APPENDIX 2: ACHIEVING SUSTAINABLE HARVEST FOR THE ALBEMARLE SOUND-ROANOKE RIVER STRIPED BASS STOCK

I. ISSUE

Implement long term management measures to achieve sustainable harvest, end overfishing and rebuild the Albemarle Sound-Roanoke River (A-R) striped bass spawning stock biomass.

II. ORIGINATION

North Carolina Division of Marine Fisheries (DMF) and North Carolina Wildlife Resources Commission (WRC).

III. BACKGROUND

Albemarle Sound-Roanoke River Striped Bass Stock Status

The 2020 A-R striped bass stock assessment was approved for management use by peer reviewers for at least the next five years. Results from the 2020 benchmark assessment indicate in the terminal year (2017) the A-R striped bass stock is overfished and overfishing is occurring, relative to the biological reference points (BRPs). Overfishing BRPs are based on a fishing mortality (F) rate of FTarget = 0.13 and FThreshold = 0.18 and overfished BRPs are based on a level of spawning stock biomass (SSB) of SSBTarget = 350,371 pounds and SSBThreshold = 267,390 pounds (Lee et al. 2020). In the terminal year of the assessment F=0.27, above the FThreshold, meaning overfishing is occurring. Female SSB was 78,576 pounds, below the SSBThreshold, indicating the stock is overfished. For more details see the Amendment 2 Stock Status section and Lee et al. (2020).

The Fisheries Reform Act of 1997 requires management measures be enacted to end overfishing within two years and the overfished status within 10 years with at least a 50% probability of achieving sustainable harvest for the fisheries (NCGS 113-182.1), with exceptions related to biology, environmental conditions, or lack of sufficient data. Amendment 1 to the North Carolina Estuarine Striped Bass FMP and Amendment 6 to the ASMFC Interstate FMP for Atlantic Striped Bass stipulate "Should the target F be exceeded then restrictive measures will be imposed to reduce F to the target level" (NCDMF 2013; ASMFC 2003). Therefore, adaptive management measures were implemented in January 2021 to reduce the total allowable landings (TAL) to 51,216 pounds, a level projected to lower F to the FTarget, in one year, a 47.6 % reduction in F (NCDMF 2020).

Striped Bass Fisheries

The striped bass fisheries in the ASMA and RRMA have been managed with a TAL since 1991 (Table 1). Combined landings from both commercial and recreational sectors in the ASMA and RRMA have ranged from 108,432 lb in 2013 to 460,853 lb in 2004. Landings followed the TAL closely until 2003 for the recreational sectors and 2005 for the commercial sector. From 2003 - 2014, when the TAL was increased to 550,000 lb, neither sector reached their respective TAL (Figure 1; Table 2). The low level of landings observed in some of these years was due to

multiple poor year classes produced since 2001. For more information on the commercial and recreational fisheries see Description of the Fisheries in the FMP.

Table 1. Total allowable landings (TAL) in pounds for the Albemarle Sound and Roanoke River Management Areas (ASMA & RRMA) 1991–2021.

Years	Total Allowable Landings (lb)	ASMA Commercial (lb)	ASMA Recreational (lb)	RRMA Recreational (lb)
1991—1997	156,800	98,000	29,400	29,400
1998	250,800	125,400	62,700	62,700
1999	275,880	137,940	68,970	68,970
2000—2002	450,000	225,000	112,500	112,500
2003—2014	550,000	275,000	137,500	137,500
2015—2020	275,000	137,500	68,750	68,750
2021—	51,216	25,608	12,804	12,804

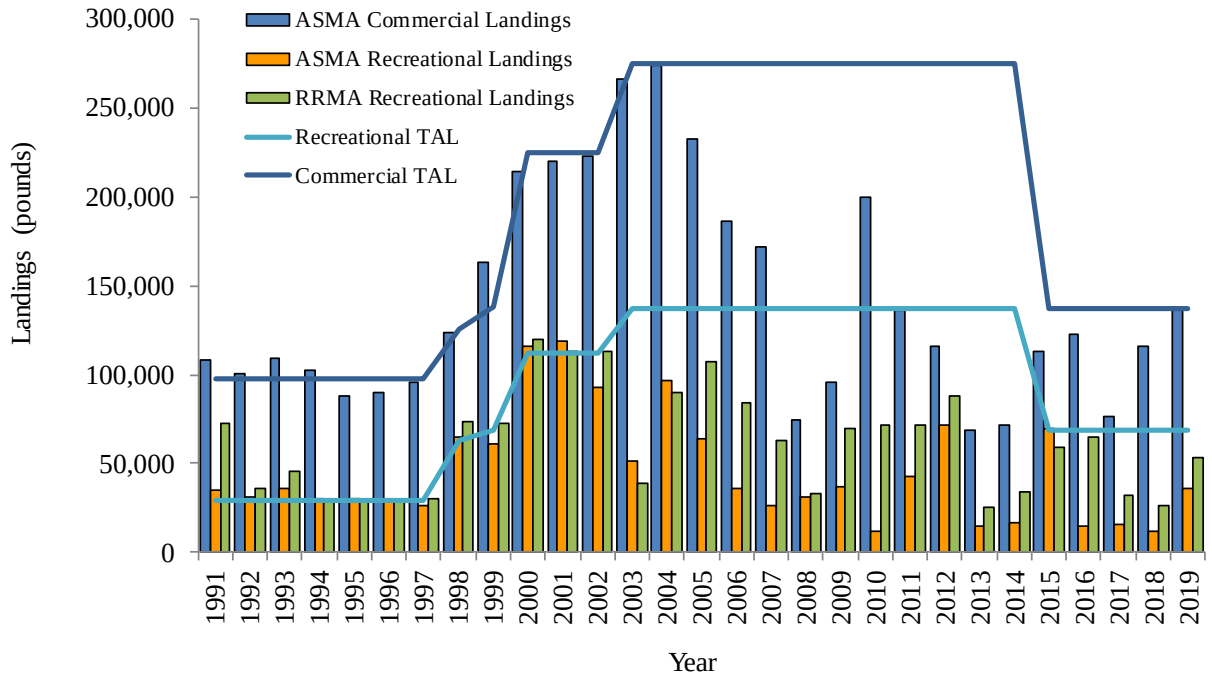

Figure 1. Striped bass landings from the Albemarle Sound Management Area (ASMA) commercial and recreational sectors and the Roanoke River Management Area (RRMA) recreational sector and the annual total allowable landings by sector (TAL), 1991-2019.

Table 2. The total allowable landings (TAL) and the annual harvest in pounds for striped bass from the commercial and recreational sectors in the Albemarle Sound Management Area (ASMA) and Roanoke River Management Area (RRMA). Bolded and underlined numbers indicate a TAL that was lowered due to previous year's overage, and red numbers in parentheses indicate landings that exceeded the respective TAL.

	ASMA Commercial			ASMA Recreational			RRMA Recreational				
Year	TAL	Landings	+/-	TAL	Landings	+/-	TAL	Landings	+/-	Total TAL	Total Landings
1991#	98,000	108,460	(10,460)	29,400	35,344	(5,944)	29,400	72,529	(43,129)	156,800	216,333
1992	98,000	100,549	(2,549)	29,400	30,758	(1,358)	29,400	36,016	(6,616)	156,800	167,323
1993	98,000	109,475	(11,475)	29,400	36,049	(6,649)	29,400	45,145	(15,745)	156,800	190,669
1994*	98,000	102,370	(4,370)	29,400	30,217	(817)	29,400	28,089	1,311	156,800	160,676
1995	***93,630***	87,836	5,794	***28,583***	30,564	(1,981)	29,400	28,883	517	***151,613***	147,283
1996	98,000	90,133	7,867	***27,419***	29,186	(1,767)	29,400	28,178	1,222	***154,819***	147,497
1997~	98,000	96,122	1,878	***27,633***	26,581	1,052	29,400	29,997	(597)	***155,033***	152,700
1998~	125,400	123,927	1,473	62,700	64,580	(1,880)	62,700	73,541	(10,841)	***250,800***	262,048
1999~	137,940	162,870	(24,930)	***67,090***	61,338	5,752	68,970	72,967	(3,997)	***274,000***	297,175
2000~	***200,070***	214,023	(13,953)	112,500	116,158	(3,658)	112,500	120,091	(7,591)	***425,070***	450,272
2001~	***211,047***	220,233	(9,186)	***108,842***	118,506	(9,664)	112,500	112,805	(305)	***432,389***	451,544
2002~	***215,814***	222,856	(7,042)	***102,836***	92,649	10,187	112,500	112,698	(198)	***431,150***	428,203
2003	***267,958***	266,555	1,403	137,500	51,794	85,706	137,500	39,170	98,330	***542,958***	357,519
2004	275,000	273,565	1,435	137,500	97,097	40,403	137,500	90,191	47,309	550,000	460,853
2005^	275,000	232,693	42,307	137,500	63,477	74,023	137,500	107,530	29,970	550,000	403,700
2006	275,000	186,399	88,601	137,500	35,997	101,503	137,500	84,521	52,979	550,000	306,917
2007	275,000	171,683	103,317	137,500	26,663	110,837	137,500	62,492	75,008	550,000	260,838
2008	275,000	74,921	200,079	137,500	31,628	105,872	137,500	32,725	104,775	550,000	139,274
2009	275,000	96,134	178,866	137,500	37,313	100,187	137,500	69,581	67,919	550,000	203,028
2010	275,000	199,829	75,171	137,500	11,470	126,030	137,500	72,037	65,463	550,000	283,336
2011	275,000	136,266	138,734	137,500	42,536	94,964	137,500	71,561	65,939	550,000	250,363
2012	275,000	115,605	159,395	137,500	71,456	66,044	137,500	88,271	49,229	550,000	275,332
2013	275,000	68,338	206,662	137,500	14,897	122,603	137,500	25,197	112,303	550,000	108,432
2014	275,000	71,372	203,628	137,500	16,867	120,633	137,500	33,717	103,783	550,000	121,956
2015	137,500	113,475	24,025	68,750	70,008	(1,258)	68,750	58,962	9,788	275,000	242,445
2016	137,500	123,108	14,392	68,750	14,487	54,263	68,750	65,218	3,532	275,000	202,813
2017	137,500	75,990	61,510	68,750	15,480	53,270	68,750	32,569	36,181	275,000	124,039
2018	137,500	115,711	21,789	68,750	11,762	56,988	68,750	26,796	41,954	275,000	154,269
2019	137,500	137,156	344	68,750	36,351	32,399	68,750	53,379	15,371	275,000	226,886

Total quota of 156,800 lb based on an 80% reduction from historical landings 1972-1979 (NCDMF 1993).

***** First year quota overages deducted from next year's quota pound for pound (NCDMF 1993).

~ Overages were not paid back in the RRMA due to a difference of opinion by the WRC as to when paybacks should occur. See 2004 FMP for more information.

^First year quota overages deducted from next year's quota only if total TAL exceeded by 10% (NCDMF 2004).

Stock Concerns

Annual recruitment is influenced by spawning stock biomass, egg and larval transport to nursery areas, predation, food availability, and optimum water quality conditions. The occurrence of recruitment failures since 2001, especially since 2017, is thought to be a function of spring flooding

events in the upper Roanoke basin during critical periods of egg and larval transport. Extended periods of flood or high flow releases during the critical spawning period (May through early June) negatively impact successful transport and delivery of eggs and fry down the Roanoke River and eventually into the western Albemarle Sound nursery area. There is high year-to-year variability regarding flow releases and year-class strength. Consequently, all years with documented high flow rates (2017, 2018, 2020) had very low juvenile abundance index values, indicating poor spawning success (NCDMF 2020).

IV. AUTHORITY

The MFC and the WRC implemented a Memorandum of Agreement in 1990 to address management of the A-R striped bass stock in the Albemarle Sound and Roanoke River (see Appendix I in DMF 1993). This was the first agreement between the two agencies to jointly manage the A-R striped bass stock. North Carolina's existing fisheries management system for estuarine striped bass is adaptive, with rulemaking authority vested in the MFC and the WRC within their respective jurisdictions. The MFC also has the authority to delegate to the fisheries director the ability to issue public notices, called proclamations, suspending or implementing particular commission rules that may be affected by variable conditions. Management of recreational and commercial striped bass regulations within the ASMA is the responsibility of the MFC. Within the RRMA commercial regulations are the responsibility of the MFC while recreational regulations are the responsibility of the WRC. The commercial harvest of striped bass in the RRMA is prohibited by 15A NCAC 03M .0202 (b). It should also be noted that under the provisions of Amendment 1 to the North Carolina Estuarine Striped Bass FMP the DMF Director maintains proclamation authority to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas as deemed necessary to maintain a sustainable harvest. The WRC Executive Director maintains proclamation authority to establish seasons.

NORTH CAROLINA GENERAL STATUTES

N.C. General Statutes

G.S. 113-134.	RULES
G.S. 113-182.	REGULATION OF FISHING AND FISHERIES
G.S. 113-182.1.	FISHERY MANAGEMENT PLANS
G.S. 113-221.1.	PROCLAMATIONS; EMERGENCY REVIEW
G.S. 113-292.	AUTHORITY OF THE WILDLIFE RESOURCES COMMISSION IN REGULATION OF INLAND FISHING AND THE INTRODUCTION OF EXOTIC SPECIES.
G.S. 143B-289.52.	MARINE FISHERIES COMMISSION—POWERS AND DUTIES
G.S. 150B-21.1.	PROCEDURE FOR ADOPTING A TEMPORARY RULE

NORTH CAROLINA RULES

N.C. Marine Fisheries Commission Rules 2020 and N.C. Wildlife Resources Commission Rules 2020 (15A NCAC)

15A NCAC 03M .0201 GENERAL

15A NCAC 03M .0202	SEASON, SIZE AND HARVEST LIMIT: INTERNAL COASTAL WATERS
15A NCAC 03M .0512	COMPLIANCE WITH FISHERY MANAGEMENT PLANS
15A NCAC 03Q .0107	SPECIAL REGULATIONS: JOINT WATERS
15A NCAC 03Q .0108	MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT WATERS
15A NCAC 03Q .0109	IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING
15A NCAC 03R .0201	STRIPED BASS MANAGEMENT AREAS
15A NCAC 10C .0110	MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT WATERS
15A NCAC 10C .0111	IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING
15A NCAC 10C .0301	INLAND GAME FISHES DESIGNATED
15A NCAC 10C .0314	STRIPED BASS

V. DISCUSSION

The Revision to Amendment 1 implemented a lower TAL calculated to end overfishing in one year. Management measures developed in Amendment 2 will be implemented to ensure long term sustainable harvest and end the overfished stock status within 10-years as required by law. Some management measures in Amendment 1 will be carried over into Amendment 2, such as the requirement that if the F_{Target} is exceeded then restrictive measures will be imposed to reduce F back to the F_{Target}. Likewise, if measures are adopted in Amendment 2 that continue to allow harvest on the A-R stock, then adaptive management measures that allow the DMF and WRC to change daily landing limits, open and close the harvest season, open and close areas to harvest, and the ability to make certain gear modifications (e.g. when to allow overnight soaks of anchored gill nets or only allowing strike nets in some areas) in order to keep landings below the TAL will go along with that management option.

Option 1. Implement a Harvest Moratorium

A complete harvest moratorium could potentially recover the striped bass stock more quickly. However, any anchored, set gill net fisheries occurring in the ASMA, as well as recreational catch-and-release angling for striped bass, will continue to contribute to discard mortality. Discard mortality in the anchored set gill net fishery for American shad would be substantial if that fishery was to continue to operate with a striped bass harvest moratorium in the ASMA. If poor environmental conditions persist on the spawning grounds during May and early June, recovery may not occur regardless of a harvest moratorium.

The A-R stock experienced several years of poor recruitment. The juvenile abundance index (JAI) from 2017–2020 indicated few eggs and larval striped bass survived. However, these years of poor recruitment do not compare to chronic spawning failures the stock experienced during 1975–1992 (Figure 2). When a TAL was implemented in 1991, it was set at nearly three times the 2021 TAL. In 2014 and 2015, the stock produced year classes above the long-term average level of recruitment (Base Plan Figure 2), indicating that with favorable environmental conditions during the spawning period the stock can produce strong year classes even during periods of low SSB. Based on past trends, stock abundance can increase quickly under the right

conditions. The 2020 stock assessment indicated SSB increased from 145,962 pounds in 1996 to above the SSBTarget in two years (Base Plan Figure 3). However, if the stock does not have strong recruitment events in the coming years, the next stock assessment may provide justification for a harvest moratorium. Additionally, if a harvest moratorium is selected, it would remain in effect until stock assessment results shows SSB is above the threshold and the stock is no longer overfished. The new TAL would be selected like normal by using projections to calculate a level of sustainable harvest.

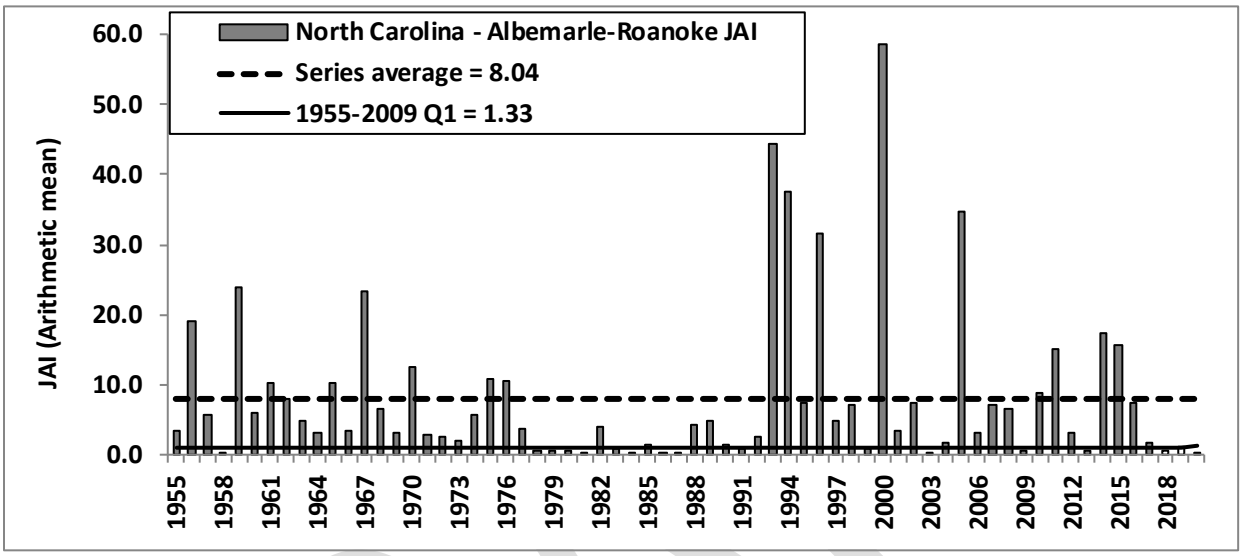

Figure 2. The juvenile abundance index (JAI) for Albemarle Sound-Roanoke River striped bass, North Carolina, 1955–2020. A JAI value below the first quartile (Q1) is considered a spawning failure for the A-R stock.

Projections evaluated trends in SSB under the existing 2021 TAL and a complete harvest moratorium. Discards were assumed equal to the terminal year of the stock assessment and three recruitment scenarios were input to account for the uncertainty and the variability of recruitment observed in the stock; 1) the average level of recruitment for the entire time series of the assessment, 1991–2017, 2) a high level of recruitment observed in years 1991–2001, and 3) a low level of recruitment as observed in years 2004–2017. Under the harvest moratorium SSB exceeds the SSBThreshold in 2024 and the SSBTarget in 2026, while under the current TAL SSB exceeds the SSBThreshold in 2025 and the SSBTarget in 2028 (Figure 3).

Option 1. Implement a Harvest Moratorium

+ Would eliminate all harvest which would likely reduce fishing mortality to the stock even more than the current TAL of 51,216 pounds
+ Would likely increase abundance and further expand the age structure
- Mortality associated with discards in other commercial and recreational fisheries would still occur and likely increase
- May not achieve the desired results if environmental factors have a greater influence than the level of SSB on the formation of strong year classes
- Would have significant economic impacts across the commercial sector if fisheries and gears that interact with striped bass were also eliminated

(a)

- Would have significant economic impacts to businesses in the recreational sector supported by recreational fishing for striped bass

PDT Recommendation: The PDT does not support Option 1, a complete harvest moratorium. Projection results indicate that under the current TAL of 51,216 pounds the stock will be recovered and no longer overfished in 2025 as compared to 2024 under a harvest moratorium.

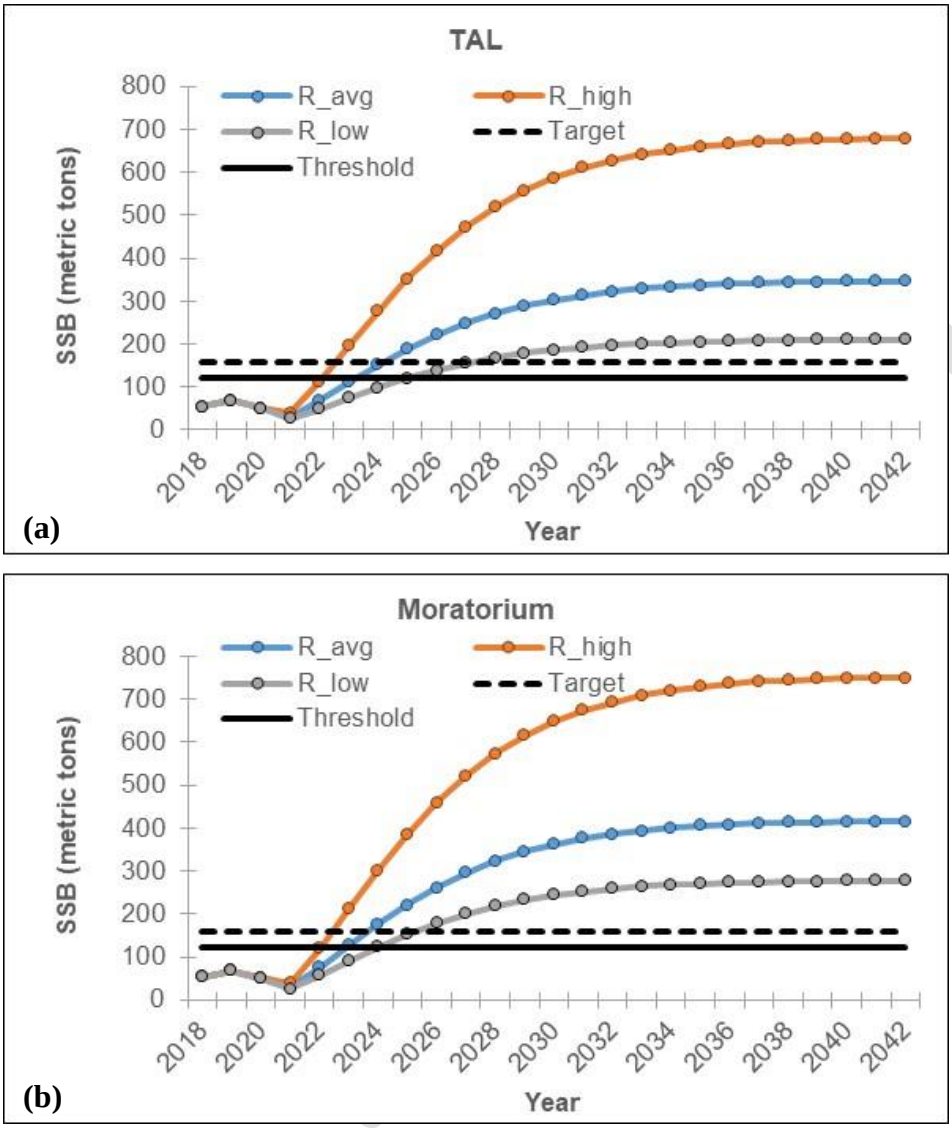

Figure 3. Projections of spawning stock biomass (SSB) in metric tons for the Albemarle Sound-Roanoke River striped bass stock under the current total allowable landings (TAL) of 51,216 lb (a) and a harvest moratorium (b). R_avg, R_low, and R_high refer to the three recruitment scenarios used in the projections.

Option 2. Status Quo: continue with the current TAL of 51,216 pounds to maintain harvest at a sustainable level

A TAL is a management measure used to set harvest levels for a stock with the goal of preventing overfishing and ensuring the stock does not get in an overfished state. The 1991 TAL was set at 20 % the average harvest from 1972–1979, 156,800 pounds (see Appendix I in NCDMF 1993). Under Amendment 1, the TAL for the A-R stock is determined through stock assessments and harvest projections. Projections are used to calculate the annual amount of harvest that maintains SSB at its target level and provides for long-term sustainable harvest. In the event the stock assessment results indicate F is above the $F_{\text{Threshold}}$ level, adaptive management allows for calculation of a new TAL to reduce F, as was done with the November 2020 Revision to Amendment 1. Adaptive management allows managers to quickly address overfishing while allowing for and monitoring fishing. See adaptive management in this issue paper for more information on determining the TAL. The use of a TAL is a management option proven effective in recovery of the striped bass stock.

A key component of successfully using a TAL as a management tool is the ability to accurately monitor recreational and commercial harvest in a timely manner and close fishing sectors when harvest is nearing the sector TAL. The DMF and WRC use agency-run creel surveys specifically designed to estimate recreational striped bass catch and effort in the ASMA and RRMA. The striped bass recreational creel surveys provide estimates of harvest. Data is available 1–2 weeks after collection. It is important to note, harvest estimates calculated with one or two weeks of data have greater uncertainty than harvest estimates calculated monthly. DMF dealer permits, which allow dealers to purchase commercially harvested striped bass, requires dealers to report the number and pounds of striped bass bought to DMF daily. The ability to monitor harvest from the recreational and commercial sectors in a timely manner means the DMF and WRC have a greater likelihood of keeping annual harvest below the TAL in their respective management areas.

If measures are adopted in Amendment 2 that continue to allow harvest on the A-R stock, then adaptive management measures that allow the DMF and WRC to change daily landing limits, open and close the harvest season, open and close areas to harvest, and the ability to make certain gear modifications (e.g. when to allow overnight soaks of anchored gill nets or only allowing strike nets in some areas) in order to keep landings below the TAL and reduce discards will be carried forward in Amendment 2.

The DMF Director has proclamation authority to open and close recreational and commercial striped bass harvest seasons in all internal coastal waters from October 1 through April 30 (NCMFC Rule 15A NCAC 03M .0202(c)). The Executive Director of the WRC also has the ability to open and close harvest seasons in the RRMA by proclamation (G.S. 113-292). This flexibility is used to prevent harvest from exceeding the TAL. Harvest seasons have been closed early in the RRMA by proclamation in years when the harvest estimate approached the TAL. Conversely, proclamation authority has also been used to extend the harvest season beyond April 30 by a few days. The decision to extend the season is based on availability of remaining landings within the TAL and environmental conditions, such as flood control operations and water temperatures. Due to much higher mortality of striped bass discards when the water temperature is warmer, both recreational and commercial harvest seasons have been closed during the summer months, typically May–September, since 1991.

Daily possession limits for the recreational and commercial sectors have been used since 1991 to limit or expand harvest opportunities and keep landings below the TAL. The DMF Director has proclamation authority to change the daily possession limits in the ASMA throughout the harvest seasons. The WRC can change daily possession limits and size limits in the RRMA through permanent or temporary rulemaking processes. In the absence of proclamation authority to change size limits or creel limits, temporary rulemaking can be used by the WRC to expedite conservation measures. Recreational sector daily possession limits have ranged from 1 to a maximum of 3 fish per person per day since 1991. Daily possession limits for the commercial sector have ranged from 3 to 25 fish per day per commercial operation.

Over the long-term, combined use of a TAL with other management measures has maintained landings in the A-R striped bass fisheries below or near the TAL. However, if actual recruitment is less than the estimated recruitment used in projections, stock abundance will not support harvest of the TAL and the FTarget may be exceeded and SSB may fall below the SSBThreshold, as the 2020 stock assessment indicates. Continuing use of a TAL with the ability to monitor harvest, adjust harvest seasons, and change daily possession limits to provide the greatest likelihood of keeping harvest below the TAL allows a balance of conservation needs and fishermen access to the resource while the stock is rebuilding.

Option 2. Status Quo: continue with the current TAL of 51,216 pounds to maintain harvest at a sustainable level

If option 2 is selected sub-options 2.A. and 2.B. need to be addressed.
+ The best option to maintain harvest at a sustainable level when mechanisms exist to monitor recreational and commercial harvest in near real-time and close fisheries when the TAC is calculated to be reached
+ Maintains a sustainable harvest if the TALs are set appropriately and updated at regular intervals
- Will not achieve sustainable harvest if TALs are set too high and not updated at regular intervals
- Does not allow for increased harvest based on year class strength if TALs are not updated often enough through stock assessments

PDT Recommendation: The PDT supports Option 2, to continue to use an annual TAL, determined through stock assessments and stock assessment updates, to set the annual TAL to maintain a sustainable harvest. The PDT notes however it is important to update the stock assessment on a regular schedule to adjust the TAL accordingly during times of poor recruitment so the TAL is not higher than the stock abundance can support which will lead to overfishing and cause the stock to be in an overfished state.

2.A. Management of striped bass harvest in the commercial fishery as a bycatch fishery

The commercial fishery for striped bass in the ASMA has been a bycatch fishery since 1995. Often the term "bycatch" is associated with species captured in a fishing operation that were not intended and are discarded and is generally considered something that should be avoided. However, the bycatch of fish while targeting other species is an acceptable and common management strategy in multi-species fisheries.

The bycatch provision was implemented as a management tool in the ASMA striped bass commercial fishery to prevent fishermen not already participating in the American shad and southern flounder gill net fisheries from entering to specifically target striped bass. The idea being, that if additional participants entered the striped bass fishery, the TAL would be caught more quickly and the large mesh gill net fisheries continuing to operate would have higher numbers of striped bass discards. However, daily landings limits discourage fishermen from targeting striped bass in the same fashion, making it not profitable to sell only striped bass each day without additional finfish catch.

The gill net fisheries have changed considerably since the early 1990s and the bycatch provision may no longer be necessary. The number of participants that landed striped bass in the ASMA peaked at nearly 450 in 2000 but has decreased to just more than 150 in 2019. The number of fishermen and trips taken each year in the American shad and flounder gill net fisheries has also declined steadily to less than 83 and 143 participants respectively in 2019 (Tables 3 and 4). The harvest season for American shad since 2015 has been March 3–March 24, whereas prior to 2015 it was open January 1–April 14. Floating gill nets are not allowed in the ASMA outside of shad season. In addition, the harvest season for southern flounder in 2021 was September 15–October 1 in the ASMA whereas previously the harvest season was 11–12 months out of the year. When flounder harvest season is closed, gill nets configured for harvesting flounder are removed from the water.

If the bycatch provision for harvesting striped bass were removed it is highly unlikely there would be a significant increase in participants in the striped bass fishery because the daily landings limit and TAL would still apply. Removing the bycatch provision associated with harvesting striped bass makes it easier to allow hook and line as a commercial gear (see the Hook and Line Issue Paper for more information). If, however, the option is chosen to stop requiring 50 % of other finfish species associated with striped bass harvest, and a large number of participants did enter the fishery, adaptive management could stipulate the DMF Director may reinstitute the bycatch requirements at any time through proclamation authority.

Table 3. Number of gill net trips, number of participants, total pounds of seafood landed, and dockside value from gill net trips that landed American shad in the ASMA, 2010-2019.

Year	Trips	Participants	Seafood sold (lb)	Dockside value
2010	2,520	176	539,233	$444,350
2011	1,960	138	481,801	$384,421
2012	1,922	139	391,407	$368,776
2013	1,953	132	411,081	$436,262
2014	714	92	206,733	$153,559
2015	817	98	252,993	$193,043
2016	587	73	178,947	$150,806
2017	601	73	167,906	$148,854
2018	387	55	109,855	$96,226
2019	690	83	215,279	$167,537

Table 4. Number of gill net trips, number of participants, total pounds of seafood landed, and dockside value from gill net trips that landed southern flounder in the ASMA, 2010-2019.

Year	Trips	Participants	Seafood sold (lb)	Dockside value
2010	5,389	323	801,426	$1,111,612
2011	1,990	204	325,799	$327,779
2012	5,661	324	821,383	$1,558,772
2013	7,417	335	1,202,078	$2,210,127
2014	5,772	297	818,565	$1,373,840
2015	3,289	234	506,042	$819,664
2016	2,306	181	368,867	$613,572
2017	3,321	193	368,709	$894,733
2018	2,681	164	294,802	$682,719
2019	2,001	143	259,438	$486,475

2.B. Accountability Measures to Address TAL Overages

Fisheries managed with a TAL commonly include accountability measures to address when the TAL is exceeded. One common option used is to subtract the number of pounds the TAL was exceeded in one year from the following year's TAL. A more complex option is to adapt accountability measures to current stock status. For example, if stock status is above the F and SSB target levels, accountability measure may include management measures to reduce harvest the following year without subtracting overages from the TAL.

In most quota-managed fisheries, unused quota is not added to the following year's quota. The reasoning for this is twofold: 1) any amount of uncaught quota will benefit the stock in the long-term and 2) if the quota is not being caught because stock abundance is declining and can no

longer support the current quota, then increasing the quota also increases the likelihood of causing the stock to become overfished and/or cause overfishing to occur.
Accountability measures for TAL overages under Amendment 1 are:

Short-term Overages: point harvest estimate exceeds the total TAL by 10 percent in a single year, overage deducted from the next year and restrictive measures implemented in the responsible fishery (ies).
Long-term Overages: five year running average of point estimate exceeds the five-year running average of the total TAL harvest by 2 percent, the responsible fishery exceeding the harvest limit will be reduced by the amount of the overage for the next five years.

The requirement that harvest must exceed the total TAL by 10 % before a reduction in the succeeding year's TAL is imposed was adopted in the 2004 FMP and re-adopted in Amendment 1 (NCDMF 2013). The rationale was that because recreational harvest estimates are generated from a statistical survey with uncertainty it was argued that as long as the upper and lower bounds of encompassed the TAL, then the harvest estimate was not statistically different from the TAL, and there was no overage to repay. In order to keep a buffer to account for the uncertainty in the recreational creel estimates yet recognize the need to ensure harvest levels are sustainable, one option for the short-term overages is to reduce the TAL buffer 10 % to 5 %, and for the long-term overages to reduce the five-year running average to a three-year running average. Another even more conservative option is to remove the buffer altogether and use the point estimate of harvest to determine if the TAL has been exceeded and subtract any overages from the succeeding year's TAL.

2.A. Management of striped bass harvest in the commercial fishery as a bycatch fishery

2.A.1. Status quo: continue managing the ASMA striped bass fishery as a bycatch fishery
+ Consistent with regulations since 1995
+ May still discourage additional participants from entering the fishery and harvesting striped bass quota that don't normally participate in the other multi-species large mesh gill net fisheries in the ASMA
- Makes it more difficult to implement hook-and-line as a commercial gear
- May no longer be necessary

2.A.2 Stop managing the ASMA striped bass fishery as a bycatch fishery
+ Would reduce enforcement issues for Marine Patrol
+Would make it easier to implement hook and line as a commercial gear by not requiring bycatch provisions for one gear and not another
+ Would have no impact on the other management measures (e.g. daily possession limits) intended to maintain harvest below the TAL
+ Would offer a more resource friendly gear that has less discard mortality than gill nets and would have less interactions with endangered species compared to gill nets
+ Would be an additional gear available to the commercial sector to harvest striped bass when gill nets may not be allowed due to excessive interactions with

endangered species are because of harvest reductions needed in other FMPs (e.g. southern flounder and American shad)
- Could potentially lead to increased participants in the commercial fishery which would possibly decrease the annual income received per participant in the fishery
- Could potentially lead to increased participants in the commercial fishery which could cause the TAL to be reached quicker and cause gill net fisheries for other species (e.g. American shad) to close earlier than planned

2.B. Accountability Measures to Address TAL Overages

2.B.1. Status Quo: continue with the current accountability measures consisting of the following:

- Short-term Overages: point harvest estimate exceeds the total TAL by 10% in a single year, overage deducted from the next year and restrictive measures implemented in the responsible fishery (ies).
- Long-term Overages: five year running average of point estimate exceeds the five-year running average of the total TAL harvest by 2%, the responsible fishery exceeding the harvest limit will be reduced by the amount of the overage for the next five years.

  + Allows for a buffer around the TAL to account for the uncertainty associated with estimates of recreational harvest
  + Could prevent constantly changing the TAL each year if overages are below the 10% buffer
  + Will be less confusing to anglers if regulations do not change often
  - Could provide an incentive to habitually exceed the TAL by less than the prescribed buffer, potentially reducing the ability to maintain a sustainable harvest

2.B.2.

- Short-term Overages: point harvest estimate exceeds the total TAL by 5 percent in a single year, overage deducted from the next year and restrictive measures implemented in the responsible fishery (ies).
- Long-term Overages: five year running average of point estimate exceeds the three-year running average of the total TAL harvest by 2 percent, the responsible fishery exceeding the harvest limit will be reduced by the amount of the overage for the next five years.

The same positives and negatives apply to this option, it is just more conservative of a buffer than option 2.B.1.

2.B.3. Implement a payback for overages in the TAL to be deducted from the offending sector the following year without a percent buffer around the TAL
+ Is the most conservative approach to managing a TAL and will provide the greatest chance at maintaining a sustainable harvest
+
- Can lead to very short seasons, or no season at all for some years, if TALs are exceeded often and/or by significant amounts when TALs are low
- Can cause confusion among users if regulations change every year

PDT Recommendation: The PDT recommends options 2.A.1. and 2.B.2. The PDT agrees the use of the various management authorities (proclamation and/or temporary rule making) of the MFC and WRC to be able to set daily landings limits and open and close the harvest seasons is the best way to keep landings below a TAL. The PDT also recognizes keeping the harvest season closed May through September is the best way to reduce discard mortality in the summer months. The PDT recognizes the commercial fishery has changed substantially since the original implementation of the bycatch provision and it is likely no longer necessary. Removing the bycatch provision will make enforcement easier and make it easier to allow the use of hook and line as a commercial gear. The PDT stresses however the importance of continuing to allow the DMF Director to implement the bycatch provision through adaptive management should undesirable issues arise from eliminating it. While the PDT understands the rationale for having a buffer around the TAL due to uncertainties in recreational harvest estimates, they also realize in the current stock condition a more conservative buffer around the TAL may be necessary to help ensure stock recovery. The PDT was split over its support of option 2.B. with some members supporting each option.

Option 3. Size limits to expand the age structure of the stock

Size limits are a common management measure to limit and focus harvest on a specific size and age class of fish in the stock. The management objectives for a stock and the life history of the species inform managers of what size limit should be implemented. By setting a size limit based on length at maturity, managers can ensure a portion of the females in the stock have a chance to spawn at least once before harvest. For long-lived fish, a slot limit may ensure fish that grow out of the slot will reproduce many times. Female A-R striped bass are 27 % mature at age–3 and 97 % mature by age–4. The corresponding length at maturity was 50 % mature at 16.8 inches, and 100 % mature at 18.8 inches (Boyd 2011; Table 5).

Table 5. Percent mature at age and length (inches) of female Albemarle-Roanoke striped bass.

Percent Mature at Age		Percent Mature at Length	
Age	**Percent Mature**	**Length (inches)**	**Percent Mature**
1	0%	16.8	50%
2	1%	17.4	75%
3	27%	18.8	100%
4	97%		
5+	100%		

It is critical to the resiliency, or ability to recover, of the stock to have a wide range of age classes present in the population. Stocks with many age classes present can withstand several years of poor spawning success. Furthermore, maximum size limits provide anglers with a "trophy" fishery, even if the fishery is catch-and-release only. Managers may implement minimum size limits or slot limits based in part on angler preference and not solely to meet sustainability objectives.

A yield-per-recruit (YPR) model was used to examine the effects of various minimum length limits and slot limits for striped bass (Goodyear 1993; Lee et al 2020). Reducing discards should be taken into consideration when choosing between similarly preforming length limits. Overall,

YPR increases as fishing mortality increases for all minimum length and slot limits (Table 6; Figure 4). The 18-inch and 20-inch minimum length limits produce the highest yields, while limits above 26--inch minimum length produce the lowest (Table 6; Figure 4A). The 18–26-inch slot and 18–27 inch slot limits produce the highest yields at FTarget while the 18–22 inch and 18–23 inch slot limits produce the lowest (Table 7; Figure 4B).
Spawning potential ratio (SPR) decreases as fishing mortality increases for all minimum length and slot limits (Table 6; Figure 5). The lowest SPR is produced by minimum length below 22-inch (Table 6; Figure 5A) and the 18–26 and 18–27 inch slot limits (Table 6; Figure 5B). The highest SPR is produced with a 30-inch minimum length limit (Table 6; Figure 5A) and 18–22 and 18–23-inch slot limits (Table 6; Figure 5B).

Eggs-per-recruit (EPR) decreases as fishing mortality increases for all minimum length and slot limits (Table 6; Figure 6). The minimum length limits under 22-inch produce the fewest eggs, while the 30-inch minimum length limits produce the most (Table 6; Figure 6A). The 18–26-inch slot and 18–27-inch slot limits produce the fewest eggs at FTarget while the 18–22-inch and 18–23-inch slot limits produce the most (Figure 6B).

Table 6. Values for spawning potential ratio (SPR) eggs-per-recruit (EPR) and yield-per-recruit (YPR) analyses at various minimum size limits and slot-limits.

	SPR (%)			EPR (# eggs)			YPR (kg)		
Size Limit	F_{2017}	F_{Target}	$F_{Threshold}$	F_{2017}	F_{Target}	$F_{Threshold}$	F_{2017}	F_{Target}	$F_{Threshold}$
18 inch	49%	69%	61%	106,964	150,541	132,508	0.20	0.14	0.17
20 inch	49%	69%	61%	106,964	150,541	132,508	0.20	0.14	0.17
22 inch	60%	77%	70%	131,946	167,122	152,835	0.19	0.13	0.15
24 inch	71%	83%	78%	154,074	181,116	170,296	0.16	0.11	0.13
26 inch	79%	88%	84%	172,246	192,247	184,355	0.14	0.09	0.11
28 inch	79%	88%	84%	172,246	192,247	184,355	0.14	0.09	0.11
30 inch	85%	92%	89%	186,472	200,743	195,193	0.12	0.09	0.09
18-22 inch	79%	90%	86%	172,966	195,573	187,278	0.06	0.03	0.04
18-23 inch	79%	90%	86%	172,966	195,573	187,278	0.06	0.03	0.04
18-24 inch	66%	82%	76%	144,454	179,294	166,074	0.11	0.06	0.08
18-25 inch	66%	82%	76%	144,454	179,294	166,074	0.11	0.06	0.08
18-26 inch	58%	77%	70%	127,499	168,525	152,352	0.14	0.08	0.11
18-27 inch	58%	77%	70%	127,499	168,525	152,352	0.14	0.08	0.11

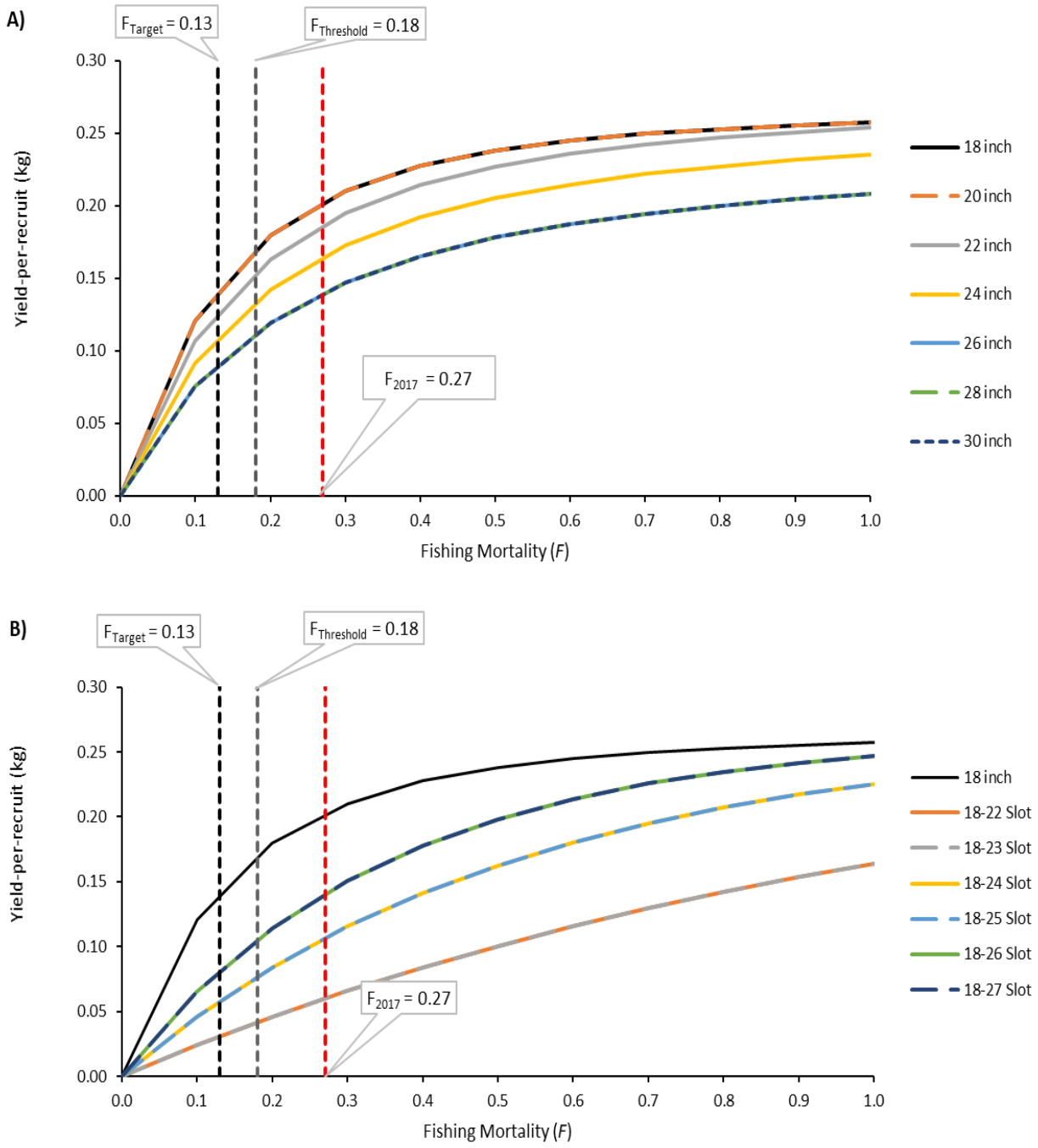

Figure 4. Yield-per-recruit (kg) at A) several minimum length regulations and B) several slot limit regulations. The current 18-inch minimum length limit is included in Figure 9B as a reference.

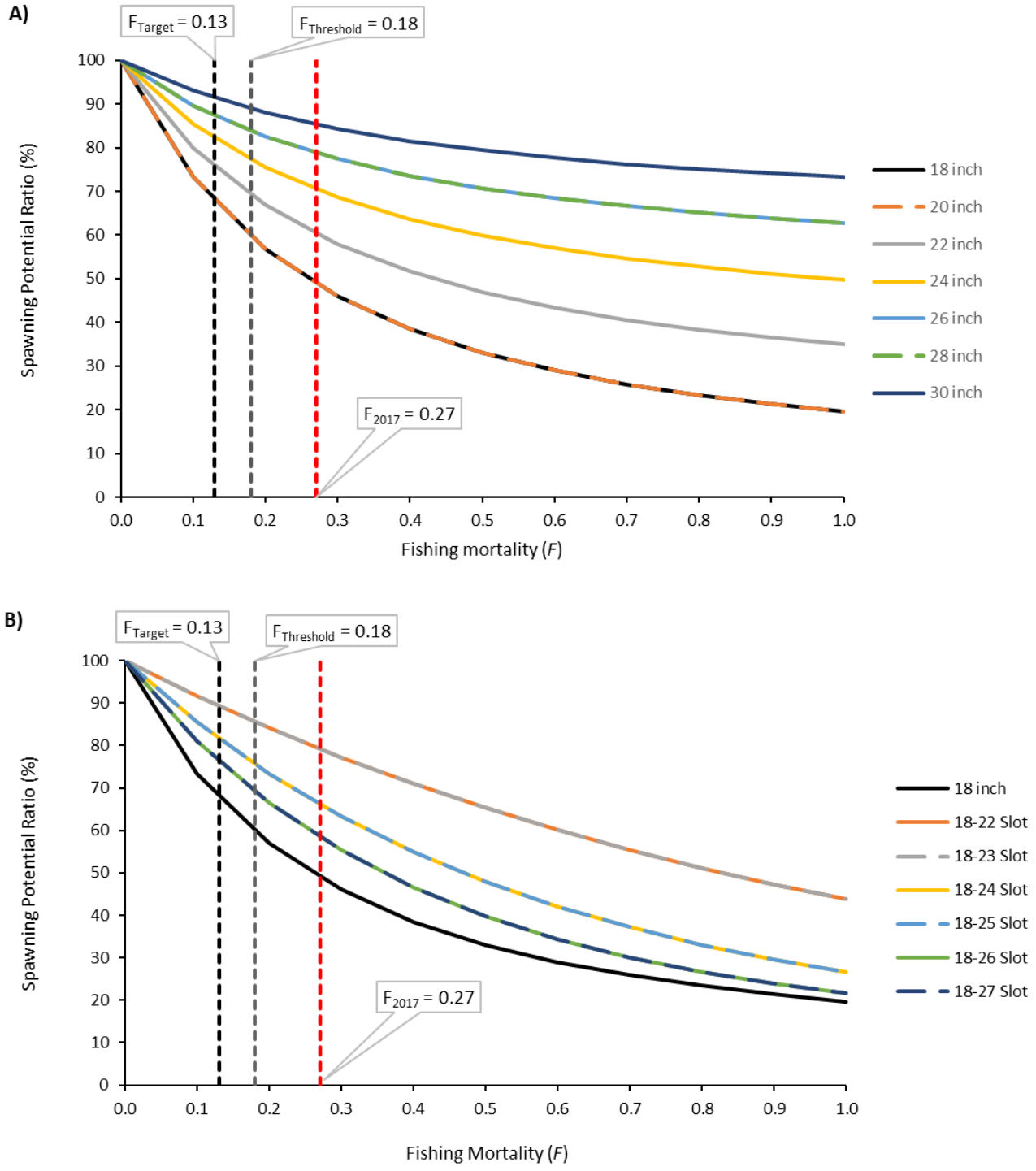

Figure 5. The performance of A) minimum length regulations and B) slot limit regulations at maximizing SPR under various fishing mortalities (*F*). The current 18-inch minimum length limit is included in Figure 10B as a reference.

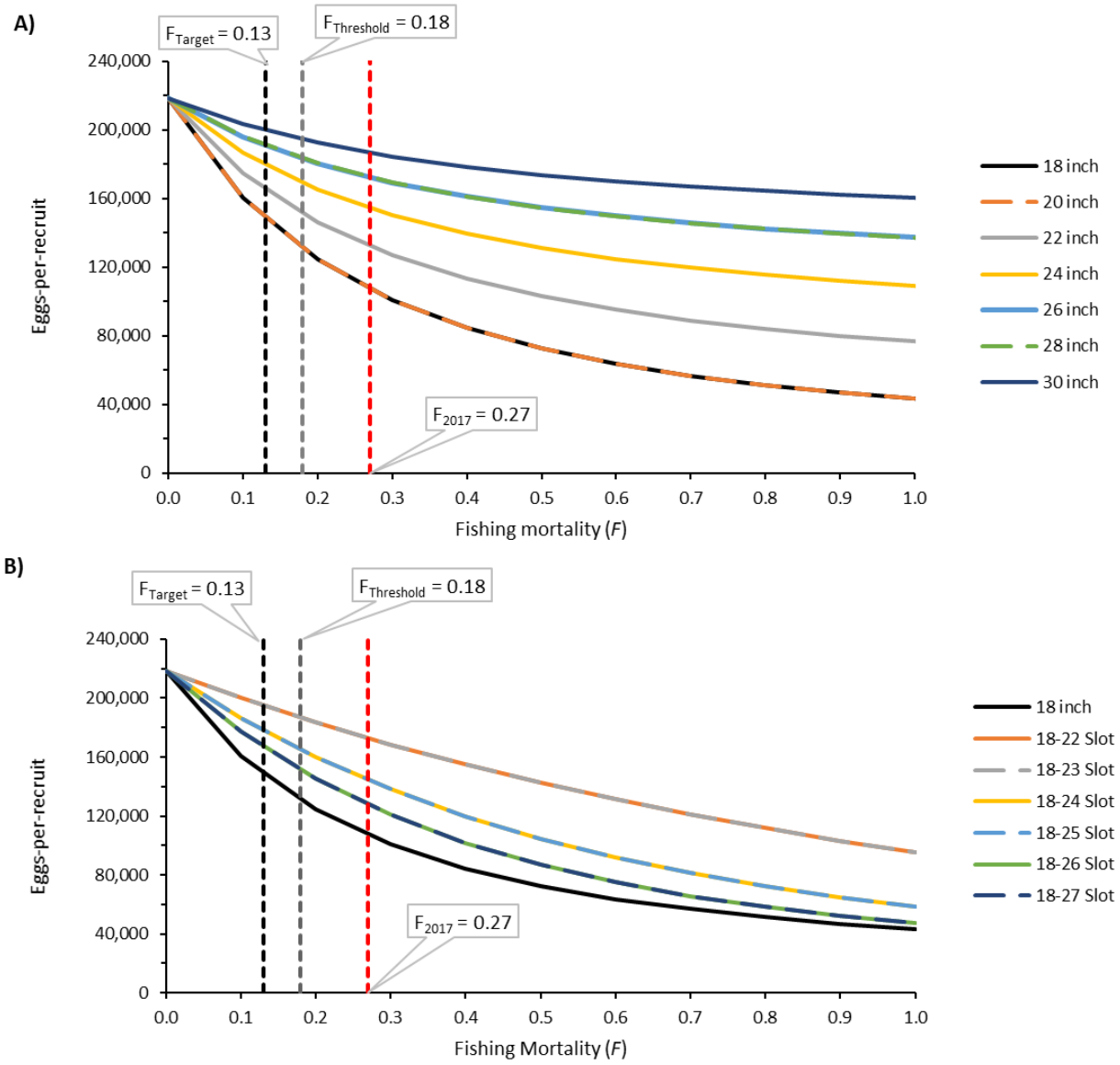

Figure 6. Egg production (number of eggs per recruit) at A) several potential length regulations and B) several slot limit regulations. The current 18-inch minimum length limit is included in Figure 11B as a reference.

Increased minimum size limits will increase the number of dead discards in the recreational and commercial sectors. Most fish harvested in the ASMA recreational sector are between 18–22 inches (Table 7; Figure 7) due to the 18–22 inch TL harvest slot limit and limiting possession to 1 fish greater than 27 inches in the RRMA (Table 7; Figure 8). The fish harvested in the ASMA commercial fishery have a wider length distribution compared to the recreational harvest (Table 7: Figure 9). If the minimum size limit is increased, a significant %age of harvest will turn into discards, of which a proportion will die. Research from a gill net study in Delaware determined 43 % of fish released alive would die. Depending on location and time of year of hook and line studies, delayed mortality estimates range from 6.4 % to 74 % (Wilde 2000).

Table 7. Percent by length bin (inches) of striped bass measured from the Albemarle Sound Management Area (ASMA) commercial fish house sampling and ASMA and Roanoke River Management Area (RRMA) recreational creel surveys, 1993–2019.

	Percent Harvest by Sector			
Total Length Bin (inches)	**All Sectors Combined**	**ASMA Commercial**	**ASMA Recreational**	**RRMA Recreational**
18	15.52%	5.95%	17.72%	25.81%
19	22.09%	11.39%	24.84%	32.75%
20	22.38%	17.88%	23.64%	26.53%
21	14.93%	19.50%	13.19%	12.04%
22	10.58%	16.52%	10.11%	1.48%
23	5.85%	10.01%	5.28%	0.18%
24	2.91%	5.03%	2.61%	0.02%
25	1.49%	2.32%	1.49%	0.01%
26	0.58%	1.11%	0.44%	0.05%
27	0.43%	0.83%	0.28%	0.21%
28	0.21%	0.44%	0.10%	0.14%
29	0.24%	0.59%	0.07%	0.11%
30	0.16%	0.40%	0.05%	0.09%
31	0.18%	0.45%	0.06%	0.05%
32	0.20%	0.57%	0.04%	0.05%
33	0.25%	0.73%	0.02%	0.10%
34	0.22%	0.67%	0.01%	0.07%
35	0.30%	0.96%	0.01%	0.03%
36	0.36%	1.10%	0.01%	0.14%
37	0.30%	0.92%	0.01%	0.07%
38	0.18%	0.59%	0.00%	0.02%
39	0.22%	0.69%	0.01%	0.06%
40	0.17%	0.56%	0.00%	0.00%
41	0.11%	0.36%	0.00%	0.00%
42	0.06%	0.17%	0.01%	0.00%
43	0.04%	0.14%	0.00%	0.00%
44	0.03%	0.07%	0.01%	0.00%
45	0.00%	0.01%	0.00%	0.00%
46	0.00%	0.01%	0.00%	0.00%
47	0.01%	0.03%	0.00%	0.00%
Totals	100.00%	100.00%	100.00%	100.00%

A harvest slot limit will increase the number of older fish in the population. However, if the slot limit is too wide, savings may be insignificant, but may increase over time in long lived fish such as striped bass. A narrow slot limit will result in additional dead discards if fishing practices do not change. Commercial sampling in the ASMA indicates 86 % of the striped bass measured were below 25 inches (Table 7). An 18 - 25-inch TL harvest slot size limit would include most of the current harvest in both the recreational and commercial sectors and not lead to significant increases in discards, while protecting fish once they grow out of the slot to increase abundance of older and larger striped bass in the A-R stock.

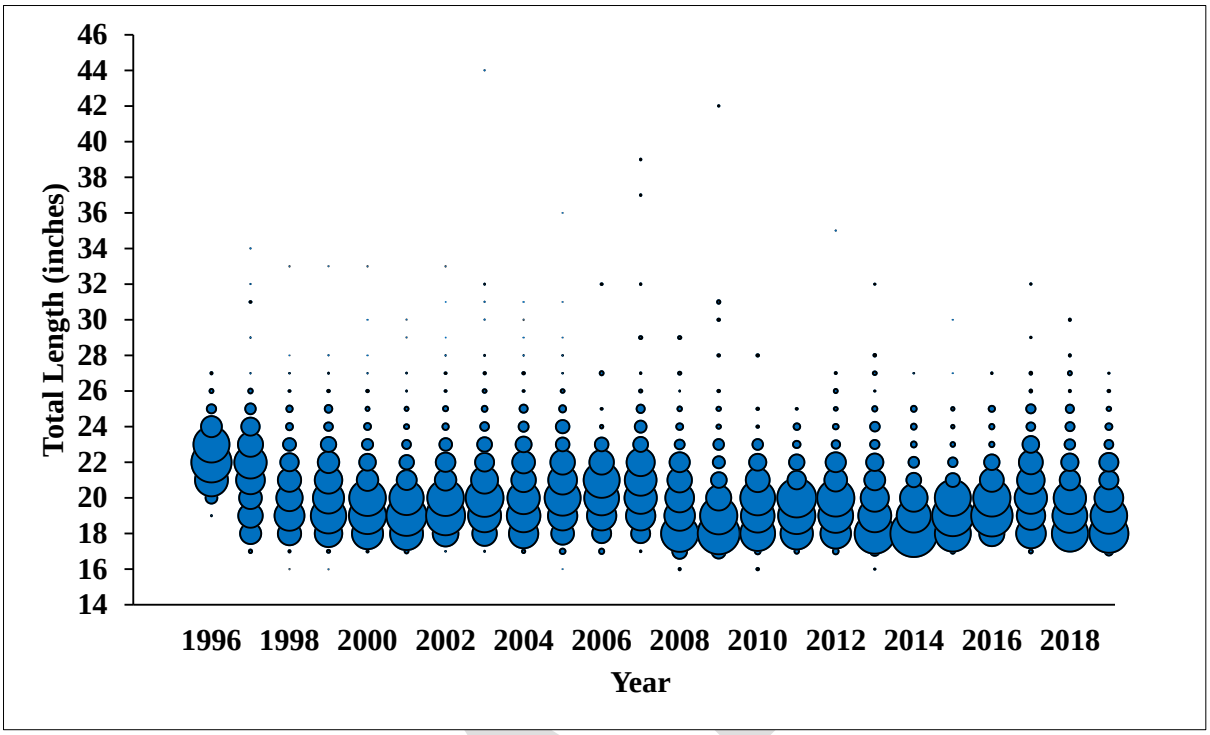

Figure 7. Recreational length frequency (total length, inches) of striped bass harvested in the ASMA, NC, 1996-2019. Bubble size represents the proportion of fish at length.

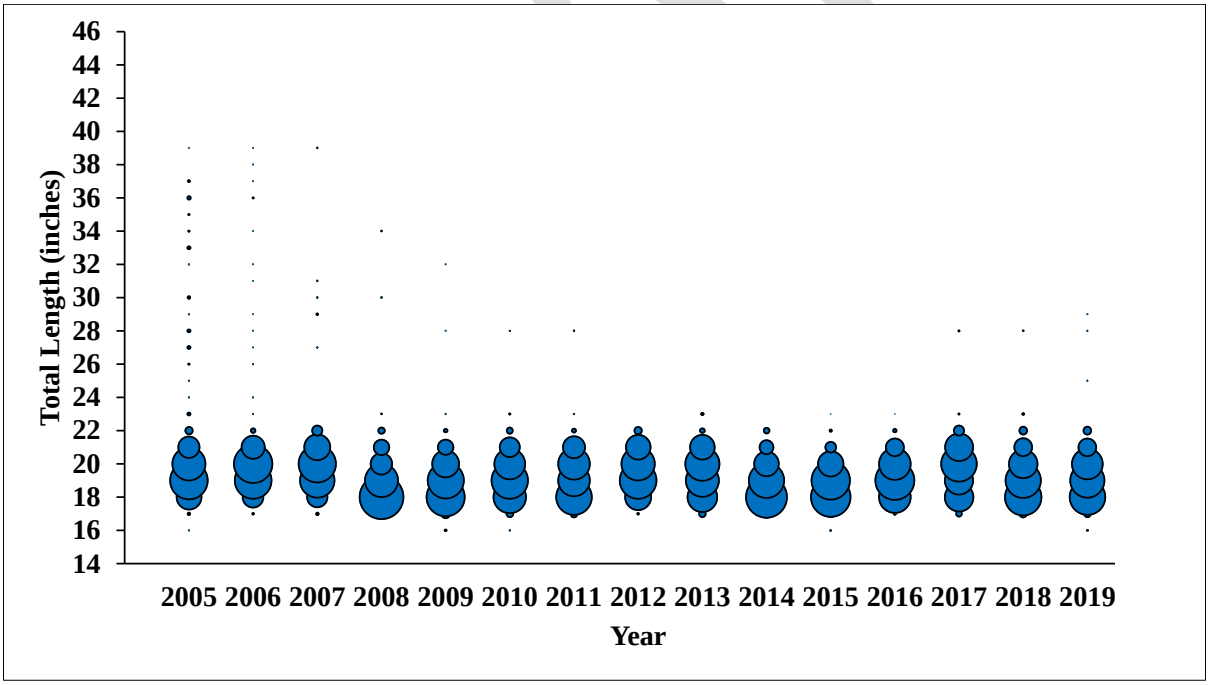

Figure 8. Recreational length frequency (total length, inches) of striped bass harvested in the RRMA, NC, 2005-2019. Bubble size represents the proportion of fish at length.

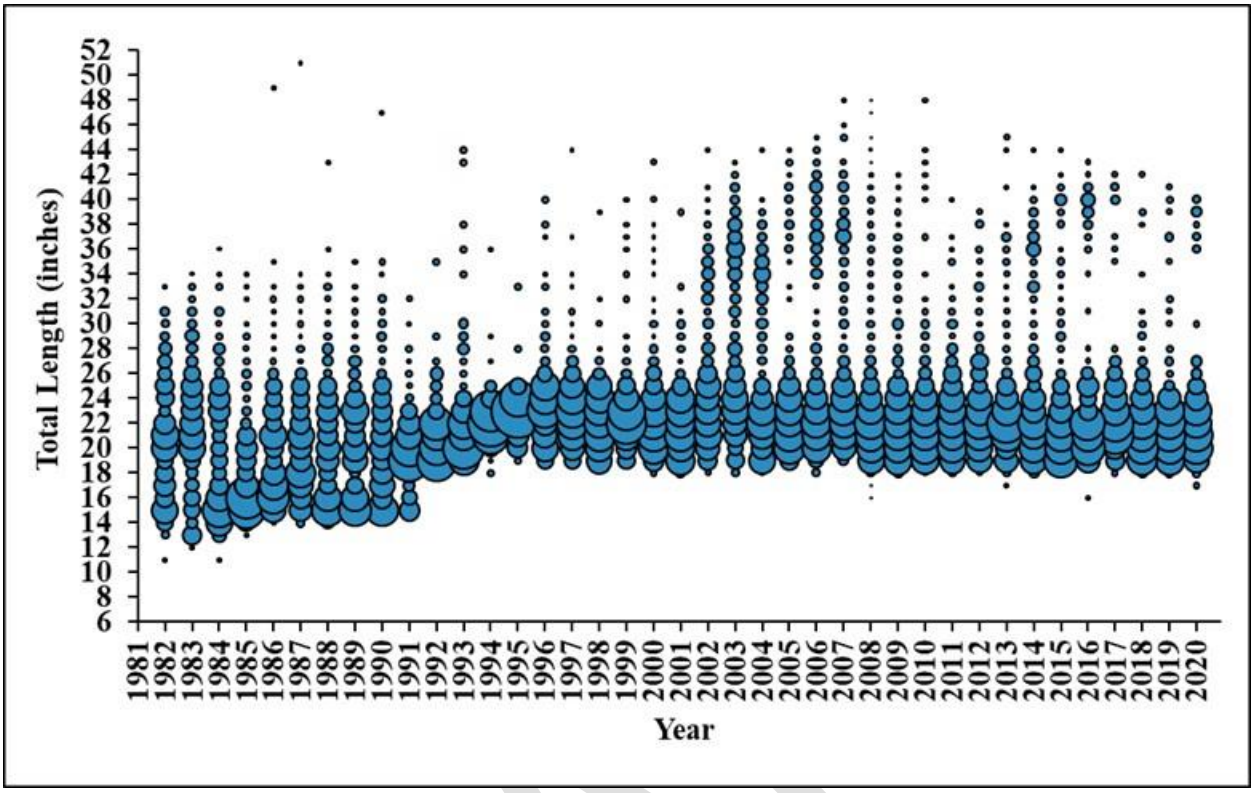

Figure 9. Commercial length frequency (total length, inches) of striped bass harvested in the ASMA, NC, 1982 to 2020. Bubble size represents the proportion of fish at length.

Projections were performed to evaluate the increase in the abundance of fish age 9+ in the stock under various slot limits in the same way harvest moratorium projections were estimated. Results indicate all slots perform similarly as the abundance of age 9+ fish increases to approximately 5,000 fish under the low recruitment scenario Figure 10).

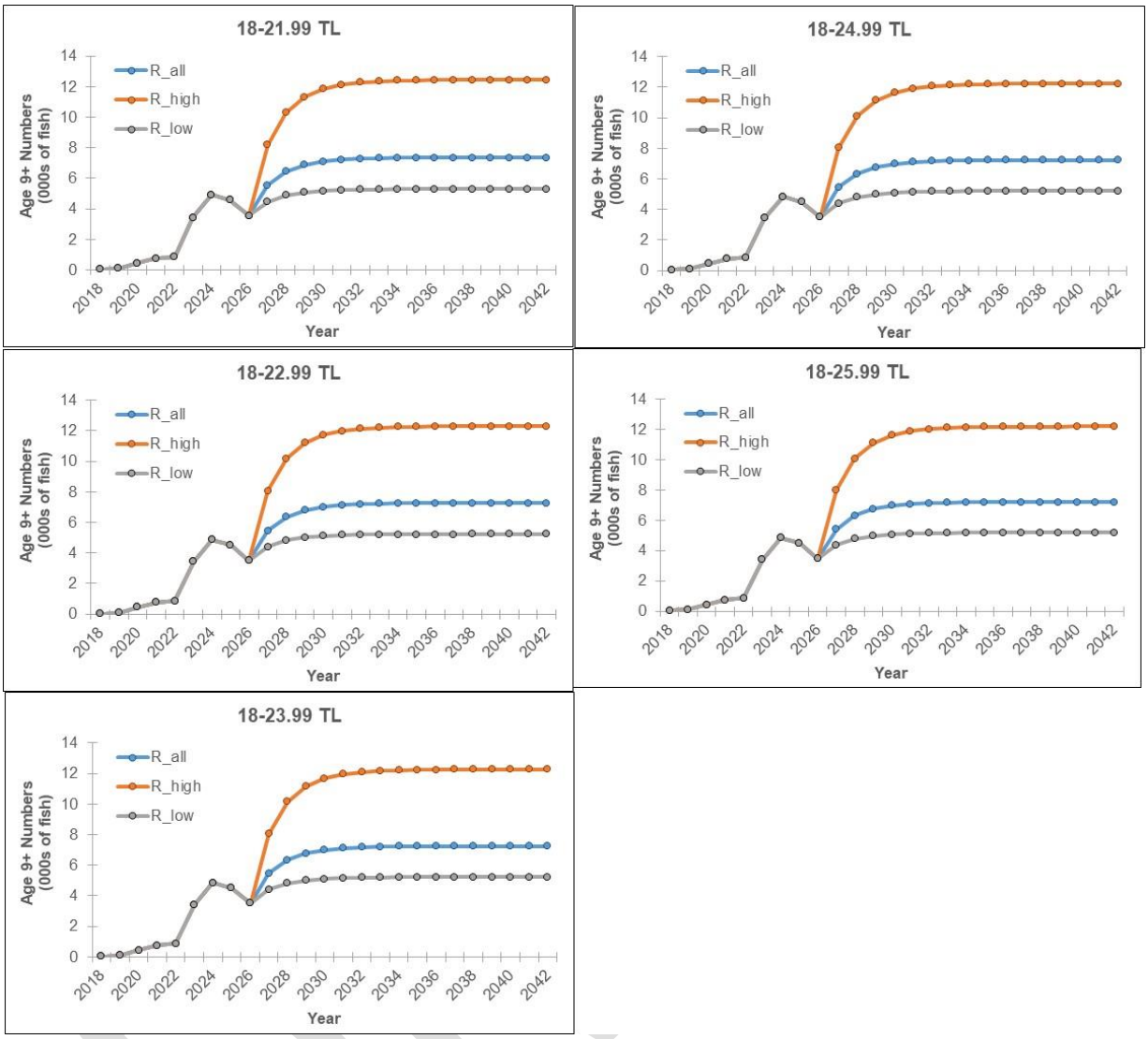

Figure 10. Projections of the abundance of age 9+ fish under various slot limits. Projections were performed in SS3.

Option 3. Size limits to expand the age structure of the stock

+ Will provide resiliency to the stock during times of poor recruitment
+ Can provide anglers with the opportunity of a "trophy" fishery, even if it is catch-and-release only
- Can reduce the amount of fish available for harvest depending on the size limit chosen
- Can increase the amount of dead discards from fisheries depending on the size limit chosen

3.A. Status Quo-maintain current minimum size limit of 18-inch TL in the ASMA, and in the RRMA maintain harvest size limit of 18–22 inch TL with a no harvest slot of 22–27 inches with only one fish in the daily creel being greater than 27 inches

+ Is consistent with management since the 1990s
+ Provides some harvest protection of females in the 22–27 inch no harvest slot while on the spawning grounds
- Does not offer as much protection of fish greater 27 inches as a harvest slot with a maximum allowed harvest size would

3.B. Increase the minimum size limit in all sectors in the ASMA and RRMA

+ Could increase chances of achieving a sustainable harvest by allowing females to spawn more times before becoming available to harvest
+ Will provide consistent regulations across all sectors and management areas
- Will lead to greater and greater discards the higher the minimum size limit is raised
- Will decrease the percentage of recreational anglers that will catch and retain the daily limit of striped bass (the greater the increase in the minimum size limit the greater the decrease in the percentage of anglers that keep a daily landings limit)
- Will not allow the harvest of a "trophy" fish by anglers

3.C. Implement a harvest slot of not less than 18 inches TL to less than 22, 23, 24, 25, or 26 inches TL in all sectors in the ASMA and RRMA

+ Will provide resiliency to the stock during times of poor recruitment
+ Can provide anglers with the opportunity of a "trophy" fishery, even if it is catch-and-release only
- Will reduce the amount of fish available for harvest depending on the size limit chosen
- Will increase the amount of dead discards from fisheries depending on the size limit chosen
- Will increase the potential to reach TAL quicker in the RRMA if harvest is allowed on larger fish
- Any increase in the abundance of older fish in the population may not be noticeable if the slot is too large

PDT Recommendation: The PDT recommends option 3.C., a harvest slot limit of 18 inches TL to less than 25 inches TL in all sectors. A harvest slot will gradually increase the abundance of older fish in the population imparting resiliency to the stock in periods of poor recruitment. The 18 to less than 25 inch harvest slot is a good match to current harvest based on gill net mesh sizes used in the American shad and flounder gill net fisheries and will not incur too many discards but yet still protect a good number of fish that can currently be legally harvested. It will also deter commercial fishermen from using illegal gill nets that are greater than the current maximum of 6 ½ inch stretched mesh to harvest larger (20 pounds plus) striped bass because fish houses will be very unlikely to buy fish greater than the maximum size limit.

Option 4. Gear modifications and area closures to reduce discard mortality

Commercial Fisheries

To reduce discard mortality from gill nets, gear modifications have included: reducing maximum yardage allowed, restricting mesh sizes, area closures, attendance requirements, not allowing harvest during the summer months when water temperatures are higher and discard mortality increases significantly, and requiring tie-downs in the flounder fishery.

Area closures are another tool used to reduce discard mortality. Since 1988 the mouth of the Roanoke River from Black Walnut Point to the mouth of Mackey's Creek has been closed to the use of gill nets during times of the year when striped bass are present in large concentrations. Other closures have eliminated the use of small mesh gill nets in shallow waters close to shore to reduce undersized discards from large year classes.

The MFC requested analysis to reduce striped bass discard mortality through the elimination of gill net use in the ASMA. While such a measure cannot be pursued in the Estuarine Striped Bass FMP, the MFC does have the authority to eliminate harvest of striped bass with gill nets. However, if the gill net fisheries for American shad and flounder continue, and striped bass cannot be retained, striped bass discards will still occur and will increase. If the large mesh gill net fisheries in the ASMA that interact create unacceptable levels of striped bass discards are eliminated, serious economic impacts will occur to numerous fishermen currently participating in these fisheries. The number of gill net trips, number of participants, pounds of seafood landed at dealers, and dockside value associated with the American shad and southern flounder fisheries in the ASMA are presented in Tables 3 and 4. The number of gill net trips, number of participants, pounds of seafood landed at dealers, and the dockside value associated with all of the gill net trips (large and small mesh) in the ASMA are presented in Table 8.

Table 8. Number of gill net trips, number of participants, total pounds of seafood landed, and dockside value from all gill net trips in the ASMA, 2010-2019.

Year	Trips	Participants	Seafood sold (lb)	Dockside value
2010	11,691	420	2,003,385	$1,972,341
2011	7,484	370	1,673,071	$1,280,433
2012	10,253	427	1,860,312	$2,316,010
2013	13,685	432	2,188,732	$3,199,403
2014	9,164	396	1,607,618	$1,903,979
2015	7,855	336	1,614,889	$1,578,145
2016	6,001	268	1,012,693	$1,108,990
2017	6,678	284	1,269,011	$1,521,611
2018	6,340	273	1,318,485	$1,349,733
2019	5,822	234	1,307,117	$1,148,976

Recreational Fisheries

Since 1997, WRC has required use of single barbless hooks for all anglers during the striped bass spawning season in the inland portions of the RRMA to reduce discard mortality. Reducing discard mortality in the RRMA is particularly important due to recreational fishery discards being many times greater than harvested striped bass. Barbless hooks reduce discard mortality by reducing the time it takes an angler to remove the hook from fish and by reducing the damage to the mouth of fish (Nelson 1994).

The use of circle hooks and barbless treble hooks to reduce discard mortality of fish is gaining popularity among anglers and the recreational fishing industry as a whole. DMF staff presented information on the efficacy of using circle hooks and bent-barbed treble hooks to reduce discard mortality of captured-and-released fish to the MFC at its May 2020 business meeting (see Information on requiring the use of circle hooks and bent-barbed treble hooks in North Carolina NCDMF 2020a). Circle hooks reduce discard mortality compared to traditional J hooks because fish are much less likely to get deep hooked (Cook et al. 2021; Kerstetter and Graves 2006). Circle hooks are required in the Atlantic Ocean waters of North Carolina when fishing for striped bass or sharks and using natural bait. Amendment 1 to the North Carolina Red Drum FMP (NCDMF 2008) requires the use of circle hooks in certain times and areas of the Pamlico Sound when anglers target large red drum using natural bait (Aguilar 2003, Beckwith and Rand 2004).

Although less research has been done on the effects of bent or barbless treble hooks on the survival of captured-and-released fish, the same reasons thought to reduce hook trauma when using single barbless hooks applies to barbless treble hooks. However, as noted in the May 2020 circle hook information paper, the promotion of barbless treble hooks as a conservation measure has largely been replaced by the use of single inline hooks instead of treble hooks on artificial lures. Use has been promoted for a variety of reasons including: less damage to fish, ease of unhooking, fish hooked more securely, less likely to collect grass or debris, and angler safety. Many manufacturers have started selling lures rigged with single hooks. This trend is being driven by the tackle industry, retailers, and conservation-minded anglers (NCDMF 2020a).

Area closures could also be implemented in the recreational fisheries to reduce striped bass discards. Catch-and-release fishing for striped bass during the closed harvest season is popular in several areas, including the old Manns Harbor Bridge in Manteo, the highway 32 bridge crossing the Albemarle Sound at Pea Ridge, Corey's Ditch located in the Mackay Island National Wildlife Refuge in Currituck, and in the Roanoke River. While data do not exist to determine the exact extent of economic losses, closing these or other areas to the use of recreational hook and line during times of year when striped bass harvest is not allowed would have impacts to numerous industries that rely in part or whole on recreational fishing. Closing an area to anglers targeting striped bass is unenforceable.

An area closure on the spawning grounds to eliminate the harvest and catch-and-release of striped bass as they gather in large numbers and spawn also serves to reduce discard mortality. Releases after the harvest period has closed on the spawning grounds has ranged from 9,754–271,328 fish (See FMP Table 5). Closing the spawning grounds to the harvest of fish is a common practice in many fisheries to protect the spawning stock, although there is no research on the impacts of catch-and-release fishing on the quality or amount of egg production for

striped bass. Based on past experience, the A-R striped bass stock has recovered from low stock abundance and produced strong year classes under the current catch-and-release fishing practices on the spawning grounds.

Option 4. Gear modifications and area closures to reduce discard mortality

4.A. Status quo-continue to allow the harvest of striped bass with gill nets and recreational harvest and catch-and-release fishing while striped bass are on the spawning grounds
+ Consistent with management since 1990
+ Allows for harvest with traditional gears and in traditional locations user groups are accustomed to
+ Past experience has demonstrated the stock can recover from low levels of abundance and produce strong year classes with these fishing practices in place
- Gill nets interact with endangered species and require incidental take permits to operate
- Catch rates can be extremely high when striped bass are congregated on the spawning grounds
- There has been little research on the effects of catch-and-release fishing to egg production and quality

4.B. Do not allow the harvest of striped bass with gill nets in the ASMA commercial fishery
+ Will reduce dead discards associated with harvesting striped bass with gill nets
- Will create a significant amount of dead discards unless all other gill net fisheries in the ASMA are eliminated
- Will have a significant economic impact to commercial fishermen using gill nets to harvest striped bass unless they can easily and inexpensively switch to another gear

4.C. Do not allow harvest or targeted catch-and-release fishing for striped bass while on the spawning grounds or other areas of high concentration
+ Would reduce all discards associated with hook and line fishing on the spawning grounds and in other areas of high striped bass concentration
+ Would likely increase abundance and further expand the age structure
- May not achieve the desired results if environmental factors have a greater influence than the level of SSB on the formation of strong year classes
- Would have significant economic impact to all businesses in the areas supported by recreational angling for striped bass while on the spawning grounds and in other areas of high concentration
- Would eliminate access to the resource by the user groups in the area of the spawning grounds and in other areas of high concentration unless they travel to another area to harvest striped bass

4.D. Implement single barbless hook rule in the remainder of the RRMA during the open harvest season and catch-and-release season

+ Would reduce mortality associated with undersized releases and catch-and-release fishing
- Would have negative impacts on other recreational fisheries mainly large mouth bass tournaments in the area and time of year
-
-

4.E. Implement a requirement to use non-offset circle hooks when fishing with live or natural bait in the RRMA during the open harvest season and catch-and-release season
+ Would reduce mortality associated with undersized releases and catch-and-release fishing
+
- Would require significant angler education on the types of circle hooks that would be required
- Would have significant impact on other recreational fisheries using live bait for other species, such as crickets for bream, if there were not exemptions for certain size J hooks
- Would require significant angler education on the types of J hooks that would be exempted

PDT Recommendation: The PDT recommends options 4.A., 4.D., and 4.E.

Option 5. Adaptive management

Adaptive management is a structured, repetitive process of decision-making when uncertainty exists, with the objective to reduce uncertainty through time with monitoring. Adaptive management is based on a learning process to improve management outcomes (Holling 1978.) Adaptive management provides flexibility to incorporate new data and information and accommodate alternative and/or additional actions. As flexibility increases, so do the resources needed to acquire and analyze data, as well as to implement and enforce complexities of management. These elements create trade-offs that must be balanced for all users.

The ASMFC uses state's annual juvenile abundance indices as an indicator of year class strength and a trigger for management evaluations (ASMFC 2010). If the JAI is below 75 percent of other values for three consecutive years, the ASMFC Striped Bass Technical Committee will review the state's data and make a recommendation to the ASMFC Striped Bass Management Board about possible causes for the spawning failures and if management action is needed. The A-R striped bass juvenile abundance index met this criterion in 2020, the third year in a row the index value was below the 75 percent threshold (Figure 2).

Option 5. Adaptive management

Adaptive management for the A-R stock and fisheries in the ASMA and RRMA encompass the following measures:

- Use of peer reviewed stock assessments and updates to recalculate the BRPs and/or TAL if assessment results deem it necessary. Stock assessments will be updated at least once

between benchmarks. Changes in the TAL will be implemented through a Revision to the Amendment.

- Use of estimates of *F* from stock assessments to compare to the *F* BRP and if *F* exceeds the F_{Target} reduce the TAL to the appropriate level through a Revision to the Amendment.
- Ability to change daily possession limits in the commercial and recreational fisheries to keep landings below the TAL.
- Ability to open and close recreational harvest seasons and commercial harvest seasons and areas to keep landings below the TAL and reduce interactions with endangered species.
- Ability to require commercial and recreational gear modifications including, but not limited to, the use of barbless or circle hooks, area closures, yardage limits, gill net mesh size restrictions and setting requirements to reduce striped bass discards.

PDT Recommendation: The PDT supports all the adaptive management measures.

VI. PROPOSED MANAGEMENT OPTIONS SUMMARY

Option 1. Implement a Harvest Moratorium

PDT does not support option 1.

Option 2. Status Quo: continue with the current TAL of 51,216 pounds to maintain harvest at a sustainable level

PDT supports option 2. In addition, the PDT supports options 2.A.1. and 2.B.2.

Option 3. Size limits to expand the age structure of the stock

PDT supports option 3.C.

Option 4. Gear modifications and area closures to reduce discard mortality

PDT supports options options 4.A., 4.D., and 4.E.

Option 5. Adaptive management

PDT supports all adaptive management measures.

VIII. LITERATURE CITED

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