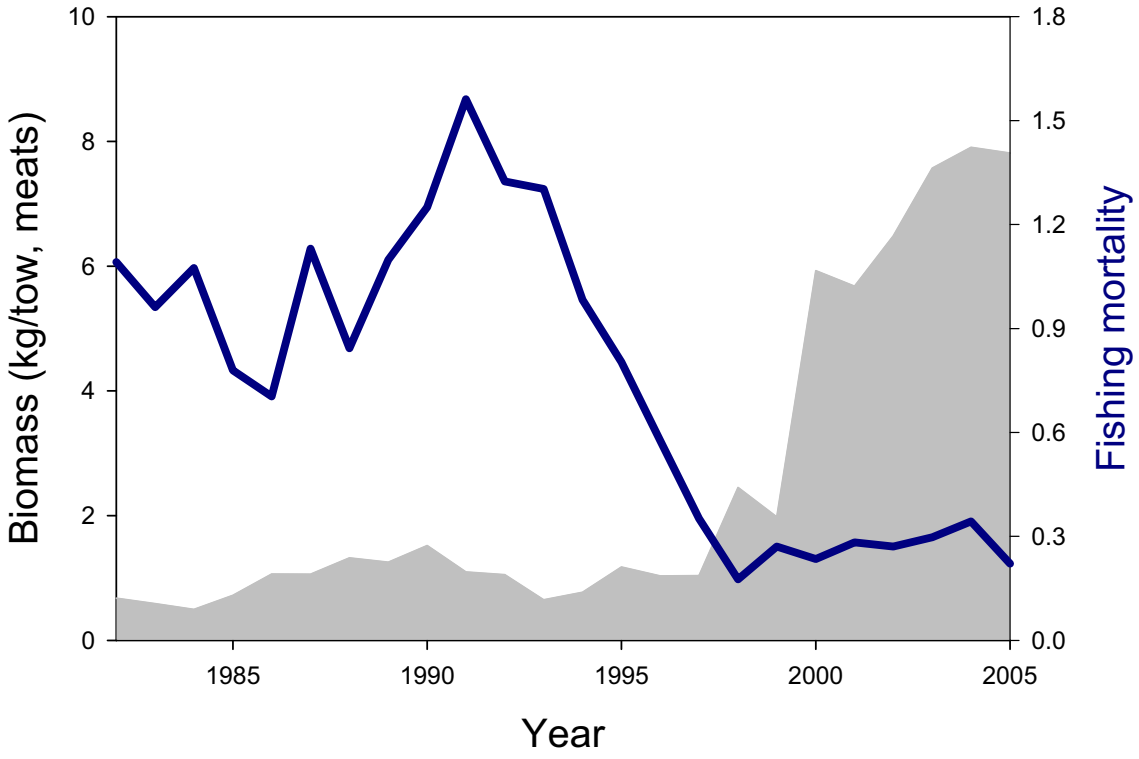
(a) Georges Bank



(b) Mid-Atlantic



(c) Overall


Biomass (kg/tow, meats)
Fishing mortality
Year
0
2
4
6
8
10
0.0
0.3
0.6
0.9
1.2
1.5
1.8
1985
1990
1995
2000
2005

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Northeast Fisheries Science Center Reference Document -- This series is issued irregularly. The series typically includes: data reports on field and lab studies; progress reports on experiments, monitoring, and assessments; background papers for, collected abstracts of, and/or summary reports of scientific meetings; and simple bibliographies. Issues receive internal scientific review, but no technical or copy editing.

Resource Survey Report (formerly *Fishermen's Report*) -- This information report is a quick-turnaround report on the distribution and relative abundance of selected living marine resources as derived from each of the NEFSC's periodic research vessel surveys of the Northeast's continental shelf. There is no scientific review, nor any technical or copy editing, of this report.

OBTAINING A COPY: To obtain a copy of a *NOAA Technical Memorandum NMFS-NE* or a *Northeast Fisheries Science Center Reference Document*, or to subscribe to the *Resource Survey Report*, either contact the NEFSC Editorial Office (166 Water St., Woods Hole, MA 02543-1026; 508-495-2350) or consult the NEFSC webpage on "Reports and Publications" (*http://www.nefsc.noaa.gov/nefsc/publications/*).

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