Atlantic Striped Bass Studies
2001 Biennial Report to Congress

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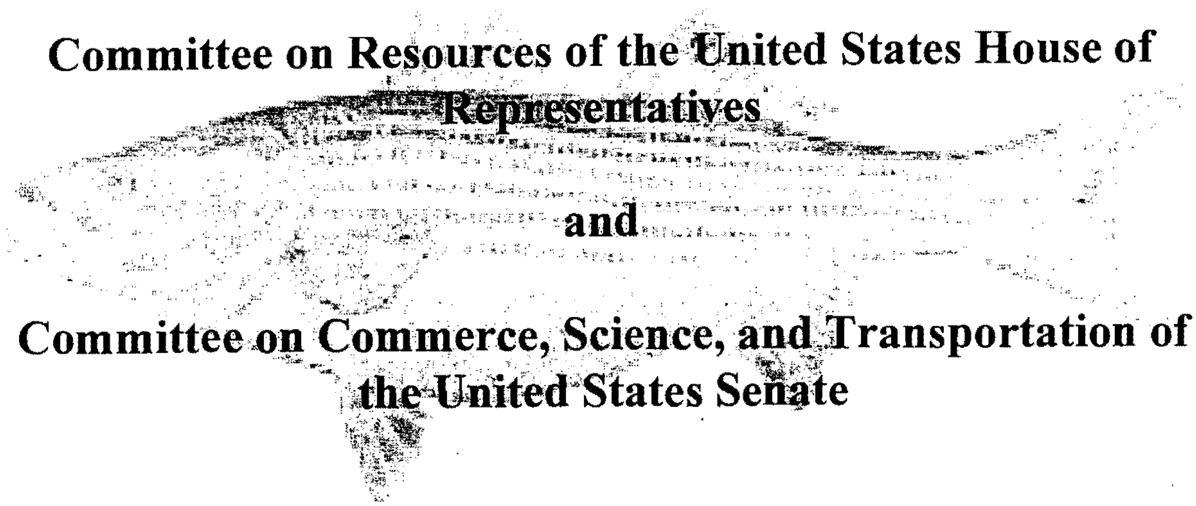

Committee on Resources of the United States House of Representatives

and

Committee on Commerce, Science, and Transportation of the United States Senate

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STRIPED BASS STUDIES
2001 BIENNIAL REPORT TO CONGRESS

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ACKNOWLEDGMENTS

This report is based, in part, on various stock assessment reports of the Striped Bass Technical Committee of the Atlantic States Marine Fisheries Commission. Much of the research and data collection have been conducted by the state fisheries agencies, whose hard work and cooperative efforts are greatly appreciated.

EXECUTIVE SUMMARY

Reauthorization of the Atlantic Striped Bass Conservation Act (ASBCA), in 1997, mandated biennial reports to Congress and to the Atlantic States Marine Fisheries Commission (ASMFC) concerning the progress and findings of continued studies of Atlantic striped bass (*Morone saxatilis*) stocks that extend work of the striped bass study conducted during 1980-1994. These studies include: annual stock assessments, population dynamics studies, investigations of causes of stock fluctuations, effects of environmental factors on recruitment, spawning potential, mortality and abundance, and interactions with other fish.

This report presents the fishery-dependent and fishery-independent data used in the population dynamic studies, describes the analyses conducted by the ASMFC Striped Bass Technical Committee, and provides the results of the most recent stock assessment of the Technical Committee. In addition, this report includes summaries of various research efforts conducted by state and federal fisheries agencies, and universities, that address continued studies of Atlantic striped bass populations, as requested in the ASBCA.

The stock assessment of striped bass is based on information from annual recreational and commercial catches, along with indices of abundance from state and federal sources. The data are used in a population model to determine the number of fish present that can account for the catch and annual fluctuations in the indices. In addition, state and federal agencies participate in a variety of tag and release programs for striped bass. The tag recovery information is used to calculate annual survival rates and annual fishing mortality rates.

The most recent stock assessment conducted in 2001 indicated that striped bass stocks are at high levels of abundance and are supporting increased landings, primarily in the recreational fisheries. Total landings in 2000 were 10,800 metric tons (23.8 million pounds), a 17% increase from 1999. The largest commercial landings continued to be from the Chesapeake Bay (Maryland and Virginia), while recreational catches were highest in Massachusetts and Maryland. The number of fish in the population has increased due to moderate fishing mortality and increasing production of juvenile fish. Estimated abundance of striped bass on January 1, 2001 was 45.6 million fish.

Current management is operating under the regulations outlined in Amendment 5 to the ASMFC Striped Bass Fishery Management Plan. A new amendment is being developed and should be implemented by 2003.

INTRODUCTION

The Atlantic striped bass (*Morone saxatilis*) fishery has gone through significant changes in the last several decades; changes in management measures aimed at conserving the stock, changes in the distribution of catch among users of the stock, and most important, a significant recovery of the stock from low levels of abundance seen during the 1970s and 1980s.

In response to precipitous declines in landings during the 1970s, Congress passed and the President enacted an amendment (P.L. 96-118) to the Anadromous Fish Conservation Act in 1979. The amendment specified that an Emergency Striped Bass Study be undertaken to determine the status of the striped bass stocks and the causes for the decline in the striped bass population. The Emergency Striped Bass Study was conducted each year from 1980 through 1994, and a report was submitted to Congress presenting results of the various research activities that were part of the overall study. The last such report was prepared in 1995 for the 1994 study year.

When Congress reauthorized the Atlantic Striped Bass Conservation Act (ASBCA) (P.L. 98-613) in 1997, it mandated that the Secretaries of Commerce and the Interior provide biennial reports to Congress and the Atlantic States Marine Fisheries Commission (ASMFC) on studies of the Atlantic striped bass resource, including annual stock assessments, population dynamics studies, investigations of causes of fluctuations in the population, effects of environmental factors on recruitment, spawning potential, mortality and abundance, and interactions with other fish. This document constitutes the second such biennial report.

The Technical Committee for the ASMFC Striped Bass Management Board conducts annual assessments of the status of the striped bass populations along the Atlantic coast, from Maine to North Carolina. These assessments are based on fishery-dependent and fishery-independent data collected by the individual states, the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS). These data include catch (including discards) from both the commercial and recreational fisheries, as well as data related to the size and age composition of the catches in these fisheries. Fishery-independent data, obtained through scientific research programs, include indices of juvenile and adult abundance, and the age and size composition of the stock. Also included in the annual assessment are survival estimates determined from tag release and recovery data.

STATUS OF STOCKS

The ASMFC Striped Bass stock assessment sub-committee and Technical Committee met in August 2001 to evaluate the status of the striped bass resource and update the previous year's assessment. The assessment includes the Hudson, Delaware, Chesapeake and mixed coastal stocks.

Trends in Juvenile Production

Juvenile indices from the Chesapeake Bay (Maryland and Virginia) increased in 2000 (Figure 1a), although the annual indices have fluctuated without any strong trend since the mid-1990s. Both the Maryland and Virginia indices indicate that strong year classes were produced in 1993 and 1996. Juvenile indices for the Hudson River (Figure 1b) and Delaware Bay stocks (Figure 1b) show an increasing trend since 1991, with above average recruitment in both stocks in 1999 and again in 2000, for the Delaware stock.

Status of Adult Stocks

Fishery-Independent Indices

The Maryland gillnet survey index of striped bass spawning biomass has declined since peaking in 1996. The 2000 and 2001 values were about one-half the series average (Figure 2a). The New York ocean haul seine index peaked during 1996-1998, markedly declined in 1999, but increased in 2000 to about average (Figure 2b). The NMFS Northeast Fisheries Science Center (NEFSC) spring inshore bottom trawl survey index of striped bass abundance (mean number per tow) increased during the mid-1990s, declined in 1998 and 1999, but increased in 2000 to a near-record high (Figure 2c). The Rappahannock River, Virginia pound net index was used for the first time this year, to provide more information on the Chesapeake Bay striped bass spawning stock. This index has increased since 1998, with the 2000 value the series high (Figure 2d). The Connecticut trawl survey striped bass index increased steadily from 1984 to 1999, but dropped slightly in 2000 (Figure 2e). Both the Delaware and New Jersey trawl indices (Figure 2e) peaked in the mid-1990s, 1993 and 1995, respectively. Thereafter, both indices decreased sharply, although the Delaware index rebounded in 1998 and 1999.

The Maryland beach seine index of age-1 fish, which has trended upward since 1997, was slightly above average in 1999, and about average in 2000 (Figure 2f). The Long Island beach seine index of age-1 striped bass, in 2000, declined from the record-high 1998 and 1999 values but still remained above average. The Long Island indices have shown an increasing trend since the mid-1980s (Figure 2f).

Fishery-Dependent Indices

The Massachusetts commercial catch per hour fished declined slightly in 1999, but recovered to near-peak values in 2000 (Figure 3a). The Connecticut volunteer angler catch per trip decreased in 1999, but was still the 4th highest in the time series (Figure 3b). No value is available for this survey for 2000. The Hudson River index of spawning striped bass (age 8+), derived from bycatch in the shad fishery, increased during the late 1980s and early 1990s and peaked in 1996. During 1997-1999, the index remained at about the time series average but in 2000 the index sharply declined (Figure 3c).

Fisheries

Commercial Harvest

Commercial landings in 2000 totaled 1.1 million fish and 6.6 million pounds (3,003 mt) (Table 1). The landings represented a decline of 46 thousand fish and an increase of 137 thousand pounds compared to 1999 (Table 2). The Chesapeake Region (Maryland, PRFC, and Virginia) accounted for most of the commercial landings, 73% by weight and 87% by number (Table 3). Overall, commercial landings represented 35% by number and 28% by weight of the total (commercial + recreational) landings in 2000 (Table 2), and 23 % by number of the total catch (landings + discard) (Figure 4). The commercial landings were dominated by fish ages 4 to 6 (67% of commercial landings).

Recreational Harvest

Recreational statistics were collected as part of the Marine Recreational Fishery Statistics Survey (MRFSS) program. Recreational landings in 2000 were 1.9 million fish totaling 17.1 million pounds (7,756 mt) (Table 1). The landings represented an increase of 604 thousand fish and 3.2 million pounds from 1999 (Table 2). Maryland, New Jersey, Virginia, New York, and Massachusetts accounted for the largest recreational landings in 2000 (Table 3). Overall, recreational landings constituted 72% by number and 65% by weight of the total (commercial + recreational) landings in 2000, and 41% by number of total 2000 catch (landings + discard) (Figure 4). Age groups 4 to 7 dominated the recreational landings (74% of landings).

Commercial Non-Harvest Mortality

Commercial discards in 1999 and 2000 were estimated using the ratio of commercial to recreational fish tag recovery data scaled by total recreational discards. Total commercial discards were estimated to be 1.2 million fish in 1999 and 3.6 million fish in 2000 (Table 2). Of these discards, losses due to culling mortality were estimated to be 147 thousand fish in 1999 and 387 thousand fish in 2000. Commercial non-harvest losses in 1999 accounted for 4%, by number, of the total (landings + discard losses: commercial + recreational) 1999 harvest, while losses in 2000 accounted for 8% of the total 2000 harvest (Table 2; Figure 4). Commercial discards were dominated by fish of ages 2 to 4.

Recreational Non-Harvest Mortality

Recreational discards were estimated to be 12.5 million fish in 1999 and 16.3 million fish in 2000 (Table 2). Applying a hooking mortality rate of 8% resulted in estimated losses from hooking mortality of 1.3 million fish (Tables 2 and 3). Massachusetts, Maryland, New Jersey and New York accounted for most of these losses (Table 3). In both 1999 and 2000, recreational discard losses accounted for 28%, by number, of the total annual harvest (Table 3, Figure 4). Highest discards occurred on the 1996 year class (age 3 in 1999 and age 4 in 2000).

Total Catch

The total harvest (landings + discard losses: commercial + recreational) of striped bass was 3.58 million fish in 1999 and 4.68 million fish in 2000 (Table 2). The 2000 catch was the highest since 1982.

Stock Size Estimates

Population abundance (stock size as of January 1) increased from 5.1 million fish in 1982 to 46.3 million fish in 1997 and subsequently has stabilized at about 46 million fish (Table 4; Figure 5). Population size at the beginning of 2001 was estimated to be 45.6 million fish, with the 1997-1999 year classes (age 2-4) accounting for 45% of the stock. Recruitment of age 1 fish in 2001 (2000 cohort) was estimated to be 11.5 million fish, the 3rd highest in the time series, only exceeded by the outstanding 1993 and 1996 cohorts (12.6 and 12.3 million fish at age 1, respectively). However, estimates of recruitment in the terminal year of the virtual population analysis (VPA) are often uncertain. Abundance of older fish (age 8+) in the stock increased from 430 thousand fish in 1982 to 3.1 million fish in 1998, declined to about 2.8 million fish during 1999 and 2000, but increased to a high of 3.2 million fish at the beginning of 2001 (Figure 5).

Fishing Mortality

Average fishing mortality rate (F) for ages 4 through 13 declined between 1982 and 1987, increased steadily between 1998 and 1999, and declined slightly in 2000 (Table 5). F in 2000 was 0.28, equal to an exploitation rate (or harvest rate) of 23%. Fishing mortality on younger striped bass (ages 3 to 8) increased slightly from 0.20 in 1998 and 1999 to 0.25 in 2000. Age group Fs in 2000 ranged from 0.03 on age 2 to a high of 0.39 on age 10. Fs were highest (>0.30) on age groups 6-10 (*i.e.*, the 1990-1994 year classes).

The average fishing mortality (F) from the coastal mixed stock tagging programs has increased over the last several years, and F in 2000 was 0.22. Producer area (Chesapeake Bay, Delaware Bay and Hudson River) tagging programs show similar increasing trends in average F.

Spawning Stock Biomass

Female spawning stock biomass (SSB) increased from 2,300 mt (5.1 million pounds) in 1982 to a high of 20,800 mt (45.9 million pounds) in 2000 (Figure 6). The SSB estimates for 1996-2000 should be interpreted with some caution as constant weights at age were used in the VPA in these years.

ADDITIONAL RESEARCH ACTIVITIES

Causes of Fluctuations in Population Abundance

Significant changes in the historic abundance of Atlantic striped bass have been chronicled in the scientific literature and the popular press. The most significant cause of these fluctuations has been fishery harvest rates that have placed the population at increased risk. Striped bass produce millions of eggs per female over multiple years of spawning (a female has the potential to spawn for 20 to 25 years). This strategy of producing excessive quantities of eggs allows the species to overcome annual fluctuations in the environment during the critical period of larval development. Richards and Rago (1999) suggested that the decline in abundance of striped bass in the Chesapeake during the 1970s and 1980s was due to a reduction in spawning biomass and concomitant reduction in egg production. The low numbers of spawning females were unable to produce the quantity of eggs necessary to offset poor environmental conditions, both natural and man made. However, once fishing mortality was reduced and improvements made in the quality of spawning habitat, particularly in the Delaware River and Chesapeake Bay, increased survival rates allowed rebuilding of the spawning biomass and annual production eventually returned to a level that could sustain the population.

Habitat and Environmental Quality

Several projects have been initiated in recent years to more clearly delineate habitat use by both juvenile and adult striped bass. The FWS's South Atlantic Fisheries Coordination Office, in cooperation with the ASMFC and NMFS, has initiated analysis of data gathered during the past 15 years of the Southeast Area Monitoring and Assessment Program (SEAMAP) Cooperative Winter Tagging Cruises, to document use of the nearshore Atlantic Ocean by striped bass and other managed species.

The cruise annually captures, tags and releases migratory striped bass from the Hudson, Delaware, Chesapeake Bay and Albemarle-Roanoke stocks while they are present on wintering grounds off southeastern Virginia and northeastern North Carolina. Data collected include depth, temperature, salinity and catch-per-unit-effort. These data have been entered into Geographic Information Systems databases in both FWS and NMFS facilities and are being analyzed to assess the locations of preferred wintering habitats as well as migratory pathways and seasonal habitat use after departure from wintering areas.

Delineation of winter habitat use is critical to assist the U.S. Army Corp of Engineers in assessing the impact of their proposed Dare County Beaches Project (located on the NC Outer Banks) on striped bass. The Corps' project will result in the creation of a seven square mile, twenty feet deep dredge excavation in the midst of striped bass wintering habitat. Before-and-after data are critical to assess the impact of the Corps' activities on striped bass use of the areas proposed for excavation. Identification of migratory pathways and habitat use during other periods of the year is also critical for assessing the potential impact of other proposed projects on the migratory stocks of striped bass. Striped bass tagged during the cruise have been recaptured as far north as Nova Scotia.

The FWS is also undertaking baseline fishery resource surveys of National Wildlife Refuges to determine use by juvenile striped bass. The first such survey, for Alligator River National Wildlife Refuge in northeastern NC, was completed in January 2002, and the data are presently being analyzed.

Species Interactions

Recent research activities supported by Congressional funding to examine the relationship between striped bass and bluefish abundance has been coordinated through Rutgers University Marine Science Center and the NMFS. These efforts have focused on predator-prey interactions between the two species, competition for available prey and long term-trends in abundance. Preliminary results suggest some degree of systematic variation in bluefish and striped bass landings but this trend does not appear to be linked to variations in abundance. Predator-prey studies have found no evidence of diet or habitat overlap between young (age 1) bluefish and striped bass that could influence the abundance of either species.

Recent studies funded by ASMFC to model the food web dynamics of menhaden in the Chesapeake Bay show that menhaden are an important food for striped bass and it has been hypothesized that increases in striped bass abundance can impact the population dynamics of menhaden.

STATUS OF MANAGEMENT

Atlantic striped bass management is based on the Atlantic Striped Bass Fishery Management Plan (FMP) of the ASMFC. The 15 coastal jurisdictions (13 States, Washington D.C. and the Potomac River Fisheries Commission), NMFS and FWS have principal management responsibility under this FMP. The ASMFC Striped Bass FMP, first adopted in 1981, has undergone five Amendments and various Addenda through 2001. The initial FMP and its first four Amendments provided a series of management measures that lead to the rebuilding of the Atlantic striped bass stocks. Amendment #4, implemented in 1989, addressed the reopening of the fishery during the initial period of stock recovery. As the status of the stock continued to improve, the adaptive strategy of the Amendment #4 allowed revisions to management measures addressing the changing circumstances. This resulted in adoption of six successive Addenda to Amendment # 4, during 1989-1994, and the declaration of recovery, as of January 1, 1995.

Amendment # 5, which became effective on April 1, 1995, completely replaced the original FMP and all subsequent Amendments and Addenda. The goal of Amendment # 5 was "to perpetuate, through cooperative interstate fishery management, migratory stocks of Atlantic striped bass so as to allow a commercial and recreational harvest consistent with the long-term maintenance of self-sustaining spawning stocks and to provide for the restoration and maintenance of their critical habitat" (ASMFC 1995). To achieve this goal, Amendment #5 adopted several objectives. In general, the objectives were to prevent overfishing, maintain spawning stock biomass, provide compatible and equitable management, promote cooperative research and monitoring, identify critical habitats, address environmental quality, and provide for plan implementation. Implementation of the Amendment was based on adoption of a target fishing mortality rate and establishment of regulatory programs for commercial and recreational fisheries that would meet the target. The target fishing mortality rate was established as F=0.31 and a threshold limit of F=0.38. Size limits were set at 20 inches for the producer areas and 28 inches for the coastal fisheries, with a two-fish bag limit for the recreational fisheries. Commercial fisheries were regulated with an annual quota based on 20% of commercial landings between 1972 and 1978. Conservation equivalency was permitted, which allowed states to propose different size and bag limits as long as the overall management regime achieved target

F. States were also required to carry out specific fishery-dependent and fishery-independent monitoring programs. With regard to offshore fisheries, the NMFS maintains a ban on striped bass fishing activity and possession of striped bass in the Exclusive Economic Zone (EEZ), with the exception of a defined route to and from Block Island in Rhode Island.

Amendment #5 was designed to manage the 1995 and 1996 fisheries, with the intent that results from the new stock assessment model, virtual population analysis (VPA), would be completed and ready for use for the 1997 fishery. That was not the case and five Addenda were adopted for Amendment # 5, through 2001. More specific information on the objectives, management programs, implementation and compliance measures of this amendment are provided in the ASMFC Amendment # 5 document (ASMFC 1995).

Additional information regarding recent striped bass management may be found in the following ASMFC reports:

Amendment #5 to the Interstate Fishery Management Plan for Atlantic Striped Bass;

Addendum I (to Amendment # 5) - 1997 fisheries;

Addendum II (to Amendment # 5) - 1998 fisheries;

Addendum III (to Amendment # 5) - 1999-2000 fisheries;

Addendum IV (to Amendment # 5) - 2000 fisheries;

Addendum V (to Amendment #5) – 2001-2002 fisheries;

1999 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Atlantic Striped Bass (*Morone saxatilis*); and

2000 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Atlantic Striped Bass (*Morone saxatilis*).

Since the implementation of Amendment # 5, the ASMFC Striped Bass Management Board and the public have recognized several shortcomings of the FMP. Among the issues that must be resolved are the development of a management control rule that incorporates population biomass levels, management strategies to promote older, trophy sized fish in the population, greater flexibility in the time necessary to incorporate regulatory adjustments following changes in striped bass population abundance, and reconsideration of the allocation scheme among users. Amendment # 6 is being developed to address these issues and is anticipated to be implemented in January, 2003.

SUMMARY AND CONCLUSIONS

The results of the most recent (2001) striped bass stock assessment indicate that stock abundance is very high and that fishing mortality is below the target fishing mortality (F=0.31). Abundance increased steadily between 1982 and 1997 and has remained relatively stable since 1998 (Figure 7).

Fishing mortality increased steadily until 1999 but decreased slightly in 2000 (Figure 7). There was a noticeable shift in the exploitation pattern in the 2000 fishery. In previous years, striped bass in older age classes experienced the highest proportion of mortality while the recent assessment showed a proportional shift to younger age groups. This was likely the result of changes in management policies, enacted during 2000, intended to reduce mortality rates on older fish to the target F.

Overall, the Atlantic stocks of striped bass appear to be abundant in number, capable of producing strong incoming year classes and are being fished at levels within the bounds of the current Fishery Management Plan.

RECOMMENDATIONS

Although several of the recommendations from the 1999 Biennial Report to Congress have been completed, there are remaining management and research issues identified by the ASMFC Striped Bass Technical Committee that require further consideration.

Management

- Commercial and recreational discards are difficult to estimate due to a lack of adequate sampling of bycatch in both Federal and state waters. Further effort should be directed toward improving discard estimates from all fishery sectors and areas.
- Since the assessment models are age-based, accurate and timely age data are crucial. States should increase efforts to coordinate sample collection and production of age data among adjacent regions to improve the timeliness and efficiency of the process.
- Annual estimates of recreational striped bass catches are based on the MRFSS. However, there are important seasonal fisheries for striped bass in river systems that are not included in the survey coverage. States should be encouraged to extend survey coverage to include in-river fisheries for anadromous species.

- Information on weight at age of striped bass is critical for estimating biomass. States should make efforts to collect annual data necessary to characterize the weight at age.

Research

- Further data are needed to estimate striped bass population sex ratios and age at maturity for each stock managed under the FMP.
- Differences in tag reporting rates among areas for use in survival models should be examined.
- The relevance of possible changes in seasonal distribution resulting from increased population abundance should be assessed.
- Information is needed to determine striped bass mortality rates associated with discarding from commercial fishing gear.
- Since the stock assessment combines several stock units, future efforts should refine assessment methods to account for different population dynamics among stocks.
- Efforts should continue to develop comparable models incorporating both tag recovery and catch at age data.

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Table 1. Atlantic Coast landings of striped bass in metric tons and numbers from 1981 to 2000 (recreational information not available prior to 1981).

	Commercial		Recreational		Total	
Year	MT	N	MT	N	MT	N
1981	1744		524		2268	
1982	992	428630	1144	217256	2136	645886
1983	639	357541	1217	299444	1856	656985
1984	1104	870871	579	114463	1683	985334
1985	4312	174621	372	133522	4684	308143
1986	68	17681	501	114623	569	132304
1987	63	13552	388	43755	451	57307
1988	117	33310	570	86725	687	120035
1989	91	7402	332	37562	423	44964
1990	313	115636	1010	163242	1323	278878
1991	460	153798	1653	262469	2113	416267
1992	638	230714	1830	300180	2468	530894
1993	777	312860	2564	428719	3341	741579
1994	805	307443	3084	565167	3889	872610
1995	1555	534914	5675	1089183	7230	1624097
1996	2178	766518	6003	1175112	8181	1941630
1997	2679	1058181	7267	1515296	9946	2573477
1998	2936	1223828	5771	1366353	8707	2590181
1999	2941	1103812	6245	1319794	9186	2423606
2000	3003	1057712	7756	1924001	10759	2981713

Table 2. Total striped bass discard and harvest in numbers and percent of total by fishery component.

2000

Fishery Component	Discard	Discard Losses	Landings	Total Catch
Recreational	16,311,806	1,304,944 (27.9%)	1,924,000 (41.1%)	3,228,945 (59.1%)
Commercial	3,620,400	386,884 (8.3%)	1,057,712 (22.6%)	1,444,596 (40.8%)
Research			7,757 (0.1%)	7,757 (0.1%)
Total	19,932,206	1,691,828 (36.2%)	2,989,470 (63.8%)	4,681,298 (100.0%)

1999

Fishery Component	Discard	Discard Losses	Landings	Total Catch
Recreational	12,514,725	1,001,178 (28.0%)	1,319,794 (36.9%)	2,320,972 (64.9%)
Commercial	1,201,673	147,031 (4.1%)	1,103,812 (30.9%)	1,250,843 (35.0%)
Research			3,577 (0.1%)	3,577 (0.1%)
Total	13,716,398	1,148,209 (32.1%)	2,427,183 (67.9%)	3,575,392 (100.0%)

Table 3. Commercial landings, recreational landings and recreational discard losses (000s of fish) for 1999 and 2000, by state.

State	Commercial Landings		Recreational Landings		Recreational Discards	
	1999	2000	1999	2000	1999	2000
Maine			21.0	59.1	52.0	71.6
New Hampshire			4.6	4.1	11.7	16.2
Massachusetts	40.8	40.2	138.2	175.5	366.3	571.5
Rhode Island	11.6	9.4	56.3	88.8	29.9	40.4
Connecticut			55.8	50.6	68.0	70.2
New York	49.8	54.9	197.7	259.1	97.1	105.1
New Jersey			237.0	390.4	111.2	69.0
Delaware	34.8	25.2	8.8	37.7	8.5	11.5
Maryland	650.0	627.8	261.0	490.7	190.4	251.1
Potomac River Fisheries Commission	90.6	91.5		31.3	*	9.4
Virginia	205.1	202.2	301.4	324.3	75.3	79.1
North Carolina	21.0	6.5	46.8	12.2	21.1	9.8
Total	1103.7	1057.7	1328.6	1923.8	1031.5	1304.9

Table 4. Estimated population abundance, thousands at age 1-15, 1982-2001. Total in millions of fish.

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	1355	2689	2355	2918	2910	3297	4570	5337	7719	7061	7170	8251	12605	9631	10760	12322	9688	10099	8622	11537
2	952	1164	2311	2021	2510	2494	2836	3931	4593	6642	6076	6169	7102	10844	8286	9261	10603	8314	8684	7387
3	872	721	900	1485	1673	2141	2137	2413	3350	3910	5649	5187	5245	5978	8937	7046	7706	8961	7069	7249
4	911	512	455	494	1184	1380	1808	1800	2003	2768	3231	4677	4293	4191	4719	7099	5613	6203	7329	5769
5	328	579	262	316	387	896	1140	1497	1486	1549	2189	2605	3722	3425	3192	3473	5321	4214	4726	5451
6	173	228	359	169	217	287	708	882	1192	1118	1183	1719	1975	2862	2585	2252	2417	3568	3042	3179
7	110	131	160	261	106	157	224	519	671	872	869	917	1308	1484	2027	1801	1387	1617	2412	1926
8	98	73	95	121	185	72	123	155	404	481	666	690	709	1000	1087	1340	1174	938	1081	1446
9	82	69	59	78	88	137	56	83	114	285	337	510	531	530	684	743	808	769	598	651
10	53	59	57	48	61	67	112	35	62	79	191	236	363	365	315	458	453	498	483	365
11	31	36	48	47	39	48	55	91	27	47	46	123	132	237	232	209	283	286	301	283
12	64	16	27	40	39	30	40	44	75	18	27	31	67	81	156	160	124	157	156	201
13	28	42	9	23	34	32	24	31	36	61	13	19	18	37	54	92	110	66	93	106
14	23	21	32	6	19	28	25	18	25	27	50	10	12	12	23	34	68	64	33	66
15+	46	24	36	55	51	101	34	61	46	135	96	95	80	22	13	21	81	35	29	40
8-15+ (KK)	0.4	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.8	1.1	1.4	1.7	1.9	2.3	2.6	3.1	3.1	2.8	2.8	3.2
Total (KK)	5.1	6.4	7.1	8.1	9.5	11.2	13.9	16.9	21.8	25.1	27.8	31.2	38.2	40.7	43.1	46.3	45.8	45.8	44.7	45.6

Table 5. Fishing mortality at age and average across ages, 1982-2000.

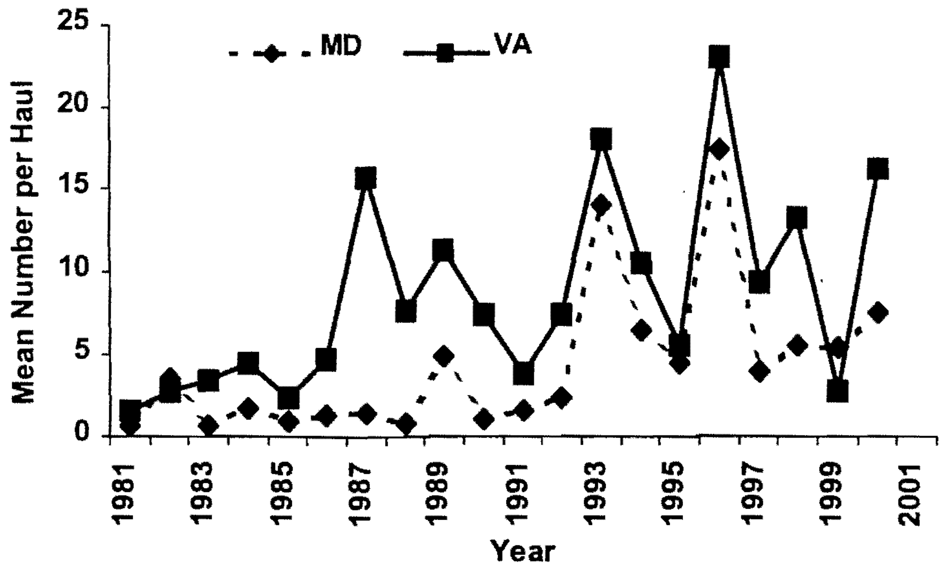
Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.13	0.11	0.29	0.04	0.01	0	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.01	0.03	0.02	0.01	0.03
3	0.38	0.31	0.45	0.08	0.04	0.02	0.02	0.04	0.04	0.04	0.04	0.04	0.07	0.09	0.08	0.08	0.07	0.05	0.05
4	0.30	0.52	0.22	0.09	0.13	0.04	0.04	0.04	0.11	0.08	0.07	0.08	0.08	0.12	0.16	0.14	0.14	0.12	0.15
5	0.21	0.33	0.29	0.22	0.15	0.08	0.11	0.08	0.13	0.12	0.09	0.13	0.11	0.13	0.20	0.21	0.25	0.18	0.25
6	0.13	0.21	0.17	0.32	0.17	0.10	0.16	0.12	0.16	0.10	0.11	0.12	0.14	0.20	0.21	0.33	0.25	0.24	0.31
7	0.27	0.17	0.13	0.20	0.23	0.09	0.22	0.10	0.18	0.12	0.08	0.11	0.12	0.16	0.26	0.28	0.24	0.25	0.37
8	0.20	0.06	0.05	0.17	0.15	0.10	0.24	0.16	0.20	0.21	0.12	0.11	0.14	0.23	0.23	0.36	0.27	0.30	0.36
9	0.17	0.05	0.04	0.09	0.12	0.05	0.31	0.14	0.22	0.25	0.21	0.19	0.23	0.37	0.25	0.34	0.33	0.32	0.34
10	0.24	0.07	0.04	0.08	0.10	0.05	0.06	0.12	0.14	0.40	0.29	0.43	0.28	0.30	0.26	0.33	0.31	0.36	0.39
11	0.49	0.15	0.02	0.02	0.10	0.03	0.08	0.04	0.23	0.40	0.25	0.45	0.35	0.27	0.22	0.37	0.44	0.46	0.25
12	0.26	0.46	0.01	0.02	0.04	0.07	0.09	0.05	0.05	0.18	0.18	0.40	0.44	0.25	0.37	0.23	0.48	0.37	0.23
13	0.14	0.13	0.31	0.02	0.03	0.12	0.11	0.07	0.12	0.05	0.15	0.30	0.23	0.32	0.32	0.15	0.37	0.54	0.19
14	0.21	0.23	0.15	0.19	0.15	0.08	0.14	0.10	0.16	0.14	0.11	0.14	0.14	0.19	0.23	0.29	0.27	0.24	0.30
15	0.21	0.23	0.15	0.19	0.15	0.08	0.14	0.10	0.16	0.14	0.11	0.14	0.14	0.19	0.23	0.29	0.27	0.24	0.30

Average Fishing Mortality. Reference ages (4-13).

Ages	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	0.24	0.21	0.13	0.12	0.12	0.07	0.14	0.09	0.15	0.19	0.15	0.23	0.21	0.24	0.25	0.27	0.31	0.31	0.28

Figure 1. Striped bass juvenile abundance indices.

a. Young of year (YOY) indices for the Chesapeake stock, Maryland and Virginia surveys, 1981 to 2000.



b. Young of year (YOY) indices for the Hudson (NY) and Delaware Bay (NJ) stocks, 1981 to 2000.

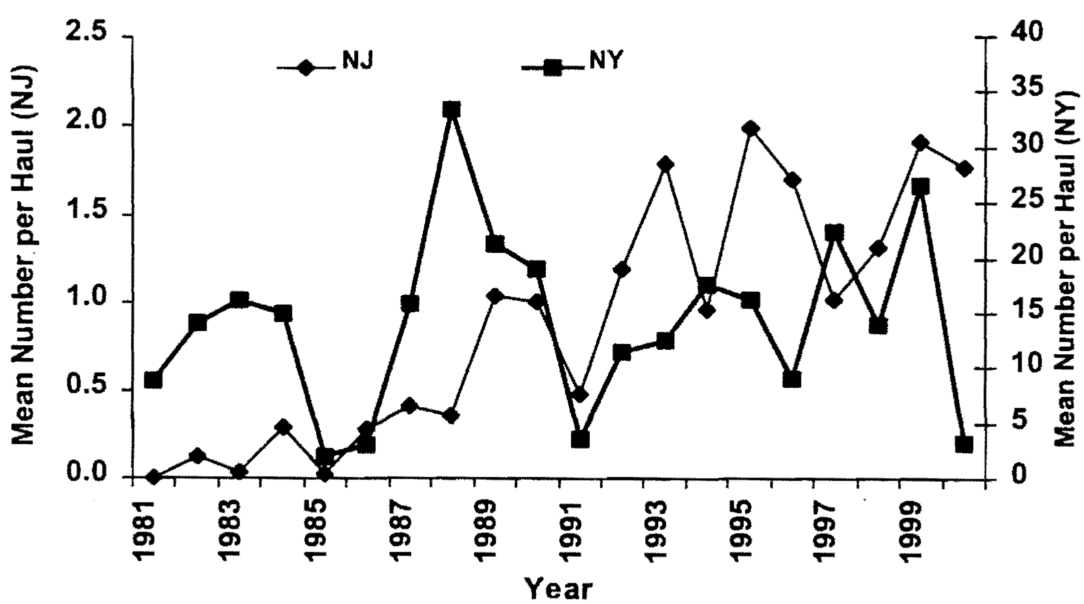
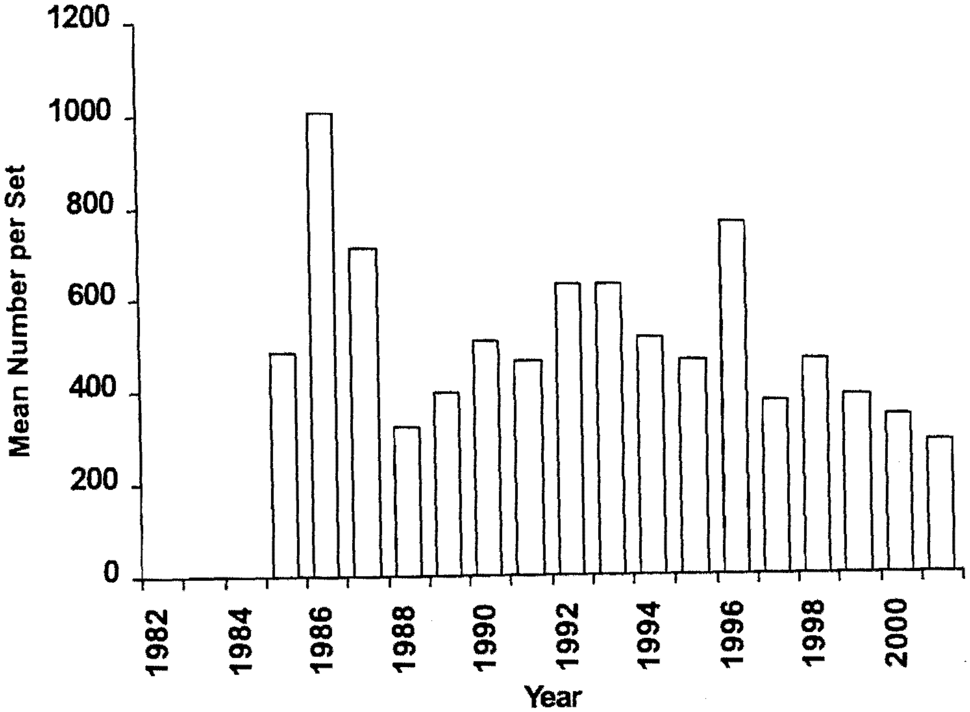
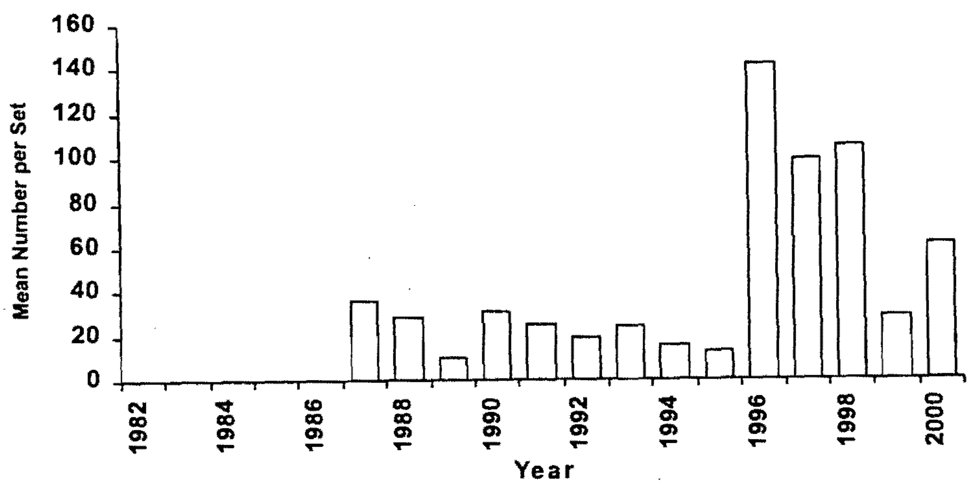


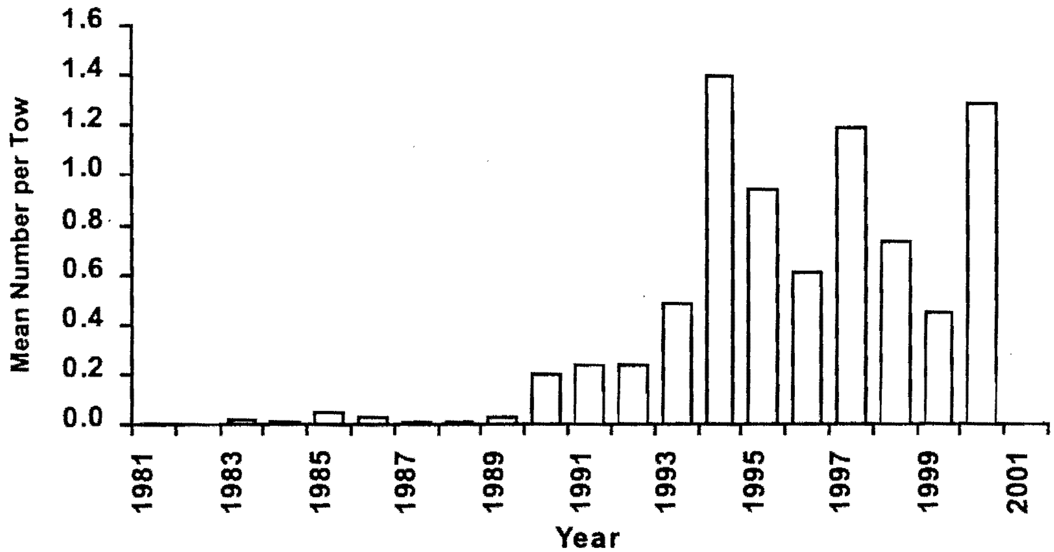
Figure 2. Striped bass fishery-independent indices of adult abundance.
a. Maryland spawning stock index of striped bass abundance, ages 2 and older, 1985 to 2001.



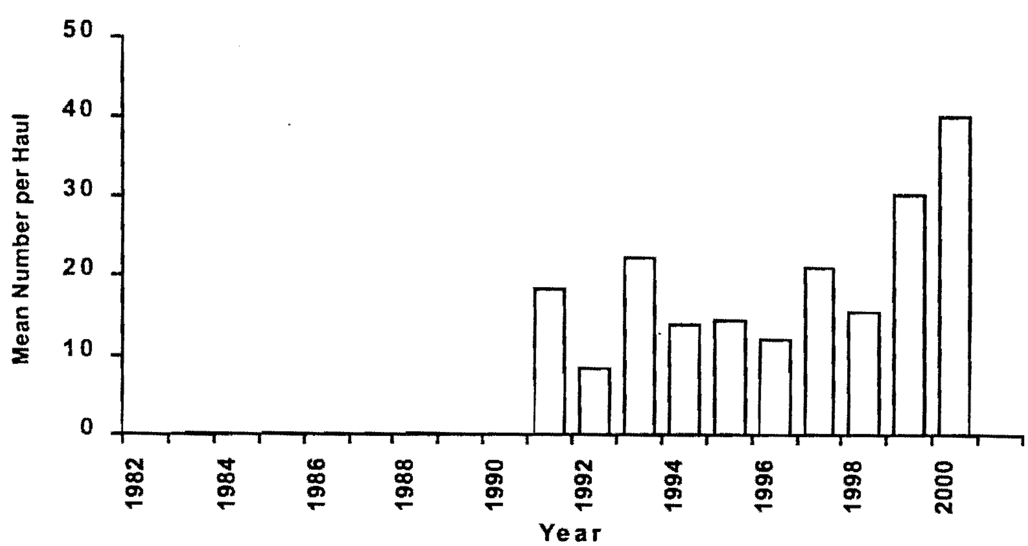
b. New York ocean haul seine index of striped bass abundance (catch per set), ages 5 and older, 1987-2000.



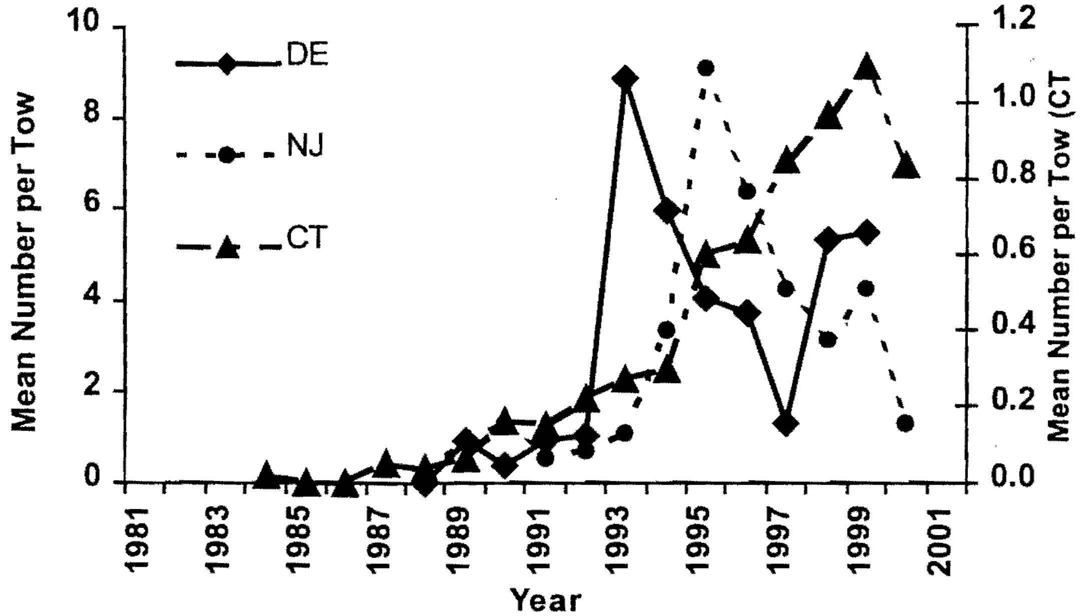
c. NMFS/NEFSC bottom trawl survey index of striped bass abundance (mean number per tow), ages 2 to 15.



d. Virginia Rappahannock River pound net index of striped bass abundance.



e. Indices of striped bass abundance from Delaware, New Jersey, and Connecticut trawl surveys.



f. Indices of age 1 striped bass abundance for Long Island and Maryland.

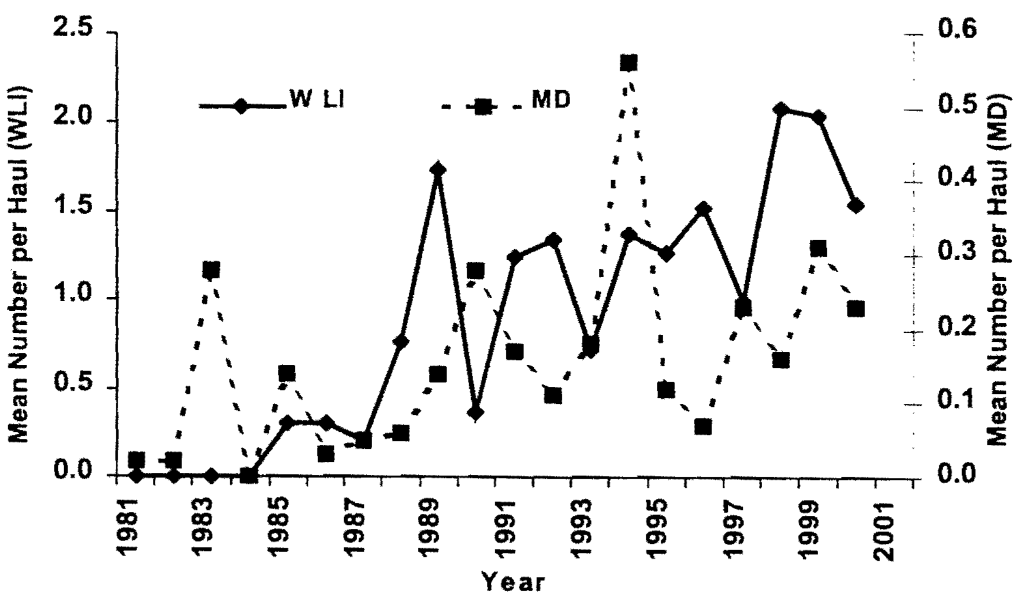
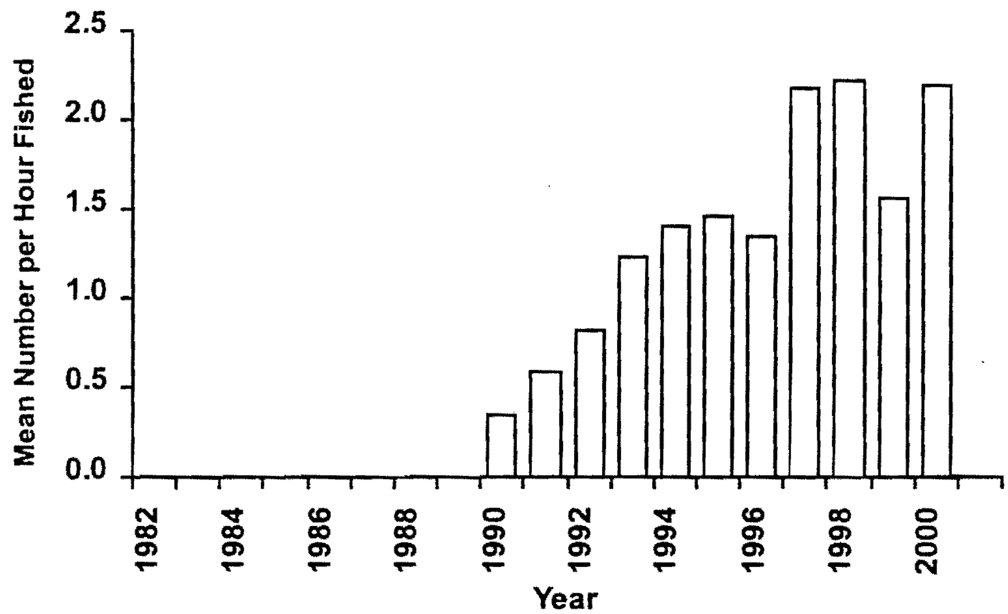
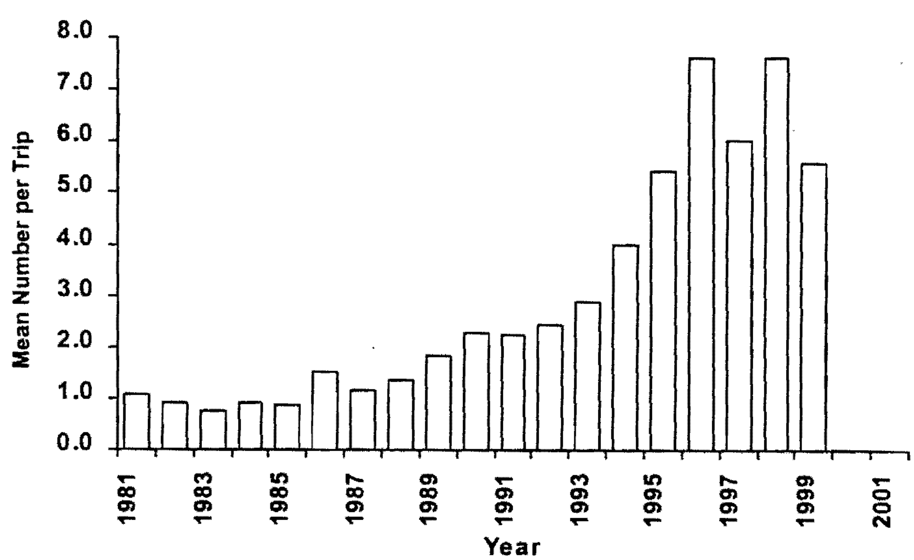


Figure 3. Striped bass fishery-dependent indices of abundance.

a. Massachusetts commercial striped bass catch per unit effort, for age 8 to 15 fish, 1990 to 2000.



b. Connecticut volunteer angler striped bass catch per trip for 1981 to 1999.



c. Hudson River shad bycatch indices of striped bass abundance, 1986 to 2000.

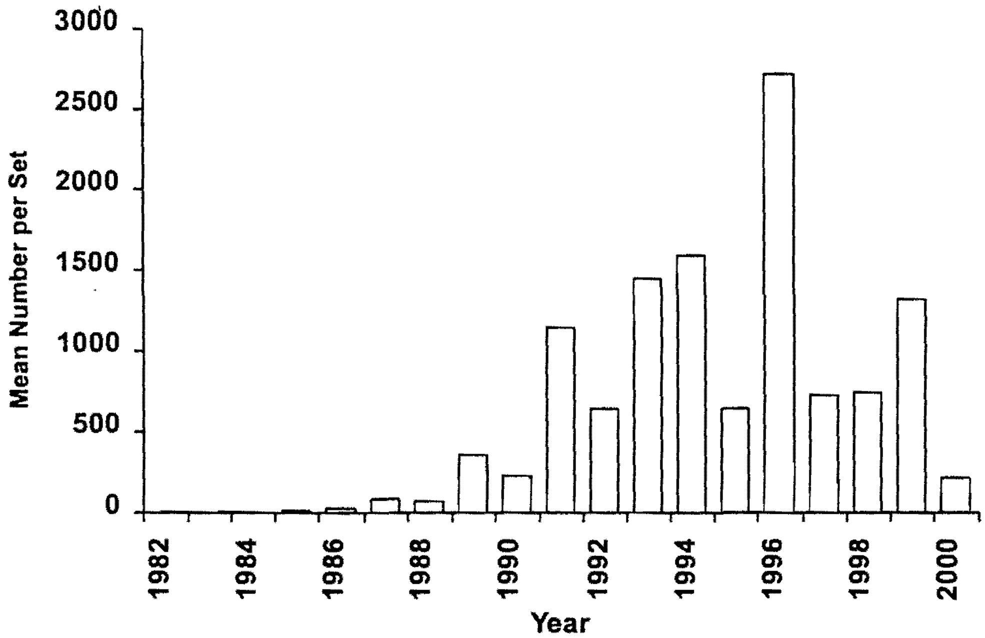


Figure 4. Percentage recreational and commercial catch (harvest and discard) in number for 2000

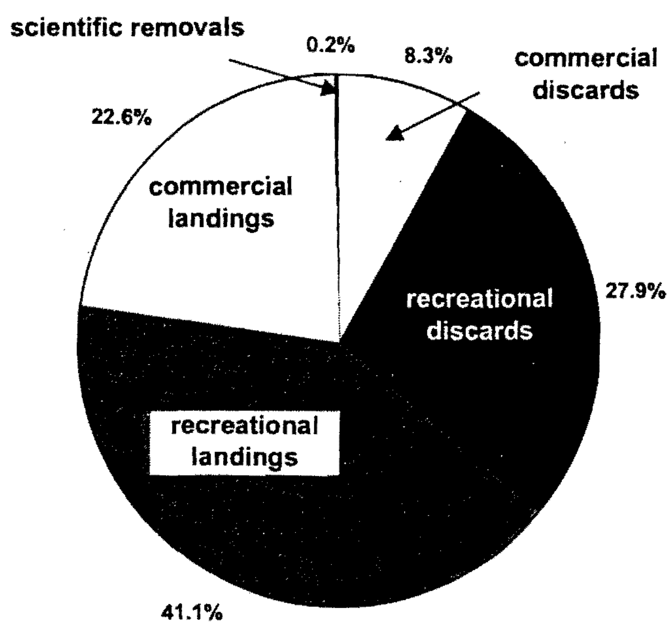


Figure 5. Striped bass population abundance (age 1 and greater, and age 8 and older) from the 2000 VPA results.

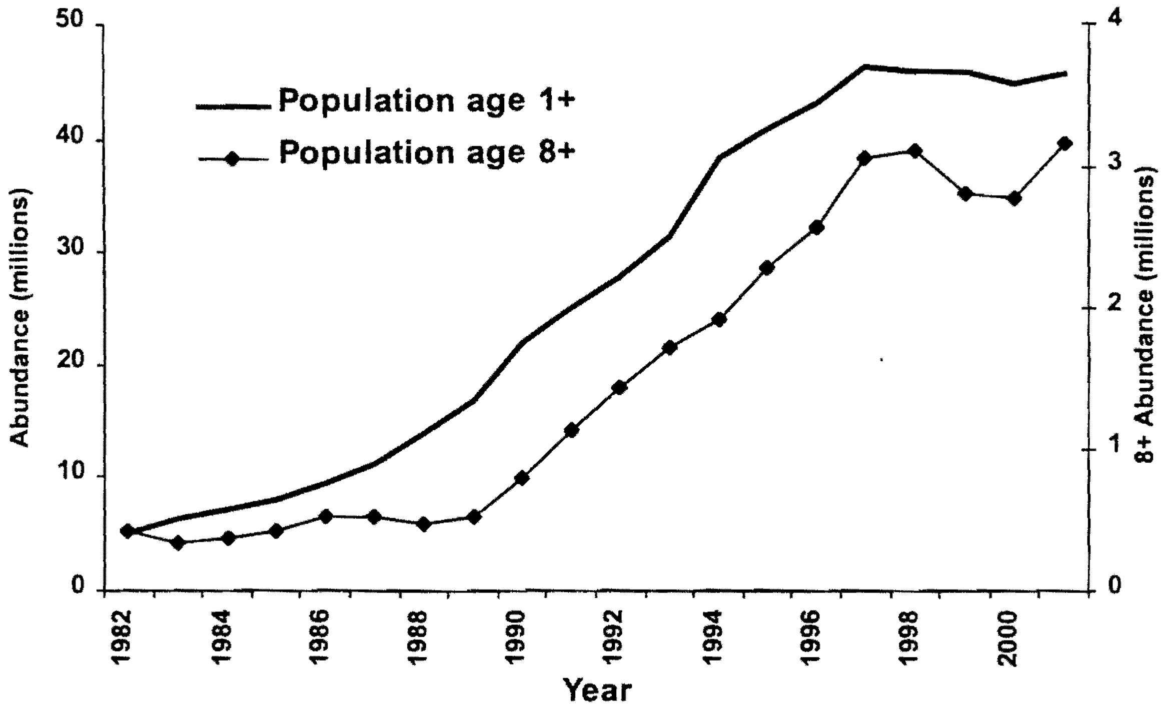


Figure 6. Trend in female spawning stock biomass, 1982 to 2000.

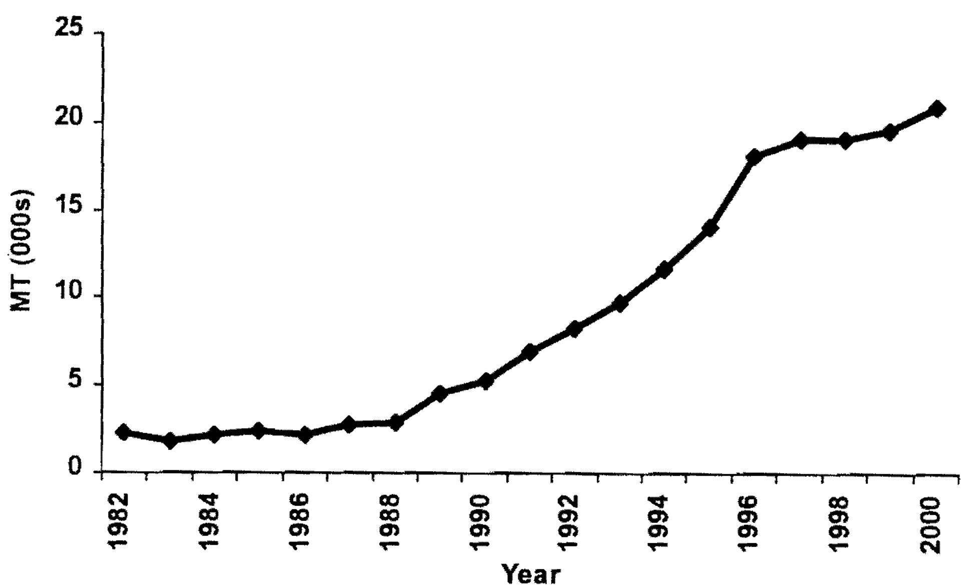


Figure 7. Estimated striped bass abundance of age 4 to 13 fish for 1982-2001, total striped bass catch of fish ages 4 to 13 for 1982 to 2000, and striped bass fishing mortality for age 4 to 13 fish from 1982 to 2000.