Technical Report

Massachusetts Division of Marine Fisheries
Technical Report TR-84

Massachusetts Striped Bass Monitoring Report for 2023

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Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Department of Fish and Game
Massachusetts Division of Marine Fisheries

December 2024

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Commonwealth of Massachusetts
Maura Healey, Governor
Executive Office of Energy and Environmental Affairs
Rebecca Tepper , Secretary
Department of Fish and Game
Thomas O'Shea, Commissioner
Massachusetts Division of Marine Fisheries
Daniel J. McKiernan, Director

Summary: During 2023, the Massachusetts commercial fishery for striped bass sold about 29,900 fish weighing 677,774 pounds. The recreational fishery harvested about 343,778 striped bass weighing over 3.2 million pounds. Total losses due to recreational fishing (including release mortality) were 732,250 fish weighing over 6.5 million pounds. Combined removals (commercial harvest plus recreational harvest and dead releases) were 762,150 fish weighing over 7 million pounds.

Introduction

This report summarizes the commercial and recreational striped bass fisheries conducted in Massachusetts during 2023. Data sources used to characterize the state fisheries come from monitoring programs of the Massachusetts Division of Marine Fisheries (DMF) and National Marine Fisheries Service (NMFS), which are considered to be essential elements of the long-term management approach described in Section 3 of the Atlantic States Marine Fisheries Commission's (ASMFC) Fisheries Management Report No. 41 (Amendment #6 to the Interstate Fishery management Plan for Atlantic Striped Bass (IFMP)).

Commercial Fishery in 2023

Season: June 19–August 9. Landings were permitted on Monday, Tuesday and Wednesday only (fishing is not allowed if an open day falls on July 3, July 4 or Labor Day).

Sold: 677,774 pounds (against a harvest quota of 700,739 pounds).

Allowable Gear Type: Hook and line.

Minimum Size: 35 inches total length.

Trip Limit: 15 fish per day for fishers with a commercial lobster or boat permit and a striped bass endorsement; 2 fish per day for fishers with a commercial individual or rod & reel permit and a striped bass endorsement. Gaffing of fish <35 inches is not allowed.

Licensing, Reporting, and Estimation of Landings. To purchase striped bass directly from fishermen, fish dealers are required to obtain special authorization from the DMF in addition to standard seafood dealer permits. Dealer reporting requirement included weekly reporting to the DMF or SAFIS system of all striped bass purchases. If sent to DMF, all landings information is entered into SAFIS by DMF personnel. Following the close of the season, dealers are also required to provide a written transcript consisting of purchase dates, number of fish, pounds of fish, and names and permit numbers of fishermen from whom they purchased. DMF personnel review dealer transactions and correct entries before calculating total landings.

Fishermen must have a *MarineFisheries* commercial fishing permit (of any type) and a special striped bass fishing endorsement to sell their catch. They are required to file monthly trip level reports which include the name of the dealer(s) that they sell to and information describing their catch

Table 1. Attributes of the Massachusetts striped bass commercial fishery, 2005-2023. * = season closed December 31.

Year	Season (Fishing Days)	Pounds 000s	Number 000s	No. Dealers That Purchased
2005	22	1104.7	59.5	77
2006	26	1312.1	69.9	75
2007	22	1040.3	54.3	76
2008	34	1160.1	61.1	78
2009	27	1138.3	59.3	82
2010	24	1224.4	60.3	83
2011	18	1163.8	56.1	68
2012	17	1219.7	61.5	79
2013	16	1004.5	58.5	76
2014	21	1138.5	56.1	71
2015	17	865.7	42.2	76
2016	17	938.7	48.0	71
2017	20	823.4	41.2	68
2018	*	753.7	37.7	66
2019	*	584.7	29.5	57
2020	*	386.9	19.6	47
2021	46	732.0	36.8	60
2022	20	770.1	32.9	58
2023	22	677.7	29.9	61

composition and catch rates.

Landings. The landings used here come from the SAFIS program. Commercial dealers bought 677,774 pounds (29,900 fish from count of commercial tags used) of striped bass in 2023 (Table 1). Most striped bass were sold in Essex (372,551 pounds), Barnstable (137,985 pounds) and Plymouth (60,450 pounds) counties of Massachusetts.

Size Composition. Information from biological sampling and catch reports is used to characterize disposition of the catch, catch weight, and size composition by catch category. Data from 390 fish sampled from the 2023 commercial harvest and 2000 DMF diet study were used to construct a length-weight equation to estimate weight-at-size for individual bass. The following geometric regression was derived:

log10(W)=-3.432+2.983*log10(L), RMSE=0.0027

where W equals weight in pounds, L equals total length in inches, and RMS is the residual mean square error. This equation was used to estimate the arithmetic average weight for a given length by back-transforming the predicted weight as follows:

$$W=10^{-3.432+2.983*\log10(L)+RMSE/2}$$

An adjustment parameter is estimated and multiplied against the resulting estimates of weight so that the sum of the predicted pounds matches the actual pounds sold. Size composition of the commercial harvest is presented in Appendix Table 1.

Age and Sex Composition. Three hundred ninety fish sampled from the 2023 commercial harvest were used to sex and age the harvested fish. In 2023, paired otolith/scale samples were collected from 188 fish. Otolith ages were used in place of scale ages when available. Age of harvested fish ranged from 6 to 15+ years. About 75.0% of the sub -sample consisted of individuals from the 2010-2015 year classes (ages 8-13) (Figure 1). With the use of otolith ages starting in 2022, the proportion of samples in the plus group has increased.

Estimates of Total Catch and Harvest Rates. Estimates of harvest rates (pounds of fish harvested per hour) for the commercial fishery were developed in order to provide an index that may be indicative of fishing success. In 2011, *MarineFisheries* switched to trip-level reporting. Significant information has been lost due to the generalization of the trip report to cover all fisheries in Massachusetts. The only information now available is daily total hours fished, pounds of fish sold and consumed, and area fished. This information was used under a generalized linear model (GLM) framework to generate standardized indices (Hilborn and Walter, 1992). Each record represented the summarization of a permit's pounds harvested and hours fished by year, month, and area fished reduced to 3 regions (Southern MA, Cape Cod Bay, North MA). Only data from July-August were used to constraint analyses to the most recent duration of the fishing season. The harvest rates for each record was calculated by dividing the total pounds caught by the total number of hours fished. The harvest rate was standardized using the GLM model

$$ln(y)=a+b_1*year+b_2*month+b_3*area+e$$

where y is the observed total catch or harvest rate, a is the intercept, bs are the factor coefficients and e is the error term. Any variable not significant at $\alpha = 0.05$ with type-III (partial) sum of squares was dropped from the initial GLM model and the analysis was repeated. First-order interactions were not considered in the analyses. The back-transformed geometric mean for each year was estimated by

$$y=e^{LSM}$$

where LSM is the least-squares natural log mean of each year.

Results of the GLM analyses of harvest rates are shown in Appendix Table 2. Although factors were significant, the variables accounted for only 5.5% of the total variation in harvest rates.

Harvest rates steadily increased after 1999, peaked in 2004, dropped through 2008, increased slightly through 2010 and then dramatically increased in 2011 and remained at high levels in 2012, dropped through 2014, increased through 2016, declined through 2019 and increased dramatically through 2022 (Figure 2A). Average catch rates in 2023 dropped in all regions (Figure 2B). The dramatic increase in harvest rates for 2011-2012 and 2015-2016 is attributed to large increases in harvest rates by fishers in Cape Cod Bay and southern Massachusetts exploiting large concentrations of striped bass (likely attracted to large aggregations of sand lance in the area) off Cape Cod, particularly off Chatham. Similarly, the dramatic increase in 2021-2022 was likely the result of exploitation of large aggregations of striped bass attracted to large schools of menhaden (pogies) throughout Massachusetts.

Recreational Fishery in 2023

Season: None

Daily Bag Limit: One fish per person

Allowable Gear Type: Hook and Line

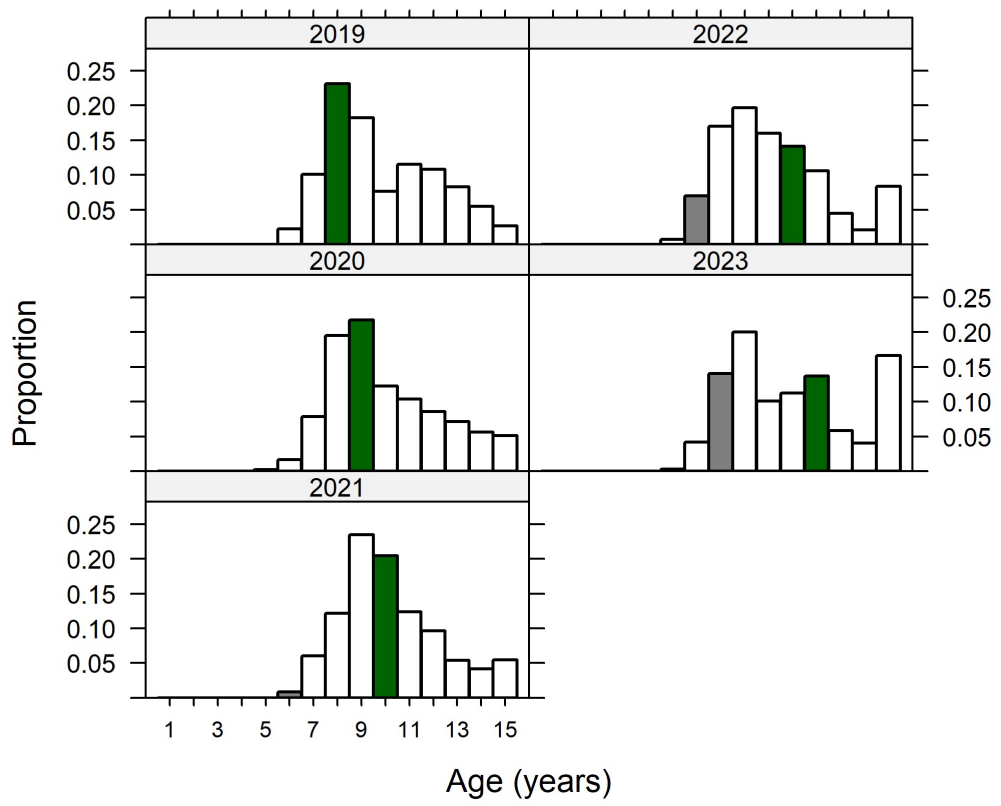

Figure 1. Age composition (proportion) of harvest from the Massachusetts commercial fishery in 2019-2023. The large 2011 and 2015 Chesapeake Bay year-classes are highlighted in dark green and gray, respectively.

Size Limit: 28-<31 inches total length

Licensing and Reporting Requirements: A recreational fishing permit is required in MA state waters.

Harvest levels: Harvest (A+B1) and total catch (A+B1+B2) estimates (Table 2) were provided by the NMFS MRIP. The MRIP estimate of total catch (including fish released alive) in 2023 was 4.66 million striped bass, which is a 25.7% decrease compared to the 2022 estimate (Table 2). The estimate of total harvest in 2023 was 343,778 fish, which is a 28.4% decrease compared to 2022. Total pounds harvested was 3,211,749 in 2023 (Table 2).

Size Composition. The length distributions of harvested and released fish were estimated from biological sampling conducted by the MRIP program in Massachusetts and from the volunteer Sportfish Data Collection Team (SADCT) angler program conducted by the Division. Volunteer recreational anglers were solicited to collect length and scale samples from striped bass that they captured each month (May-October). Each person was asked to collect a minimum of 5 scales from at least 10 fish per month and record the disposition of each fish (released or harvested) and fishing mode. Eight hundred sixty six samples were received from 31 anglers in 2023. The size frequencies of measured fish are shown in Figure 3 by disposition and mode. The size frequency of released fishes was used to allocate MRIP release numbers by mode among size classes. Numbers-at-length and weight-at-length data by disposition are summarized in Appendix Table 3.

Age Composition. A sub-sample of 495 fish from the volunteer angler survey was aged by using scales and an age-length key was developed to convert the MRIP and MA volunteer angler size distributions into age classes. Recreational samples were selected using a weighted random design based on the total number of striped bass caught in each wave and mode stratum (as determined by MRIP). Recreational harvest and

total removals (harvest plus dead releases) in 2023 were comprised mostly of the 2015-2018 year-classes (Figure 4).

Trends in Catch Rates. To examine trends in recreational angler catches, standardized catch rates (total number of fish per trip) for striped bass were calculated for all fish caught using a delta-Gamma model (Lo et al., 1992; Stefansson, 1996) which adjusts trip catches for the effects of year, wave, county, area fished, mode fished, and time spent fishing. A delta-Gamma model was selected as the best approach to estimate year effects after examination of model dispersion (Terceiro, 2003) and standardized residual deviance plots (McCullagh and Nelder, 1989). In the delta-Gamma model, catch data is decomposed into catch success/failure and positive catch components. Each component is analyzed separately using appropriate statistical techniques and then the model estimates are recombined to obtain the index. The catch success/failure was modeled as a binary response to the categorical variables using multiple logistic regression:

$$\text{logit}(p) = \log(p/1-p) = a + \sum_{i=1}^{n} b_i X_i + e$$

where p is the probability of catching a fish, a is the intercept, b_i is the slope coefficient of the ith factor, X_i is the ith categorical variable, and e is the error term. The function *glm* in *R* was used to estimate parameters, and goodness-of-fit was assessed using partial and empirical probability plots.

Positive catches were modeled assuming a Gamma error distribution with a log link using function *glm* in *R:*

$$y = \exp^{(a+\sum_{i=1}^{n} b_i X_i)} + e$$

where y is the observed positive catch, b_i ,and X_i are the same symbols as defined earlier, and e is the Gamma error term. Any variable not significant at α=0.05 was dropped from the initial GLM model and the analysis was repeated. First-order interactions were considered in the initial analyses but it was not always possible to generate annual means by the least-square methods with some interactions included (see Searle et al., 1980); therefore, only main effects were considered.

The annual index of striped bass total catch per trip was estimated by combining the two component models. The estimate in year i from the models is given by

$$\hat{I}_i = \hat{p}_i * \hat{y}_i$$

where p_i and y_i are the predicted annual responses from the least-squares mean estimates from the logistic and GLM models. Only data for those anglers who said they targeted striped bass were used in the analyses.

Results of the delta-Gamma model analyses are given in Appendix Tables 4A and 4B for 1988-2023. Standardized catch rates for striped bass in

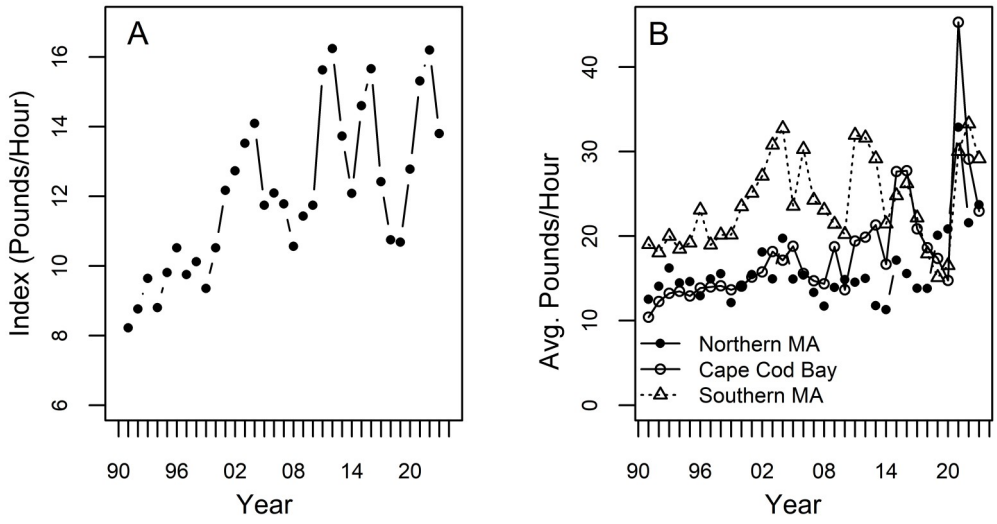

Figure 2. A) Harvest index (standardized pounds/hour) and B) average harvest rates by area for the Massachusetts commercial striped bass fishery, 1991-2023.

Table 2. MRIP estimates of striped bass harvest and releases in Massachusetts, 1986-2023

Year	Harvest		Releases	Total
	Number	Weight (lbs)	Number	Number
1986	48,955	529,384	445,610	494,565
1987	30,782	872,782	233,065	263,847
1988	28,139	713,589	440,173	468,312
1989	43,594	1,185,606	480,528	524,122
1990	20,502	400,384	1,251,060	1,271,562
1991	51,069	866,326	1,290,441	1,341,510
1992	229,178	4,096,126	3,019,869	3,249,047
1993	116,384	1,908,614	1,942,334	2,058,718
1994	159,592	3,683,376	4,667,318	4,826,910
1995	124,300	2,738,834	8,427,141	8,551,441
1996	156,550	2,983,343	8,215,706	8,372,256
1997	365,611	5,132,817	10,675,648	11,041,259
1998	500,885	7,358,692	17,386,770	17,887,655
1999	327,086	4,995,322	13,434,701	13,761,787
2000	306,179	4,863,458	13,743,428	14,049,607
2001	551,038	7,187,897	10,222,067	10,773,105
2002	723,457	10,260,617	13,532,846	14,256,303
2003	797,161	10,251,621	9,787,679	10,584,840
2004	666,703	9,329,231	13,338,234	14,004,937
2005	536,058	7,541,049	9,042,756	9,578,814
2006	483,187	6,786,934	19,278,586	19,761,773
2007	471,873	7,009,584	10,839,699	11,311,572
2008	514,064	8,424,309	7,495,513	8,009,577
2009	694,992	9,409,753	5,989,390	6,684,382
2010	808,175	9,958,677	5,089,524	5,897,699
2011	873,496	11,953,163	4,035,634	4,909,130
2012	1,010,563	14,940,507	3,629,395	4,639,958
2013	658,713	9,024,975	4,670,184	5,328,897
2014	523,531	7,965,139	6,425,468	6,948,999
2015	485,317	7,798,768	4,470,735	4,956,052
2016	230,069	3,730,639	6,299,215	6,529,284
2017	392,347	5,666,309	12,865,677	13,258,024
2018	389,457	4,924,791	5,377,213	5,766,670
2019	195,608	2,697,736	5,498,550	5,694,158
2020	67,158	776,115	5,127,649	5,194,807
2021	179,116	1,826,450	4,675,035	4,854,151
2022	479,920	5,288,214	5,796,858	6,276,778
2023	343,778	3,211,749	4,316,354	4,660,132

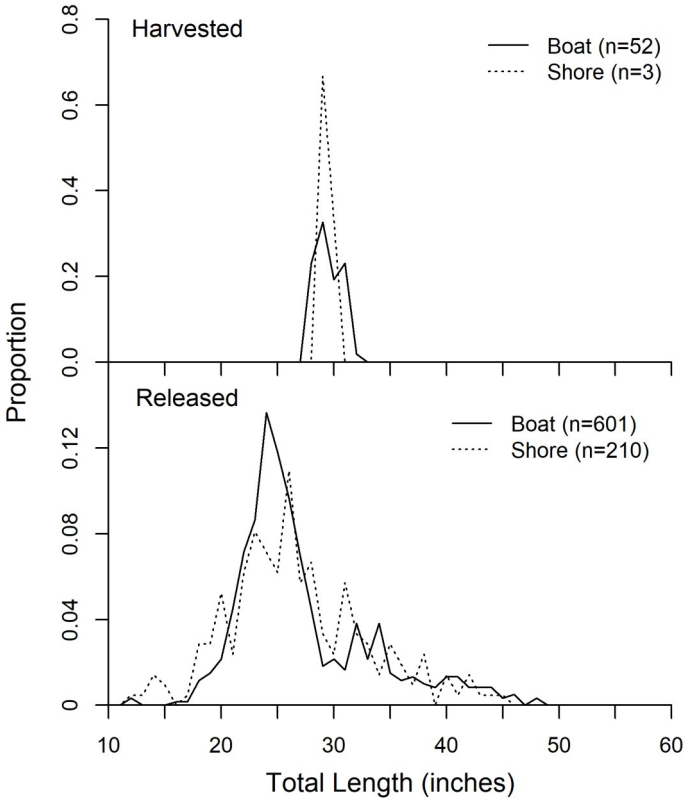

Figure 3. Sizes of striped bass caught by volunteer recreational anglers in 2023 by disposition and fishing mode.

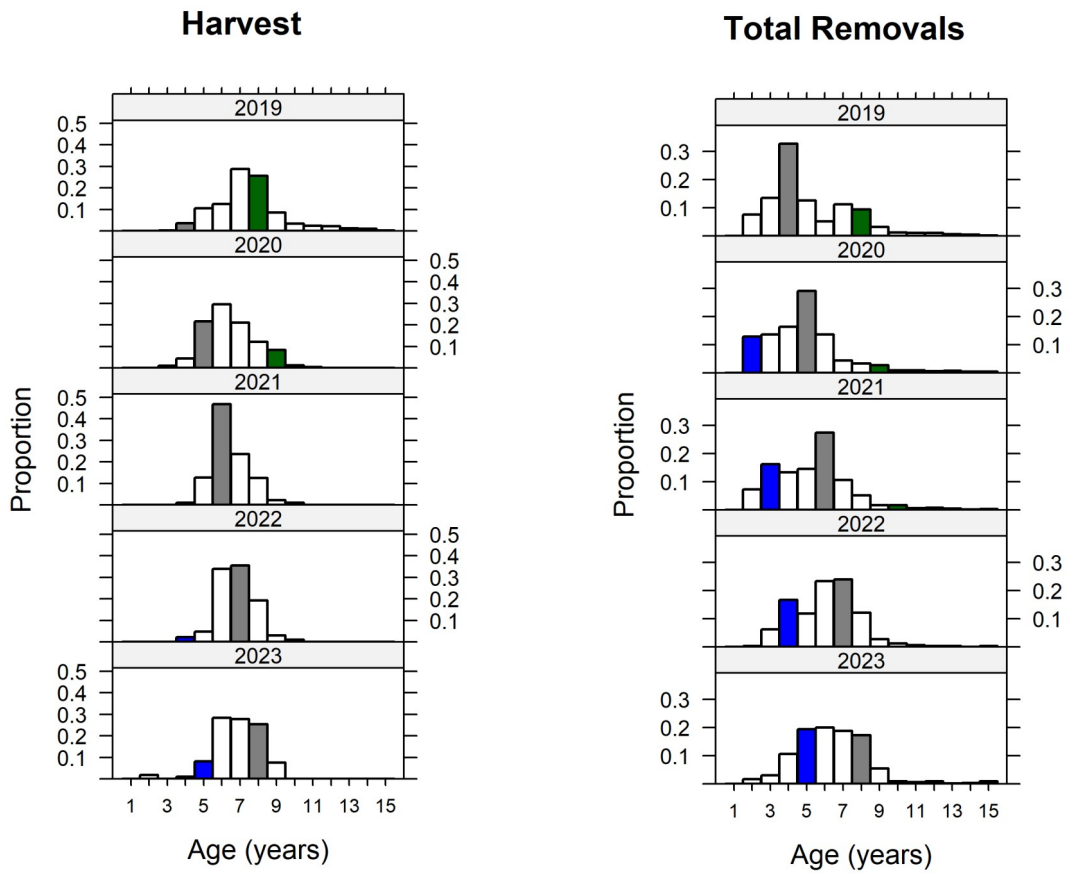

Figure 4. Age composition (proportion) of harvest and total removals (harvest plus dead releases) in 2019-2023 from the Massachusetts recreational fishery. The large 2011 and 2015, and moderate 2018 Chesapeake Bay year-classes are highlighted in dark green, gray, and blue, respectively.

Massachusetts waters increased from 1993 to 2000, declined in 2001, but increased through 2006 (Fig. 5). Catch rates declined through 2011 and remained low through 2015. Catch rates increased dramatically in 2017 as the 2011, 2014 and 2015 year-classes became vulnerable to the fishery. Catch rates have remained relatively stable since 2018, averaging 3.6 fish per trip (Fig. 5).

Characterization of Losses

Losses due to hook-and-release calculated by using a release mortality rate of 0.09. Losses due to hook-and-release were 388,472 fish (about 3.3 million pounds) (Table 3).

Bycatch in Other Fisheries

During 1994, *MarineFisheries* sea-sampling efforts identified striped bass as by-catch in a Nantucket Sound springtime trawl fishery directed at long-finned squid (*Loligo pealei*). The bycatch estimate was about 3,100 fish (17,600 pounds). Anecdotal information was also reported which suggested that a single tow could land up to 19,000 pounds. Division personnel sampled this fishery at sea during 1995-2000 and observed only incidental catches of striped bass. Limited sampling and low catch rates make it unreasonable to extrapolate sample information. *MarineFisheries* will continue to monitor potential sources of striped bass by-catch during 2023.

Estimated Total Losses in 2023

Total estimated loss (commercial harvest plus recreational harvest plus recreational dead releases) of striped bass during 2023 was 762,150 fish weighing over 7.18 million pounds (Table 3).

Removals-At-Age Matrix in 2022

The removals (numbers) by the recreational and commercial fisheries are apportioned by age and mortality source in Table 4. The 2015-2018 (5-8 years) year-classes from Chesapeake Bay incurred the highest losses in 2023 (Figure 6).

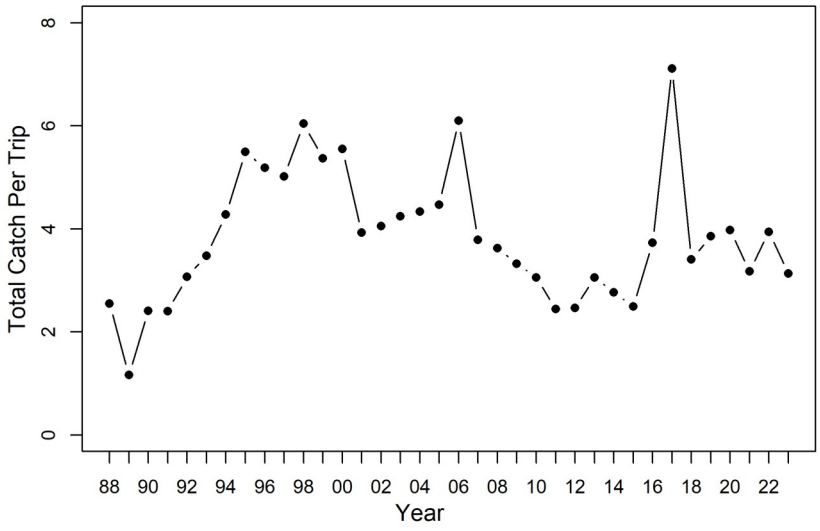

Figure 5. Standardized total catch rates (total number of fish caught per trip) of the recreational fishery for striped bass in Massachusetts waters, 1988-2023

Age-Length Relationship

A von Bertalanffy growth model was fitted to age (years) and total length (inches) data from samples collected in the tagging study, the recreational fishery, and commercial fishery from 2023. The resulting equation and predicted relationship are shown in Figure 7.

Required Fishery-Independent Monitoring Programs

Massachusetts Tagging Study

DMF joined the Striped Bass Cooperative State -Federal Coast-wide Tagging Study in 1991. The study's primary objective has been to develop an integrated database of tag releases and recoveries that will provide current information related to striped bass mortality and migration rates. The Massachusetts tagging effort has focused on the tag and release of large fish that reach coast-wide legal sizes. To accomplish this job, DMF contracts several select charter boat captains to take DMF personnel on board to tag and release their catch during regularly scheduled fishing trips. Fish are caught in fall by trolling artificial baits in shoal areas around Nantucket Island. Floy internal anchor tags provided by the USFWS are used. Total length of each fish is recorded. Scales are removed from each fish for aging. The release data are made available to the Annapolis, Maryland office of the USFWS, which coordinates regional tagging programs of state-federal participants.

Table 3. Estimates of striped bass losses occurring in Massachusetts waters during 2023.

Fishery	Number	Pounds	Mean Wt
Commercial			
Harvest	29,900	677,774	22.7
Recreational			
Harvest	343,778	3,211,749	9.3
Dead Releases	388,472	3,290,733	8.5
Total	762,150	7,180,256	

Table 4. Massachusetts striped bass removals-at-age matrix of 2023 by source. There are very minor differences in total numbers due to rounding errors.

Age	Recreational Dead Releases	Recreational Harvest	Commercial Harvest	Total
1	0	0	0	0
2	5,438	6,179	0	11,617
3	21,893	0	0	21,893
4	73,901	3,523	0	77,424
5	114,247	27,915	0	142,162
6	48,896	97,781	78	146,755
7	42,146	95,218	1,238	138,602
8	39,235	87,400	4,189	130,824
9	14,669	25,745	5,995	46,409
10	6,647	15	3,021	9,683
11	4,895	0	3,356	8,251
12	6,814	0	4,087	10,901
13	1,162	0	1,752	2,914
14	1,955	0	1,209	3,164
15+	6,575	0	4,974	11,549
Total	388,473	343,778	29,900	762,150

Summary statistics compiled since the start of the study are shown in Table 5.

Planned Management Programs in 2024

Regulations

Due to the recent declaration that the migratory stock is overfished and overfishing is occurring, Massachusetts' recreational bag will remain at 1 fish per day, and a slot limit of 28-<31 inches total length will be imposed.. For the commercial fishery, the minimum size limit and quota will remain at 35 inches and 683,773 pounds, respectively. The quota change is the result of the Atlantic States Marine Fisheries Commission's adoption of Addendum II to the Interstate Fishery Management Plan for Atlantic Striped Bass. The commercial fishery quota will be monitored using the SAFIS system. All monitoring programs will continue in 2024.

Acknowledgements

The collection and quality of striped bass data would suffer greatly without the efforts of many DMF employees. Staff of the Fisheries Statistics section collected, entered, and compiled all commercial data. Erich Druskat provided the commercial data. Kim Fine coordinated the

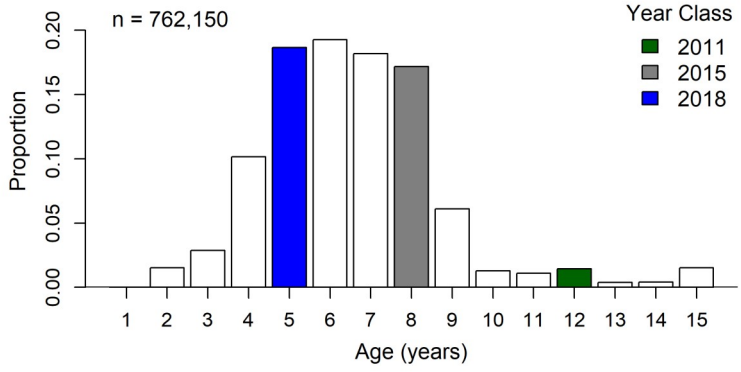

Figure 6. Proportion of striped bass total removals (commercial plus recreational) in 2023 by age. The 2011, 2015, and 2018 year-classes from Chesapeake Bay are indicated.

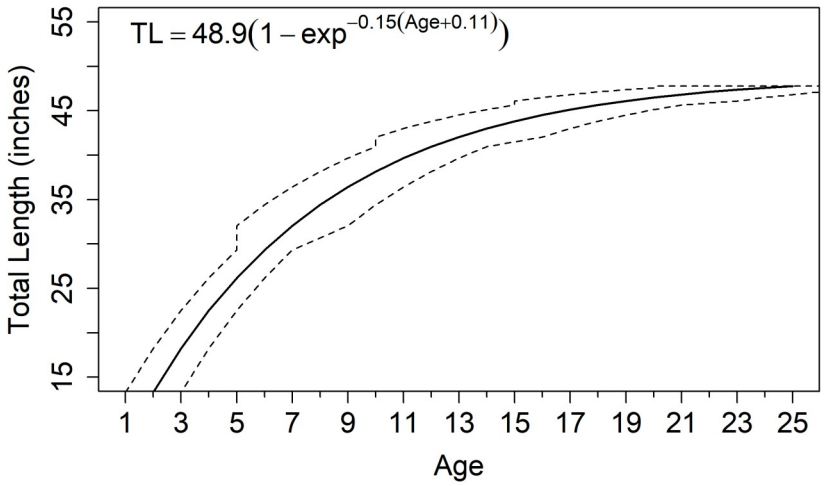

Figure 7. Mean length-age relationship (solid line) for striped bass captured in Massachusetts during 2023. Dotted lines represent the minimum and maximum ages found at a given length.

Table 5. Massachusetts tag summary statistics. SD = standard deviation.

			Number	Ave.	Ave.	SD	SD		Length Range		
Year	Trips	Boats	Tagged	Length (mm)	Length (in)	(mm)	(in)	Min (mm)	Min (in)	Max (mm)	Max (in)
1991	17	4	388	817	32.2	106.4	4.2	534	21.0	1300	51.2
1992	29	3	899	798	31.4	125.9	5.0	524	20.6	1267	49.9
1993	15	2	678	784	30.9	125.0	4.9	515	20.3	1210	47.6
1994	13	2	377	735	28.9	93.2	3.7	548	21.6	1028	40.5
1995	11	2	449	767	30.2	110.2	4.3	470	18.5	1178	46.4
1996	8	2	203	748	29.4	64.1	2.5	541	21.3	1077	42.4
1997	10	2	321	773	30.4	114.7	4.5	485	19.1	1090	42.9
1998	12	2	382	797	31.4	93.8	3.7	597	23.5	1055	41.5
1999	16	2	471	777	30.6	95.5	3.8	594	23.4	1108	43.6
2000	25	4	1095	752	29.6	102.6	4.0	510	20.1	1204	47.4
2001	14	3	456	786	30.9	102.5	4.0	503	19.8	1110	43.7
2002	12	3	239	764	30.1	103.6	4.1	487	19.2	1060	41.7
2003	15	3	655	825	32.5	92.1	3.6	602	23.7	1204	47.4
2004	25	7	784	707	27.8	193.1	7.6	316	12.4	1164	45.8
2005	19	4	752	726	28.6	210.5	8.3	299	11.8	1114	43.9
2006	11	4	390	813	32.0	94.2	3.7	565	22.2	1114	43.9
2007	16	3	530	848	33.4	105.2	4.1	600	23.6	1225	48.2
2008	13	2	456	821	32.3	104.6	4.1	530	20.9	1202	47.3
2009	15	3	501	840	33.1	101.8	4.0	572	22.5	1146	45.1
2010	13	3	329	825	32.5	84.0	3.3	668	26.3	1095	43.1
2011	15	3	504	831	32.7	91.9	3.6	580	22.8	1174	46.2
2012	15	3	643	852	33.5	87.7	3.5	524	20.6	1203	47.4
2013	15	3	487	854	33.6	92.2	3.6	617	24.3	1145	45.1
2014	15	3	455	876	34.5	98.8	3.9	536	21.1	1203	47.4
2015	15	3	348	857	33.7	90.9	3.6	597	23.5	1063	41.9
2016	14	3	711	788	31.0	108.2	4.3	523	20.6	1065	41.9
2017	10	2	381	777	30.6	97.8	3.9	518	20.4	1035	40.7
2018	10	2	394	794	31.2	90.9	3.6	489	19.2	1154	45.5
2019	10	2	416	761	29.9	121.3	4.8	540	21.2	1077	42.4
2020	Tagging not conducted due to COVID restrictions										
2021	10	2	466	734	28.9	95.3	3.8	513	20.2	1150	45.3
2022	10	2	438	768	30.2	88.4	3.5	548	21.6	1092	43.0
2023	10	2	374	770	30.3	88.4	3.5	614	24.2	1039	40.9

volunteer recreational angler data collection program, entered scale envelope data, and prepared data for analysis. Scott Elzey, Christy Draghetti Kim Fine and Kara Duprey prepared and aged scale samples. John Boardman and Elise Koob conducted the commercial sampling of stripers. John Boardman also coordinated and conducted the USFWS cooperative tagging study. Funding for this effort was provided by the Massachusetts Division of Marine Fisheries and Sportfish Restoration Funds Grants F-57-R and F-48-R.

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Appendix Table 1. Estimated size distribution of the Massachusetts commercial striped bass harvest (numbers and weight of fish) by total length (TL in inches) in 2023.

TL (in.)	Number	% Number	Weight (lbs)	% Weight
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	367	1.2	5,009	0.7
35	1,604	5.4	23,906	3.5
36	4,153	13.9	67,365	9.9
37	2,633	8.8	46,378	6.8
38	2,253	7.5	43,002	6.3
39	2,918	9.8	60,217	8.9
40	2,135	7.1	47,545	7.0
41	3,029	10.1	72,657	10.7
42	3,031	10.1	78,179	11.5
43	2,076	6.9	57,464	8.5
44	2,375	7.9	70,453	10.4
45	3,327	11.1	105,598	15.6
Total	29,900		677,774	
Avg. Size	40.0		22.7	

Appendix Table 2. Results of the GLM analyses of total catch rates (pounds/hour) for the commercial striped bass fishery, 1991-2023

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Analysis of Deviance Table
Model: gaussian, link: identity

Response: INDEX
Terms added sequentially (first to last)

      Df Deviance Resid. Df Resid. Dev        F  Pr(>F)
NULL                 71061      78074
YEAR  32  2168.47     71029      75906   65.232 < 2e-16 ***
MONTH  1    22.04     71028      75884   21.221 4.1e-06 ***
AREA   2  2099.68     71026      73784 1010.598 < 2e-16 ***
```

Coefficients:

	Estimate	Std. Error	t	Pr(>|t|)	
(Intercept)	1.973165	0.026475	74.529	2.00E-16	***
YEAR1992	0.064129	0.035619	1.8	0.0718	.
YEAR1993	0.159058	0.035478	4.483	7.36E-06	***
YEAR1994	0.068166	0.035421	1.924	0.0543	.
YEAR1995	0.176775	0.031657	5.584	2.36E-08	***
YEAR1996	0.246378	0.051549	4.779	1.76E-06	***
YEAR1997	0.170797	0.030627	5.577	2.46E-08	***
YEAR1998	0.208326	0.031222	6.672	2.53E-11	***
YEAR1999	0.129073	0.031903	4.046	5.22E-05	***
YEAR2000	0.247263	0.032437	7.623	2.51E-14	***
YEAR2001	0.392517	0.032501	12.077	2.00E-16	***
YEAR2002	0.437536	0.031993	13.676	2.00E-16	***
YEAR2003	0.497826	0.029557	16.843	2.00E-16	***
YEAR2004	0.539169	0.035655	15.122	2.00E-16	***
YEAR2005	0.356275	0.03228	11.037	2.00E-16	***
YEAR2006	0.385704	0.030525	12.636	2.00E-16	***
YEAR2007	0.359532	0.031	11.598	2.00E-16	***
YEAR2008	0.250473	0.030972	8.087	6.21E-16	***
YEAR2009	0.329588	0.030724	10.727	2.00E-16	***
YEAR2010	0.356588	0.03291	10.835	2.00E-16	***
YEAR2011	0.642602	0.037004	17.366	2.00E-16	***
YEAR2012	0.681097	0.033462	20.355	2.00E-16	***
YEAR2013	0.513189	0.034216	14.999	2.00E-16	***
YEAR2014	0.384874	0.032715	11.764	2.00E-16	***
YEAR2015	0.574264	0.033471	17.157	2.00E-16	***
YEAR2016	0.644347	0.033413	19.285	2.00E-16	***
YEAR2017	0.412495	0.033197	12.426	2.00E-16	***
YEAR2018	0.268716	0.033233	8.086	6.27E-16	***
YEAR2019	0.261964	0.034597	7.572	3.72E-14	***
YEAR2020	0.441747	0.043363	10.187	2.00E-16	***
YEAR2021	0.621897	0.045189	13.762	2.00E-16	***
YEAR2022	0.678823	0.036693	18.5	2.00E-16	***
YEAR2023	0.518459	0.03826	13.551	2.00E-16	***
MONTHJuly	-0.03442	0.007758	-4.436	9.16E-06	***
AREACCB	0.065694	0.011143	5.896	3.75E-09	***
AREASMA	0.385884	0.010089	38.248	2.00E-16	***

Appendix Table 2 cont.

	lsmeans
1991	8.219270
1992	8.763635
1993	9.636325
1994	8.799079
1995	9.808572
1996	10.515595
1997	9.750104
1998	10.122974
1999	9.351661
2000	10.524907
2001	12.170297
2002	12.730712
2003	13.521852
2004	14.092603
2005	11.737122
2006	12.087660
2007	11.775412
2008	10.558742
2009	11.428030
2010	11.740797
2011	15.628295
2012	16.241645
2013	13.731191
2014	12.077629
2015	14.595967
2016	15.655592
2017	12.415876
2018	10.753139
2019	10.680772
2020	12.784437
2021	15.308045
2022	16.204749
2023	13.803746

Appendix Table 3. Estimated size distribution of the Massachusetts recreational striped bass catch (numbers and weight of fish) in 2023 by disposition.

	Harvested				Released				Total			
TL (in.)	Number	% Number	Weight	% Weight	Number	% Number	Weight	% Weight	Number	% Number	Weight	% Weight
9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
10	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
11	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
12	0	0.0	0	0.0	16,227	0.4	10,099	0.0	16,227	0.3	10,099	0.0
13	6,179	1.8	4,892	0.2	6,332	0.1	5,013	0.0	12,511	0.3	9,906	0.0
14	0	0.0	0	0.0	12,710	0.3	12,577	0.0	12,710	0.3	12,577	0.0
15	0	0.0	0	0.0	10,569	0.2	12,870	0.0	10,569	0.2	12,870	0.0
16	0	0.0	0	0.0	4,460	0.1	6,596	0.0	4,460	0.1	6,596	0.0
17	0	0.0	0	0.0	8,697	0.2	15,433	0.0	8,697	0.2	15,433	0.0
18	0	0.0	0	0.0	75,208	1.7	158,495	0.4	75,208	1.6	158,495	0.4
19	0	0.0	0	0.0	85,250	2.0	211,387	0.6	85,250	1.8	211,387	0.5
20	0	0.0	0	0.0	131,390	3.0	380,153	1.0	131,390	2.8	380,153	1.0
21	0	0.0	0	0.0	175,384	4.1	587,662	1.6	175,384	3.8	587,662	1.5
22	0	0.0	0	0.0	288,051	6.7	1,110,157	3.0	288,051	6.2	1,110,157	2.8
23	0	0.0	0	0.0	367,897	8.5	1,620,745	4.4	367,897	7.9	1,620,745	4.1
24	0	0.0	0	0.0	514,580	11.9	2,576,575	7.0	514,580	11.0	2,576,575	6.5
25	0	0.0	0	0.0	421,325	9.8	2,385,277	6.5	421,325	9.0	2,385,277	6.0
26	5,023	1.5	31,997	1.0	426,512	9.9	2,717,020	7.4	431,535	9.3	2,749,016	6.9
27	15,692	4.6	111,983	3.5	281,449	6.5	2,008,478	5.5	297,141	6.4	2,120,461	5.3
28	41,628	12.1	331,411	10.3	223,016	5.2	1,775,476	4.9	264,644	5.7	2,106,888	5.3
29	105,619	30.7	934,472	29.1	96,166	2.2	850,840	2.3	201,785	4.3	1,785,312	4.5
30	76,549	22.3	749,990	23.4	98,709	2.3	967,099	2.6	175,258	3.8	1,717,089	4.3
31	64,314	18.7	695,439	21.7	116,106	2.7	1,255,470	3.4	180,420	3.9	1,950,908	4.9
32	24,811	7.2	295,168	9.2	151,787	3.5	1,805,784	4.9	176,598	3.8	2,100,952	5.3
33	1,928	0.6	25,163	0.8	100,997	2.3	1,318,071	3.6	102,925	2.2	1,343,234	3.4
34	343	0.1	4,903	0.2	146,144	3.4	2,086,485	5.7	146,488	3.1	2,091,388	5.3
35	1,690	0.5	26,331	0.8	77,015	1.8	1,199,722	3.3	78,706	1.7	1,226,053	3.1
36	0	0.0	0	0.0	66,735	1.5	1,131,513	3.1	66,735	1.4	1,131,513	2.8
37	0	0.0	0	0.0	47,227	1.1	869,549	2.4	47,227	1.0	869,549	2.2
38	0	0.0	0	0.0	61,492	1.4	1,226,770	3.4	61,492	1.3	1,226,770	3.1
39	0	0.0	0	0.0	31,511	0.7	679,748	1.9	31,511	0.7	679,748	1.7
40	0	0.0	0	0.0	57,603	1.3	1,340,920	3.7	57,603	1.2	1,340,920	3.4
41	0	0.0	0	0.0	49,130	1.1	1,231,854	3.4	49,130	1.1	1,231,854	3.1
42	0	0.0	0	0.0	48,412	1.1	1,305,123	3.6	48,412	1.0	1,305,123	3.3
43	0	0.0	0	0.0	32,679	0.8	945,587	2.6	32,679	0.7	945,587	2.4
44	0	0.0	0	0.0	38,818	0.9	1,203,667	3.3	38,818	0.8	1,203,667	3.0
45	0	0.0	0	0.0	46,764	1.1	1,551,484	4.2	46,764	1.0	1,551,484	3.9
Total	343,777		3,211,749		4,316,354		36,563,698		4,660,131		39,775,447	
Avg. Size	29.8				27.2				27.3			

Appendix Table 4A. Results of the Gamma regression analysis of MRFSS striped bass catch positive catches.

Analysis of Deviance Table (Type III tests)
Response: tot_fish

	LR Chisq	Df	Pr(>Chisq)
year	806.69	35	< 2.2e-16 ***
area_x	91.45	2	< 2.2e-16 ***
mode_fx	452.82	2	< 2.2e-16 ***
wave	547.12	3	< 2.2e-16 ***
cnty	159.91	7	< 2.2e-16 ***
ffdays12c	737.48	12	< 2.2e-16 ***
hours	361.56	11	< 2.2e-16 ***

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.15969	0.133888	1.193	0.23299	
year1989	-0.07126	0.170942	-0.417	0.676803	
year1990	-0.0783	0.154221	-0.508	0.611637	
year1991	0.037656	0.1516	0.248	0.803833	
year1992	0.189246	0.140176	1.35	0.177005	
year1993	0.093915	0.138779	0.677	0.498587	
year1994	0.150181	0.133775	1.123	0.2616	
year1995	0.39081	0.132518	2.949	0.003189	**
year1996	0.372709	0.133054	2.801	0.005094	**
year1997	0.434353	0.132035	3.29	0.001004	**
year1998	0.531157	0.131261	4.047	5.21E-05	***
year1999	0.471194	0.131452	3.585	0.000338	***
year2000	0.524751	0.132358	3.965	7.37E-05	***
year2001	0.266736	0.132111	2.019	0.043492	*
year2002	0.265722	0.132967	1.998	0.045681	*
year2003	0.314827	0.133395	2.36	0.018275	*
year2004	0.357319	0.134725	2.652	0.008	**
year2005	0.371506	0.135311	2.746	0.006044	**
year2006	0.615492	0.133153	4.622	3.81E-06	***
year2007	0.293136	0.134291	2.183	0.029055	*
year2008	0.246535	0.135979	1.813	0.069835	.
year2009	0.174684	0.135061	1.293	0.195891	
year2010	0.10913	0.137312	0.795	0.42676	
year2011	-0.03314	0.139087	-0.238	0.811652	
year2012	-0.0059	0.139223	-0.042	0.966189	
year2013	0.064134	0.133677	0.48	0.631398	
year2014	0.123228	0.136078	0.906	0.36517	
year2015	0.069405	0.134795	0.515	0.606634	
year2016	0.28821	0.13586	2.121	0.033898	*
year2017	0.754199	0.132996	5.671	1.43E-08	***
year2018	0.161168	0.132342	1.218	0.223305	
year2019	0.335192	0.131994	2.539	0.011107	*
year2020	0.332926	0.13192	2.524	0.011617	*
year2021	0.100083	0.132411	0.756	0.449741	
year2022	0.211455	0.132083	1.601	0.109402	
year2023	0.108166	0.133423	0.811	0.417542	
area_x2	-0.02371	0.024434	-0.97	0.331809	
area_x5	0.127773	0.014766	8.653	2.00E-16	***
mode_fx6	0.397767	0.028816	13.804	2.00E-16	***
mode_fx7	0.444694	0.019872	22.378	2.00E-16	***
wave4	-0.31558	0.014459	-21.826	2.00E-16	***
wave5	-0.19246	0.018975	-10.143	2.00E-16	***
wave6	0.484515	0.078937	6.138	8.45E-10	***
cnty19	-0.16164	0.076427	-2.115	0.034444	*
cnty21	0.01413	0.038339	0.369	0.712471	
cnty23	-0.04358	0.020506	-2.125	0.033579	*
cnty25	-0.21207	0.048767	-4.349	1.37E-05	***
cnty5	-0.089278	0.0331	-2.697	0.006996	**
cnty7	-0.34182	0.049295	-6.934	4.16E-12	***
cnty9	0.10776	0.016118	6.686	2.33E-11	***
ffdays12c10	0.070205	0.020672	3.396	0.000684	***
ffdays12c20	0.186324	0.021516	8.66	2.00E-16	***
ffdays12c30	0.225189	0.024954	9.024	2.00E-16	***
ffdays12c40	0.333872	0.030658	10.89	2.00E-16	***
ffdays12c50	0.347641	0.027134	12.812	2.00E-16	***
ffdays12c60	0.419074	0.037914	11.053	2.00E-16	***
ffdays12c70	0.472956	0.046882	10.088	2.00E-16	***
ffdays12c80	0.453886	0.06559	6.92	4.59E-12	***
ffdays12c90	0.555954	0.078773	7.058	1.73E-12	***
ffdays12c100	0.560054	0.029601	18.92	2.00E-16	***
ffdays12c150	0.576776	0.052211	11.047	2.00E-16	***
ffdays12c200	0.436118	0.039008	11.18	2.00E-16	***
hours2	0.188814	0.038921	4.851	1.23E-06	***
hours3	0.359946	0.036688	9.811	2.00E-16	***
hours4	0.511364	0.036299	14.087	2.00E-16	***
hours5	0.643978	0.036983	17.413	2.00E-16	***
hours6	0.765814	0.03784	20.238	2.00E-16	***
hours7	0.89607	0.041926	21.372	2.00E-16	***
hours8	0.915675	0.044622	20.521	2.00E-16	***
hours9	0.891877	0.06057	14.725	2.00E-16	***
hours10	1.058975	0.070659	14.987	2.00E-16	***
hours11	1.238683	0.132468	9.351	2.00E-16	***
hours12	1.079902	0.085727	12.597	2.00E-16	***

Appendix 4A cont'd.

year	posabund
1988	4.254035
1989	3.961463
1990	3.933634
1991	4.41728
1992	5.140312
1993	4.672913
1994	4.943377
1995	6.288218
1996	6.17542
1997	6.568076
1998	7.235686
1999	6.814562
2000	7.189482
2001	5.554474
2002	5.548846
2003	5.828125
2004	6.081109
2005	6.167995
2006	7.872377
2007	5.703064
2008	5.443398
2009	5.066005
2010	4.744557
2011	4.11535
2012	4.229004
2013	4.535801
2014	4.811918
2015	4.559773
2016	5.675042
2017	9.043688
2018	4.99799
2019	5.94803
2020	5.934566
2021	4.701828
2022	5.255752
2023	4.739987

Appendix Table 4B. Results of the logistic regression analysis of MRFSS striped bass success/failure.

Analysis of Deviance Table (Type III)

Response: p

	LR Chisq	Df	Pr(>Chisq)	
year	1691.2	35	2.20E-16	***
area_x	726	2	2.20E-16	***
mode_fx	5452.5	2	2.20E-16	***
wave	615.6	3	2.20E-16	***
cnty	712.3	7	2.20E-16	***
ffdays12c	643	12	2.20E-16	***
hours	781.6	11	2.20E-16	***

Coefficients:

	Estimate	Std Error	z	Pr(>|z|)	
(Intercept)	-2.20677	0.17332	-12.732	2.00E-16	***
year1989	-1.28202	0.20305	-6.314	2.72E-10	***
year1990	0.05718	0.20697	0.276	0.782351	
year1991	-0.22632	0.19657	-1.151	0.24959	
year1992	-0.00841	0.18565	-0.045	0.963868	
year1993	0.66647	0.18539	3.595	0.000324	***
year1994	1.46063	0.18607	7.85	4.16E-15	***
year1995	1.53377	0.18143	8.454	2.00E-16	***
year1996	1.2542	0.17786	7.052	1.77E-12	***
year1997	0.77172	0.17305	4.459	8.22E-06	***
year1998	1.22076	0.17316	7.05	1.79E-12	***
year1999	0.90766	0.17322	5.24	1.61E-07	***
year2000	0.8159	0.17478	4.668	3.04E-06	***
year2001	0.47502	0.17251	2.754	0.005896	**
year2002	0.5954	0.1752	3.398	0.000678	***
year2003	0.5849	0.17501	3.342	0.000831	***
year2004	0.50543	0.17861	2.83	0.004658	**
year2005	0.56112	0.17869	3.14	0.001689	**
year2006	0.83065	0.17669	4.701	2.59E-06	***
year2007	0.27791	0.17731	1.567	0.117037	
year2008	0.28399	0.1795	1.582	0.113622	
year2009	0.24231	0.17784	1.362	0.173048	
year2010	0.19085	0.18163	1.051	0.293377	
year2011	-0.02605	0.18193	-0.143	0.886118	
year2012	-0.07156	0.18303	-0.391	0.695836	
year2013	0.32066	0.177	1.812	0.070037	.
year2014	-0.09823	0.17981	-0.546	0.584874	
year2015	-0.21732	0.17702	-1.228	0.219575	
year2016	0.25051	0.1817	1.379	0.167993	
year2017	0.89851	0.17961	5.003	5.66E-07	***
year2018	0.35545	0.17476	2.034	0.041958	*
year2019	0.2103	0.17302	1.215	0.224181	
year2020	0.3068	0.17315	1.772	0.076426	.
year2021	0.32981	0.17393	1.896	0.05793	.
year2022	0.69544	0.17486	3.977	6.98E-05	***
year2023	0.2618	0.17578	1.489	0.136386	
area_x2	-0.22915	0.03963	-5.782	7.39E-09	***
area_x5	0.5515	0.02386	23.117	2.00E-16	***
mode_fx6	2.58101	0.04635	55.688	2.00E-16	***
mode_fx7	1.75568	0.02754	63.753	2.00E-16	***
wave4	-0.53679	0.02511	-21.376	2.00E-16	***
wave5	-0.63242	0.03037	-20.821	2.00E-16	***
wave6	-0.35242	0.09926	-3.55	0.000385	***
cnty19	-0.726	0.09208	-7.884	3.16E-15	***
cnty21	0.33662	0.06949	4.844	1.27E-06	***
cnty23	-0.00856	0.03293	-0.26	0.794917	
cnty25	0.63167	0.09181	6.88	5.99E-12	***
cnty5	-0.48217	0.05084	-9.485	2.00E-16	***
cnty7	-0.36757	0.06609	-5.562	2.67E-08	***
cnty9	0.46493	0.02656	17.503	2.00E-16	***
ffdays12c1	0.13266	0.03249	4.083	4.45E-05	***
ffdays12c2	0.30805	0.03487	8.834	2.00E-16	***
ffdays12c3	0.2972	0.04043	7.351	1.97E-13	***
ffdays12c4	0.46737	0.05219	8.955	2.00E-16	***
ffdays12c5	0.6773	0.04784	14.159	2.00E-16	***
ffdays12c6	0.58278	0.06464	9.015	2.00E-16	***
ffdays12c7	0.89092	0.08829	10.09	2.00E-16	***
ffdays12c8	0.70898	0.1164	6.091	1.12E-09	***
ffdays12c9	0.61873	0.13158	4.702	2.57E-06	***
ffdays12c1	0.81873	0.0529	15.477	2.00E-16	***
ffdays12c1	1.01516	0.09298	10.918	2.00E-16	***
ffdays12c2	0.64577	0.06764	9.547	2.00E-16	***
hours2	0.33425	0.04904	6.816	9.35E-12	***
hours3	0.58054	0.04719	12.302	2.00E-16	***
hours4	0.79963	0.04755	16.815	2.00E-16	***
hours5	0.87876	0.04984	17.632	2.00E-16	***
hours6	1.02673	0.05302	19.364	2.00E-16	***
hours7	1.02634	0.06367	16.118	2.00E-16	***
hours8	1.04545	0.06891	15.172	2.00E-16	***
hours9	1.19954	0.1062	11.295	2.00E-16	***
hours10	1.34845	0.13075	10.313	2.00E-16	***
hours11	1.17571	0.2426	4.846	1.26E-06	***
hours12	1.44911	0.15955	9.083	2.00E-16	***

Appendix 4B cont'd.

year	bin.eff
1988	0.599498
1989	0.293459
1990	0.613145
1991	0.544148
1992	0.597477
1993	0.744567
1994	0.865763
1995	0.874038
1996	0.839912
1997	0.764064
1998	0.835365
1999	0.787687
2000	0.771935
2001	0.706489
2002	0.730818
2003	0.728747
2004	0.712755
2005	0.724021
2006	0.774522
2007	0.664025
2008	0.665381
2009	0.656037
2010	0.644334
2011	0.593227
2012	0.582202
2013	0.673495
2014	0.5757
2015	0.546379
2016	0.657885
2017	0.786152
2018	0.681099
2019	0.64878
2020	0.670439
2021	0.675503
2022	0.750039
2023	0.660422