March 2026

2026 REVISION
to the
NORTH CAROLINA ESTUARINE STRIPED BASS FISHERY MANAGEMENT PLAN
AMENDMENT 2

North Carolina Department of Environmental Quality
North Carolina Division of Marine Fisheries
3441 Arendell Street
P. O. Box 769
Morehead City, NC 28557

And

North Carolina Wildlife Resources Commission
Inland Fisheries Division
1751 Varsity Drive
Raleigh, NC 27606

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EXECUTIVE SUMMARY

Estuarine striped bass (*Morone saxatilis*) in North Carolina are managed under Amendment 2 to the N.C. Fishery Management Plan (FMP) adopted in November 2022 and its subsequent revision (2024). Striped bass stocks in North Carolina are managed jointly by the N.C. Marine Fisheries Commission (MFC) and the N.C. Wildlife Resources Commission (WRC).

The goal of Amendment 2 is to manage the estuarine striped bass fisheries to achieve self-sustaining populations that provide sustainable harvest based on science-based decision-making processes. If biological and/or environmental factors prevent a self-sustaining population, then alternate management strategies will be implemented that provide protection for and access to the resource. The following objectives will be used to achieve this goal.

- Implement management strategies within North Carolina and encourage interjurisdictional management strategies that maintain and/or restore spawning stock with adequate age structure and abundance to maintain recruitment potential and to prevent overfishing.
- Restore, enhance, and protect critical habitat and environmental quality in a manner consistent with the Coastal Habitat Protection Plan, to maintain or increase growth, survival, and reproduction of the striped bass stocks.
- Use biological, social, economic, fishery, habitat, and environmental data to effectively monitor and manage the fisheries and their ecosystem impacts.
- Promote stewardship of the resource through public outreach and interjurisdictional cooperation regarding the status and management of the North Carolina striped bass stocks, including practices that minimize bycatch and discard mortality.

Amendment 2 management for the Tar-Pamlico and Neuse rivers stocks carried forward the Supplement A no-possession measure, maintained the gill net closure above the ferry lines, and maintained the use of 3-foot tie-downs for gill nets below the ferry lines. The Amendment 2 adaptive management framework for the Tar-Pamlico and Neuse rivers stocks prescribes that in 2025, data through 2024 will be evaluated to determine if populations are self-sustaining and if sustainable harvest can be determined. In addition, the MFC approved the following measure in Amendment 2 regarding the gill net closure: “maintain the gill net prohibition through 2024 to allow for assessment of its performance”. If analysis indicated the populations are self-sustaining and a level of sustainable harvest can be determined, recommendations for harvest strategies would be developed. If analysis indicated biological and/or environmental factors prevented a self-sustaining

population, alternate management strategies would be developed providing protection for and access to the resource.

In addition, the MFC approved the following measure in Amendment 2 regarding the ferry line gill net closures in the Tar-Pamlico and Neuse rivers: “maintain the gill net prohibition through 2024 to allow for assessment of its performance”. As adopted, the gill net closures sunset after 2024.

Results of the data evaluation indicate:

- No ‘wild’ juveniles have been caught in the Tar-Pamlico or Neuse rivers since the juvenile survey began in 2017, except two “wild” fish were caught in 2021
- During 2019–2024 the percentage of hatchery striped bass on the spawning grounds of the Tar-Pamlico and Neuse rivers has increased to nearly 100%
- During 2019–2024 the percentage of hatchery origin striped bass in the lower Tar-Pamlico and Neuse rivers has been variable ranging from <50% to >90%
- Abundance of all age classes in the lower rivers is significantly lower after the harvest closure
- Abundance of all age classes on the spawning grounds did not increase significantly after the harvest closure

Based on data from the Division of Marine Fisheries (DMF) and WRC fishery-independent and -dependent sampling programs reviewed through 2024, the striped bass populations in the Tar-Pamlico and Neuse rivers are currently not self-sustaining. Evaluation of the harvest and gill net closures show these measures were ineffective at increasing adult abundance, expanding the age structure, and promoting natural recruitment through year six of implementation. Factors other than fishing mortality are preventing sustainability of the Tar-Pamlico and Neuse rivers striped bass stocks. Acoustic telemetry and genetic data suggest there are three groups of striped bass in the Tar-Pamlico and Neuse rivers. Most of the fish are hatchery reared stocked fish, followed by ‘wild’ fish originating from the Albemarle-Roanoke, with a small portion of ‘wild’ fish originating from the spawning grounds on the Tar-Pamlico and Neuse rivers.

As part of the data evaluation, similar analyses were conducted for red drum (*Sciaenops ocellatus*), southern flounder (*Paralichthys lethostigma*), spotted seatrout (*Cynoscion nebulosus*), and striped mullet (*Mugil cephalus*) to assess the impact of the 2019 gill net closure above the ferry lines in the Tar-Pamlico and Neuse rivers (see Appendix 3 for results and conclusions). For most species, there was no significant abundance trend before and after the gill net closure. The exceptions were that relative abundance of spotted seatrout was significantly higher above the ferry lines in the Neuse and Pamlico rivers after the closure and relative abundance of striped mullet was significantly lower

above the ferry lines in the Neuse and Pamlico rivers after the closure. The lack of consistent results suggests the ferry line closures were unlikely to have either a positive or negative impact on species abundance. This finding is not surprising for species that occur in these river systems temporarily based on migratory patterns influenced by life history and tolerance to changes in environmental conditions.

Consistent with the Amendment 2 goal and adaptive management framework, the DMF and WRC staff have developed a harvest management strategy that provides protection for and access to the resource. The harvest management strategy limits the timing of and spatial extent of allowed harvest in the Tar-Pamlico and Neuse rivers to concentrate harvest on stocked fish while limiting harvest of Albemarle-Roanoke stock striped bass that occasionally occur in these rivers. Tagging data were reviewed to evaluate the spatial extent and timing of Albemarle-Roanoke and stocked striped bass residence in the Tar-Pamlico and Neuse rivers. Additionally, overall harvest will be limited to maintain abundance of mature stocked striped bass in the rivers so in the event of favorable environmental conditions, natural reproduction could occur.

Management measures for the recreational fishery in 2026 will be:

- Open recreational harvest season upstream of a line running roughly from Gum Point to Fork Point in the Tar-Pamlico River and from Cooper Point to Fisher Landing Point in the Neuse River (large-mesh gill net distance from shore demarcation lines see Figure 12) April 1–30
- One fish per person per day recreational creel limit
- An 18 inch minimum total length (TL) and no striped bass between 22 and 27 inches TL

Management measures for the commercial fishery in 2026 will be:

- Open commercial harvest season upstream of a line running roughly from Gum Point to Fork Point in the Tar-Pamlico River and from Cooper Point to Fisher Landing Point in the Neuse River (large-mesh gill net distance from shore demarcation lines see Figure 12) April 1–30
- One fish per person per day trip limit
- An 18 inch minimum TL and no striped bass between 22 and 27 inches TL
- Allow hook-and-line as a legal commercial gear in the striped bass commercial fishery (consistent with Amendment 2)
- Continue commercial tagging requirement

- Maintain tie-down and distance from shore requirements for gill nets and implement additional gill net restrictions to further reduce incidental take of striped bass in the shad gill net fishery

Recreational and commercial seasons in Joint and Coastal Fishing Waters will be opened by proclamation. Additionally, Proclamation M-15-2025 re-opened the areas upstream of the ferry lines in the Tar-Pamlico and Neuse rivers to gill nets.

ISSUE

The goal of Amendment 2 to the N.C. Estuarine Striped Bass Fishery Management Plan is to manage the estuarine striped bass fisheries to achieve self-sustaining populations that provide sustainable harvest based on science-based decision-making processes. If biological and/or environmental factors prevent self-sustaining populations in the Tar-Pamlico and Neuse rivers, then alternate management strategies will be implemented that provide protection for and access to the resource.

The 2025 data evaluation for the Tar-Pamlico and Neuse rivers indicated biological and/or environmental factors are preventing self-sustaining populations in these rivers (Appendix 1). Consistent with Amendment 2 adaptive management, management will be implemented providing protection for and access to the resource.

ORIGINATION

Adaptive management for the striped bass stocks in the Tar-Pamlico and Neuse rivers, North Carolina Estuarine Striped Bass Fishery Management Plan Amendment 2, Appendix 3: Achieving Sustainable Harvest for the Tar-Pamlico and Neuse Rivers Striped Bass Stocks.

BACKGROUND

Amendment 2 to the N.C. Estuarine Striped Bass FMP was adopted by the MFC in November 2022. The Amendment 2 adaptive management strategy for the Tar-Pamlico and Neuse rivers was to maintain the harvest closure in the Tar-Pamlico and Neuse rivers through 2024, and then in 2025 evaluate key population parameters including adult abundance, age structure, natural recruitment, and hatchery contribution to determine whether the populations are self-sustaining and if sustainable harvest can be determined. Per the amendment, if analysis indicates the populations are self-sustaining and a level of sustainable harvest can be determined, recommendations for harvest strategies will be developed. If analysis indicates biological and/or environmental factors prevent a self-sustaining population, alternate management strategies will be developed that provide protection for and access to the resource. Adaptive management may be used to adjust management measures including area and time restrictions and gear restrictions if it is determined additional protection for the stocks is needed.

Results of the analysis indicate the harvest closure was ineffective at promoting natural recruitment, increasing adult abundance, or expanding the age structure and increasing the number of older (age-10+), larger striped bass through year six of implementation of the harvest closure. Factors other than fishing mortality and inadequate spawner abundance are preventing successful reproduction and self-sustaining Tar-Pamlico and Neuse rivers striped bass stocks. (Appendix 1).

Consistent with the Amendment 2 adaptive management framework, Division of Marine Fisheries (DMF) and Wildlife Resources Commission (WRC) staff have developed a harvest management strategy that provides access to and protection for the resource. Specifically, this strategy is designed to allow harvest of stocked fish in these rivers.

Confounding development of a new management strategy is the documented residency of a portion of the Albemarle-Roanoke (A-R) striped bass stock in the Tar-Pamlico and Neuse rivers outside of the A-R striped bass spawning season. The A-R striped bass stock has had chronic, poor spawning success since 2017 (Figure 1; NCDMF 2025a), and striped bass harvest in the Albemarle Sound Management Area (ASMA) and the Roanoke River Management Area (RRMA) has been prohibited since January 2024 (NCDMF 2024a Revision to Amendment 2).

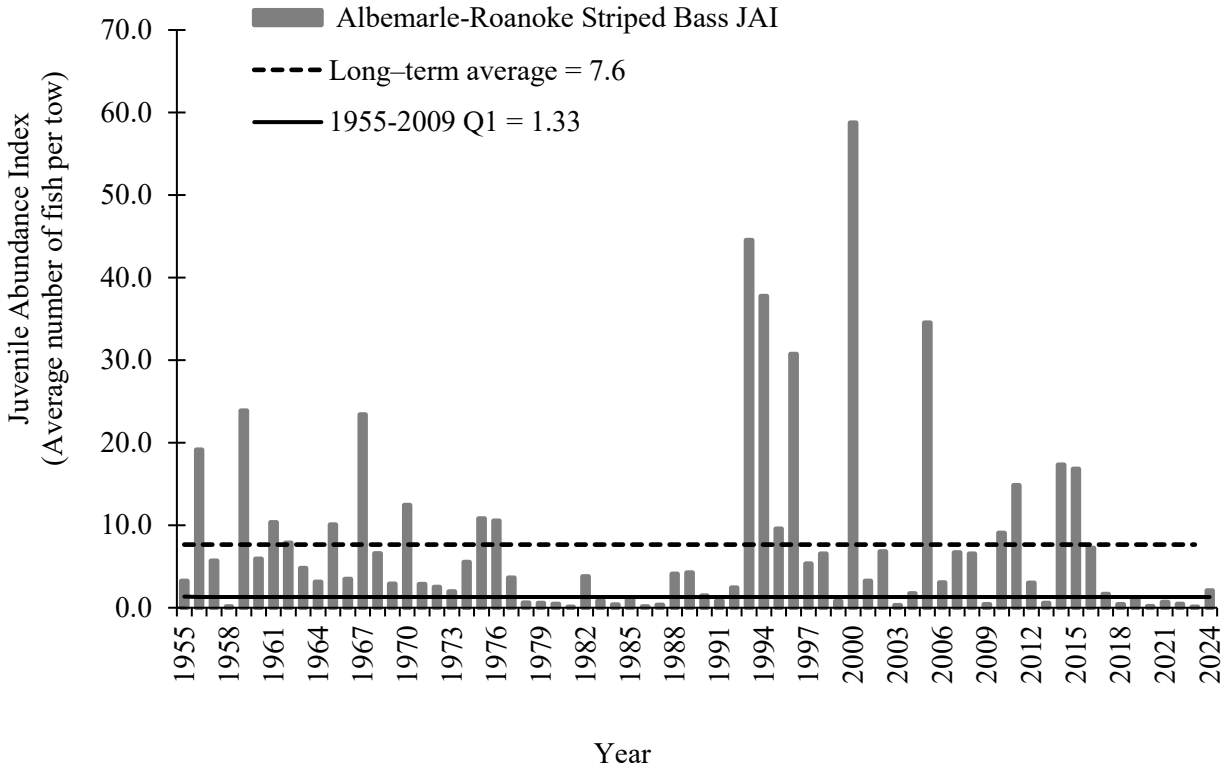

Figure 1. Juvenile abundance index (JAI) for the Albemarle-Roanoke striped bass stock, 1955–2024. Values below the Q1 value of 1.33 (the 75% percentile) are considered spawning failures.

Therefore, a harvest management strategy was developed that focuses harvest on stocked fish in the Tar-Pamlico and Neuse rivers, while limiting harvest of A-R stock striped bass present in the Tar-Pamlico and Neuse rivers to the greatest extent possible,

by restricting the times and areas harvest can occur. Harvest levels will be restricted to low levels for two reasons. First, low harvest levels will maintain an abundance of mature stocked striped bass in the Tar-Pamlico and Neuse rivers in the event of favorable environmental conditions, natural reproduction could occur. Additionally, low harvest levels would further limit any harvest of A-R striped bass that may occasionally occur in the time and area open to harvest.

AUTHORITY

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	PROCEDURES FOR ADOPTING A TEMPORARY RULE

<u>N.C. Marine Fisheries Commission and N.C. Wildlife Resources Commission Rules (15A NCAC)</u>

15A NCAC 03H .0103	PROCLAMATIONS, GENERAL
15A NCAC 03M .0201	STRIPED BASS REQUIREMENTS: GENERAL
15A NCAC 03M .0202	STRIPED BASS SEASON, SIZE AND HARVEST LIMIT: INTERNAL WATERS
15A NCAC 03M .0512	COMPLIANCE WITH FISHERY MANAGEMENT PLANS
15A NCAC 03Q .0107	SPECIAL REGULATIONS: JOINT FISHING WATERS
15A NCAC 03Q .0108	MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT FISHING WATERS
15A NCAC 03Q .0109	IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING
15A NCAC 03Q .0202	DESCRIPTIVE BOUNDARIES FOR COASTAL-JOINT-INLAND WATERSs
15A NCAC 03R .0201	STRIPED BASS MANAGEMENT AREAS
15A NCAC 10C .0107	SPECIAL REGULATIONS: JOINT FISHING WATERS
15A NCAC 10C .0108	SPECIFIC CLASSIFICATION OF WATERS
15A NCAC 10C .0110	MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT FISHING 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

DISCUSSION

A variety of datasets were used to develop a harvest management strategy in the Tar-Pamlico and Neuse rivers including season, area, size, and possession limits. To evaluate the temporal and spatial extent of A-R stock striped bass residency in the Tar-Pamlico and Neuse rivers, DMF conventional and acoustic tagging data, along with results of other tagging studies were evaluated. Data from tagging studies were used to develop the seasonal and spatial extent of an open striped bass harvest season that minimizes, to the greatest extent possible, harvest of A-R stock striped bass while allowing modest harvest of stocked fish. Recreational and commercial landings from previous open seasons were reviewed to evaluate harvest potential and develop possession and size limits.

Movement and Migration

Striped bass stocks in the mid-Atlantic bight are anadromous and originate from four principal spawning areas; the Hudson River, Delaware River, numerous rivers within the Chesapeake Bay, and the Roanoke River (Merriman 1941; Boreman and Lewis 1987; Dorazio et al. 1994; Waldman et al. 1997; Welsh et al. 2007; Able et al. 2012; Callihan et al. 2014; Kneebone et al. 2014). Tag return data show that larger A-R stock striped bass migrate outside of the Albemarle Sound after spawning and return to the Roanoke River each year with no evidence of straying (i.e., spawning in a river system other than the Roanoke River; Callihan et al. 2015). Callihan et al. (2014) reported A-R stock striped bass greater than 24 inches (in.) total length (TL) were more likely to emigrate to ocean waters after spawning, while fish less than 24 in. TL were more likely to remain within the Albemarle Sound (Figure 2). Callihan et al. (2014) also noted up to 31% of the A-R stock may migrate outside of the Albemarle Sound estuary to adjacent internal estuarine systems, and migratory fish less than 24 in. TL were more likely to remain in inshore estuarine waters, especially the Pamlico Sound, Tar-Pamlico, Pungo and Neuse rivers, and the lower Chesapeake Bay (Callihan et al. 2014; Figure 2).

Striped bass stocks south of Albemarle Sound, including stocks in the Tar-Pamlico and Neuse rivers, are considered riverine rather than anadromous spending their entire life in the estuary and river systems (Raney 1952; Dudley et al. 1977; Setzler et al. 1980; Rulifson et al. 1982; Bulak et al. 2004; Callihan et al. 2014).

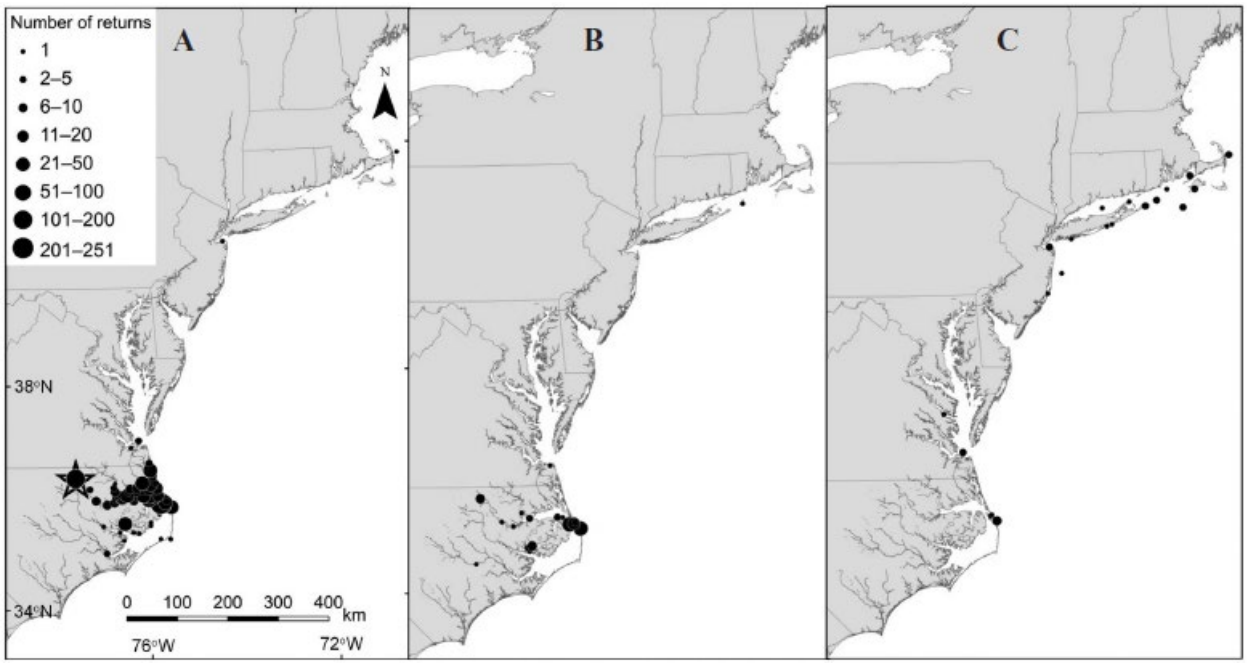

Figure 2. Tag return locations of striped bass (n = 1,176) along the eastern seaboard of the United States by length group (data pooled across years): (A) fish 287–599 mm or 11.3–23.5 inches total length (TL; n = 1,020 returns), (B) fish 600–799 mm or 23.6–31.4 inches TL (n = 101 returns), and (C) fish 800–1,105 mm or 31.5–43.5 inches TL (n = 55 returns). Bubble size represents the number of tag returns from each location. The star in panel A denotes tagging location during annual spring electrofishing surveys conducted in the Roanoke River from 1991–2008. Only tag returns that occurred after the first two weeks but within the first calendar year at liberty were included in analyses (Callihan et al. 2014).

Harvest Strategy

Harvest Season

Conventional tag return data were used to provide insight on where and when stocked hatchery fish and A-R stock fish occur in the Tar-Pamlico and Neuse rivers to inform the best harvest management strategy.

The DMF and WRC have consistently applied internal anchor tags to striped bass during surveys in the Roanoke, Tar-Pamlico, Neuse and Cape Fear rivers since 1980 (Winslow 2010). A portion of hatchery reared phase-II (5–8 inches TL) striped bass are also tagged each year before being released into the Tar-Pamlico and Neuse rivers. Phase-I (1–2

inches TL) and phase-II annual stocking numbers for the Albemarle Sound and the Tar-Pamlico and Neuse rivers 2014–2024 are provided in Table 1.

Table 1. Annual stocking numbers of phase-I (1–2 inches TL) and phase-II (5–8 inches TL) hatchery striped bass by area, 2014–2024.

	Albemarle Sound		Tar-Pamlico River		Neuse River	
Year-Class	Phase-I	Phase-II	Phase-I	Phase-II	Phase-I	Phase-II
2014	0	0	138,889	92,727	79,864	78,866
2015	0	0	0	52,922	0	109,107
2016	0	0	234,718	121,190	80,910	134,559
2017	0	0	0	101,987	0	14,203
2018	0	0	0	120,668	96,900	86,556
2019	0	0	0	97,920	0	85,694
2020	0	0	0	90,614	0	96,933
2021	0	0	0	23,082	31,208	80,122
2022	0	0	175,633	55,465	91,569	33,560
2023	668,243	0	116,989	66,165	62,885	71,527
2024	427,176	133,395	0	0	0	0

During 2014–2024, DMF staff tagged 8,232 A-R striped bass on the Roanoke River spawning grounds, of which 999 have been returned (i.e., caught by a fisherman and reported to DMF) through 2024, for a tag return rate of 12% (Table 2). Tag return locations for all months of the year show 7% of returns came from the Tar-Pamlico and Neuse rivers (Figure 3), and no returns came from outside the Albemarle Sound Management Area (ASMA) during April (Figure 4).

During that same period (2014–2024), 25,044 hatchery reared phase-II striped bass were tagged and released into the Tar-Pamlico River and 34,848 were tagged and released into the Neuse River (Table 2). For tagged striped bass released in the Tar-Pamlico River, 21% of returns occurred outside the Tar-Pamlico River (Figure 5), and for striped bass tagged in the Neuse River, 26% of returns came from outside the Neuse River (Figure 6). Most returns from outside of the tagging system occurred in the adjacent river (i.e., either the Tar-Pamlico or Neuse; Figures 5 and 6). Less than 5% of returns for tagged fish released in either the Tar-Pamlico and Neuse rivers came from outside of the system during April, and all were from adjacent rivers (Figures 7 and 8).

Table 2. Number of striped bass tagged with conventional external tags, number of overall tag returns, number of returns outside of the system where they were tagged, and number of returns in April outside the system they were tagged, 2014–2024.

Tagging Location	Number tagged	Number of overall tag returns (% of tagged)	Number of tag returns outside of system (% of overall returns)	Number of April tag returns outside of system (% of overall returns)
Roanoke River A-R Spawning Stock	8,232	999 (12%)	68 (7%)	0 (0%)
Tar-Pamlico Phase-II Hatchery Stockings	25,044	105 (0.4%)	22 (21%)	3 (3%)
Neuse Phase-II Hatchery Stockings	34,848	150 (0.4%)	39 (26%)	6 (4%)

Figure 3. Tag return locations (all months) of Albemarle-Roanoke striped bass tagged and released on the Roanoke River spawning grounds near Weldon, 2014–2024. Tag returns outside of N.C. are not shown. Each dot represents a single return.

Figure 4. Tag return locations during April of Albemarle-Roanoke striped bass tagged and released on the Roanoke River spawning grounds near Weldon, 2014–2024. Tag returns outside of N.C. are not shown. Each dot represents a single return.

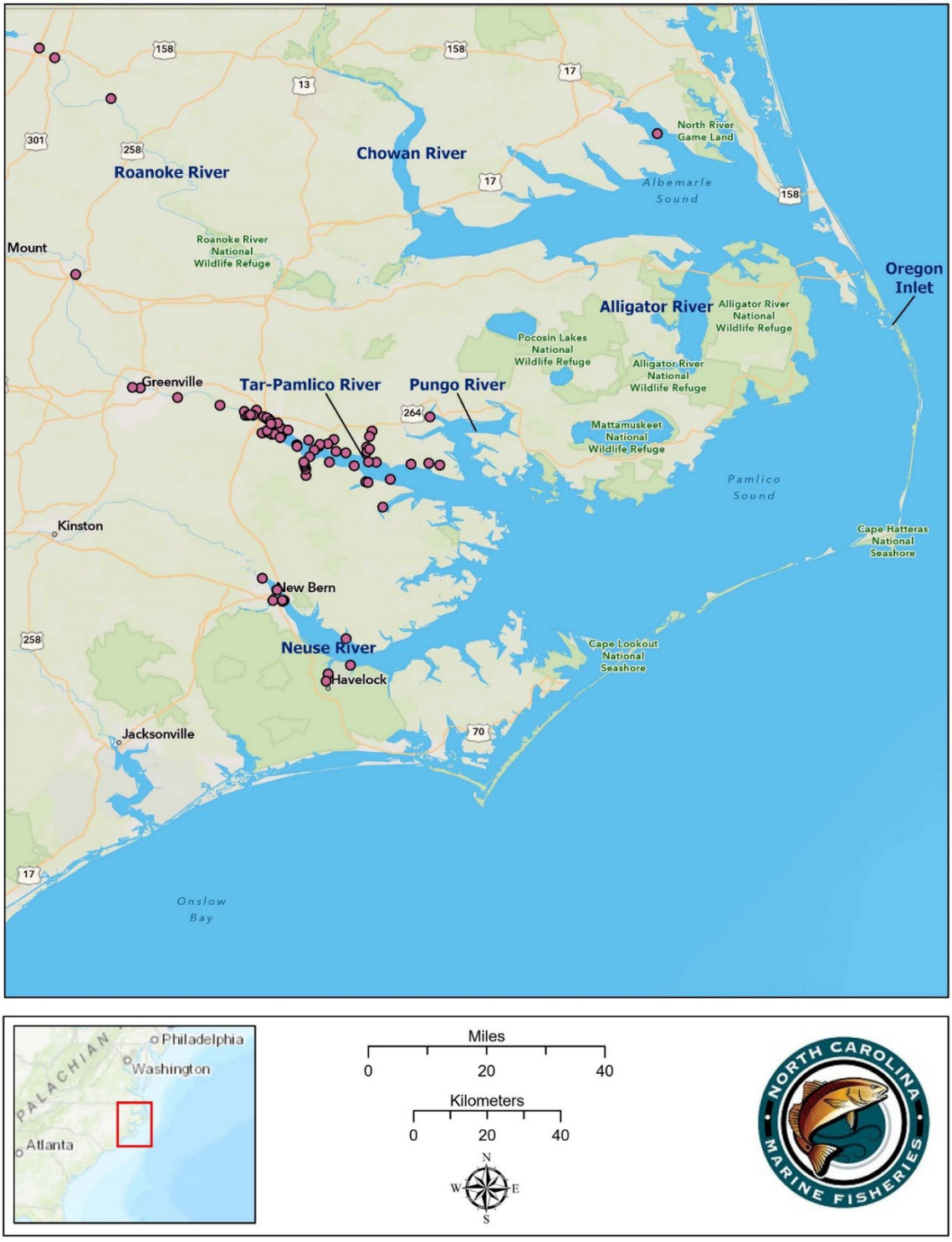

Figure 5. Tag return locations (all months) of phase-II (5–8 inches TL) hatchery reared striped bass tagged and released in the Tar-Pamlico River, 2014–2024. Tag returns outside of N.C. are not shown. Each dot represents a single return.

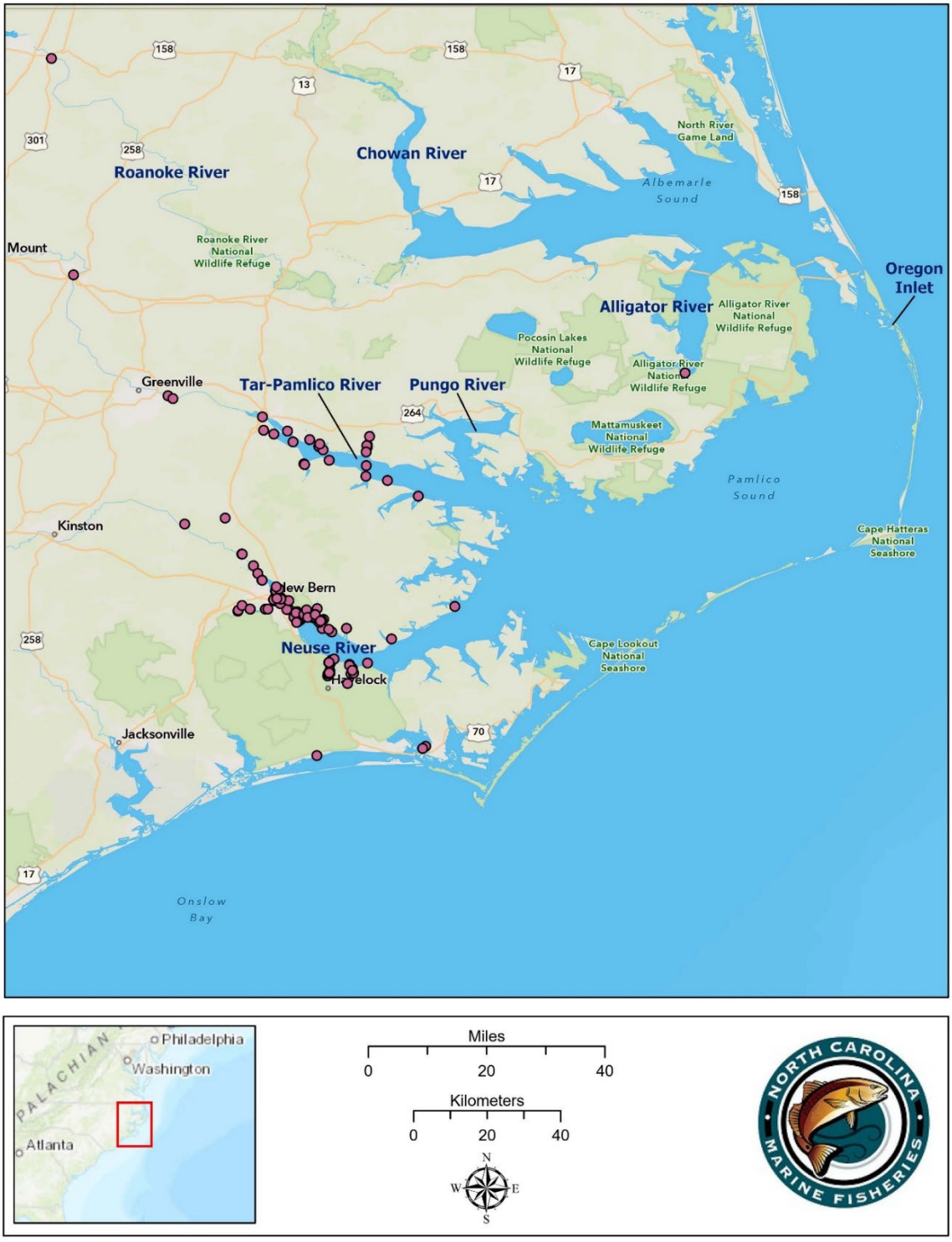

Figure 6. Tag return locations (all months) of phase-II (5–8 inches TL) hatchery reared striped bass tagged and released in the Neuse River, 2014–2024. Tag returns outside of N.C. are not shown. Each dot represents a single return.

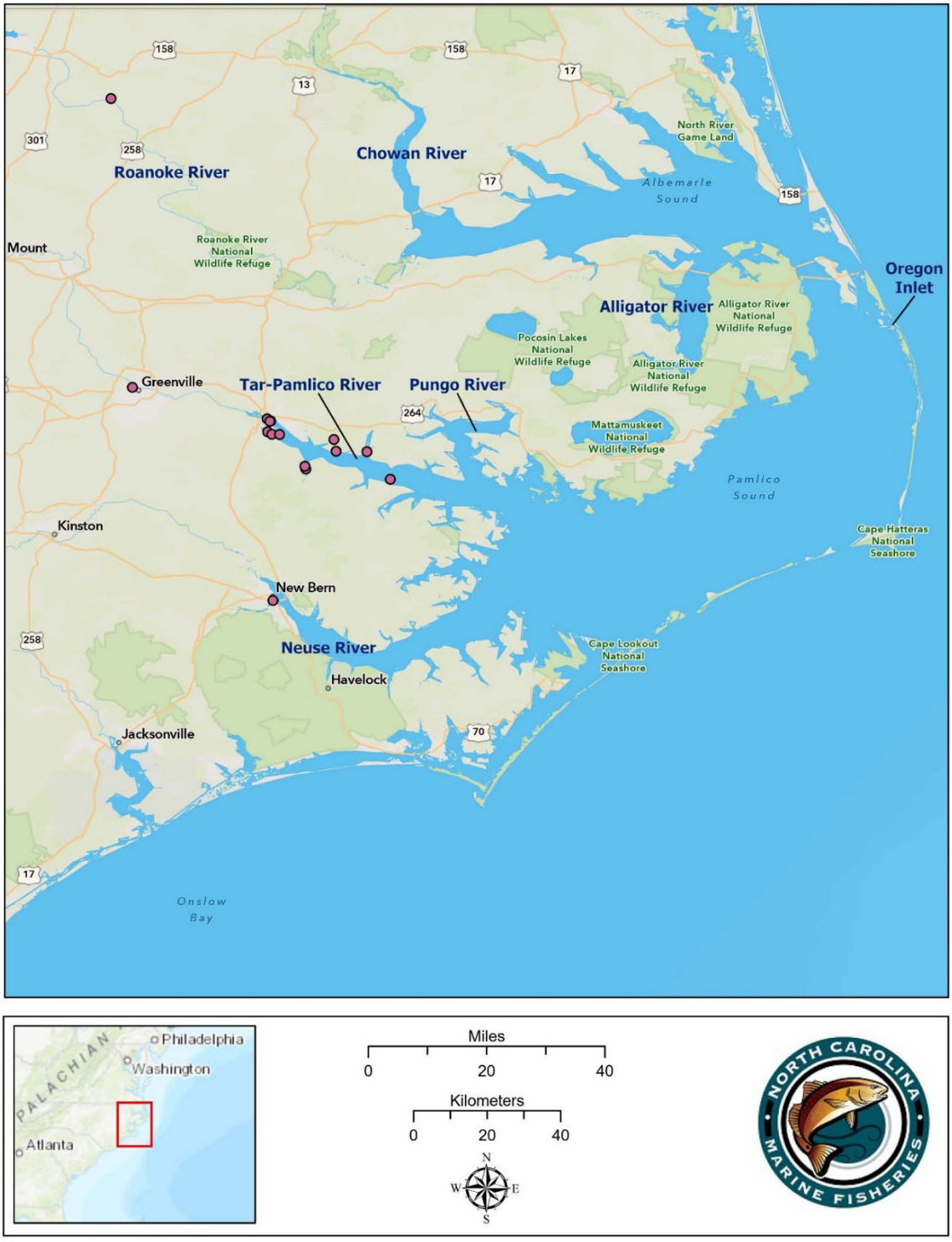

Figure 7. Tag return locations during April of phase-II (5–8 inches TL) hatchery reared striped bass tagged and released in the Tar-Pamlico River, 2014–2024. Each dot represents a single return.

Figure 8. Tag return locations during April of phase-II (5–8 inches TL) hatchery reared striped bass tagged and released in the Neuse River, 2014–2024. Each dot represents a single return.

Based on conventional tag returns, A-R fish start moving from the Tar-Pamlico and Neuse rivers to the Albemarle Sound in March and April and are absent from the rivers in April (Figures 3 and 4). However, acoustic tag data indicate that A-R stock striped bass remain in parts of the Tar-Pamlico and Neuse rivers in April. A-R stock striped bass are still present in the Tar-Pamlico and Neuse rivers during April; therefore, limiting the spatial extent of where harvest can occur in the rivers can be used to further minimize harvest of A-R fish.

Harvest Season Management: Based on analysis of conventional and acoustic tagging data, harvest of striped bass in the Tar-Pamlico and Neuse rivers will only be allowed April 1–April 30 to minimize harvest of A-R fish.

Harvest Area

Acoustic telemetry data provide additional information about striped bass movement that does not rely on a fish being recaptured and reported. Acoustic telemetry data in combination with conventional tag data were used to further refine where and when harvest can occur in the Tar-Pamlico and Neuse rivers so harvest of A-R stock striped bass is minimized.

In response to a significant increase in under-sized (i.e., < 18 inches TL) recreational striped bass releases in 2016 and 2017 (Table 1) and increased abundance of non-hatchery origin (wild) striped bass present in the Tar-Pamlico and Neuse rivers in 2017 and 2018 (Farrae and Darden 2018; NCDMF 2022a), DMF initiated an acoustic telemetry study in 2019 to track movements of acoustically tagged fish (see Appendix 2 and Rock et al. 2016 for further discussion of methodology). Because A-R striped bass return to natal rivers to spawn (Callihan et al. 2015), the objective of the acoustic tagging study was to infer natal origin of wild striped bass found in the lower-middle Tar-Pamlico and Neuse rivers by tracking spring spawning migrations of acoustically tagged fish.

Fifty adult striped bass (from the 2014 and 2015 year classes, age 4–5 in 2020 and 2021 based on length and scale ages) from the lower-middle Tar-Pamlico and Neuse rivers were implanted with acoustic tags. Fin clips were taken from each fish, and Parentage Based Tagging (PBT) analysis was conducted to determine if the fish were of hatchery or 'wild' origin (see Denson et al. 2012). Results of PBT analysis indicated 30 of the tagged striped bass were 'wild' (20 were hatchery origin). Six of those 30 "wild" striped bass did not have enough detection data to be used in analysis. Of the 30 wild striped bass, 70% (n=21) were later detected in the Albemarle Sound or on the Roanoke River spawning grounds in the spring. Most (53%, 11 out of 21) of the wild fish entering the Albemarle Sound were detected on the spawning grounds near Weldon, N.C., with five making

repeated annual migrations in the spring back to the Roanoke River spawning grounds, suggesting these fish were part of the A-R stock. A single 'wild' striped bass tagged in the Tar-Pamlico River was later detected on the spawning grounds in the Tar-Pamlico River and one 'wild' striped bass tagged in the Neuse River was later detected on the spawning grounds in the Neuse River, suggesting limited natural recruitment in these rivers, or possible straying of A-R stock fish to the Tar-Pamlico and Neuse rivers spawning grounds. Additionally, one wild striped bass tagged in the Neuse River was later detected on the spawning grounds in the Tar River. The patterns indicated by the acoustic detections suggest most wild fish from the 2014 and 2015 year classes present in the Tar-Pamlico and Neuse rivers were part of the A-R stock, which had above-average recruitment in 2014 and 2015 (Figure 1; see Appendix 1 for additional details).

In contrast to conventional tag return data, telemetry data indicated a portion of the A-R stock resides in the Tar-Pamlico and Neuse rivers during the month of April. To evaluate the potential spatial extent of harvest that would minimize harvest of A-R stock striped bass, the rivers were divided into four areas based on already established boundary lines (gill net tie down line, gill net distance from shore line, small mesh gill net attendance line, and Coastal/Joint/Inland Fishing Waters boundary lines; see Figures 9 and 10).

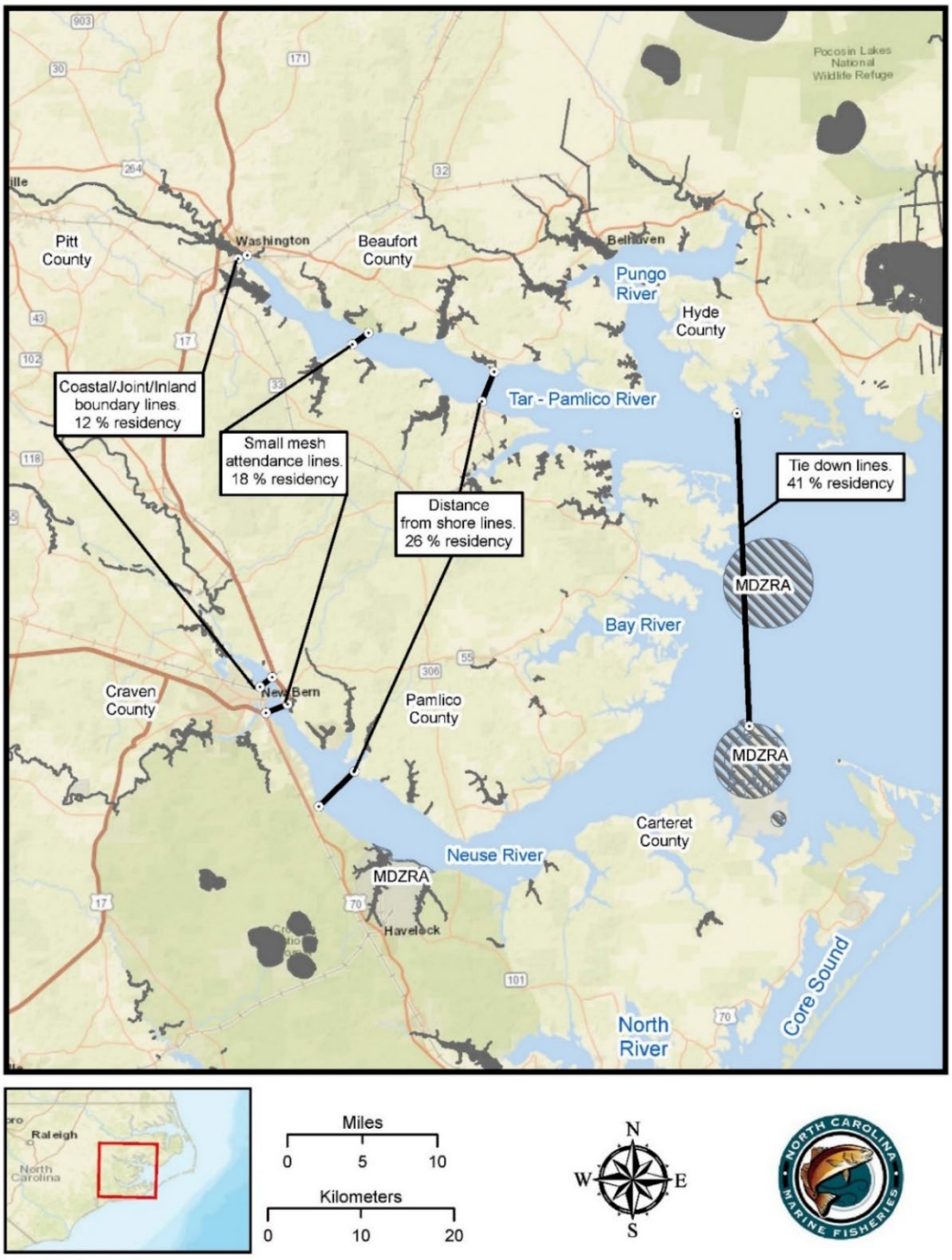

Figure 9. Harvest area lines analyzed using acoustic tagged ‘wild’ Albemarle-Roanoke striped bass in the Tar-Pamlico and Neuse rivers during April 2020 and 2021.

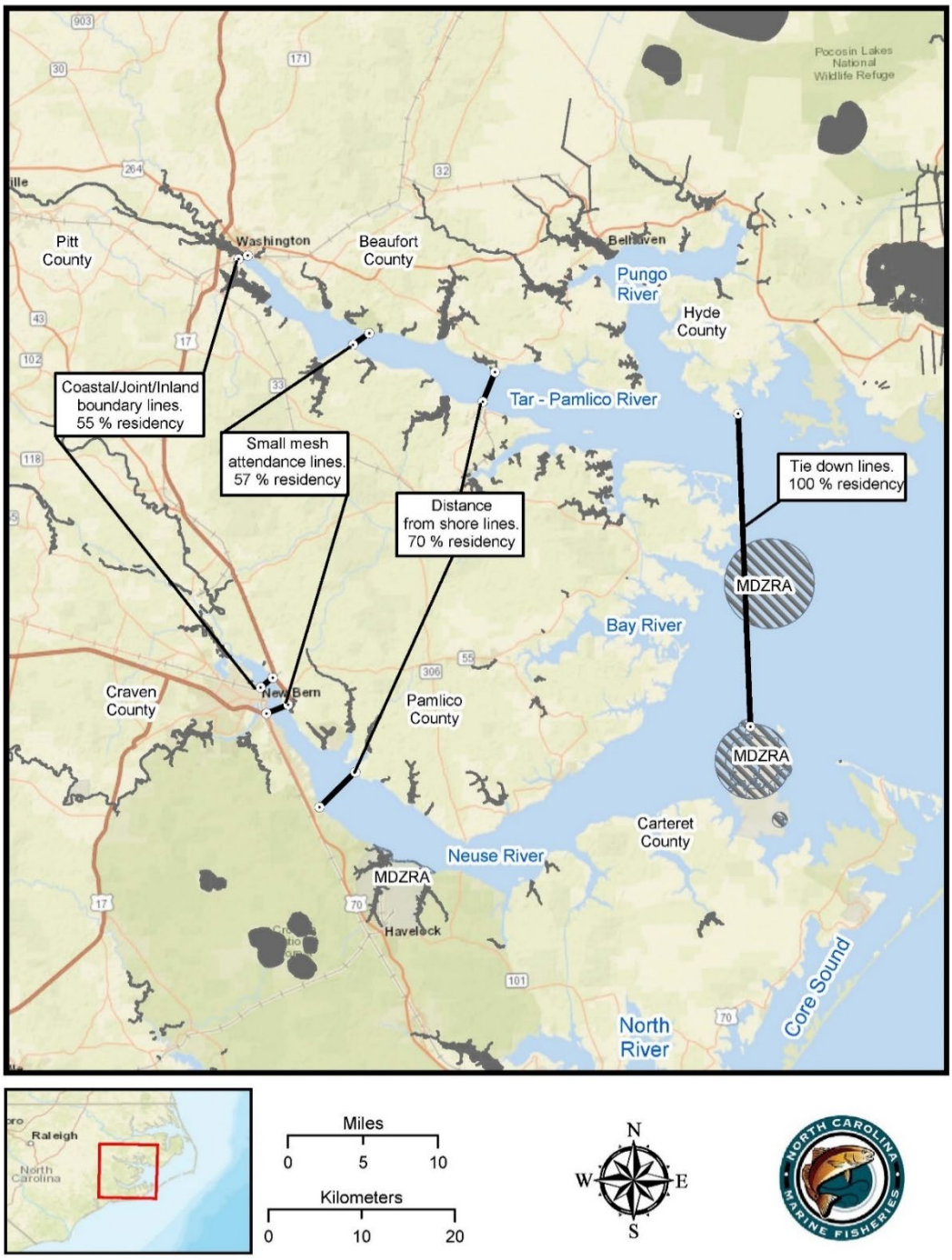

Figure 10. Harvest area lines analyzed using acoustic tagged hatchery stocked striped bass in the Tar-Pamlico and Neuse rivers during April 2020 and 2021.

Residency analysis, examining the amount of time an acoustic tagged fish was present in each area based on acoustic detections on receivers in that area, indicated A-R stock

striped bass were in the Tar-Pamlico and Neuse rivers above the gill net tie down line 41% of the days in April 2021 and 2022 (Table 3; Figure 9).

Table 3. Percent residency time of 'wild' acoustic tagged Albemarle-Roanoke striped bass in segments of the Tar-Pamlico and Neuse rivers during April 2021 and 2022. Harvest line boundaries are based on existing management boundaries and locations of acoustic receivers in the Tar-Pamlico and Neuse rivers.

Harvest line boundaries	Percent residency time 'wild' Albemarle-Roanoke striped bass
Coastal/Joint/Inland Boundaries	12%
Small Mesh Attendance Line	18%
Distance From Shore Line	26%
Tie-Down Line	41%

Residency analysis considering other boundaries farther upriver indicated A-R stock striped bass are not found throughout the entire Tar-Pamlico and Neuse rivers during the entire month of April. Residency analysis of hatchery origin striped bass in the Tar-Pamlico and Neuse rivers indicated hatchery striped bass were concentrated in upriver areas during the entire month of April (Table 4; Figure 10).

Table 4. Percent residency time of hatchery stocked acoustic tagged striped bass in segments of the Tar-Pamlico and Neuse rivers during April 2021 and 2022. Harvest line boundaries are based on existing management boundaries and locations of acoustic receivers in the Tar-Pamlico and Neuse rivers.

Harvest line boundaries	Percent residency time hatchery striped bass
Coastal/Joint/Inland Boundaries	55%
Small Mesh Attendance Line	57%
Distance From Shore Line	70%
Tie-Down Line	100%

Residency patterns of 21 A-R fish were compared to stocked fish to determine the downstream extent of where harvest can occur in April to minimize harvest of A-R stock fish. Residency analysis indicated limiting harvest to areas above the distance from shore line (acoustic tagged fish only available 26% of April above this line) should limit potential harvest of A-R stock striped bass (Table 3; Figure 9).

Residency analysis for the 20 acoustically tagged hatchery striped bass shows hatchery fish reside in the Tar-Pamlico and Neuse rivers year-round (Table 4; Figure 10). April tag detections indicate hatchery fish reside between the Coastal/Joint/Inland Fishing Waters boundary lines and the distance from shore line, with very little residency time above the Coastal/Joint/Inland Fishing Waters boundary lines (Table 4; Figure 10). In addition, most conventional tag returns are from the middle and lower parts of the rivers, with very few returns above the Coastal/Joint/Inland Fishing Waters boundary lines (Figures 7 and 8).

Unless the harvest line is at least upstream of the distance from shore line in each river, there will be limited opportunity to harvest stocked striped bass.

Harvest Area Management: Considering the intent of allowing harvest of hatchery striped bass while limiting potential harvest of A-R striped bass, harvest will be allowed upstream of the distance from shore demarcation lines.

HARVEST SIZE LIMIT

Current size limits for striped bass are established in rule and proclamation but vary across N.C. jurisdictional waters. For example, the MFC has authority over striped bass in Coastal Fishing Waters (excluding Joint Fishing Waters), where the minimum size limit is 18 inches TL, while the WRC has authority over striped bass in Inland Fishing Waters, where the minimum size limit is 26 inches TL. The MFC and WRC share authority over striped bass in Joint Fishing Waters through joint rules 15A NCAC 03Q .0107 and 15A NCAC 10C .0107, which allow harvest of fish that are a minimum length of 18 inches TL and no fish between 22 and 27 inches TL. For Coastal and Inland fishing waters, changes to size limits can be made relatively quickly. Changes to size limits in Coastal Fishing Waters can be made effective within 48 hours through the MFC's delegation of proclamation authority to the DMF Director (15A NCAC 03M .0202); changes in Inland Fishing Waters can be accomplished through WRC's temporary rulemaking process, which can happen in under a year. However, standardizing size limits in Joint Fishing Waters requires amending the joint rules 15A NCAC 03Q .0107 and 15A NCAC 10C .0107, which must be approved by the MFC and WRC and go through the established permanent rule-making process (e.g., approximately two to three years).

The DMF and WRC staff decided that implementing the same size limit across jurisdictional boundaries in the harvest area of the Tar-Pamlico and Neuse rivers and their tributaries should help to avoid angler and enforcement confusion. Because of the significant time it would take to change the size limit in Joint Fishing Waters, the striped bass harvest season in April 2026 will open with the size limit in the joint rules: 18 inch minimum and no fish between 22 and 27 inches TL. Prior to the April 2026 harvest

season, the WRC will initiate temporary rulemaking to amend the size limit in their rule for Inland Fishing Waters and the DMF Director will set the size limit for Coastal Fishing Waters through proclamation. It is critical to the resiliency of the stock to maintain a wide range of age classes in the population. Female striped bass produce more eggs of higher quality as they get older (see NCDMF 2022 for review). Because of this, allowing harvest of fish greater than 27 inches TL may hinder future recruitment potential if environmental conditions are sufficient to support recruitment. However, based on the length frequency of striped bass observed in the recreational harvest, very few fish greater than 27 inches TL are expected to be harvested (Figure 11).

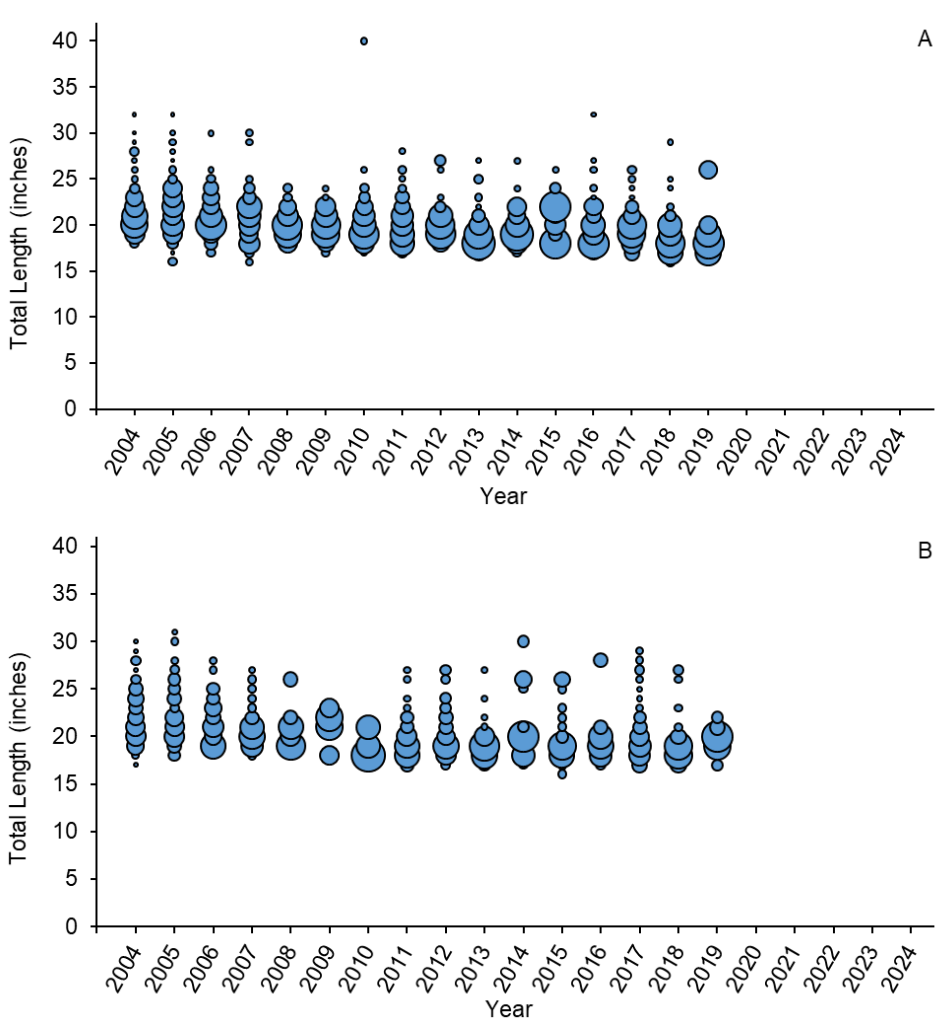

Figure 11. Recreational length frequency of striped bass harvested in the Tar-Pamlico/Pungo rivers (A), and the Neuse River (B), 2004–2024. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length. There was a limited recreational harvest season in 2019 (January 1–March 19, 2019) prior to the harvest closure.

DMF and WRC staff plan to begin the process for joint rulemaking to establish a consistent size limit for striped bass fisheries across all jurisdictions and management areas, including the Roanoke River Management Area (RRMA), ASMA, and Central Southern Management Area (CSMA). As a result, future seasons will remove the allowance for fish greater than 27 inches TL.

Size Limit Management: For the Coastal/Joint/Inland Fishing Waters of the Tar-Pamlico and Neuse rivers and all tributaries above the distance from shore demarcation lines, allow harvest of striped bass that are 18 inch minimum TL and no fish between 22 and 27 inches TL until the MFC and WRC Joint Fishing Waters rules can be amended to not allow harvest of fish greater than 27 inches TL.

HARVEST DAILY POSSESSION LIMITS

With the goal of allowing protection for and access to the resource, while also limiting harvest of A-R fish, possession limits must be conservative to limit overall harvest. Potential harvest levels can be inferred from historical data. Historical recreational and commercial fisheries data were reviewed to evaluate overall harvest potential and April harvest potential. Striped bass harvest, in numbers of fish, for both the recreational and commercial sectors in the Tar-Pamlico and Neuse River systems averaged 7,810 per year during 2004–2018 (Table 5).

During 2004–2018, the recreational sector average annual harvest of striped bass was 3,753 fish per year (range = 843–7,334) and 4,056 fish per year (range = 1,719–6,029) for the commercial sector (Table 5); data from 2019 were excluded from this calculation because the fishery closed in March of that year and do not represent a complete fishing year. When the fishery was open, daily possession limits were two fish per person per day for the recreational sector and 10–15 fish per operation per day for the commercial sector. The recreational season was open October 1–April 30 each year with no harvest quota, while the commercial season opened April 1 and closed when the 25,000 lb quota was reached, usually in 3–4 weeks. Reverting back to management measures in place before the harvest closure that allowed this level of harvest risks unintended capture of A-R striped bass. During 2012–2017, the number of commercial participants in the striped bass fishery in the Tar-Pamlico and Neuse rivers ranged from 63 to 97 participants (NCDMF 2019a; Supplement A). If a 10-fish commercial daily limit per operation were allowed, it could potentially result in between 18,900 and 29,100 striped bass harvested during April if commercial effort and participation were high.

Because April is the target month to open the striped bass fishery in the harvest management strategy, harvest estimates for that month only were examined. Based on

available April data during the open harvest seasons (2007–2018), annual recreational harvest estimates averaged 233 fish in the Neuse River and 435 fish in the Tar-Pamlico River, with the Tar-Pamlico harvest exceeding 2,000 fish in 2016 (Table 6).

Table 5. Recreational harvest estimates (number and weight in pounds) and releases (number of fish) and total commercial harvest (number and weight in pounds) of striped bass in the Tar-Pamlico, Pungo, and Neuse rivers, 2004–2024. There was a limited recreational harvest season in 2019 (January 1–March 19, 2019) prior to the harvest closure. Data sources: DMF Striped Bass Creel Survey for recreational data and the Division of Marine Fisheries Trip Ticket Program for commercial data. Gray shading indicates large increase in recreational releases that, in part, prompted development of Supplement A to Amendment 1 (NCDMF 2019a).

	Recreational			Commercial			
Year	Number Landed	Number Released	Weight Landed	Number Landed	Weight Landed	Total Number Landed	Total Weight Landed
2004	6,141	13,557	22,958	3,950	32,479	10,091	55,437
2005	3,832	16,854	14,965	3,723	27,132	7,555	42,097
2006	2,481	14,895	7,352	2,850	21,149	5,331	28,501
2007	3,597	23,527	10,794	3,608	25,008	7,205	35,802
2008	843	17,966	2,990	1,719	10,115	2,562	13,105
2009	895	6,965	3,061	4,140	24,847	5,035	27,908
2010	1,757	7,990	5,537	4,486	23,888	6,243	29,425
2011	2,728	24,188	9,474	4,083	28,054	6,811	37,528
2012	3,922	43,313	15,240	3,693	22,725	7,615	37,964
2013	5,467	32,816	19,537	4,439	28,597	9,906	48,134
2014	3,301	30,209	13,368	5,830	25,245	9,131	38,613
2015	3,934	31,353	14,269	6,029	27,336	9,963	41,605
2016	6,697	75,461	25,260	4,123	23,041	10,820	48,301
2017	7,334	131,129	26,973	4,382	23,018	11,716	49,991
2018	3,371	49,122	10,884	3,788	20,057	7,159	30,941
2019	959	36,080	3,562	0	0	959	3,562
2020	0	19,420	0	0	0	0	0
2021	0	23,216	0	0	0	0	0
2022	0	30,026	0	0	0	0	0
2023	0	13,536	0	0	0	0	0
2024	0	9,795	0	0	0	0	0
Mean	3,579	31,020	12,889	4,056	24,179	5,624	35,557

Table 6. Number of striped bass harvested, pounds harvested, total caught, and total discards in the recreational fishery during April in the Tar-Pamlico and Neuse rivers, 2007–2018.

Year	Neuse				Tar-Pamlico			
	Number Harvested	Pounds Harvested	Number Caught	Number Discarded	Number Harvested	Pounds Harvested	Number Caught	Number Discarded
2007	135	462	256	121	69	363	1,809	1,740
2008	0	0	0	0	0	0	494	494
2009	0	0	151	151	0	0	86	86
2010	71	252	71	0	188	761	796	608
2011	0	0	637	637	83	0	717	634
2012	245	967	929	684	179	695	1,072	893
2013	385	1,460	1,919	1,534	627	2,135	2,115	1,488
2014	309	1,404	892	583	276	1,033	2,025	1,749
2015	203	730	400	196	267	978	1,597	1,330
2016	783	2,923	3,061	2,278	2,380	9,017	9,589	7,208
2017	378	1,496	2,532	2,153	653	2,351	6,697	6,045
2018	291	915	675	385	500	1,725	2,540	2,040
Mean	233	884	960	727	435	1,588	2,461	2,026

To limit harvest levels below what occurred prior to the 2019 closure, the daily possession limit will be one fish per person for both the commercial and recreational sectors. Per the Amendment 2 adaptive management framework, hook-and-line will be a legal commercial gear for directed harvest of striped bass in the coastal and Joint Fishing Waters of the Tar-Pamlico and Neuse rivers. The intent is to not allow a directed commercial gill net fishery but allow limited incidental harvest in other gill net fisheries occurring in April (e.g., American shad *Alosa sapidissima*, hickory shad *Alosa mediocris*, spotted seatrout, and striped mullet gill net fisheries). There are a series of small and large mesh gill net regulations currently in rule, many of which specifically limit the capture of striped bass (Figure 12). As described in Amendment 2, additional restrictions on the use of large mesh gill nets during the open shad season will also be considered to limit incidental capture of striped bass. Analysis of observer data shows striped bass are less abundant in shad nets set greater than 200 yards offshore (striped bass observed in only 26% of nets), while harvest of hickory and American shad was not significantly impacted (NCDMF 2022a). If it is determined additional protections for the stocks are needed, the Amendment 2 adaptive management framework provides for adjustment of management measures, including area, time, and gear restrictions. Dealers will still be required to tag each striped bass commercially landed.

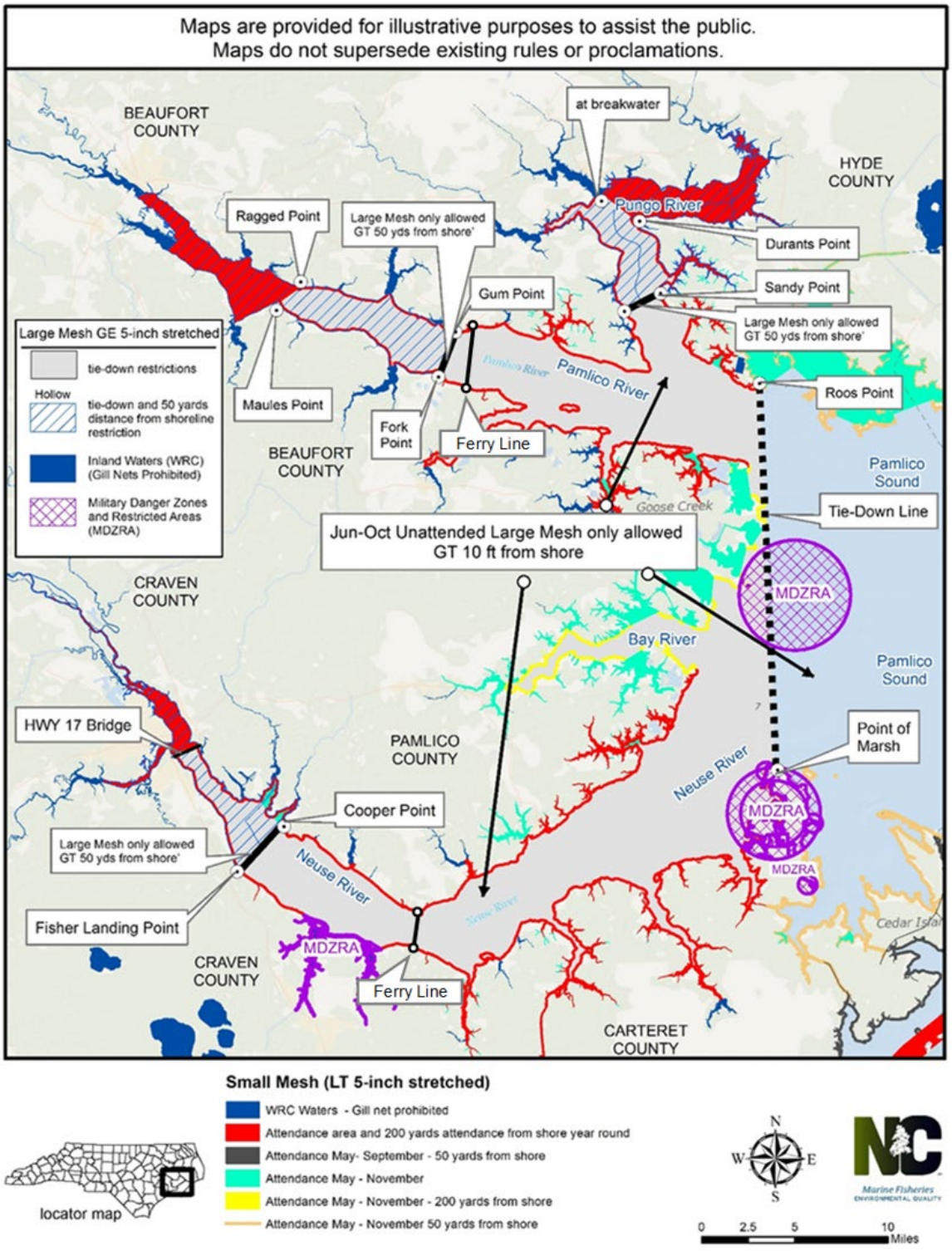

Figure 12. Gill net regulations in the Tar-Pamlico and Neuse rivers. GT=greater than and LT=less than.

Prior to the harvest closure in 2019, commercial striped bass harvest in the CSMA was quota managed. Dealers were required to obtain a Striped Bass Dealer Permit to purchase striped bass. The permit required dealers to submit a daily report of the number and pounds of striped bass purchased. This reporting was necessary to monitor harvest and avoid exceeding the quota. When the CSMA harvest closure was continued in Amendment 2 to the N.C. Estuarine Striped Bass FMP (NCDMF 2022a), quota management ended and the Striped Bass Dealer Permit was no longer necessary. The current revision does not reinstate quota management and without a quota to monitor, there is no longer a need for daily reporting of commercially harvested striped bass in the CSMA. Elimination of the daily reporting requirement lightens the regulatory burden for dealers participating in this limited fishery. In the future, if a quota is reestablished in the CSMA, the Striped Bass Dealer Permit and its requirements will apply.

Harvest Daily Possession Limit Management: One fish per person daily possession limit for both the commercial and recreational sectors. Hook-and-line gear will be a legal commercial gear to directly harvest striped bass when the harvest season opens. Incidental harvest of striped bass in commercial gill net fisheries will also be allowed.

Monitoring And Adaptive Management

It is crucial to evaluate both the total level of harvest and the percent of harvest attributed to hatchery or A-R striped bass (assuming all non-hatchery ‘wild’ striped bass are from the A-R stock) during the April harvest seasons. Fin clips will be obtained from the commercial and recreational fisheries and analyzed to determine the percentage of hatchery versus ‘wild’ fish in the harvest. If the level harvest of A-R striped bass is determined to be excessive, the Amendment 2 adaptive management framework will be used to implement changes to the Harvest Management Strategy prior to future harvest seasons. Additional information collected from the recreational and commercial harvest, including length and age, will provide important information to further monitor the stocks.

Onboard observer coverage in the applicable gill net fisheries will be important so estimates of striped bass discards can be calculated. If necessary, the Amendment 2 adaptive management framework will be used to address striped bass discards and implement changes to the harvest management strategy prior to future harvest seasons.

PROPOSED RULE(S)

DMF and WRC staff plan to begin the process for joint rulemaking to establish a consistent size limit for striped bass fisheries across all jurisdictions and management areas. Establishing a consistent size limit will provide protection for larger, older striped bass, alleviate angler confusion, and ease enforcement of size limits.

FINAL MANAGEMENT STRATEGY

Open a recreational and commercial harvest season for striped bass in the Coastal and Joint Fishing Waters, and recreational harvest season in the Inland Fishing Waters of the Tar-Pamlico and Neuse rivers, including all adjacent tributaries, upstream of the distance from shore demarcation lines (Figure 12)

The season will be open April 1–30

One fish per person per day possession limit for recreational and commercial sectors

An 18 inch minimum TL and no striped bass between 22 and 27 inches TL

Hook-and-line will be a legal commercial gear in the Coastal and Joint Fishing Waters

APPENDICES

APPENDIX 1: ANALYSIS OF STRIPED BASS FISHERY-INDEPENDENT AND FISHERY-DEPENDENT DATA FROM THE TAR-PAMLICO AND NEUSE RIVERS FOR PURPOSES OF AMENDMENT 2 ADAPTIVE MANAGEMENT

ISSUE

Determine whether striped bass populations in the Tar-Pamlico and Neuse rivers are self-sustaining and if sustainable harvest can be determined

Assess the impact of the 2019 no-possession provision and the gill net closure (closures) on the stocks

Assess the impact of the 2019 gill net closure above the ferry line in each river system on the stocks

The goal of Amendment 2 is to manage the estuarine striped bass fisheries to achieve self-sustaining populations that provide sustainable harvest based on science-based decision-making processes. If biological and/or environmental factors prevent a self-sustaining population, then alternate management strategies will be implemented that provide protection for and access to the resource.

ORIGINATION

Amendment 2 to the North Carolina Estuarine Striped Bass Fishery Management Plan (FMP) adopted an adaptive management strategy where data through 2024 will be reviewed in 2025 to determine if populations are self-sustaining and if sustainable harvest can be determined. In addition, the approved North Carolina Marine Fisheries Commission (MFC) motion included language to: “maintain the gill net prohibition through 2024 to allow for assessment of its performance”.

The Amendment 2 adaptive management strategy further stated if the data review suggests continuing the no-possession provision is needed for additional stock recovery, no changes in harvest management measures will be recommended until the next scheduled FMP Amendment is developed starting in 2027. Adaptive management may be used to adjust management measures including area and time restrictions and gear restrictions if it is determined additional protections for the stock are needed.

If analysis indicates the populations are self-sustaining and a level of sustainable harvest can be determined, recommendations for harvest strategies will be developed. If analysis indicates biological and/or environmental factors prevent a self-sustaining population, then alternate management strategies will be developed that provide protection for and access to the resource.

BACKGROUND

Natural reproduction is required for maintaining self-sustaining fish populations at levels that support harvest. In self-sustaining populations, the numbers of offspring produced by natural reproduction are greater than can be stocked by managers. Until there are naturally reproducing populations in the Tar-Pamlico and Neuse rivers capable of self-replacement, the sustainable harvest objective of Amendment 2 cannot be met.

The Tar-Pamlico and Neuse rivers striped bass populations have been sustained by continuous stocking since at least the early 2000's (O'Donnell and Farrae 2017; see NCDMF 2022a), providing harvest opportunities for recreational and commercial fisheries in the rivers (Table 5).

Roanoke River origin striped bass have either been stocked or used as broodstock in the Tar-Pamlico and Neuse rivers for decades (Bayless and Smith 1962; Woodroffe 2011). Although North Carolina rivers, including the Tar-Pamlico and Neuse rivers, may have once supported genetically distinct populations, evidence suggests there is little genetic differentiation among populations (Reading et al. 2020). The need for continued conservation management efforts are supported by persistent recruitment failure, multiple mortality sources, absence of older, larger fish, low water flow levels on the spawning grounds in the spring, poor environmental conditions in nursery areas, and the high percentage of stocked fish in the populations (Bradley et al. 2018; Rachels and Ricks 2018; Mathes et al. 2020). Reliable population estimates have never been determined for the Tar-Pamlico River stock. In 2018, Bradley et al. (2018) provided a population estimate of 18,457 adult striped bass for the Neuse River stock.

Life History

Striped bass are an estuarine dependent species found from the lower St. Lawrence River in Canada to the west coast of Florida through the northern shore of the Gulf of Mexico to Texas. Striped bass typically migrate long distances to spawning grounds located in freshwater portions of coastal rivers. The Albemarle-Roanoke (A-R) stock is considered migratory, meaning they spend most of their adult life in estuarine and nearshore ocean waters, migrating to fresh water to spawn in the spring. Striped bass stocks from the Tar-Pamlico and Neuse rivers south through Florida, are considered riverine, meaning they do not make extensive seasonal ocean migrations like northern (Roanoke River and north) striped bass stocks and, instead, spend their entire life in the upper estuary and riverine system (Setzler et al. 1980; Rulifson et al. 1982; Callihan 2012).

Historically there were naturally reproducing stocks of striped bass in many of the large coastal rivers in South Carolina, Georgia, and Florida. Similar to North Carolina, the striped bass stocks in these states started showing declines in abundance and reduced

natural spawning success in the 1970s or earlier. While there remain a few coastal rivers in these states that have naturally reproducing populations of striped bass, reproduction is limited and harvest management strategies are supported by extensive striped bass stocking programs in these states (see SCDNR; GADNR; FLFWC for information about striped bass stocks and stocking programs in South Carolina, Georgia, and Florida; Bulak et al. 2004; Reinhart and Peterson 2008).

Striped bass can live to approximately 30 years and attain a size of 60 inches total length (TL; NCDMF 2025a). However, a maximum age of 15 years has been observed for striped bass in the Tar-Pamlico and Neuse rivers, and fish older than eight are rare. Striped bass in the Central Southern Management Area (CSMA; Tar-Pamlico, Neuse and Cape Fear rivers) grow at a faster rate and have a greater total length at age compared to the A-R stock (Knight 2015) and Neuse River striped bass exhibit the fastest growth rate in the CSMA (Mathes et al. 2020).

In the Tar-Pamlico and Neuse rivers, 50% of female striped bass are mature at 2.7 years and 98% are mature by age-3 (Knight 2015). Length at 50% maturity (L50) in the Tar-Pamlico and Neuse rivers was estimated at 467.8 mm TL (18.4 inches TL) and fish were estimated to be 100% mature at 537.3 mm TL (21.2 inches TL). Female striped bass produce large quantities of eggs that are broadcast into riverine spawning areas and are then fertilized by age-2 and older males. In the Tar-Pamlico and Neuse rivers, fecundity ranged from 223,110 eggs for an age-3 female to 3,273,206 eggs for an age-10 female.

In the Tar-Pamlico River, striped bass spawning is suspected to occur from the Rocky Mount Mills Dam, 125 miles upstream of Washington, NC, to Tarboro, NC (Smith and Rulifson 2015). Neuse River spawning grounds are centered between Smithfield and Clayton, NC, but range from Kinston at river mile (rm) 130 to Raleigh (rm 236). Successful juvenile recruitment occurs infrequently and at low levels in the Tar-Pamlico and Neuse rivers (Mathes et al. 2020). The Tar-Pamlico and Neuse rivers stocks are supported by continuous stocking efforts as evidenced by stocked fish comprising nearly 100% of the striped bass on the spawning grounds and up to 70% in downriver coastal fishing waters in some years (O'Donnell and Farrae 2017; Cushman et al. 2018; Farrae 2019; Harris and Farrae 2020; Mathes et al. 2020; Harris and Farrae 2021; Harris and Farrae 2022; Doll and Farrae 2023; Doll and Farrae 2024).

Management History

FMP Amendment 1

Amendment 1 amended the 2004 Estuarine Striped Bass FMP. Management measures in Amendment 1 consisted of daily possession limits, open and closed harvest seasons,

seasonal gill net attendance and other gill net requirements, minimum size limits, and slot limits to work towards the goal of achieving sustainable harvest (NCDMF 2013). Other gill net requirements included tie down and distance from shore management measures maintained from the 2004 Estuarine Striped Bass FMP (NCDMF 2004). Amendment 1 also maintained the 2004 FMP stocking measures in the major CSMA river systems.

Supplement A to Amendment 1

In 2017 and 2018, Parentage Based Tagging (PBT) genetic analyses suggested there were potentially one or two successful striped bass spawning events in the Tar-Pamlico and Neuse rivers in 2014 and 2015 that produced 'wild' fish (Table 1.1; NCDMF 2019a). Additionally, 2016–2018 CSMA Creel Survey angler data showed a significant increase in recreational catch of under-sized (i.e., < 18 inches TL) striped bass in the Pungo, Tar-Pamlico and Neuse rivers (Figure 1.1).

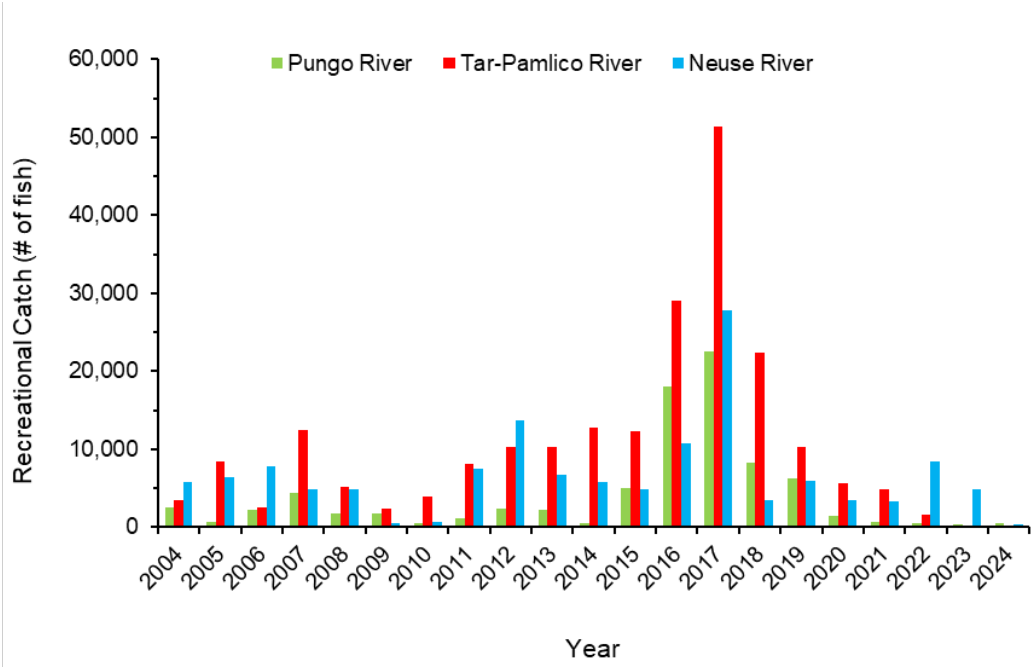

Figure 1.1. CSMA Creel Survey estimates of under-sized (i.e., < 18 inches TL) recreationally caught striped bass in the Pungo, Tar-Pamlico, and Neuse rivers, 2004–2024.

Table 1.1. Parentage Based Tagging (PBT) results from Tar-Pamlico and Neuse rivers striped bass showing the number and percentages of hatchery origin versus 'wild' origin fish, 2016–2024.

River System	Year	Number of PBT Samples	Hatchery (n)	'Wild' (n)	Hatchery (%)	'Wild' (%)
Tar-Pamlico	2016	190	164	26	86.0	14.0
	2017	147	102	45	70.0	31.0
	2018	206	74	132	36.0	64.0
	2019	108	48	60	44.4	55.6
	2020	56	39	17	69.6	30.4
	2021	103	53	50	51.5	48.5
	2022	81	75	6	92.6	7.4
	2023	47	44	3	93.6	6.4
	2024	21	20	1	95.2	4.8
Neuse	2016	150	142	8	95.0	5.0
	2017	118	66	52	56.0	44.0
	2018	86	46	40	54.0	47.0
	2019	102	68	34	66.7	33.3
	2020	24	17	7	70.8	29.2
	2021	114	56	58	49.1	50.9
	2022	34	29	5	85.3	14.7
	2023	35	33	2	94.3	5.7
	2024	23	22	1	95.7	4.3

These two data streams indicated potentially naturally produced year classes. Supplement A to Amendment 1 was developed specifically to provide additional protection for these year classes (NCDMF 2019a). The supplement implemented a recreational and commercial no-possession provision for striped bass in the internal Coastal and Joint Fishing Waters of the Tar-Pamlico and Neuse rivers in support of the Amendment 1 goal to achieve sustainable harvest through science-based decision-making processes that conserve adequate spawning stock and provide and maintain a broad age structure. Supplement A also maintained commercial gill net restrictions requiring 3-foot tie-downs and 50-yard distance from shore measures year-round (M-5-2019) while prosecuting other fisheries. Rock et al. (2016) estimated these measures decreased striped bass discards by 82% compared to estimates prior to implementation, indicating effectiveness of these measures.

Ferry Line Gill Net Closure

Independent of Supplement A but also at the February 2019 MFC business meeting, the following motion passed:

“Ask the director of the NCDMF to issue a proclamation, effective in conjunction with the Supplement, that restricts the use of gill nets that interact with striped bass upstream of the ferry lines and requires attendance of gill nets that interact with striped bass upstream of the tie-down lines.”

After careful consideration, the DMF Director declined the request concluding that scientific data did not support the requested management measure (see Appendix 4, DMF Director Memo). On March 13, 2019, the MFC held an emergency meeting to request the North Carolina Wildlife Resources Commission (WRC) to adopt concurrent regulations regarding recreational harvest of striped bass in Joint Fishing Waters. At the emergency meeting the MFC passed a motion directing the division to issue a proclamation regarding gill nets beyond what was contained in Supplement A (see Appendix 5).

An emergency meeting called under N.C. General Statute section 113-221.1(d), authorizes the MFC to review the desirability of directing the fisheries director to issue a proclamation. Once the MFC votes under this provision to direct issuance of a proclamation, the fisheries director has no discretion to choose another management option and is bound by law to follow the MFC decision. In these cases, under existing law, the decision of the MFC to direct the director to issue a proclamation is final and can only be overruled by the courts. Given this requirement, Proclamation M-6-2019 implemented the following:

Prohibits the use of all gill nets upstream of the ferry lines from the Bayview Ferry to Aurora Ferry on the Pamlico River and the Minnesott Beach Ferry to Cherry Branch Ferry on the Neuse River.

Maintains tie-down (vertical net height restrictions) and distance from shore restrictions for gill nets with a stretched mesh length 5 inches and greater in the western Pamlico Sound and rivers (superseded proclamation M-5-2019).

Amendment 2

Amendment 2, adopted in November 2022, contained management measures for the Tar-Pamlico and Neuse rivers stocks that maintained the no-possession measure, the gill net closure above the ferry lines, and the use of 3-foot tie-downs below the ferry lines. Additionally, the Amendment 2 adaptive management framework prescribed that in 2025, data through 2024 would be reviewed to determine if populations are self-sustaining and if sustainable harvest can be determined. In addition, the approved motion in Amendment 2 “maintained the gill net prohibition through 2024 to allow for assessment of its performance”.

Data Evaluation Methods

To assess if the 2019 no-possession provision and ferry line gill net closures (hereafter, "closures") have increased relative abundance of adult striped bass and expanded the age structure of the stock, and to assess whether striped bass populations in the Tar-Pamlico and Neuse rivers have achieved a level of sustainability through successful natural reproduction, several fishery-independent and dependent data sources were reviewed. The DMF Fisheries-Independent Gill Net Survey (Program 915) and the WRC Electrofishing Survey data sets were the primary data sources for the evaluation; however, the CSMA Striped Bass Creel survey and DMF gill net observer program data were also evaluated.

Striped bass otoliths and genetic samples (fin clips) were collected opportunistically from DMF fishery-independent and dependent sampling programs. The WRC collected genetic samples from striped bass on the spawning grounds. Ages can be determined from striped bass produced in a hatchery. Age samples were primarily collected from the Fisheries-Independent Gill Net Survey (Program 915; see below for survey methodology), but DMF also collected striped bass through electrofishing sampling to increase the sample size and collect a representative size range of striped bass including older, larger m2,

Summary method descriptions are provided below. For further information about survey methodology, design, and data collection see Mathes et al. (2020) and NCDMF (2024).

Fisheries-Independent Gill Net Survey (Program 915)

Program 915 employs a random survey design where each river system is overlaid with a one-minute by one-minute grid system (equivalent to one square nautical mile) and stratified by area and depth strata (shallow (≤6 feet) and deep (>6 feet); Figure 1.2) Grids containing only deep strata and grids with obstructions are not sampled. Samples have been collected in the Tar-Pamlico, Pungo, and Neuse rivers since 2004. Sampling gear consists of an array of gill nets consisting of 30-yard segments of 3, 3½, 4, 4½, 5, 5½, 6, and 6½ inch stretched mesh webbing (240 total yards of gill net). An array of nets is employed, to reduce gear selectivity bias and enable the gear to capture multiple species over a wide range of sizes. Catches from this array of gill nets, combined together, comprise a single sample. Relative abundance was defined as the number of fish species captured per sample.

To calculate relative abundance of adult striped bass, Program 915 data were compiled for shallow water sets in the Tar-Pamlico and Neuse rivers during April and October–November, 2004–2024 (See Figure 1.2 for sample numbers). The depth strata and months were selected because striped bass are most available to the survey in these

areas and months. Data from Pungo River were excluded due to elevated presence of A-R stock fish in this river (Mathes et al. 2020).

Figure 1.2. Program 915 sampled grids with sample numbers in the Tar-Pamlico and Neuse rivers during April, and October–November, in shallow water sets, 2004–2024. No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December). Gill net closure lines are shown in red (Ferry Lines).

WRC Spawning Grounds Electrofishing Survey

Electrofishing surveys have been conducted by the WRC on the Tar-Pamlico River spawning grounds since 1996 and on the Neuse River spawning grounds since 1994. The objectives of these surveys are to monitor and quantify population metrics of striped bass migrating to the spawning grounds during spring each year (Mathes et al. 2020). In the Tar-Pamlico and Neuse rivers, striped bass sampling typically begins in March and continues into May until water temperatures consistently exceed optimal temperatures for spawning (18–22 °C) and spawning is assumed to be complete. Sampling is conducted a minimum of once at per week during the spawning season and is highly dependent on streamflow, with low flow conditions causing sampling to only occur at the lower extent of the spawning grounds. In these instances, striped bass using upper river habitats would not be sampled; however, striped bass access to upriver habitats is also limited during low water levels.

Relative abundance of adult striped bass from the WRC Spawning Grounds Electrofishing Survey was calculated as the number of fish captured per hour of electrofishing using survey data collected during 1994–2024 on the Tar-Pamlico River and during 1996–2024 on the Neuse River.

Juvenile Relative Abundance (Program 100)

Program 100 surveys have been conducted in the Tar-Pamlico and Neuse rivers since 2017 to monitor relative abundance of juvenile (i.e., < 100 mm TL) striped bass. The surveys employ beach seines (June–July) and trawls (July–October) to monitor striped bass recruitment and assess the effectiveness of management measures aimed at promoting natural reproduction. Seine and trawl survey stations are located in the upriver sections of the Tar-Pamlico and Neuse rivers, near Washington and New Bern, respectively.

Relative abundance was calculated as the number of juvenile striped bass captured per trawl tow or seine pull during 2017–2024 (Mathes et al. 2020). Fin clips were collected from all young-of-year (YOY) striped bass to determine if natural recruitment of ‘wild’ origin striped bass was occurring. Trawl sampling was not used in calculating relative abundance due to zero catch.

Striped Bass Creel Survey

A comprehensive creel survey was initiated in January 2004 to identify and estimate recreational striped bass effort and catch in the CSMA, particularly the Tar-Pamlico and Neuse rivers (Mathes et al 2020). Site visitation probabilities were set in proportion to the likely use of the site according to time of day, day of the week, and season. During the late winter and spring months, anglers in the upper areas of the Tar-Pamlico and Neuse

rivers were interviewed (January–May), while anglers in the lower zone were interviewed year-round. Catch was defined as the sum of harvested fish and discarded fish. Daily effort and catch for each river were calculated by expanding observed numbers by the sample probability (time of day probability multiplied by access area probability). Total catch estimates for the CSMA were calculated based on the Horvitz-Thompson estimator for non-uniform probability sampling (NCDMF 2019b; Pollock et al. 1994). Although the recreational striped bass season in the CSMA has remained closed since March 2019, data collection characterizing fishing effort and release disposition has continued.

Onboard Observer Program

Onboard Observer Monitoring (initiated in 2012) was designed to monitor fisheries for protected species interactions in the large and small mesh anchored commercial gill-net fishery by providing onboard observations (DMF Observer Program). During onboard trips, this program also monitors finfish catch and discards (includes striped bass) and characterizes effort in the fishery. The observer program does not conduct observations on commercial trips using gill nets that are exempt from the Division's Incidental Take Permit, including runaround, strike, drop, or drift gill nets. Due to the gill net closures above the ferry lines in the Tar-Pamlico and Neuse rivers it is anticipated that overall gill-net activity and observed striped bass numbers will be lower after the 2019 closures.

Parentage Based Tagging (PBT)

Analysis using microsatellite markers has been used by the WRC since 2010 and the DMF since 2016 to genetically identify stocked fish in the Tar-Pamlico and Neuse rivers. Parentage Based Tagging (PBT) techniques identify a fish as hatchery reared or non-hatchery by using genetic microsatellite markers to match stocked fish with broodfish used in hatchery production (Denson et al. 2012). PBT cannot distinguish the origin of non-hatchery striped bass. Fish determined to not be of hatchery origin could be the result of 'wild' reproduction in any system. Additionally, striped bass stocked prior to 2010 are not identifiable using PBT techniques. Striped bass fin clip samples were collected opportunistically from DMF fishery-independent and dependent sampling programs, as well as from the WRC spawning ground surveys to identify fish as either hatchery or non-hatchery origin.

Mann-Kendall (M-K) Trend Test

The M-K trend test is a non-parametric statistical test used to detect significance of increasing or decreasing trends over time, without requiring the data to be normally distributed. M-K trend tests were used to assess the impact of the 2019 no-possession provision on the stocks. The test provides a probability value (*P)*, which indicates the probability of observing the results if there is no trend in the time series. If the *P* value is below a certain significance level (e.g., 0.05), the null hypothesis is rejected, indicating

there is a statistically significant trend. In an M-K trend test, Kendall's Tau is a correlation coefficient that ranges between -1.0 and 1.0 and is used as a measure of the relationship between two variables. Kendall's Tau measures the strength and direction of the trend in a time series. It indicates whether the values tend to increase or decrease over time. A positive Tau indicates an increasing trend, a negative Tau indicates a decreasing trend, and a value close to zero indicates no trend.

The M-K trend test was used to compare Program 915 and the WRC Electrofishing Survey abundance trends before and after the striped bass harvest and gill net closures to determine if striped bass abundance trends were significant after the closures. The spatial extent of Program 915 data covered the entire river system (Figure 1.2) and WRC data was collected from upriver on the spawning grounds. To evaluate the performance of the closures for only the area above the ferry lines, a subset of Program 915 data was used to compare striped bass abundance upstream of the lines before and after the striped bass closures were put in place.

Randomization Test

The randomization test is a non-parametric statistical test used to detect significant differences between groups that relies on randomly shuffling observed data to determine if observed differences are statistically significant (Romano 1989). Randomization tests shuffle data many times to evaluate mean catch per unit effort differences. Additionally, after each shuffle, the means computed from the shuffled data are compared with the observed mean difference. The *P* value for the randomization test is the percentage of times the absolute value of the shuffled mean difference is equal to or greater than the absolute value of the observed mean. For randomization test, data were shuffled 5,000 times, which is generally a sufficient number of iterations to produce a reliable and precise *P* value, especially when testing at the traditional significance level (i.e., 0.05).

Randomization tests were applied to fisheries-independent data (Program 915 and WRC Electrofishing Survey) to assess if striped bass relative abundance was significantly different after the harvest closure compared to before the harvest closure and if striped bass abundance was significantly different above the ferry lines after the gill net closure compared to before. A subset of Program 915 data was used to compare striped bass abundance upstream of the lines before and after the striped bass closures were put in place.

RESULTS

Fisheries-Independent Gill Net Survey (Program 915)

Striped bass relative abundance from Program 915 in the Tar-Pamlico and Neuse rivers ranged from 0.8 to 9.0 fish per set during 2004–2024. Striped bass relative abundance in the Tar-Pamlico River was the lowest in the time series during 2021–2024, and well below the time series average of 4.3 striped bass per set before the 2019 closure (Figure 1.3). After the management measures went into place in the Tar-Pamlico River there was a decrease in relative abundance (61% reduction, 4.3 to 1.7 fish per set; Figure 1.3).

In the Neuse River, striped bass relative abundance has declined since 2021 and in 2022–2024 had the lowest values in the time series, well below the time series average of 3.6 striped bass per set before the 2019 closure (Figure 1.4). After the closure went into place in the Neuse River there was a decrease in relative abundance (42% reduction, 3.6 to 2.1 fish per set; Figure 1.4).

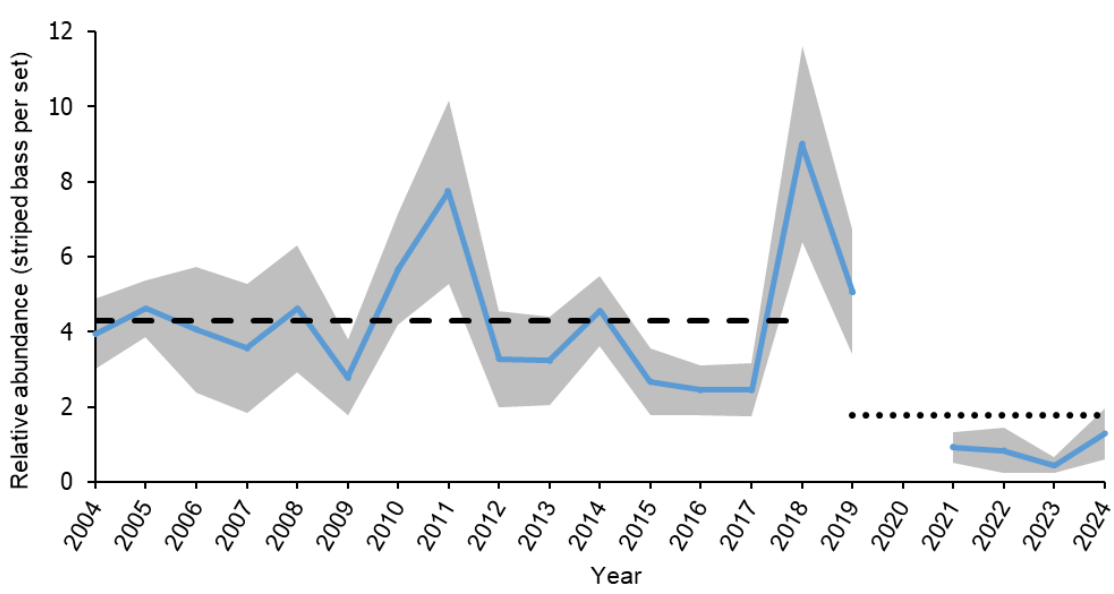

Figure 1.3. Relative abundance of Tar-Pamlico River striped bass from Program 915 during April, and October–November, in shallow water sets, 2004–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the closures (2004–2018), and the dotted line represents mean number of fish per set after the closures (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

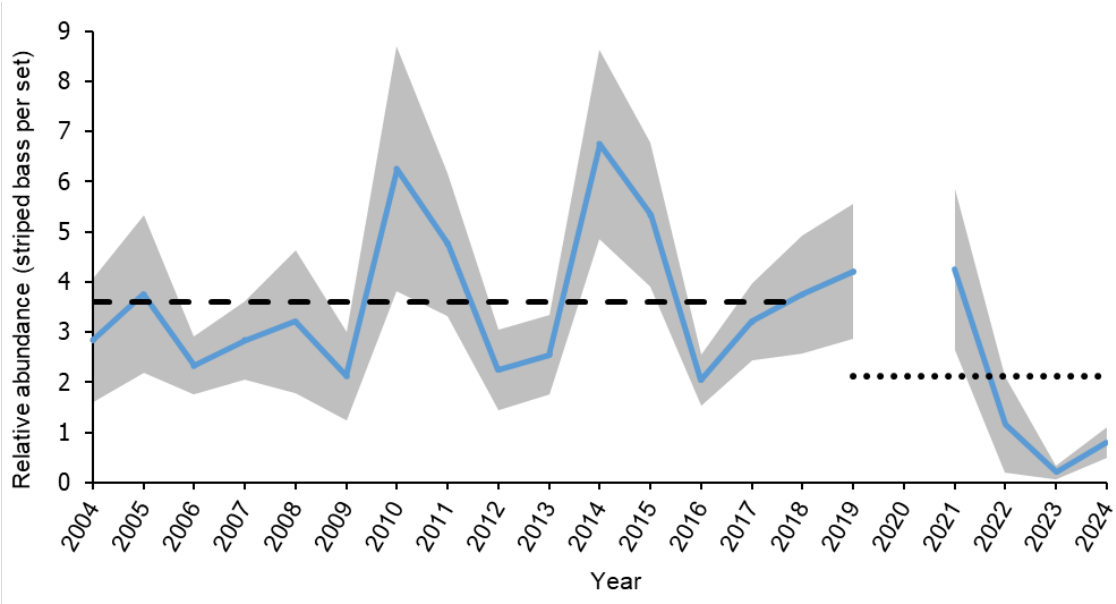

Figure 1.4. Relative abundance of Neuse River striped bass from Program 915 during April, and October–November, in shallow water sets, 2004–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the closures (2004–2018), and the dotted line represents mean number of fish per set after the closures (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

Striped bass length frequency distributions in the Tar-Pamlico and Neuse rivers were variable among years but generally ranged 10–25 inches total length (TL; Figure 1.5). However, in the Tar-Pamlico River during 2016–2017 (Figure 1.5A) and in the Neuse River during 2015–2017 (Figure 1.5B), there was a higher percentage of small fish that could represent the two-year classes of striped bass thought to be the result of successful natural reproduction in 2014 and 2015. In 2023, there was a high percentage of fish greater than 20 inches TL, which could represent continued growth and perpetuation of the 2014- and 2015-year classes.

During 2021–2023 there were few smaller fish, less than 15 inches TL, collected in the gill net survey (Figure 1.5). In 2024, there was an even distribution of striped bass lengths in the Tar-Pamlico River ranging from 12-29 inches TL, while lengths in the Neuse River were centered around 20 inches TL. The decrease in the proportion of larger fish may be reflective of A-R fish from the 2014- and 2015-year classes leaving the rivers and entering the Atlantic Ocean migratory stock. Due to the low numbers of striped bass captured (n =

17 during April, and October–November from shallow water sets), the length-frequency distribution may not be reflective of the actual size distribution for each river stock.

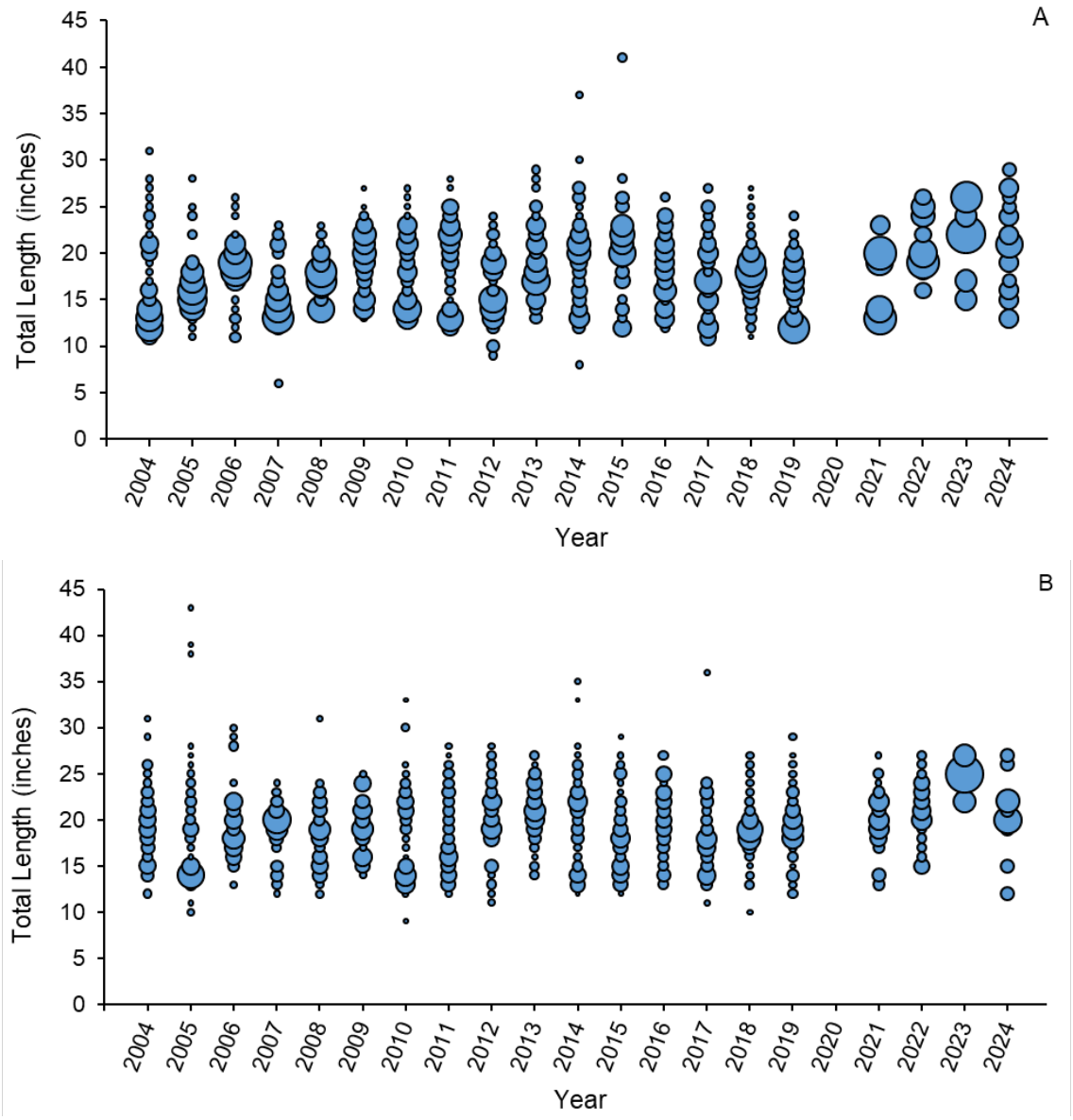

Figure 1.5. Length frequency of striped bass captured in Program 915 in the Tar-Pamlico River (A), and the Neuse River (B) during April, and October–November, in shallow water sets (2004–2024). No sampling occurred in 2020 and limited sampling occurred in 2021 (July–December only) due to COVID restrictions. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

WRC Spawning Grounds Electrofishing Survey

During 1994–2024, striped bass relative abundance from the WRC spawning grounds electrofishing survey in the Tar-Pamlico River ranged from a low of 18.2 striped bass per hour in 2018 to a peak of 100.0 per hour in 2010 (Figure 1.6).

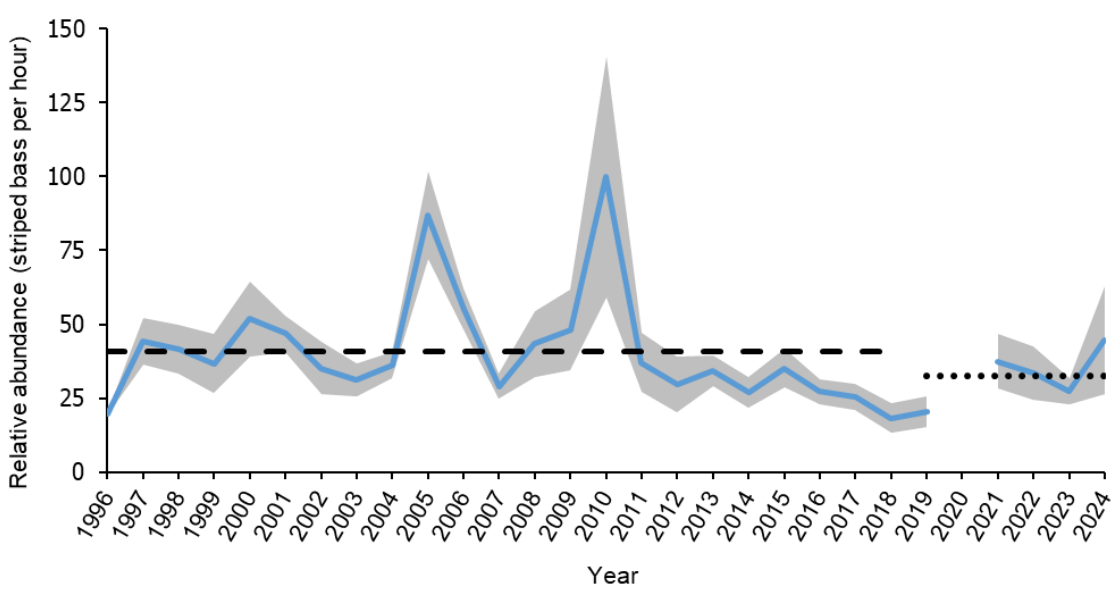

Figure 1.6. Relative abundance of Tar-Pamlico River striped bass from the WRC spawning grounds electrofishing survey, 1996–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per hour before the closures (2004–2018), and the dotted line represents mean number of fish per hour after the closures (2019–2024). No sampling occurred in 2020 due to COVID restrictions.

Since the harvest closure in 2019, relative abundance has increased approaching levels near the 1996–2018 time series average of 40.8 fish per hour; however, there was a decrease in relative abundance after the 2019 closures went into place (20% reduction, 40.8 to 32.7 fish per sample; Figure 1.6). Additionally, the percentage of Age 6+ (~600 mm TL) striped bass on the Tar River spawning grounds has decreased from a 10-year average (2009–2018) of 18% by approximately 12% since the 2019 closures.

During the same time frame, striped bass relative abundance in the Neuse River was highly variable, ranging from 4.4 fish per hour in 2008 to 20.4 fish per hour in 1999 (Figure 1.7). Although relative abundance has continued to be highly variable since the 2019 closures, ranging from 16.7 fish per hour in 2023 to 3.1 fish per hour in 2024, the mean value during 2019–2024 (7% reduction, 10.1 fish per hour) is at the 1994–2018 time series average (10.8 fish per hour). Relative abundance from the WRC electrofishing

surveys in the Tar-Pamlico and Neuse rivers shows little to no trend since the 2019 closures.

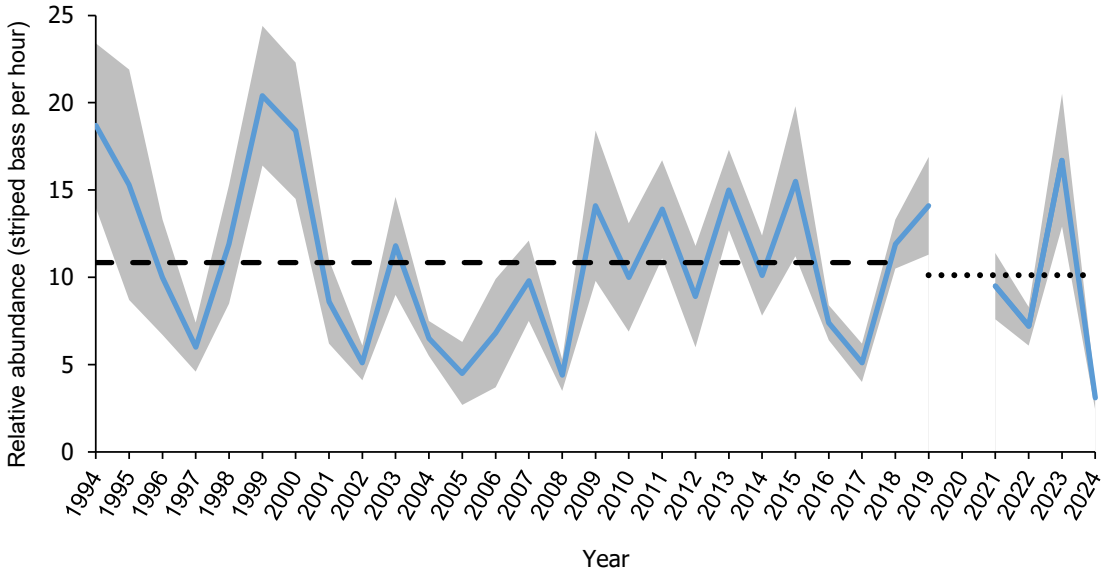

Figure 1.7. Relative abundance of Neuse River striped bass from the WRC spawning grounds electrofishing survey, 1994–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per hour before the closures (2004–2018), and the dotted line represents mean number of fish per hour after the closures (2019–2024). No sampling occurred in 2020 due to COVID restrictions.

Age Structure

Fishery-independent and fishery-dependent age data (2004–2024) collected from otolith and genetic samples showed no expansion of the age structure (i.e., increased numbers of age-10+ fish) in the Tar-Pamlico or Neuse rivers since implementation of the harvest and gill net closures in 2019. Modal and maximum age did not increase beyond what was observed prior to 2019 (Table 1.3, modal age=3; maximum age=12).

Striped bass up to age-6 were commonly encountered and accounted for around 90% of the DMF otolith age samples in the Tar-Pamlico and Neuse rivers (Figure 1.8). However, fish older than age-10 were rare and accounted for less than 10% of age samples in all years since 2013.

Tag-return data from hatchery fish provided evidence of older maximum age than what was found in the ageing data. Two tagged striped bass, raised at Edenton National Fish Hatchery and released into the Tar-Pamlico River as phase-II sized fingerlings in 2008, were recaptured in November 2023 by an angler in the Tar-Pamlico River in Washington, NC. As such, these fish were 15 years old, older than the maximum age of 12 years from the aged fish.

Table 1.2. Tar-Pamlico and Neuse rivers striped bass otolith and genetic age data from fishery dependent and independent surveys, 2004–2024.

	Modal Age		Minimum Age		Maximum Age		Total Number Aged	
Year	otolith	genetic	otolith	genetic	otolith	genetic	otolith	genetic
2004	3	-	1	-	11	-	50	-
2005	2	-	1	-	9	-	78	-
2006	3	-	1	-	9	-	111	-
2007	3	-	1	-	9	-	86	-
2008	3	-	1	-	8	-	103	-
2009	4	-	1	-	6	-	37	-
2010	5	-	1	-	9	-	154	-
2011	3	-	1	-	6	-	56	-
2012	3	-	1	-	7	-	205	-
2013	3	-	1	-	8	-	156	-
2014	3	-	1	-	11	-	172	-
2015	3	-	1	-	9	-	113	-
2016	2	3	1	2	8	6	38	323
2017	2	4	1	1	9	7	98	247
2018	3	4	1	1	12	8	109	201
2019	4	3	1	1	11	9	307	183
2020	5	4	1	1	9	9	147	99
2021	3	3	1	1	10	10	352	109
2022	3	4	1	0	11	11	114	128
2023	3	3	1	0	9	8	95	84
2024	4	4	1	1	10	7	65	45

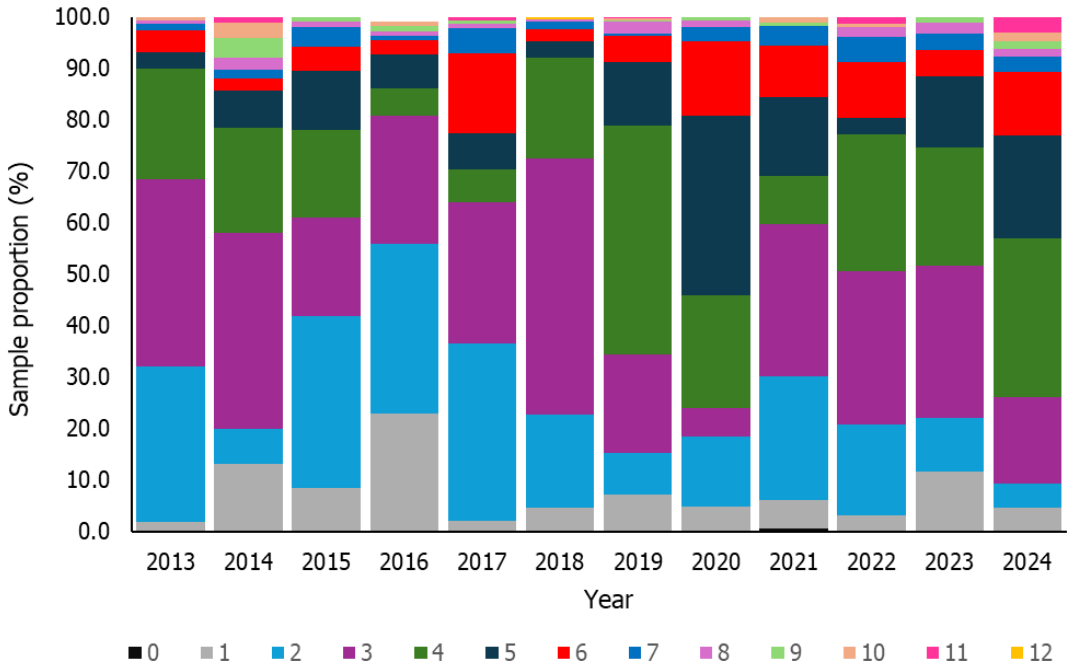

Figure 1.8. Proportion (%) at age (otolith ages) for striped bass collected from DMF sampling programs in the Tar-Pamlico and Neuse rivers, 2013–2024.

Juvenile Relative Abundance

Results from these sampling efforts support the hypothesis of very limited natural reproduction occurring in the CSMA for several decades (Hawkins 1980; Barwick et al. 2008). From 2017–2024, the number of juvenile striped bass collected were so low that the data are not informative for interpreting relative abundance. As of 2024, of the 43 total fish captured between the rivers, only two of the juvenile striped bass were classified as ‘wild’ (Table 1.3). The two ‘wild’ fish were captured during 2021 in the Tar-Pamlico River, and no ‘wild’ juvenile striped bass were collected in the Neuse River. Hatchery stocked phase-I size (1–2 inch TL) juvenile striped bass were collected in the Tar-Pamlico (n = 35) and Neuse rivers (n = 8) in 2022 and 2023 (Table 1.3).

Striped Bass Creel Survey

Despite the harvest closure in March 2019, a significant catch-and-release fishery has continued. Releases (i.e., discards) during the past ten years (2015–2024) have averaged 43,168 fish annually (Table 1.4). In 2024, the number of striped bass caught and released as discards was 6,971 fish, a decrease from 12,957 fish in 2023 and below the ten-year average. Under-sized discards peaked in 2017 mainly due to the large number of sub-legal striped bass available in the Tar-Pamlico River system; however, the number of

under-sized discards has declined since, and in 2024 there were only an estimated 944 under-sized striped bass discards.

Onboard Observer Program

During 2012–2024, 1,335 commercial gill net trips were observed in the Tar-Pamlico and Neuse rivers west of the tie-down line (Table 1.5). The number of observed trips has decreased over this timeframe due in part to the prohibition of gill nets above the ferry lines and harvest restrictions in other fisheries, most notably southern flounder, that have significantly limited the use of anchored large mesh gill nets (NCDMF 2025d). The number of striped bass observed averaged 1.0 fish per trip from 2012–2024 with a high of 302 fish observed in 2014 and a low of zero fish observed in 2020 and 2021 (Table 1.5). Since implementation of the harvest and gill net closures (2019), the number of striped bass observed has averaged 0.2 fish per trip.

Table 1.3. Relative abundance (Index) of striped bass (number of individuals per sample), total number of striped bass collected, and the number of beach seine and trawl samples (n) in the Tar-Pamlico and Neuse rivers, 2017–2024.

	Tar-Pamlico River						Neuse River					
	Beach seine			Trawl			Beach seine			Trawl		
Year	Number of Striped bass	Samples (n)	Index	Number of Striped bass	Samples (n)	Index	Number of Striped bass	Samples (n)	Index	Number of Striped bass	Samples (n)	Index
2017	0	54	0.00	0	48	0.00	0	54	0.00	0	48	0.00
2018	0	30	0.00	0	36	0.00	0	30	0.00	0	36	0.00
2019	0	36	0.00	0	48	0.00	0	36	0.00	0	48	0.00
2020	0	48	0.00	0	48	0.00	0	48	0.00	0	48	0.00
2021*	2	48	0.04	0	48	0.00	0	48	0.00	0	48	0.00
2022†	21	48	0.44	0	36	0.00	4	48	0.08	0	36	0.00
2023†	14	71	0.20	-	-	-	4	70	0.06	-	-	-
2024	0	63	0.00	-	-	-	0	64	0.00	-	-	-
Total	37	398	0.09	0	264	0.00	8	398	0.02	0	264	0.00

*non-hatchery or ‘wild’ fish

† phase-I hatchery origin

Table 1.4. Recreational striped bass effort (directed trips and hours), harvest (number and pounds), and discards (number) from the Pungo, Tar-Pamlico, and Neuse rivers (2004–2024). There was a limited recreational harvest season in 2019 (January 1–March 19, 2019) prior to the closure.

Year	Number Striped Bass Trips	Number Striped Bass Hours	Harvest		Discard				Total Catch (Number)
			Number	Pounds	Over Creel	Under-Sized	Legal-Sized	Slot	
2004	12,782	63,791	6,141	22,958	85	11,729	1,743	0	19,698
2005	16,414	69,370	3,832	14,965	152	15,609	1,016	77	20,671
2006	10,611	42,066	2,481	7,352	33	12,548	2,314	0	17,376
2007	10,971	46,655	3,597	10,794	147	21,673	1,707	0	27,124
2008	6,621	28,413	843	2,990	2,838	11,721	3,316	91	18,809
2009	5,642	26,611	895	3,061	7	4,471	1,769	718	7,860
2010	6,559	25,354	1,757	5,537	29	5,200	2,401	360	9,747
2011	12,606	51,540	2,728	9,474	9	16,659	5,397	2,123	26,916
2012	18,338	71,964	3,922	15,240	439	26,343	13,621	2,910	47,236
2013	20,136	86,049	5,467	19,537	447	19,302	10,356	2,357	37,928
2014	15,244	68,153	3,301	13,368	728	19,185	7,104	1,641	31,959
2015	17,950	78,696	3,934	14,269	40	22,272	8,029	813	35,088
2016	23,283	108,989	6,697	25,260	203	57,874	9,977	6,779	81,529
2017	26,100	119,522	7,334	26,973	549	101,787	26,487	2,293	138,450
2018	16,369	69,856	3,371	10,884	871	34,128	12,092	1,890	52,353
2019	8,796	40,485	959	3,562	924	22,375	7,817	2,481	34,557
2020	2,839	13,247	0	0	0	10,440	7,575	1,406	19,420
2021	4,641	17,596	0	0	0	8,815	12,311	1,769	22,895
2022	3,953	13,727	0	0	0	10,601	12,159	4,701	27,462
2023	3,020	10,923	0	0	0	5,268	5,860	1,829	12,957
2024	1,604	7,867	0	0	0	944	4,724	4,055	9,722
Total	244,480	1,060,873	57,258	206,224	7,502	438,943	157,776	38,293	699,758

Table 1.5. Number of onboard observed gill net trips and number of striped bass harvested and discarded, including disposition observed by mesh size in the Tar-Pamlico and Neuse rivers (all trips west of Tie Down line; see Figure 12), 2012–2024. Note: observations in 2020 and 2021 were limited due to COVID restrictions.

	Large Mesh				Small Mesh				Total Numbers				
Year	Trips	Harvested	Dead Discard	Alive Discard	Trips	Harvested	Dead Discard	Alive Discard	Trips	Harvested	Dead Discard	Alive Discard	Striped Bass Captured
2012	70	19	1	8	17	0	1	12	87	19	2	20	41
2013	104	58	14	12	11	0	0	0	115	58	14	12	84
2014	252	167	41	83	39	2	0	9	291	169	41	92	302
2015	149	202	16	42	39	4	4	9	188	206	20	51	277
2016	153	119	25	14	23	0	4	12	176	119	29	26	174
2017	163	110	12	134	35	0	0	36	198	110	12	170	292
2018	122	37	15	45	23	1	2	10	145	38	17	55	110
2019	60	0	8	12	45	0	2	5	105	0	10	17	27
2020	0	0	0	0	7	0	0	1	7	0	0	0	1
2021	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	3	0	0	0	0	0	0	0	3	0	0	0	0
2023	8	0	0	3	4	0	0	3	12	0	0	3	3
2024	4	0	0	1	4	0	0	1	8	0	0	1	1
Totals	1,088	712	132	355	247	7	13	98	1,335	719	145	447	1,312

Parentage Based Tagging

PBT analysis of samples collected on the spawning grounds and from Coastal and Joint Fishing Waters of the Tar-Pamlico and Neuse rivers indicated stocked striped bass can make up greater than 90% of the fish sampled in some years (2013–2016); however, results from 2017 and 2018 indicated a noticeable decrease in contribution of hatchery-stocked fish in the Tar-Pamlico and Neuse rivers (Farrae and Darden 2018; Figure 1.9).

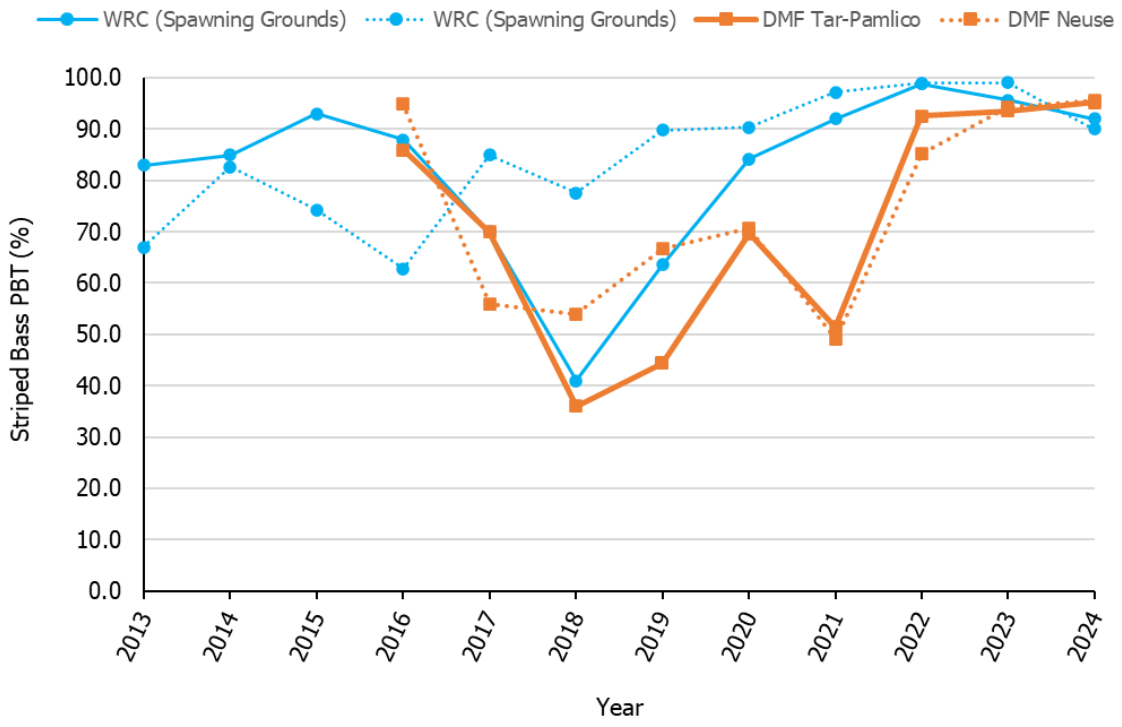

Figure 1.9. Hatchery contribution from DMF fishery-independent and dependent sampling programs (2016–2024) and WRC Electrofishing Survey (2013–2024) on the spawning grounds in the Tar-Pamlico and Neuse rivers. Hatchery contribution is defined as the percentage of fish determined to be stocked fish based on PBT analyses.

From 2019 to 2024, the percentage of stocked fish continued to increase. However, results from 2021 DMF samples (n = 220) showed a noticeable drop in the percentage of hatchery fish to a 50/50 split with ‘wild’ striped bass. Upon further investigation of the 2021 PBT data, DMF striped bass collections in the Tar-Pamlico and Neuse rivers from January through March consisted of nearly 100% ‘wild’ origin striped bass. Interestingly, ages 6 and 7 represented 29% of the fish collected which could be ‘wild’ A-R stock striped bass from the 2014- and 2015-year classes produced in the Roanoke River. Additionally, age-3 striped bass represented 27% of the samples, which could indicate successful natural

recruitment in the Tar-Pamlico and Neuse rivers from the 2018-year class, or recruitment from the A-R system even though the 2018 A-R juvenile abundance index was low.

Analysis of Pre and Post Closures Abundance Trends

M-K Trend Tests

There was no significant trend in the relative abundance of striped bass from Program 915 before or after the closures in the Tar-Pamlico River or in the Neuse River ($P > 0.05$; Table 1.6). Results from WRC spawning grounds Electrofishing Surveys on spawning grounds were similar, with one exception. There was a significant decreasing trend in relative abundance before the closures in the Tar-Pamlico River ($P = 0.05$, Tau=-0.3; Table 1.7).

Table 1.6. Results from the M-K trend tests for determining trends in striped bass relative abundance from Program 915 surveys in the Tar-Pamlico and Neuse rivers before (2004–2018) and after (2019–2024) the closures. No significant trend (NS) was detected across all combinations of river and time period (P > 0.05).

System	Closures	Probability (*P*)	Trend	Tau
Tar-Pamlico River	Before (2004–2018)	0.28	NS	-0.22
	After (2019–2024)	0.46	NS	-0.40
Neuse River	Before (2004–2018)	0.65	NS	0.10
	After (2019–2024)	0.22	NS	-0.60

Table 1.7. Results from the M-K trend tests for determining trends in striped bass relative abundance from WRC Electrofishing Spawning Ground Surveys in the Tar-Pamlico and Neuse rivers before (2004–2018) and after (2019–2024) the closures. Trends were significant if Probability (P) $\leq$ 0.05). NS = not a significant trend.

System	Closures	Probability (*P*)	Trend	Tau
Tar-Pamlico River	Before (1996–2018)	0.05	Decreasing	-0.30
	After (2019–2024)	0.46	NS	0.40
Neuse River	Before (1994–2018)	0.48	NS	-0.10
	Ater (2019–2024)	0.46	NS	-0.40

Randomization Tests

Relative abundance of striped bass from Program 915 was significantly lower after the closures than before in the Tar-Pamlico River (*P* = 0.0006) and the Neuse River (*P* = 0.0006; Table 1.8; Figures 1.10 and 1.11).

Table 1.8 Randomization test results comparing mean striped bass relative abundance in the Tar-Pamlico and Neuse rivers from Program 915 before (2004 – 2018) and after (2019 – 2024) the harvest and gill net closures. *Represents a statistically significant difference (Probability P ≤ 0.05).

		Number of Samples		Relative Abundance		
Agency	System	Before	After	Before	After	Probability (*P*)
DMF	Tar-Pamlico River	270	82	2.05	0.9	<0.01*
	Neuse River	360	112	1.73	0.82	<0.01*
WRC	Tar-Pamlico River	193	65	0.01	0.007	0.03*
	Neuse River	654	300	0.003	0.003	0.08

The same trend occurred in the Tar-Pamlico River using data from WRC electrofishing survey where the relative abundance of striped bass was significantly lower after the

closures than before (*P* = 0.03; Figure 1.12). In contrast, relative abundance in the Neuse River using data from WRC electrofishing survey was higher after the closure than before, but this difference was not significant (*P* = 0.08; Table 1.8; Figure 1.13).

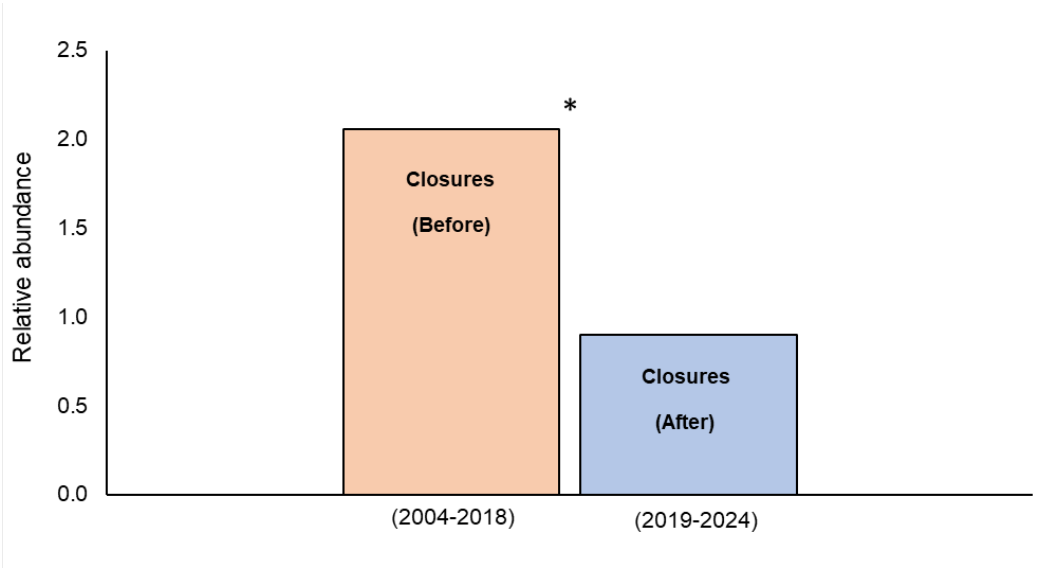

Figure 1.10. Relative abundance of Tar-Pamlico River striped bass from Program 915 before (2004–2018, n = 270 gill net samples) and after (2019–2024, n = 82 gill net samples) the closures. *Represents a statistically significant difference (P = 0.0006) between time periods calculated from Randomization Tests.

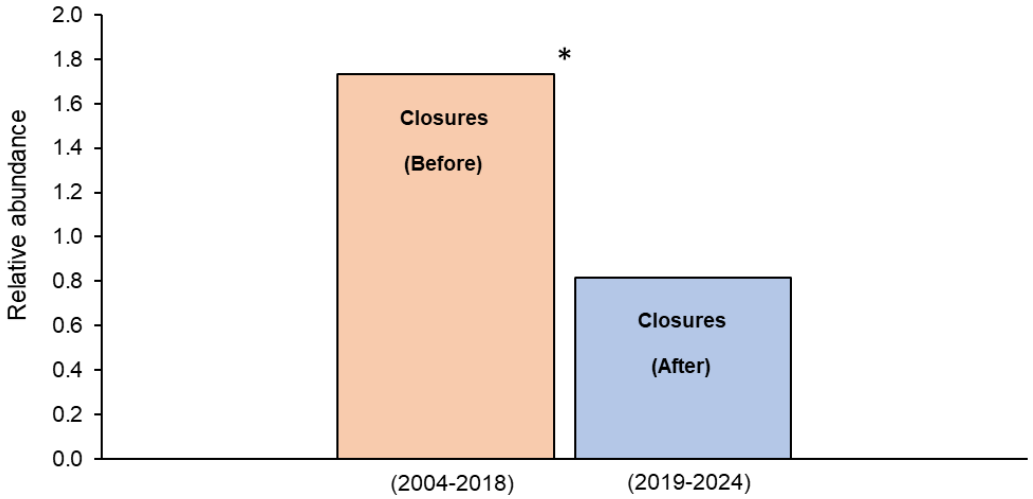

Figure 1.11. Relative abundance of Neuse River striped bass from Program 915 before (2004–2018, n=360 gill net samples) and after (2019–2024, n = 112 gill net samples) the closures. *Represents a statistically significant difference (P = 0.0006;) between time periods calculated from randomization tests.

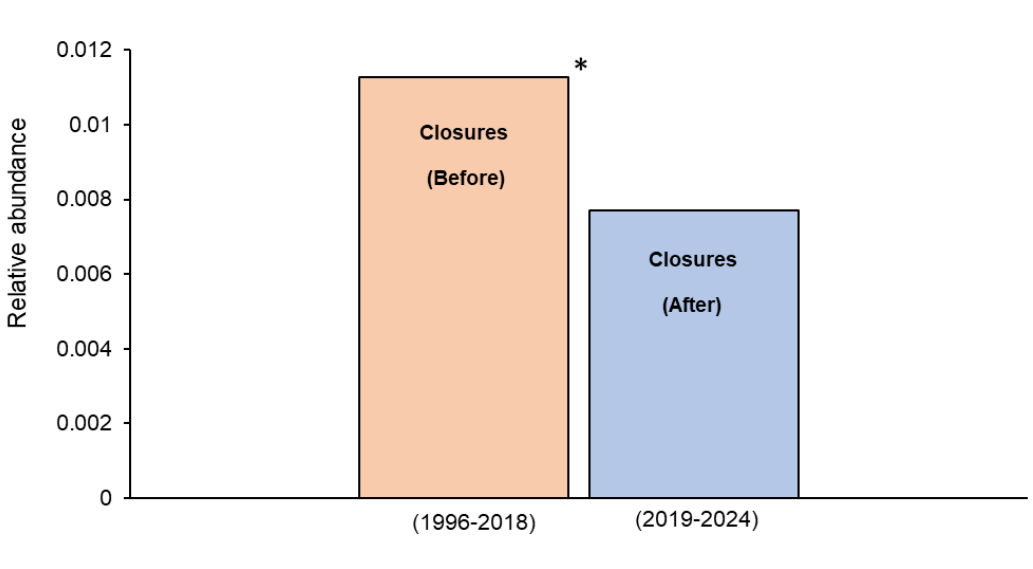

Figure 1.12. Relative abundance of Tar-Pamlico River striped bass from the WRC Electrofishing Survey before (1996–2018, n = 193 samples) and after (2019–2024, n = 65 samples) the closures. *Represents a statistically significant difference (P = 0.03) between time periods calculated from randomization tests.

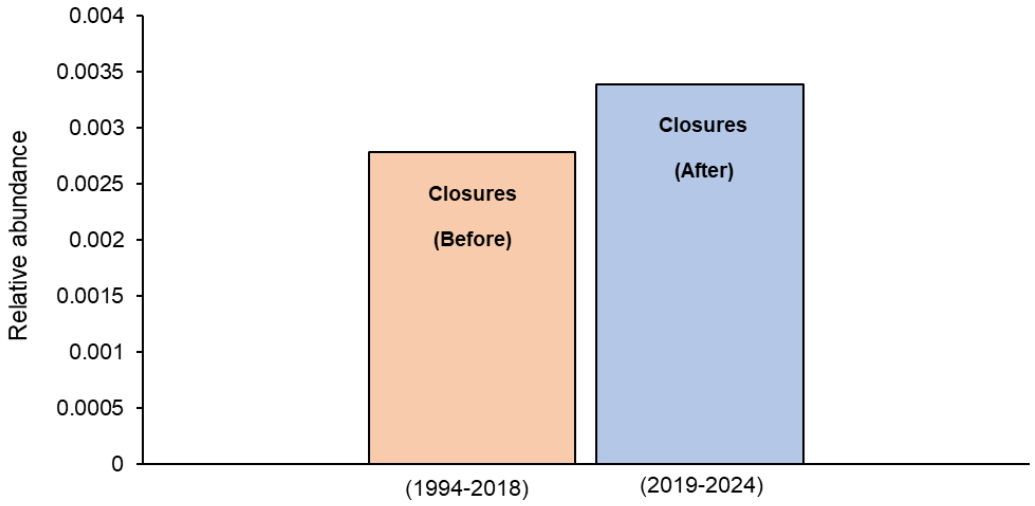

Figure 1.13. Relative abundance of Neuse River striped bass from the WRC Electrofishing Survey before (1994–2018, n = 654 samples) and after (2019–2024, n = 300 samples) the closures. There was no significant difference (P = 0.08) between time periods calculated from randomization tests.

Ferry Line Gill Net Closure Analysis

M-K Trend Test

There was no significant trend in the relative abundance of striped bass from Program 915 surveys above the ferry line before or after the closures in the Tar-Pamlico River or in the Neuse River ($P > 0.05$; Table 1.9).

Table 1.9. Results from the M-K trend tests for determining trends in striped bass relative abundance from Program 915 for the areas above the ferry lines in the Tar-Pamlico and Neuse rivers, before (2004–2018) and after (2019–2024) the closures. No significant trend (NS) was detected across all combinations of river and time period (P > 0.05).

System	Closures	Probability (*P*)	Trend	Tau
Tar-Pamlico River	Before (2004–2018)	0.30	NS	-0.21
	After (2019–2024)	0.46	NS	-0.40
Neuse River	Before (2004–2018)	0.88	NS	0.04
	After (2019–2024)	0.09	NS	-0.80

Randomization Test

Relative abundance of striped bass above the ferry lines was significantly lower after the closures than before in the Tar-Pamlico River (*P* = 0.0002) and the Neuse River (*P* = 0.003; Table 1.10; Figures 1.14 and 1.15).

Table 1.10. Randomization test results comparing mean striped bass relative abundance in the Tar-Pamlico and Neuse rivers from Program 915 for the areas above the ferry lines before (2004 – 2018) and after (2019 – 2024) the harvest and gill net closures. *Represents a statistically significant difference (Probability (P) ≤ 0.05).

	Number of Samples		Relative Abundance		
System (above ferry lines)	Before	After	Before	After	Probability (*P*)
Tar-Pamlico River	187	60	2.51	1.1	<0.01*
Neuse River	267	81	2.2	1.08	<0.01*

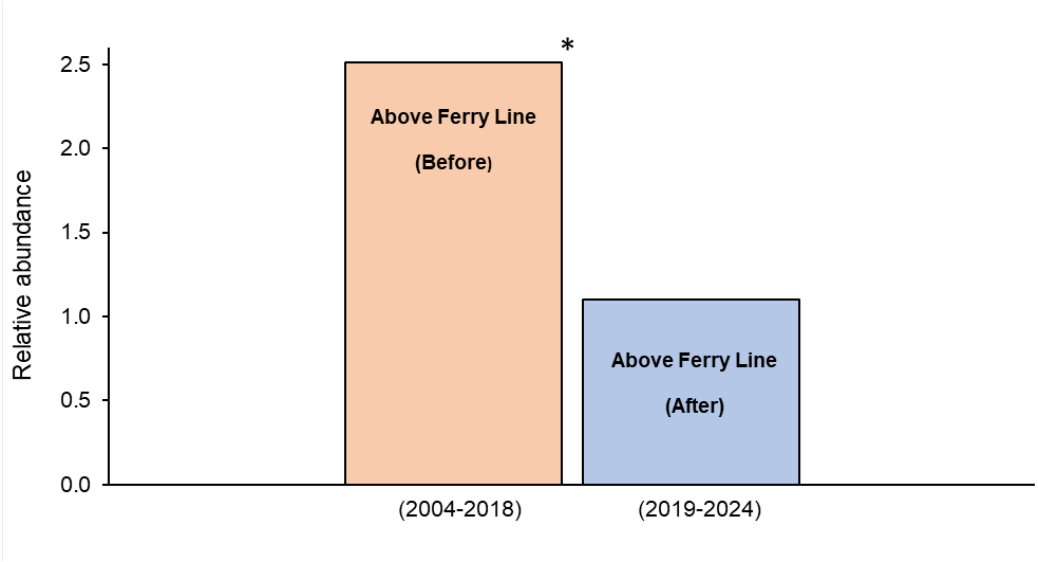

Figure 1.14. Relative abundance of Tar-Pamlico River striped bass from Program 915 above the ferry line closure area before (2004–2018, n = 187 gill net samples) and after (2019–2024, n = 60 gill net samples) the closures. *Represents a statistically significant difference (P < 0.01) between time periods calculated from randomization tests.

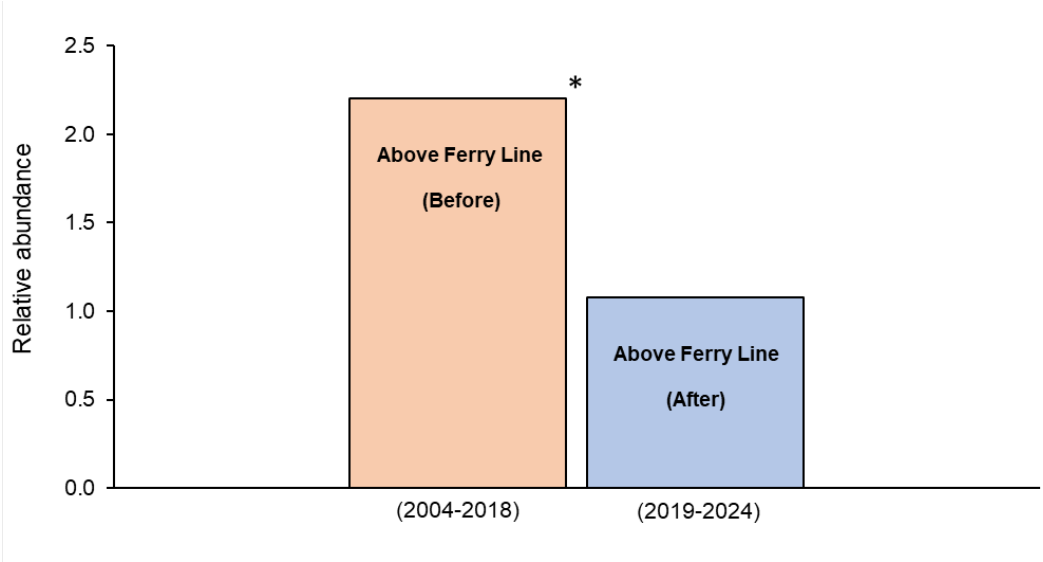

Figure 1.15. Relative abundance of Neuse River striped bass from Program 915 above the ferry line closure area before (2004–2018, n = 267 gill net samples) and after (2019–2024, n = 81 gill net samples) the closures. *Represents a statistically significant difference *(P* < 0.01 between time periods calculated from randomization tests.

DISCUSSION

Amendment 2 to the North Carolina Estuarine Striped Bass FMP adopted an adaptive management framework to review data through 2024 to determine if striped bass populations in the Tar-Pamlico and Neuse rivers are self-sustaining and if sustainable harvest can be determined. In addition, Amendment 2 included language to: “maintain the gill net prohibition through 2024 to allow for assessment of its performance”. Adaptive management allows adjustments to management measures as new information or data becomes available. Trends in key population parameters including natural recruitment, adult abundance, age structure, and hatchery contribution were evaluated to determine the impact of the 2019 no-possession provision and the gill net closure above the ferry lines on the stocks.

Recovery Potential

Based on historical stocking efforts for striped bass, population abundance can increase dramatically from just a few individuals, provided adequate environmental conditions exist. In 1879, 132 young striped bass from the Navesink River, New Jersey, were released into the Carquinez Strait, the tidal estuary where the Sacramento and San Joaquin rivers drain into San Francisco Bay. A second batch of 300 young fish from the Shrewsbury River, New Jersey, were introduced in 1882. Commercial harvest started in the early 1880s, and by 1900 exceeded 99,208 lb. (450,000 kg) annually. The greatest catch occurred in 1903 when over 1,984,160 lb. (900,000 kg) were harvested (Craig 1928).

The striped bass population in the southern Gulf of St. Lawrence, Canada, provides another examples of striped bass stock recovery. The Gulf of St. Lawrence striped bass stock declined to less than 5,000 spawners in the late 1990s which led to the closure of the commercial fishery in 1996 and recreational and indigenous fisheries in 2000 (DFO 2023). Between 2002 and 2009 a stocking program stocked 6,475,000 striped bass fry and 6,321 striped bass ages 0–6 (Robitaille et al. 2011) into the systems. The striped bass population subsequently increased to an estimated 900,000 spawners by 2017 (DFO 2023).

As part of Amendment 2 development, a demographic matrix model was used to evaluate stocking and management strategies for striped bass in the Tar-Pamlico and Neuse rivers (Mathes et al. 2020). Matrix model results indicated natural recruitment is the primary factor limiting Tar-Pamlico and Neuse rivers stocks and if stocking was stopped the populations would decline. Based on matrix model results, the striped bass populations in the Tar-Pamlico and Neuse rivers were depressed to an extent that no level of fishing mortality was sustainable.

The matrix model results indicated a 10-year closure was most effective at increasing adult (age-3+) and old adult (age-6+) abundance (Figure 1.16; Mathes et al. 2020). The stocking strategy in the Tar-Pamlico and Neuse rivers during the closure has been to stock 100,000 phase-II fish per year in each river (stocking scenario 4; Figure 1.16).

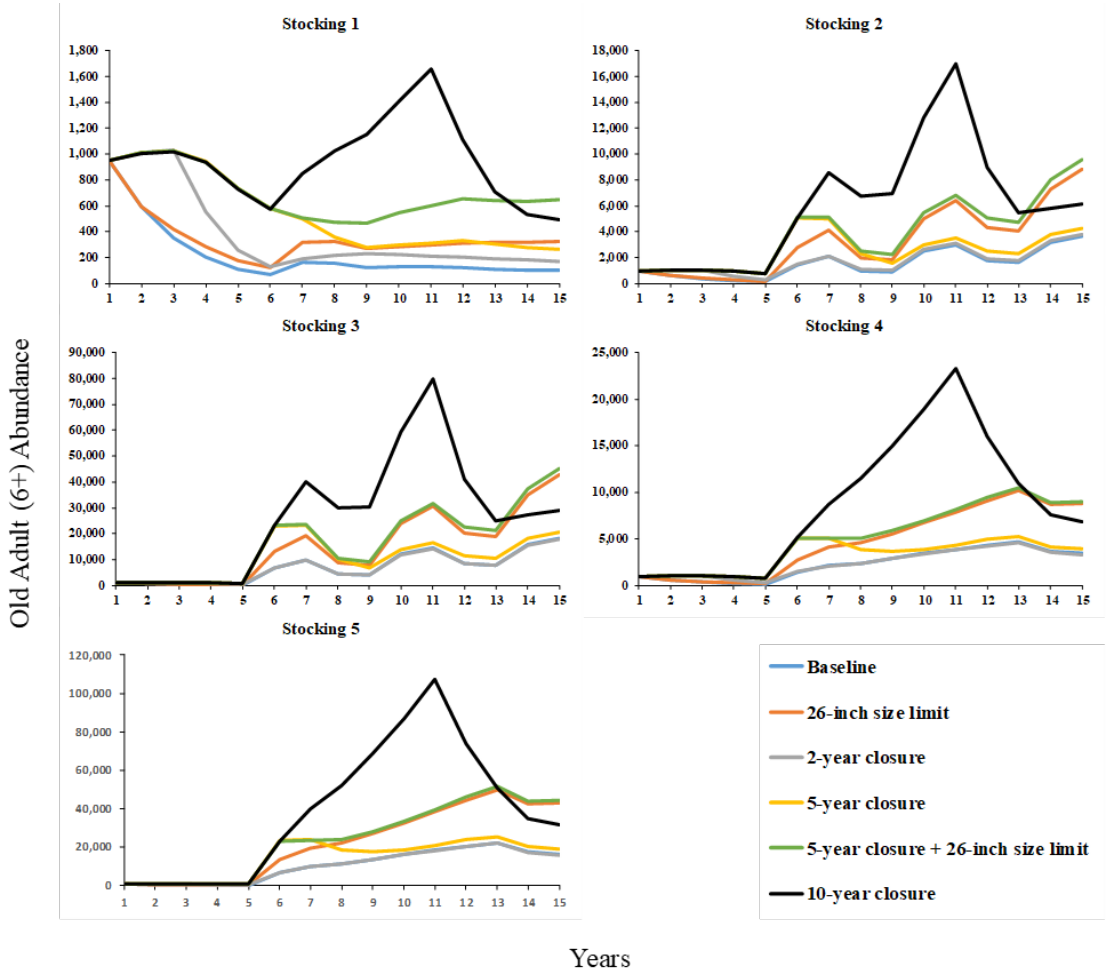

Figure 1.16. Abundance of old adults (age 6+) projected under five stocking strategies and six fishing strategies. Stocking 1 - no stocking; Stocking 2 - stocking 100,000 fish per year with 2-year stocking and 2-year no stocking alternating for 15 years (8 years of stocking in total); Stocking 3 - stocking 500,000 fish per year with 2-year stocking and 2-year no stocking alternating for 15 years (8 years of stocking in total); Stocking 4 - stocking 100,000 fish per year with 8-year continuous stocking; Stocking 5 - stocking 500,000 fish per year with 8-year continuous stocking. Lines show the median from 10,000 iterations (figure from Mathes et al. 2020).

Under this stocking scenario and a 10-year closure old adult abundance was not projected to increase significantly for the first five years of the closure before starting to

increase in year six. In this stocking and management scenario, abundance of age-3+ striped bass was projected to begin increasing in year two of a harvest closure.

The striped bass harvest and ferry line gill net closures in the Tar-Pamlico and Neuse rivers were implemented in 2019 and as of 2024 have been in place for six years. These closures have significantly decreased the number of striped bass removed from these rivers by fishing each year (Table 5). Fishery-independent monitoring since 2019 does not indicate abundance increases in downriver areas and abundance on the spawning grounds remains at levels similar to what was observed before the closure. Abundance of age-3+ and age-6+ striped bass has declined or remained consistent and there appears to be little expansion of the age structure past age-6.

Since 2019 the percentage of stocked fish on the spawning grounds has increased to greater than 90% suggesting the 'wild' fish present in 2018 and 2019 were not making spawning runs in these systems and were not contributing to natural reproduction. In the lower rivers, the percentage of 'wild' fish has been more variable, and examination of age data suggests some persistence of the 2014- and 2015-year classes, at least through 2020.

Why was Management Ineffective?

It is difficult to pinpoint specific reasons why abundance has not increased, and the age structure has not expanded despite significant reductions in fishing mortality. It is likely there is no single factor confounding effectiveness of management. Rather it is likely multiple factors including limitations of the stocking program, natural mortality, fishing mortality, and environmental conditions that have prevented self-sustaining populations. Further, residence of A-R stock striped bass in the Tar-Pamlico and Neuse rivers has likely created past perceptions of increased striped bass abundance in these rivers.

Stocking

The Tar-Pamlico and Neuse rivers striped bass stocks are supported by a stocking program with an annual goal of stocking 100,00 phase-II striped bass per river system. However, since implementation of the harvest and ferry line gill net closures in 2019 actual stocking numbers have been variable. Phase-II stocking in the Tar-Pamlico River averaged 55,541 fish and phase-II stocking in the Neuse River averaged 66,036 phase-II fish since 2019 (Table 1.11). Recently (beginning in 2023) stocking resources have shifted toward maintaining and restoring the A-R stock, which has experienced consistently low recruitment since 2017 (Figure 1). Given hatchery and resource constraints it is unlikely the number of fish stocked in the Tar-Pamlico and Neuse rivers can be increased by any significant amount, and without increased stocking, the populations may not be able to grow beyond current levels, though recovery and

expansion of the A-R stock is likely to increase abundance of striped bass in the Tar-Pamlico and Neuse rivers.

Table 1.11. Number of Phase-I and Phase-II size striped bass stocked in the Tar-Pamlico and Neuse rivers, 2010–2024.

Year-Class	Tar-Pamlico River		Neuse River	
	Phase-I	Phase-II	Phase-I	Phase-II
2010	0	114,012	0	107,142
2011	0	107,767	0	102,089
2012	0	45,667	50,180	91,985
2013	257,404	123,416	181,327	113,784
2014	138,889	92,727	79,864	78,866
2015	0	52,922	0	109,107
2016	234,718	121,190	80,910	134,559
2017	0	101,987	0	14,203
2018	0	120,668	96,900	86,556
2019	0	97,920	0	85,694
2020	0	90,614	0	96,933
2021	0	23,082	31,208	80,122
2022	175,633	55,465	91,569	33,560
2023	116,989	66,165	62,885	71,527
2024	0	0	0	0

Natural And Fishing Mortality

There is evidence that total mortality (especially natural mortality) of striped bass can be high in the Tar-Pamlico and Neuse rivers. A telemetry tagging study conducted on the Neuse River from December 2013 through September 2015 estimated a discrete annual total mortality of 66.3% for phase II stocked juveniles (202–227 mm TL), a discrete annual total mortality of 54.0% for adults (349–923 mm TL), and a discrete natural mortality of 20.1% for adults (Bradley et al. 2018). Analysis of tagging data showed that striped bass stocked in the Neuse and Tar-Pamlico rivers experienced higher mortality (instantaneous total mortality of 0.48–0.51) than in the Roanoke River/Albemarle Sound habitat (instantaneous total mortality of 0.33; Callihan et al. 2014).

Mathes et al. (2020) and Rachels and Ricks (2018) documented commercial effort as an important predictor of striped bass mortality in the Neuse River. Model averaging analysis by Rachels and Ricks (2018) indicated commercial gill net effort was far more influential than other parameters that were examined. Although Rachels and Ricks (2018) did not

include recreational effort or harvest in the model due to the benefits of a longer available time series for commercial data, the study acknowledged the potential importance of recreational angling on total mortality of Neuse River striped bass. Results of analysis from Mathes et al. (2020) indicated recreational effort and recreational discards may indeed be as influential on annual striped bass mortality as commercial effort and commercial harvest. While recreational and commercial harvest and commercial discard mortality of striped bass have been minimized by the harvest closure and concurrent gill net restrictions, recreational and commercial discards remain a source of mortality and may confound capacity for the stock to grow. Since the harvest closure, recreational striped bass discards remain similar to those observed prior to the harvest closure in some years (Table 1.5; NCDMF 2025a), whereas commercial discards decreased after the closure (Mathes et al. 2020).

Environmental Effects

Environmental conditions, such as dissolved oxygen, water temperature, and habitat suitability play a role in successful striped bass recruitment and increasing stock size (NCDMF 2022a). Over the past several decades, few larval and juvenile striped bass have been collected from CSMA systems (Marshall 1976; Hawkins 1980; Nelson and Little 1991; Burdick and Hightower 2006; Barwick et al. 2008; Smith and Rulifson 2015; and Buckley et al. 2019, NCDMF 2025a). Several factors have been suggested as potentially affecting natural recruitment in the Tar-Pamlico and Neuse rivers, including spawning stock abundance, truncated age structure, and egg abundance (Bradley et al. 2018; Rachels and Ricks 2018; Buckley et al. 2019). Even in the absence of most fishing mortality, abundance has not increased, and the age structure has not expanded suggesting biological and/or environmental factors are preventing self-sustaining populations and that additional management changes aimed at achieving sustainable striped bass populations in these rivers are unlikely to be successful unless significant environmental improvements occur.

One possible confounding factor is that eggs produced by Tar-Pamlico and Neuse rivers broodstock are very small, heavy (dense) eggs, which are more likely to sink than float (Kowalchyk 2020). If flows are too low during the spawning period, heavy eggs may be more likely to contact the bottom and die before hatching successfully Egg densities have been shown to be influenced by both genetic and environmental factors (Kowalchyk 2020). Spawning grounds in these river systems are predominantly shallow (between 0.2 and 1.0 meters), so the potential for heavy eggs to contact bottom sediment and die is increased. Additionally, because many of the streams and creeks in these systems have been altered by channelization, rapid flow increases can occur shortly after a rainfall event begins followed by a rapid return to base conditions after the end of the rainfall event potentially impacting striped bass spawning success (NCDWQ 2009; NCDWQ 2010).

Flows during the spring striped bass spawning season are an important factor affecting successful striped bass natural reproduction; however, unlike on the Roanoke River, there are no agreements with the U.S. Army Corps of Engineers (USACE) to maintain adequate flows for striped bass spawning in the Tar-Pamlico or Neuse rivers. The USACE is consulted weekly regarding water releases in the Neuse River from Falls Lake in Raleigh, but due to the watershed and storage capabilities, it is not possible to manipulate flows in the Neuse River like it is in the Roanoke River. The USACE, in cooperation with DMF and WRC staff, is currently studying flows in the Neuse River in an attempt to identify conditions that could be beneficial for striped bass spawning. Flows on the Tar-Pamlico River are based on pulse rainfall events. The ability to manipulate releases, while limited, may become an important tool to manage flows during the spawning season in these systems.

A-R Stock Mixing

In response to increased abundance of non-hatchery origin (wild) striped bass present in the Tar-Pamlico and Neuse rivers in 2017 and 2018, DMF initiated an acoustic telemetry study to track movements of 'wild' fish. Because striped bass return to natal rivers to spawn, the objective of the acoustic tagging study was to infer origin of wild striped bass found in the lower-middle Tar-Pamlico and Neuse rivers by tracking spring spawning migrations. A summary of study results can be found in Appendix 2. Briefly, fifty adult striped bass (ages 4–5) from the lower-middle Tar-Pamlico and Neuse rivers were implanted with acoustic tags. Fin clips were taken from each fish, and PBT analysis was conducted to determine if the fish were hatchery or wild origin. PBT results indicated 30 of the tagged striped bass were wild. Of the 30 wild striped bass, 70% (n = 21) were later detected in the Albemarle Sound or on the Roanoke River spawning grounds in the spring. A single wild striped bass tagged in the Tar-Pamlico River was later detected on the spawning grounds in the Tar River, one wild striped bass tagged in the Neuse River was later detected on the spawning grounds in the Neuse River, and one wild striped bass tagged in the Neuse River was later detected on the spawning grounds in the Tar River suggesting limited natural recruitment in these rivers or straying of A-R stock fish to the Tar and Neuse rivers spawning grounds.

Results of the acoustic study add additional support to the existing body of evidence indicating annual movement of striped bass between the Albemarle Sound and Tar-Pamlico and Neuse rivers. Conventional tag return data has documented increased movement of smaller A-R stock striped bass into the Tar-Pamlico and Neuse rivers during periods of increased A-R stock abundance (Callihan et al. 2014). While abundance of A-R stock striped bass is currently very low, 2014 and 2015 represent the most recent strong year classes produced (see Figure 1). Striped bass from the strong 2014 and 2015 A-R year classes likely migrated to the Tar-Pamlico and Neuse rivers: increasing abundance

and providing the appearance of successful natural reproduction. Callihan et al. (2014) indicated up to 31% of the A-R stock could use areas outside the Albemarle Sound during times of higher abundance. Rulifson (2014) concluded 53% of striped bass sampled from the Neuse River in 2010 were not of hatchery origin. While the exact origin of these fish is unknown, they could be fish from the strong 2005 A-R year class. Potential spillover of the 2005 A-R year class into the Tar-Pamlico and Neuse rivers may also explain the 2010 and 2011 striped bass abundance peaks from Program 915 in the Tar-Pamlico and Neuse rivers (Figures 1.3 and 1.4) and the 2010 abundance peak from the WRC Electrofishing Survey on the Tar River spawning grounds (Figure 1.6).

Striped bass are generally thought to exhibit low levels of straying to non-natal rivers and Roanoke River striped bass are suspected to have high spawning site fidelity (Callihan et al. 2015); though, potential straying to non-natal systems has been suggested for other stocks (Secor et al. 2020). In addition, striped bass have been documented to reside in non-natal estuaries in Maine and New Jersey, including moving upriver during expected spawning seasons suggesting an attempt to reproduce (Grothues et al. 2009). Albemarle-Roanoke striped bass have been documented in river systems in other states outside of the spawning season (Callihan et al. 2015). This body of evidence across states suggests it would not be unlikely for A-R stock striped bass to reside in the adjacent Tar-Pamlico and Neuse rivers and for some small portion of the stock to make spawning runs in these systems. Therefore, abundance of striped bass in the lower Tar-Pamlico and Neuse rivers is highly influenced by year-class strength of the A-R stock.

CONCLUSIONS

Based on data from DMF and WRC fishery-independent and dependent sampling programs, the striped bass populations in the Tar-Pamlico and Neuse rivers are currently not self-sustaining. However, it is worth noting again that striped bass have been shown to quickly rebound even at low population levels given favorable environmental conditions in other systems (Craig 1928; Reinert and Peterson 2008; DFO 2023). Evaluation of the harvest and gill net closures has shown these measures to be ineffective at promoting natural recruitment, increasing adult abundance, or expanding the age structure and increasing the number of older, larger (age-10+) striped bass through year six of implementation. Even if these closures had resulted in a measurable effect on striped bass populations, it would be impossible to attribute the effect to either the harvest or gill net closures individually because they occurred concurrently. Factors other than fishing mortality and inadequate spawner stock abundance are preventing successful reproduction and self-sustaining populations of the Tar-Pamlico and Neuse rivers striped bass stocks. Environmental factors and declines in the A-R stock have likely contributed to reduced striped bass abundance in the Tar-Pamlico and Neuse rivers. Additional management aimed at trying to achieve sustainability of these stocks is unlikely to be

effective unless significant environmental improvements occur. The need to better understand environmental factors affecting the populations is necessary to identify minimum flow requirements in the Tar-Pamlico and Neuse rivers necessary for successful spawning, egg development, and larval transport to nursery grounds.

Acoustic telemetry and PBT data suggest there are three groups of striped bass in the Tar-Pamlico and Neuse rivers. Most of the fish are hatchery reared stocked fish, followed by wild fish originating from the A-R (see Appendix 2), with a very small portion of fish originating from the spawning grounds on the Tar-Pamlico or Neuse rivers. Acoustic data revealed that striped bass stocked in the Tar-Pamlico and Neuse rivers resided throughout the entire river, but did not leave the system where they were released; however, a portion of adult wild fish were shown to reside within the lower portions of both the Tar-Pamlico and Neuse rivers and return annually to the Roanoke River spawning grounds in spring (April\May).

Based on Amendment 2 adaptive management, if analysis indicates biological and/or environmental factors prevent a self-sustaining population, then alternate management strategies will be developed that provide protection for and access to the resource. Based on the results of the data evaluation that indicates reaching sustainability of the Tar-Pamlico and Neuse rivers stocks is unlikely due to factors other than fishing mortality and inadequate spawning abundance, DMF and WRC developed a one-month harvest season in April to allow for some access to stocked fish in the Tar-Pamlico and Neuse rivers. The season and locations were selected to limit harvest of Albemarle Sound-Roanoke River striped bass stock fish that occur in these rivers.

APPENDIX 2: NOVEMBER 2022 MEMO TO MFC SUMMARIZING PRELIMINARY RESULTS OF A STRIPED BASS ACOUSTIC TAGGING STUDY IN THE TAR-PAMLICO AND NEUSE RIVERS

November 1, 2022

MEMORANDUM

TO: North Carolina Marine Fisheries Commission

FROM: Todd Mathes, Striped Bass Fishery Management Plan Co-Lead

SUBJECT: Acoustic Tagging Striped Bass in the Tar-Pamlico and Neuse Rivers Summary of Results

Goal
To deploy acoustic tags in striped bass from the 2014 and 2015 year-classes captured in the Tar-Pamlico and Neuse rivers to determine movement patterns during the summer, fall, and winter months and spring spawning migrations.

Background
Parentage Based Tagging (PBT) of striped bass stocked in the Central Southern Management Area (CSMA) began in 2010. Genetic stock identification of striped bass captured in the Central Southern Management area since 2010 indicates the stocks are near 100% hatchery origin, suggesting there has been minimal successful natural reproduction in these systems (NCDMF 2019a). However, more recent PBT analysis of striped bass collected in 2017 shows there may have been successful ‘‘wild’’ striped bass spawning events in 2014 and 2015 in the Tar-Pamlico and Neuse rivers (Farrae and Darden 2018). Results of PBT analysis from fish captured in 2017 revealed a decrease in the contribution of hatchery fish found in these rivers. Striped bass <22 inches total length (TL) identified by PBT analysis as non-hatchery or ‘‘wild’’ fish collected in 2017 are potentially the result of successful natural spawning events in the Tar-Pamlico and Neuse rivers. Otolith ages of the non-hatchery fish <22 inches TL indicate these fish collected in 2017 are all from the 2014 and 2015 year classes (Farrae and Darden 2018; NCDMF 2019a).

Based on this information, the North Carolina Marine Fisheries Commission (MFC) approved Supplement A to Amendment 1 to the N.C. Estuarine Striped Bass Fishery Management Plan in February 2019 implementing a no-possession limit for striped bass in the Internal Coastal and Joint Fishing Waters of the CSMA. In March 2019, the North Carolina Wildlife Resources Commission (NCWRC) passed a concurrent measure prohibiting the possession of striped bass

in Inland and Joint Fishing Waters. Supplement A to Amendment 1 was adopted by the MFC to protect these two important year classes of striped bass while Amendment 2 to the N.C. Estuarine Striped Bass Fishery Management Plan was being developed.

Though a portion of striped bass collected from this period in the CSMA are classified as non-hatchery produced, it is not possible to identify the river system where these ‘‘wild’’ striped bass were spawned. Conventional tag return data suggests density-dependent movement occurs from Albemarle-Roanoke stock striped bass moving into the CSMA rivers (Callihan et al. 2014). Juvenile sampling for striped bass in the Albemarle Sound indicated above average abundance of juveniles for the 2014 and 2015 year-classes (see Figure 1), so it is possible the increased abundance of ‘‘wild’’ striped bass from the 2014 and 2015 year classes observed in the Tar-Pamlico and Neuse Rivers are actually related to an expansion from the Albemarle-Roanoke stock for these two year-classes. If these fish are from the Albemarle-Roanoke stock, they will likely not make spawning runs in the Tar-Pamlico and Neuse rivers. Albemarle-Roanoke stock striped bass exhibit size dependent migrations to the ocean and exhibit natal homing to the Roanoke River (Callihan et al. 2015) whereas CSMA striped bass stocks are considered non-migratory and do not exhibit the anadromous behavior of the Albemarle-Roanoke stock. Alternatively, Rock et al. (2016) noted that some larger acoustic tagged striped bass in the Tar-Pamlico and Neuse rivers later migrated to the ocean and at least one was detected in the Chowan River and Albemarle Sound providing additional evidence for overlap between the Albemarle-Roanoke and CSMA stocks. It is also possible the presence of the 2014 and 2015 cohorts were the result of spawning success from one of either the Tar-Pamlico or Neuse rivers, and not in both systems. If this is the case, it is critical to determine the river system these fish were spawned in and understand movement patterns between the Tar-Pamlico and Neuse rivers to guide future management should natural reproduction continue to occur.

Understanding the movement and migration patterns of these two year classes of striped bass is important in gauging the success of Supplement A and directing future management. Striped bass from these year classes were tagged with acoustic transmitters following the methods of Rock et al. (2016) and movements within the Tar-Pamlico and Neuse rivers are tracked using existing acoustic receiver arrays in place in these rivers. In addition, any movement of these fish in the Albemarle Sound and Roanoke River is detected from existing acoustic arrays in that system. If these striped bass were naturally produced in the CSMA rivers this acoustic study would collect initial migration data for these cohorts of striped bass from these rivers. If these striped bass were naturally produced in the Albemarle-Roanoke, additional data about movement patterns of striped bass between the CSMA and Albemarle Sound will provide valuable information to inform future assessment and management of this stock.

Because there is a no-possession limit for striped bass in the CSMA, fishing mortality on tagged striped bass should be minimized allowing for maximum rates of detection. Tagging fish with

Vemco V16 (10-year tags) allows for long term monitoring of movement patterns and potentially multiple spawning runs.

Objectives

The objectives of this project are:

1. Insert acoustic tags, as well as conventional tags, into striped bass from the 2014 and 2015 year classes captured in the Tar-Pamlico and Neuse rivers.
2. Determine if these striped bass make spawning runs in the Tar-Pamlico and Neuse rivers.
3. Determine if these striped bass move between the CSMA and ASMA and RRMA.
4. Determine if these striped bass migrate to the ocean.

Methods

Striped bass were collected using electrofishing gear in the Tar-Pamlico and Neuse rivers. Effort was made to capture fish throughout the river and to deploy tags across multiple tagging days. Only fish at lengths that would be in the 2014 and 2015 year classes (ages 4 and 5) were tagged (Table 2.1). All striped bass were tagged with Vemco V16 (10-year tags) acoustic tags following the methods of Rock et al. (2016), along with a PIT tag and an internal anchor tag. All acoustic tagged fish were measured to the nearest millimeter (FL and TL), weighed, and a fin clip was collected to determine hatchery origin. When possible, sex was recorded. Acoustic tags were deployed during the winter when low water temperatures provided the greatest chance of survival and provided time for the fish to recover prior to the spawning period (March–May).

Receiver downloads in RRMA, ASMA, and CSMA rivers occurred quarterly, and this schedule has been maintained to collect additional detections.

Results

All acoustic tagging occurred in the Tar-Pamlico and Neuse rivers. Between December 2019 and January 2020, Division staff tagged 50 striped bass (25 from the Tar-Pamlico River and 25 from the Neuse River) with acoustic, PIT, and conventional tags. In addition, 48 striped bass (23 from the Tar-Pamlico River and 25 from the Neuse River) were collected and sacrificed in conjunction with the acoustic tagged fish to provide ages of ‘‘wild’’ striped bass. Since ages derived from PBT analysis can only be achieved with fish of hatchery origin, there was a need to sample a subset of fish to determine ages for ‘‘wild’’ fish from structures (otoliths). Results from length and age data indicate success in targeting fish from the 2014 and 2015 year classes. Acoustic tagged striped bass varied in size from 20.8 to 25.6 inches TL, with a mean of 22.7 inches TL (Table 2.2). Striped bass that were determined to be ‘‘wild’’ varied in size from 20.8 to 25.0 inches TL, with a mean of 22.9 inches TL (Table 2.2). Additionally, “wild’’ striped bass that were collected and sampled for age determination using otoliths ranged in age from four to six and had a modal age of four years old in the Neuse River, and five years old in the Tar-Pamlico River.

The acoustic tag detection data for this analysis covers a period beginning in December 2019 through March 2022.

PBT analysis from the 50 acoustically tagged striped bass revealed that 30 were non-hatchery origin and classified as ‘‘wild’’, with the remaining 20 fish being classified as hatchery origin. Twenty of the 25 fish tagged in the Tar-Pamlico River were classified as ‘‘wild’’ while 10 of the 25 fish tagged in the Neuse River were classified as ‘‘wild’’. Of the 20 fish determined to be hatchery fish, five were tagged in the Tar-Pamlico River and 15 were tagged in the Neuse River.

“Wild” Origin Striped Bass

Of the 30 total tagged ‘‘wild’’ striped bass, 70% (n=21) were determined to likely be ‘‘wild’’ Roanoke River striped bass because they left the CSMA river systems where they were tagged and were detected within the Albemarle Sound and/or Roanoke River (Figure 2). Most of the ‘‘wild’’ Roanoke River striped bass that left the CSMA and moved into the Albemarle Sound migrated up the Roanoke River (60%; n=18) and were ultimately detected on the spawning grounds near Weldon, N.C. (53%; n=16). Many of the ‘‘wild’’ Roanoke River striped bass had detection patterns indicating these fish reside in CSMA rivers throughout the year prior to undertaking migrations to the spawning grounds in the Roanoke River in the spring, then returning to the CSMA rivers after spawning is complete. The three remaining ‘‘wild’’ Roanoke River striped bass that left the CSMA system, were only detected as far as the Alligator River end of the Intracoastal Waterway (ICW) and the Alligator River Bridge. One of these was presumed dead due to repeated detections at the same location for an extended period and the other two had limited detections during the study period.

The remaining ‘‘wild’’ acoustic tagged striped bass (n=9) did not move out of the CSMA rivers and were not detected in Albemarle Sound; however, six of these fish did not have enough detection data to analyze movement patterns. Results indicate that a limited number of ‘‘wild’’ striped bass make spawning runs in the Tar-Pamlico and Neuse rivers. A single ‘‘wild’’ striped bass tagged in the Tar-Pamlico River was later detected on the spawning grounds in the spring near Rocky Mount, N.C. and one ‘‘wild’’ striped bass tagged in the Neuse River was later detected on the spawning grounds in the Neuse River (Figure 2.2). Additionally, one ‘‘wild’’ striped bass tagged in the Neuse River was later detected in the Tar-Pamlico River and ultimately on the spawning grounds near Rocky Mount, N.C. ‘‘wild’’ fish moving to the spawning grounds within the river systems they were tagged, or adjacent CSMA rivers, suggests some striped bass from other stocks may stray into CSMA rivers to attempt spawning or some low level of successful natural reproduction occurs.

Noteworthy movement data of ‘‘wild’’ striped bass:

- 53% (n=16) of the ‘‘wild’’ fish were detected on the spawning grounds near Weldon, N.C. Several of these ‘‘wild’’ striped bass (n=5) made repeated annual migrations in the spring back to the Roanoke River spawning grounds.

- 50% (n=4) of the ‘‘wild’’ fish tagged in the Neuse River were detected moving through Manns Harbor, and 13% (n=1) moved into the Albemarle Sound through the Pungo River/Alligator River ICW.

- 31% (n=4) of the ‘‘wild’’ striped bass tagged in the Tar-Pamlico River entered the Albemarle Sound through the Pungo River/Alligator River ICW

- One ‘‘wild’’ striped bass tagged in the Tar-Pamlico River was detected two years in a row on the Roanoke River spawning grounds and resided in the Tar-Pamlico the first year and in the Neuse River the second year.

- One ‘‘wild’’ striped bass after being detected on the spawning grounds at Weldon, NC, was later detected at Oregon Inlet presumably out-migrating to join the Atlantic migratory stock.

- One ‘‘wild’’ striped bass was commercially harvested in Edenton Bay on May 14, 2020.

Hatchery origin striped bass

Movement patterns of hatchery origin striped bass (n=20) show they did not leave the river system where they were tagged. Results indicate hatchery striped bass make spawning runs in the Tar-Pamlico and Neuse rivers. Due to the low sample size of hatchery origin fish collected in the Tar-Pamlico River (n=5) there is minimal data to infer movement patterns; however, a single hatchery origin striped bass was detected on the spawning grounds (n=1; 20%; Figure 3). In the Neuse River, 10 of 15 hatchery origin striped bass (62%) were detected on the spawning grounds (Figure 2.4).

Next Steps

All striped bass were tagged with 10-year acoustic tags; however, detections decreased substantially within the first two years after tagging (Figure 2.5). Currently, there are approximately seven ‘‘wild’’ and four hatchery origin striped bass that are still being detected routinely on acoustic receivers throughout the tracking area. A total of three striped bass are considered mortalities because they have been detected at the same location for an extended period, and one striped bass was harvested in the commercial fishery in the ASMA. Division staff will continue to download the acoustic receiver array to monitor for additional striped bass detections for the duration of the tag life.

Table 2.1. Striped bass length at age (2016-2017 PBT ages) for the Neuse and Tar-Pamlico rivers. Shaded cells are size ranges that were targeted for acoustic tagging.

			TL (mm)			TL (inch)		
Age	**River System**	**n**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
3	Neuse	70	517	446	616	20.4	17.6	24.3
	Tar-Pamlico	18	498	460	568	19.6	18.1	22.4
4	Neuse	54	572	451	641	22.5	17.8	25.2
	Tar-Pamlico	119	574	473	659	22.6	18.6	25.9
5	Neuse	30	632	489	717	24.9	19.3	28.2
	Tar-Pamlico	79	618	528	681	24.3	20.8	26.8
6	Neuse	21	669	573	735	26.3	22.6	28.9
	Tar-Pamlico	40	657	587	718	25.9	23.1	28.3
7	Neuse	7	704	651	766	27.7	25.6	30.2
	Tar-Pamlico	2	696	668	723	27.4	26.3	28.5

Table 2.2. Acoustic tagged striped bass lengths for the Neuse and Tar-Pamlico rivers separated by treatment (tagged or sampled for aging structure) and origin.

				TL (mm)			TL (inch)		
River	**Treatment**	**Origin**	**n**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Neuse	tagged	hatchery	15	581	537	650	22.9	21.1	25.6
		‘wild’	10	597	539	635	23.5	21.2	25.0
	sampled	hatchery	16	591	527	665	23.3	20.7	26.2
		‘wild’	9	586	533	641	23.1	21.0	25.2
Tar-Pamlico	tagged	hatchery	5	545	531	572	21.5	20.9	22.5
		‘wild’	20	572	529	633	22.5	20.8	24.9
	sampled	hatchery	7	558	535	626	22.0	21.1	24.6
		‘wild’	16	567	533	642	22.3	21.9	25.3

Table 2.3. Striped bass ages (otolith and Parentage Based Tagging; PBT) for the Neuse and Tar-Pamlico rivers separated by treatment (tagged or sampled for aging structure) and origin.

			Age						Total Number Aged	
			Modal		Min		Max			
River	Treatment	Origin	otolith	PBT	otolith	PBT	otolith	PBT	otolith	PBT
Neuse	tagged	hatchery	-	4	-	4	-	6	-	15
		'wild'	-	-	-	-	-	-	-	-
	harvested	hatchery	4	4	3	3	7	7	16	16
		'wild'	4	-	4	-	6	-	9	-
Tar-Pamlico	tagged	hatchery	-	4	4	-	4	-	-	5
		'wild'	-	-	-	-	-	-	-	-
	harvested	hatchery	4	4	4	4	6	6	7	7
		'wild'	5	-	5	-	6	-	16	0

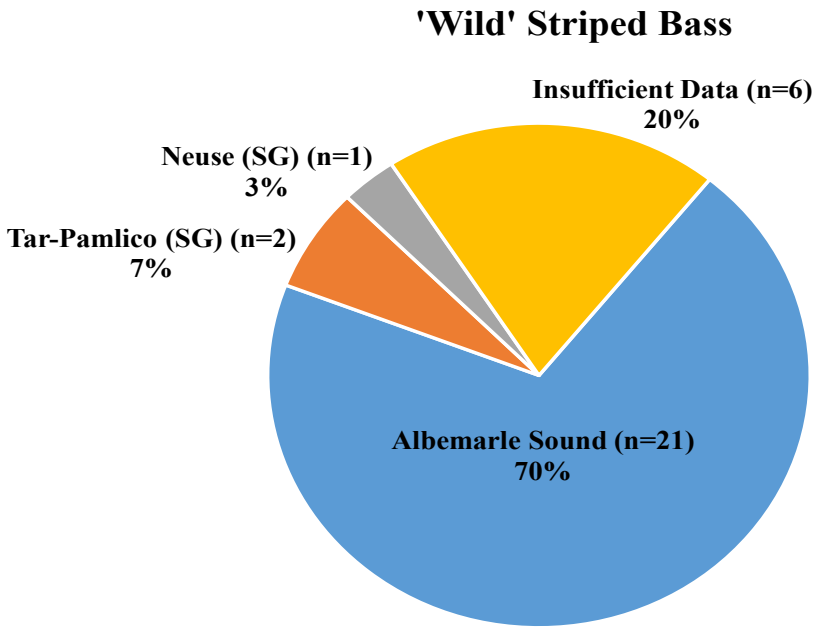

Figure 2.1. Detection location (%) of all acoustic tagged "wild" striped bass (n=30) by area (Tar-Pamlico and Neuse Rivers spawning grounds (SG), and Albemarle Sound). All original tagging events occurred in the Tar-Pamlico and Neuse River systems.

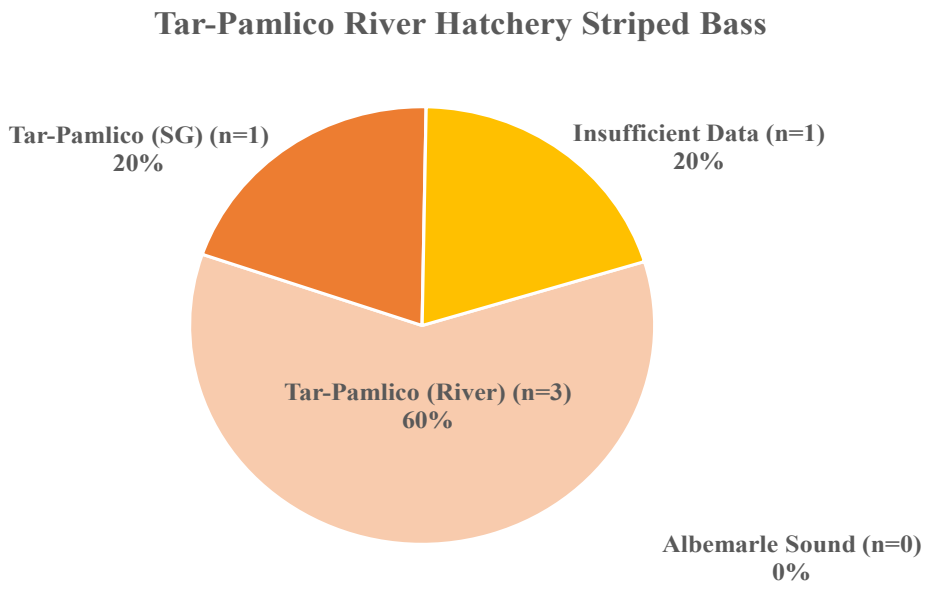

Figure 2.2. Detection location (%) for acoustic tagged hatchery origin striped bass in the Tar-Pamlico River system (n=5) by area (detection on spawning grounds (SG) or river residence). No hatchery origin fish from the Tar-Pamlico River system were detected in the Albemarle Sound area.

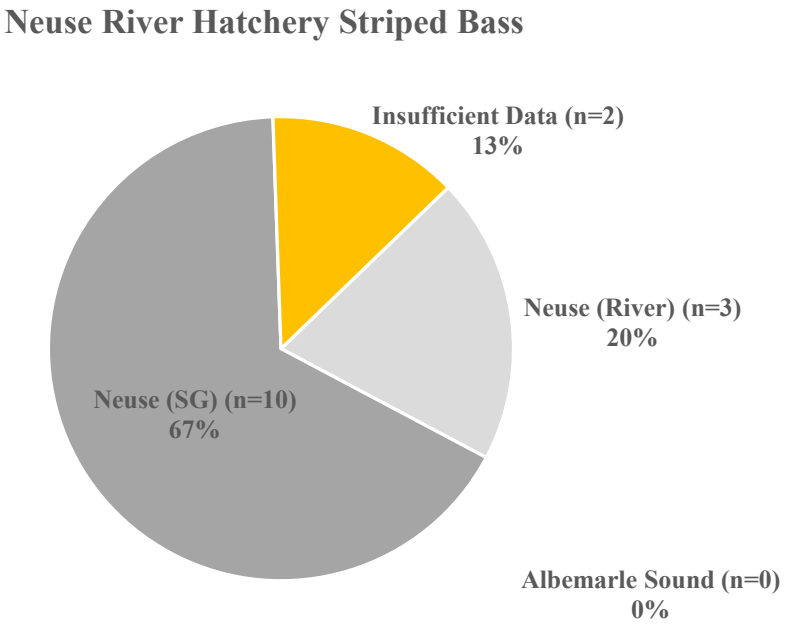

Figure 2.3. Detection location (%) for acoustic tagged hatchery origin striped bass in the Neuse River system (n=15) by area (detections on the spawning grounds (SG) or river residence). No hatchery origin fish from the Neuse River system were detected in the Albemarle Sound area.

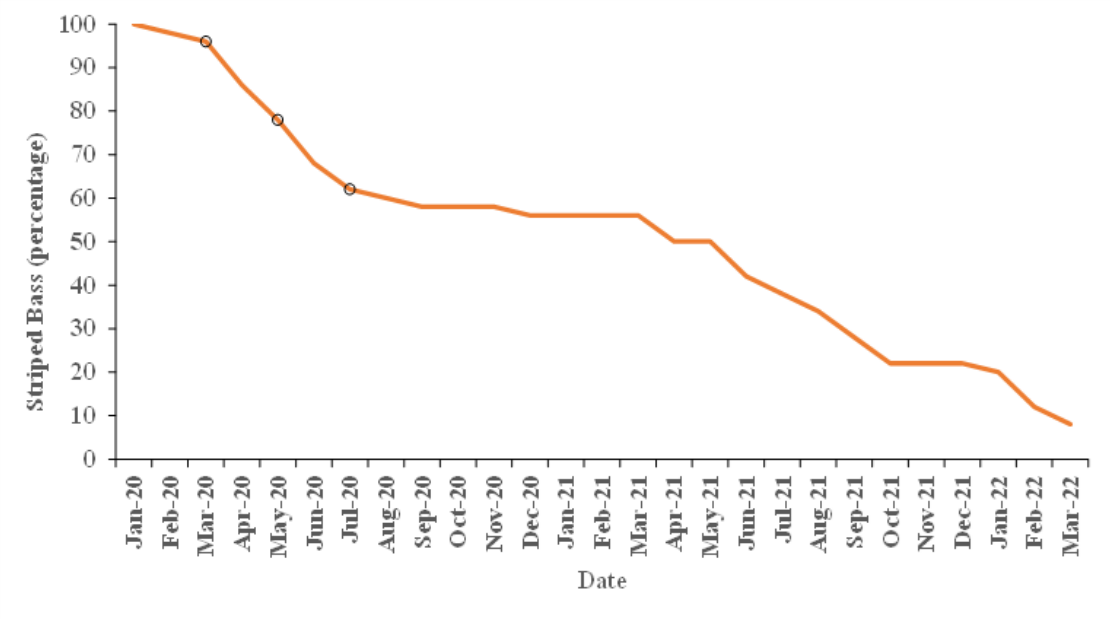

Figure 2.4. Tag detection loss (%) of acoustic tagged striped bass. Black circles represent known mortalities (n = 4).

APPENDIX 3: EVALUATION OF GILL NET CLOSURE ON RED DRUM, SOUTHERN FLOUNDER, SPOTTED SEATROUT, AND STRIPED MULLET ABOVE THE FERRY LINES IN NEUSE AND TAR-PAMLICO RIVERS

ISSUE

Assess the impact of the 2019 gill net closure above the ferry line in the Neuse and Tar-Pamlico rivers on red drum (*Sciaenops ocellatus*), southern flounder (*Paralichthys lethostigma*), spotted seatrout (*Cynoscion nebulosus*), and striped mullet (*Mugil cephalus*) abundance.

BACKGROUND

In 2019, the N. C. Marine Fisheries Commission (MFC) directed the N.C. Division of Marine Fisheries (DMF) to issue a Proclamation that prohibited all gill nets upstream of the ferry lines in the Neuse and Tar-Pamlico rivers to protect striped bass (see Appendix 1 for summary of actions). This prohibition was maintained in Amendment 2 of the Striped Bass FMP, adopted in November 2022. As part of the Amendment 2 adaptive management framework, the DMF analyzed data through 2024 to determine if there were significant differences in relative abundance of striped bass before (2004–2018) and after (2019–2024) the striped bass harvest and ferry line gill net closures. For a full description of management history and analysis results see Appendix 1.

The MFC expressed interest at their August 2025 quarterly business meeting in the use of similar analyses to determine if there were significant differences in relative abundance of red drum, southern flounder, spotted seatrout, and striped mullet before and after the ferry line gill net closure. Data from the DMF Independent Gill Net Survey (Program 915) above the ferry lines were analyzed using Mann-Kendall (M-K) trend tests and the randomization tests. The M-K test is a non-parametric statistical test used to detect significance of increasing or decreasing trends over time. The randomization test is a non-parametric statistical test used to detect significant differences between groups by randomly shuffling observed data to determine if observed differences are significant. See Appendix 1 Data section for additional details for Program 915 and the M-K and randomization test analyses used in this evaluation. A subset of Program 915 data was used for each species based on the species-specific months and depth strata (deep or shallow) used to calculate nominal abundance indices in annual Fishery Management Plan (FMP) updates (NCDMF 2025b).

RESULTS

Red Drum

Annual relative abundance of red drum in Program 915 was calculated using all sampling months and strata (NCDMF 2025b). Between 2004 and 2024, annual relative abundance in the Neuse and Tar-Pamlico rivers above the ferry lines was variable with no trend (Figures 3.1 and 3.2).

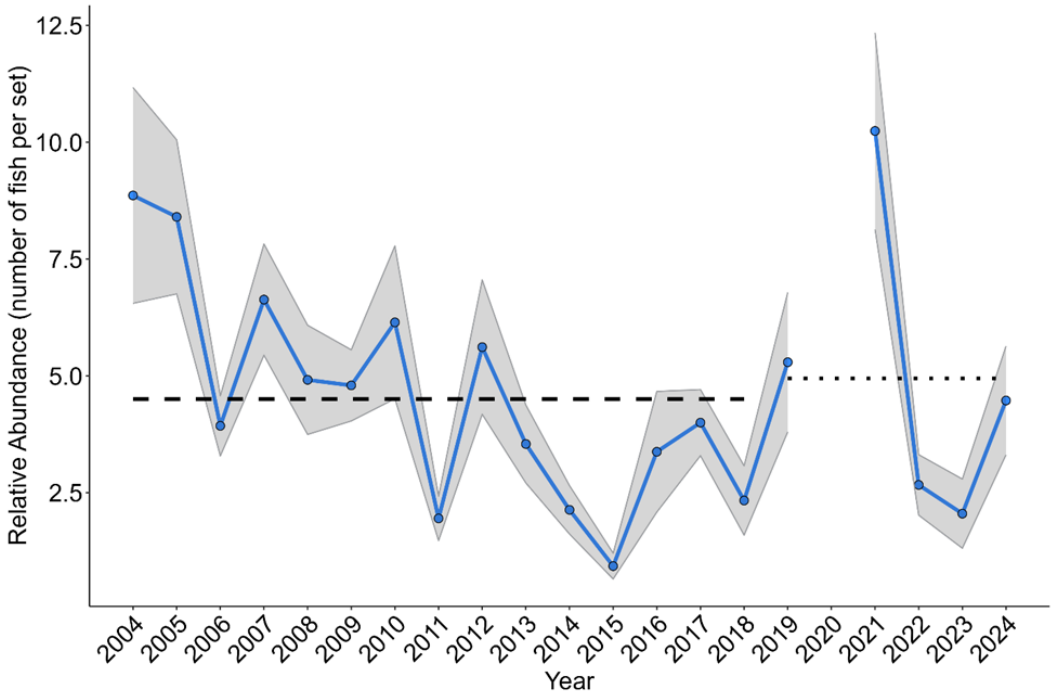

Figure 3.1. Relative abundance of Neuse River red drum from Program 915 above the ferry line during all months, in deep and shallow water sets, 2004–2024.The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the ferry line closure (2004–2018), and the dotted line represents mean number of fish per set after the ferry line closure (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

In both rivers, relative abundance was high in 2021, but sampling only occurred from July–December so results are not directly comparable to other years. M-K trend test results for the Neuse River indicate a significant, decreasing trend in red drum abundance above the ferry line in the period before the gill net closure (P = 0.01, tau = –0.54);

however, there was no significant trend in red drum abundance after the closure (P = 0.46; Table 3.1). In the Tar-Pamlico River, there was no significant trend in red drum abundance above the ferry line before or after the closure. Randomization test results indicate no statistically significant difference in red drum abundance above the ferry line before or after the gill net closure in the Neuse River (P = 0.45; Table 3.2). Similarly, there was no statistically significant difference in red drum abundance above the ferry line before or after the gill net closure in the Tar-Pamlico River (P = 0.16; Table 3.2).

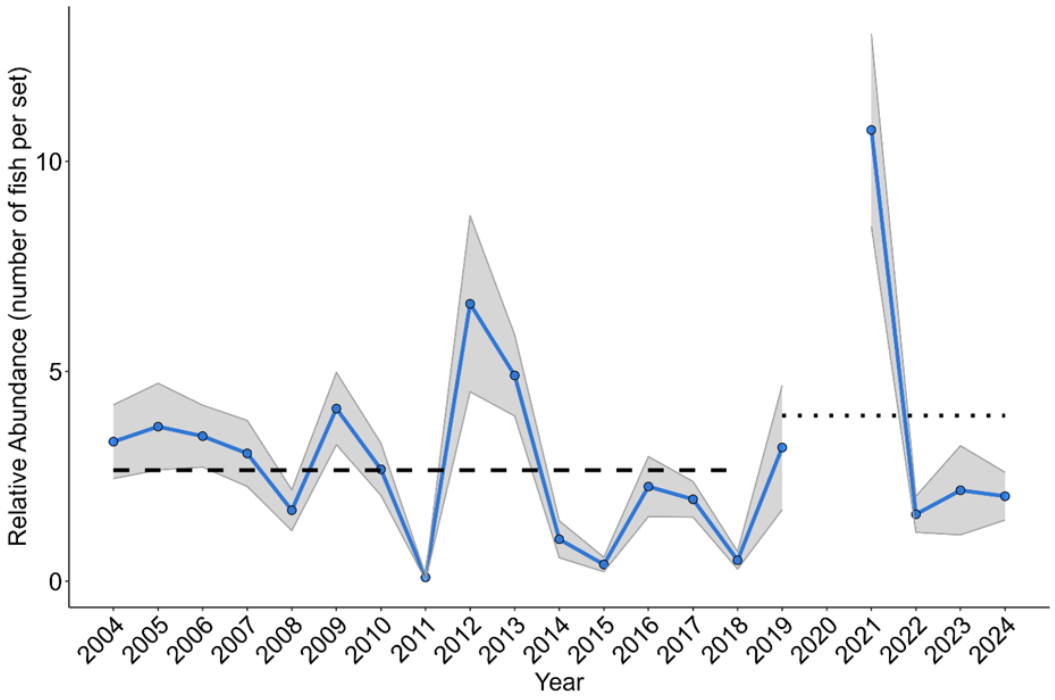

Figure 3.2. Relative abundance of Tar-Pamlico River red drum from Program 915 above the ferry line during all months, in deep and shallow water sets, 2004–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the ferry line closure (2004–2018), and the dotted line represents mean number of fish per set after the ferry line closure (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

Table 3.1. M-K trend test results for Program 915 red drum, southern flounder, spotted seatrout, and striped mullet relative abundance trends above the ferry lines in the Neuse and Tar-Pamlico rivers before (2004–2018) and after (2019–2024) the ferry line gill net closure. NS = not significant. *Represents a statistically significant difference (Probability (P) ≤ 0.05).

Species	System	Period	Probability *(P)*	Trend	Tau
Red Drum	Neuse	Before	0.01*	Decreasing	-0.54
		After	0.46	NS	-0.40
	Tar-Pamlico	Before	0.11	NS	-0.31
		After	0.46	NS	-0.40
Southern Flounder	Neuse	Before	0.62	NS	-0.11
		After	0.46	NS	-0.40
	Tar-Pamlico	Before	0.11	NS	-0.31
		After	0.46	NS	-0.40
Spotted Seatrout	Neuse	Before	0.46	NS	-0.15
		After	0.81	NS	0.20
	Tar-Pamlico	Before	0.69	NS	-0.09
		After	0.46	NS	0.40
Striped Mullet	Neuse	Before	0.20	NS	-0.26
		After	0.81	NS	0.20
	Tar-Pamlico	Before	0.20	NS	-0.26
		After	0.81	NS	0.20

Table 3.2. Randomization test results comparing mean red drum, southern flounder, spotted seatrout, and striped mullet relative abundance in the Neuse and Tar-Pamlico rivers from Program 915 before (2004–2018) and after (2019–2024) the ferry line gill net closure. *Represents a statistically significant difference (Probability (P) ≤ 0.05).

		Number of Samples		Relative Abundance		
Species	System	Before	After	Before	After	Probability (*P*)
Red Drum	Neuse	1,779	532	1.17	1.06	0.45
	Tar-Pamlico	1,263	397	0.71	0.86	0.16
Southern Flounder	Neuse	176	58	2.85	1.86	0.05
	Tar-Pamlico	127	44	2.66	1.80	0.23
Spotted Seatrout	Neuse	1,064	314	0.33	0.53	<0.01*
	Tar-Pamlico	755	235	0.29	1.20	<0.01*
Striped Mullet	Neuse	399	133	5.28	3.29	0.01*
	Tar-Pamlico	287	97	5.30	2.76	<0.01*

Southern Flounder

Annual relative abundance of southern flounder in Program 915 was calculated using data from shallow sets in August and September only (NCDMF 2025b). Between 2004 and 2024, annual relative abundance of southern flounder in the Neuse River was variable with a general downward trend after a peak in 2012 (Figure 3.3). Annual relative abundance of southern flounder in the Tar-Pamlico River was also variable with a general downward trend outside of a peak in abundance in 2021 (Figure 3.4). M-K trend test results for the Neuse and Tar-Pamlico rivers indicate no significant trend in southern flounder abundance before or after the closures (Table 3.1). Randomization test results indicate no statistically significant difference in southern flounder abundance above the ferry line before or after the gill net closure in either the Neuse (*P* = 0.05) or Tar-Pamlico (*P* = 0.23) rivers (Table 3.2).

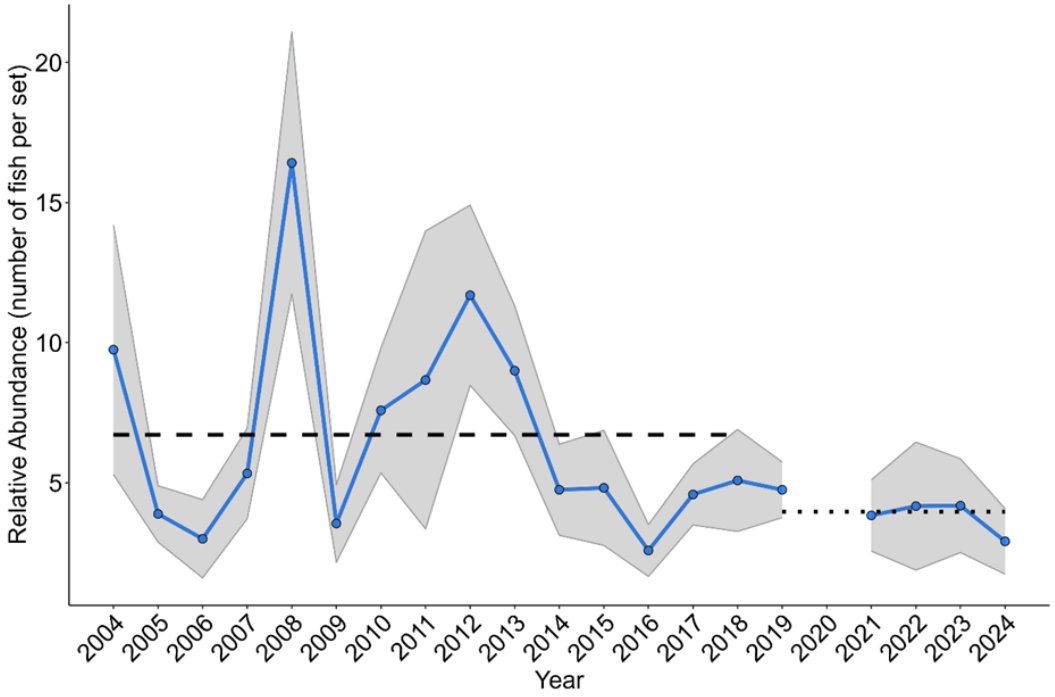

Figure 3.3. Relative abundance of Neuse River southern flounder from Program 915 above the ferry line during August and September, in shallow water sets, 2004–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the ferry line closure (2004–2018), and the dotted line represents mean number of fish per set after the ferry line closure (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

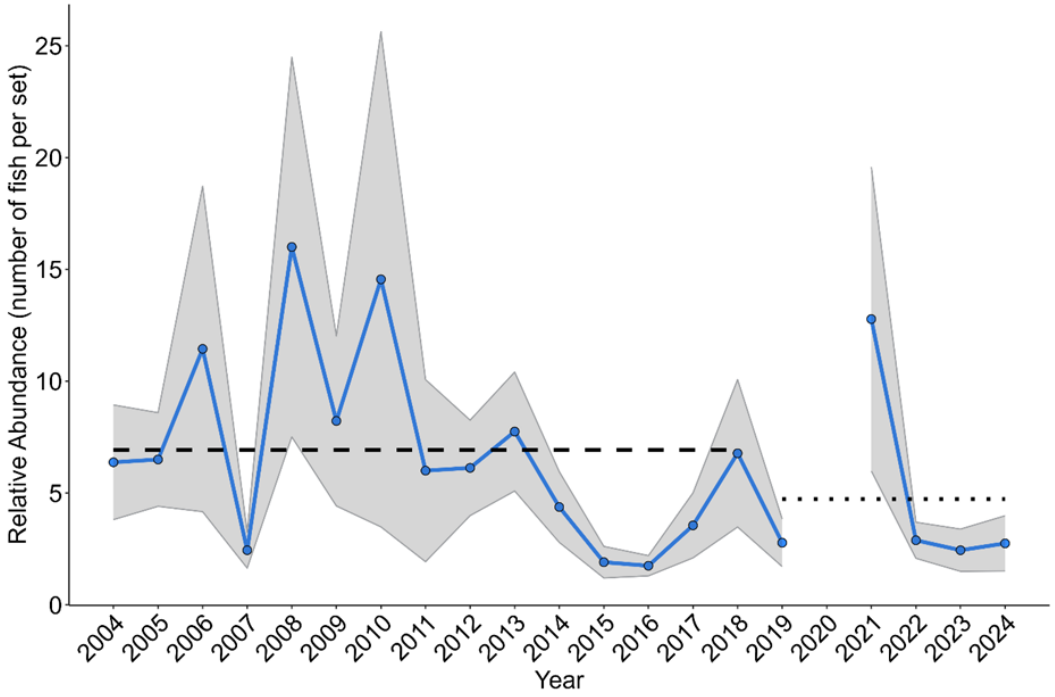

Figure 3.4. Relative abundance of Tar-Pamlico River southern flounder from Program 915 above the ferry line during August and September, in shallow water sets, 2004–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the ferry line closure (2004–2018), and the dotted line represents mean number of fish per set after the ferry line closure (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

Spotted Seatrout

Annual relative abundance of spotted seatrout in Program 915 was calculated using deep and shallow sets from April through June and September through November (NCDMF 2025b). Between 2004 and 2024, annual relative abundance of spotted seatrout above the ferry line in the Neuse River was variable with no apparent trend (Figure 3.5). While annual relative abundance of spotted seatrout above the ferry line in the Tar-Pamlico River was also variable, 2023 and 2024 had notably high relative abundance compared to other years (Figure 3.6). While 2021 also had high relative abundance, sampling only occurred from July–December so results are not directly comparable to other years. M-K trend test results indicate no significant trend in spotted seatrout relative abundance above the ferry line before or after the closure in either river system (Table 3.1). Randomization test results indicate spotted seatrout relative abundance above the ferry

lines in the Neuse (P = <0.01) and Tar-Pamlico (P = <0.01) rivers was significantly higher after the gill net closure compared to relative abundance before the closure (Table 3.2).

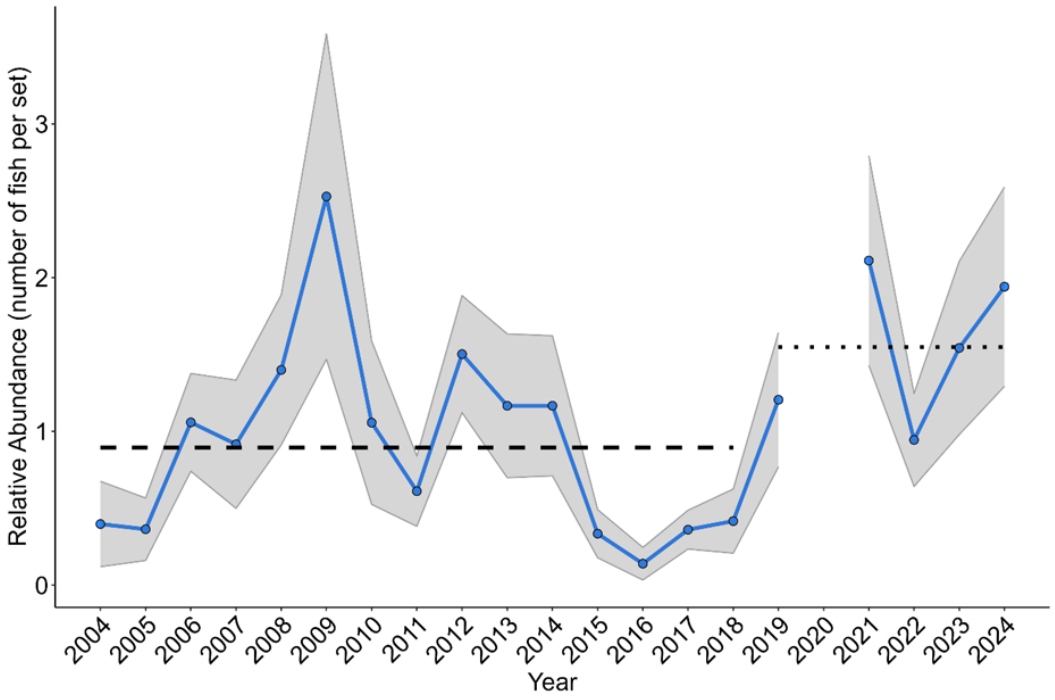

Figure 3.5. Relative abundance of Neuse River spotted seatrout from Program 915 above the ferry line during April–June and September–November, in deep and shallow water sets, 2004–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the ferry line closure (2004–2018), and the dotted line represents mean number of fish per set after the ferry line closure (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

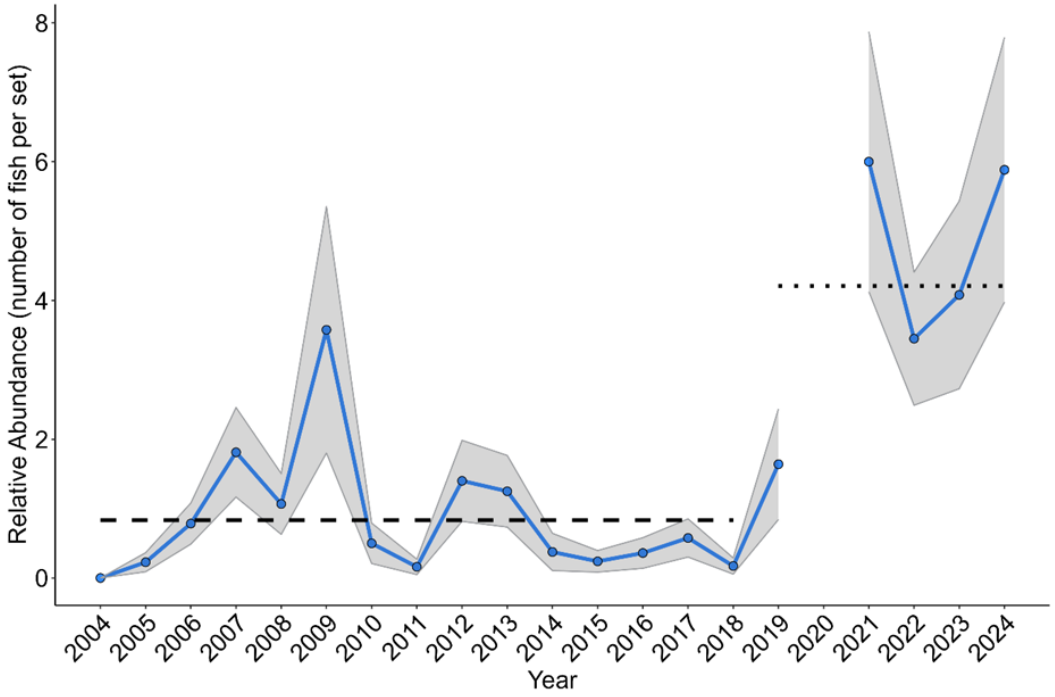

Figure 3.6. Relative abundance of Tar-Pamlico River spotted seatrout from Program 915 above the ferry line during April–June and September–November, in deep and shallow water sets, 2004–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the ferry line closure (2004–2018), and the dotted line represents mean number of fish per set after the ferry line closure (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

Striped Mullet

Annual relative abundance of striped mullet in Program 915 was calculated using shallow sets in August through December (NCDMF 2025b). Between 2004 and 2024, annual relative abundance of striped mullet was variable with a generally increasing trend above the ferry line in the Neuse River and no trend in the Tar-Pamlico River (Figures 3.7 and 3.8). M-K trend test results for both river systems indicate no significant trend in striped mullet relative abundance above the ferry lines before or after the closure (Table 3.1). However, Randomization test results indicate striped mullet relative abundance was significantly lower above the ferry line after the closure in both the Neuse River (P = 0.01) and Tar-Pamlico rivers (P = <0.01; Table 3.2).

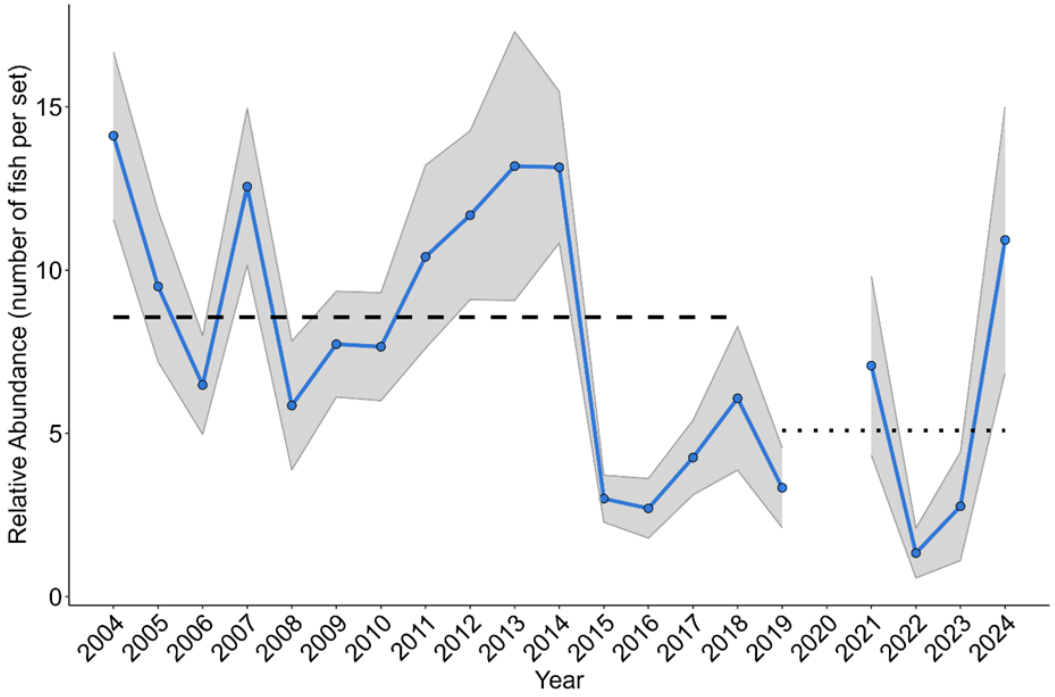

Figure 3.7. Relative abundance of Neuse River striped mullet from Program 915 above the ferry line, during August–December, in shallow water sets, 2004–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the ferry line closure (2004–2018), and the dotted line represents mean number of fish per set after the ferry line closure (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

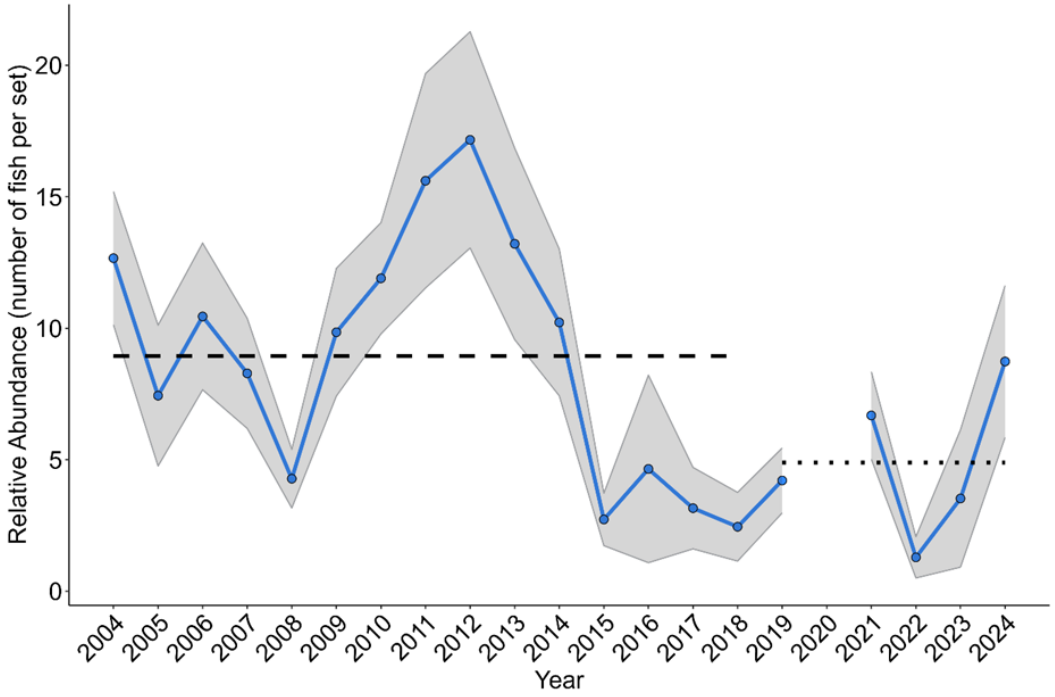

Figure 3.8. Relative abundance of Tar-Pamlico River striped mullet from Program 915 above the ferry line during August–December, in shallow water sets, 2004–2024. The shaded gray error bars represent ± 1 standard error, the dashed line represents mean number of fish per set before the ferry line closure (2004–2018), and the dotted line represents mean number of fish per set after the ferry line closure (2019–2024). No sampling occurred in 2020, and limited sampling occurred in 2021 (July–December only) due to COVID restrictions.

DISCUSSION

Results of the M-K trend tests and the Randomization tests were inconsistent across species and between river systems. Red drum was the only species with a significant abundance trend (increasing or decreasing) before the gill net closure. Red drum abundance in the Neuse River before the gill net closure showed a significant but modest downward trend but had no trend after the closure. However, randomization test results indicated there was no significant difference in red drum abundance after the gill net closure compared to before. No other species had a significant abundance trend before or after the gill net closure and only spotted seatrout had significantly higher abundance above the ferry lines after the gill net closure. Inconsistency of results is not surprising given the small area considered and differences in life history between species analyzed.

Localized finfish abundance can be influenced by many factors, including stock status, natural mortality (e.g., spotted seatrout cold stuns NCDMF 2025c), environmental fluctuations, habitat suitability, life stage, and recruitment variability (NCDEQ 2016; Odell et al. 2017). This combination of factors can lead to interannual variability in abundance. For Tar-Pamlico and Neuse river striped bass populations that spend their entire life within the river systems, examining abundance trends before and after the ferry line closures may be appropriate because these striped bass stocks are resident and the majority do not leave the rivers. However, when only considering small areas within a stock's entire range (such as red drum, southern flounder, spotted seatrout, and striped mullet), deciphering the extent to which each factor influences abundance can be difficult and changes in local abundance may not be correlated to population abundance. For example, lower than average rainfall can lead to higher salinity further upriver providing more favorable conditions for marine fishes that might not typically be found in these areas, increasing local abundance without a corresponding increase in population abundance. Alternatively, higher than average rainfall can lead to the opposite situation and an artificially depressed local abundance that may or may not be reflective of stock abundance.

Localized abundance may also be directly related to overall stock abundance. When stock abundance is high, local abundance may also be high and vice versa. As an example, in 2019 spotted seatrout spawning stock biomass was high (NCDMF 2022b) and abundance from Program 915 above the ferry lines in the Tar-Pamlico and Neuse rivers was also higher than the pre-closure period. However, abundance was also high in other areas of the throughout the entire state. The statewide nature of high spotted seatrout abundance after the closure makes it difficult to ascribe the increase specifically to the ferry line closures rather than other factors that might impact abundance on a larger scale (e.g., no significant cold stun occurring during this period).

In contrast, in 2019 striped mullet spawning stock biomass was low (NCDMF 2022c) and abundance from Program 915 above the ferry lines in the Tar-Pamlico and Neuse rivers was also lower than the pre-closure period. While preventing gill net harvest of striped mullet in a small area of the stock's range may increase local abundance, the migratory nature of striped mullet limits the effectiveness of small area closures. Essentially, the gill net closure acts as a commercial harvest delay measure for striped mullet, where the fish become available to the gill net fishery when they move down river below the ferry lines toward the ocean to spawn (NCDMF 2024b). This is also true for southern flounder, which has a similar life history to striped mullet. Neither example provides a definitive judgement on the effectiveness of the gill net closures but do provide additional context for how local abundance must be viewed in the context of a stock's entire range.

In addition to the small spatial scale affected by the gill net closure relative to the broader range for these stocks, the specific before and after timeframes further complicate the analyses discussed here. The period before the gill net closure includes 14 years (2004–2018) while the best case for the period after the gill net closure only includes five years (2019–2024) with a one-year data gap in 2020 as sampling in Program 915 paused in 2020 due to the Covid-19 Pandemic and did not resume until July 2021. Although all species discussed here are missing abundance estimates for 2020, the pause in Program 915 sampling does not equally affect abundance estimates for each species. For example, 2021 abundance estimates for red drum (all months) and spotted seatrout (Apr–Jun and Sep–Nov) should be viewed with a high degree of caution as multiple months were unavailable for estimating abundance in 2021. For southern flounder (Aug–Sep) and striped mullet (Aug–Dec), all sampling months were available for 2021 abundance estimates. It is difficult to separate any longer-term abundance trends from the sometimes wide range in interannual abundance variation over the much shorter period after the gill net closure.

When Area Closures Work

Area restrictions can be an effective management measure to meet sustainability objectives, protect specific life stages, reduce bycatch, and protect vulnerable habitat (Fujioka 2006; O'Keefe et al. 2014; Hoos et al. 2019; McConnaughey et al. 2019; Hilborn et al. 2020). In North Carolina, area restrictions have been implemented in coastal estuarine waters to protect important habitats, reduce bycatch, or reduce user group conflicts (NCDMF 2022d).

For example, Primary and Secondary Nursery Areas have been designated throughout the estuarine waters of North Carolina primarily in the upper portions of estuarine rivers, creeks, and bays. Gear restrictions in nursery areas (e.g., use of trawl nets are prohibited in designated nursery areas) provide protection for juvenile finfish and shellfish during the early part of their life.

Blue crab spawning sanctuaries (CSS) have been designated at all coastal inlets to protect mature female crabs in these areas prior to and during the spawning season allowing them access to ocean waters to release their eggs (NCDMF 2020). The CSS are closed to the use of pots, and mechanical methods for oysters or clams and to the taking of crabs with any commercial fishing equipment from March 1 through August 31 in areas from Barden Inlet north and from March 1 through October 31 in areas from Beaufort Inlet west and south (NCMFC Rule 15A NCAC 03L .0205). The CSS are also permanently closed to trawling (NCDMF 2022d).

In both examples, abundance data and life history information were used to identify specific habitats as crucial to the species of interest and restrictions were targeted toward

gear or practices that would disrupt use of these habitats. No such data was reviewed when establishing the ferry line gill net closures. Furthermore, restrictions were limited to a single gear (gill nets) that may not be the most significant source of fishing mortality for all species (e.g., harvest and dead discards from hook-and-line gear is the primary source of spotted seatrout fishing mortality; NCDMF 2025b), thus limiting the effectiveness of the ferry line closures as a conservation tool.

The lack of consistency in the results presented here – within river systems, across river systems, and across species – suggests the ferry line closures were unlikely to have had either a positive or negative impact on species abundance. This finding is not surprising for species whose occurrence in these river systems is temporary based on migratory patterns influenced by their life history and tolerance to changes in environmental conditions. For species that require reductions in fishing mortality to meet sustainability objectives, a more effective approach to developing management is to consider options across a species' habitat range and for all sources of fishing mortality. These options are included in species-specific FMPs, which are updated approximately every five years.

APPENDIX 4: MARCH 4, 2019, DMF DIRECTOR LETTER TO MFC CHAIRMAN REGARDING THE NEED FOR ADDITIONAL GILL NET RESTRICTIONS TO CONSERVE STRIPED BASS

March 4, 2019

Dear Chairman Bizzell,

At the February 2019 Marine Fisheries Commission (MFC) meeting the MFC passed Supplement A to Amendment 1 of the Estuarine Striped Bass Fishery Management Plan. As approved, Supplement A specifies a no-possession limit, essentially a closed season for striped bass, in the Central Southern Management Area (CSMA). There are, however, complicating jurisdictional issues between MFC and the Wildlife Resources Commission (WRC).

Last week, Department of Environmental Quality (DEQ) and Division of Marines Fisheries (DMF) staff met with the Director and staff of the WRC. The WRC Director indicated that because of the joint jurisdictional language in N.C.G.S. §113-132 that the Supplement A measure would be inconsistent with existing WRC recreational Joint Fishing Waters of the CSMA. After consulting with WRC and with legal counsel for both Commissions and DEQ it was decided that the best approach forward would be to convene a special meeting of the MFC to formally request that the WRC implement management measures consistent with Supplement A for the joint Coastal Fishing Waters of the CSMA to harmoniously resolve the jurisdictional conflict. I think this could be done over the phone with at least one listening station and it would be up to you to decide if any additional public comment would be warranted.

If a special meeting is not called, then it is important to have this on the May agenda for the MFC meeting. The recreational season closes April 30 by rule (15A NCAC 03M .0202) so if we do hold a special meeting it would only buy a brief period with the no-possession limit was in place for the recreational spring season. However, it is important to address it to implement the no-possession limit in the fall recreational fishery. The next regularly scheduled meeting of the WRC is in April.

Considering this, I plan to issue proclamations this week to implement the following:

1. Close the remainder of the recreational season on striped bass in the coastal waters of the CSMA. This closes the season year-round.
2. Allowing the joint Coastal Fishing Water recreational season to remain open with current catch limits until the MFC can request from concurrence from the WRC and they concur.
3. Implementing in the coastal and joint coastal waters 36-inch tie-down and 50-yard distance from shore regulations in the western Pamlico Sound including the Tar-Pamlico and Neuse

rivers and their tributaries. This is required under the management measures of the FMP whenever the striped bass season is closed. The MFC, in the adoption of the Supplement confirmed that action.

4. The CSMA commercial season which opens by proclamation will not be opened due to the adoption of Supplement A.

This will present a situation where our coastal waters include stronger recreational conservation measures for striped bass than the joint coastal waters until this consistency issue is resolved. It is likely the recreational season for spring 2019 will close before this can happen (April 30). Because WRC does not regulate any commercial gear, there is not an inconsistency with existing rule to prevent our implementing the commercial no-possession and gill net measures in the joint coastal waters as well. Finally, after the passage of Supplement A, the MFC approved a motion to "ask" the DMF Director to issue a proclamation, effective in conjunction with the supplement, that restricts the use of gill nets that interact with striped bass upstream of the ferry lines and requires attendance of gill nets that interact with striped bass upstream of the tie-down lines. I have received dozens of emails supporting this measure both in form letters and in original letters.

While I respect the concerns of both the public and the MFC, after careful consideration I have concluded that such a measure is not supported by the scientific data that support gill nets as the primary or even the most significant source of discard mortality. As you are aware, recreational effort will not be controlled under the Supplement and catch and release will be a source of discard mortality as well. The motion to remove nets was also not a part of the supplement measure approved by the DEQ Secretary. The DMF Director's proclamation authority acts within the bounds of the FMP.
Therefore, I respectfully decline to act on this request to issue a proclamation further restricting gill nets beyond those measures outlined in Supplement A. I would, however, like to provide some supporting information underlying the basis for this decision.

SUPPORTING INFORMATION FOR DECISION

The journal article by Rachels and Ricks (2018), explores causal factors of spawning stock mortality sources in the N.C. riverine striped bass fishery, and notes that their inability to include recreational angling as an exploitation factor reduces the amount of variability in spawning stock mortality that can be accounted for in their study. The authors go on to include that it is likely that the inclusion of recreational harvest and discard would perform comparably to the results of the commercial harvest in their modeling.

In Supplement A, the DMF used the CSMA creel survey data, (not a part of MRIP), to determine recreational harvest, discards and discard mortality. From 2012-2017 all but the last two years' total removals of striped bass (harvest + dead discards) were nearly equal between the recreational and commercial sector. The increase in recreational discard mortality in the last two years is due to what appears to be a successful natural spawning event in the rivers during 2014 and possibly 2015.

Moreover, the following is a list of gill net regulations that are either already in place or will be implemented by proclamation in the areas upstream of the Tie Down lines. The purpose of these regulations is to reduce regulatory discards of striped bass and important estuarine finfish and protected species. On-board observer data and empirical *in-situ* field studies by the DMF has shown these large mesh regulations have decreased striped bass discards significantly (potentially up to 75%) compared to pre-2008 estimates of striped bass discards before the tie- downs and distance from shore regulations were implemented. Striped bass gill-net discards mortality estimates for 2012-2017 in the Tar-Pamlico and Neuse rivers combined, range from 507 to 986 fish annually.

Regulations for gill nets with stretched mesh of 5 inches and greater:

- It is unlawful to fail to equip gill nets with tie-downs spaced no farther apart than 10 yards to restrict the vertical distance between the top and bottom lines to 36 inches or less. If the vertical height of the net (distance between the top and bottom line) is 36 inches or less, no tie-downs are required. Nets must be set to fish on the bottom and not exceed a vertical height of 36 inches. (Tie- down regulation see map)
- It is unlawful for any portion of the net to be within 50 yards of any point on shore when set or deployed in the following river areas: (distance from shore regulation - see map)

The previous years estuarine striped bass commercial seasons in the CSMA have been as follows:

Year	Day Open	Day Closed*
2014	03/01/14	03/20/14
2015	03/01/15	03/18/15
2016	03/01/16	03/21/16
2017	03/01/17	04/03/17
2018	03/01/18	04/30/18

*Closings before 4/30 of a year are early closures due to the 25,000 lb. quota being met or exceeded.

In the figure below (Figure 4.1), interactions with striped bass drop significantly in the large mesh gill net fishery above the tie-down line following the closure of the commercial striped bass season. Remember that the tie-down requirement and distance from shore requirements are not in place when the commercial season is open. With a no possession limit under Supplement A, the commercial season will not open and tie-down and distance from shore requirements will be in effect year-round. Gill net bycatch is anticipated to be more reflective of the May-February figures.

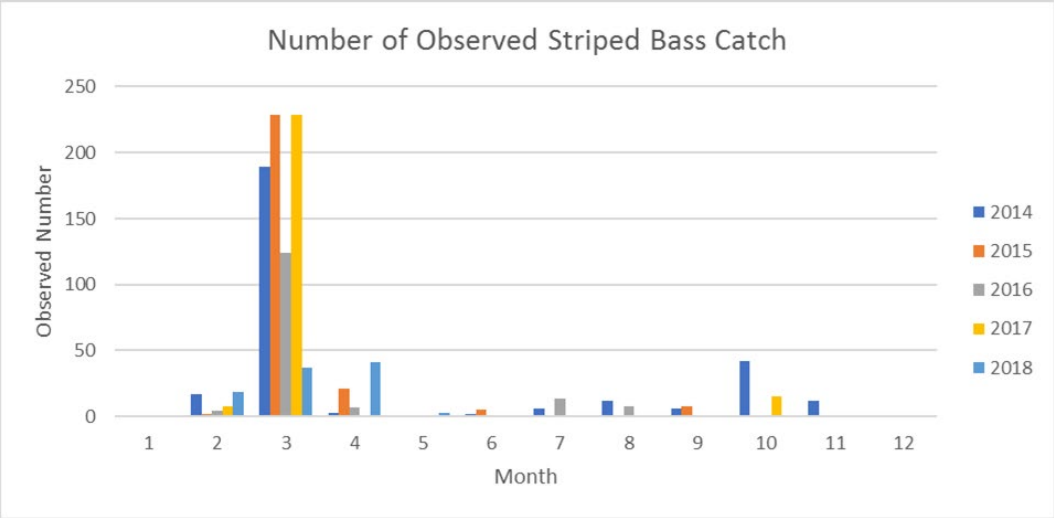

Figure 4.1. All striped bass (striped bass and hybrid bass) observed during Program 466 trips on the Pamlico, Neuse, Trent, and Pungo rivers, 2014–2018. These data were selected to mirror the area that would be affected by the Proclamation requested at the February 2019 MFC meeting.

Regulations for gill nets with stretched mesh of less than 5 inches:

- Attendance of small mesh gill nets (<5 ISM) is required year-round in the following areas based on NCMFC rule 15A NCAC 3R.0112 (a):
    - Upper portions of the Pamlico, Pungo, Neuse, and Trent rivers
    - Within 200 yards of shore in the lower portions of the Pamlico, Pungo, Neuse, and Trent rivers

Regulations in effect statewide, large and small mesh gill nets:

- All unattended gill nets ≥ 5 ISM must be at least 10 feet from shore from June through November (NCDMF 2008).
- Gill nets with a mesh size ≥ 5 ISM and <5 ½ ISM is prohibited from April 15 through December 15 (NCDMF 2005).
- 2,000 yard/vessel limit on gill nets ≥ 5 ISM (NCDMF 2005).
- Gill nets with a mesh size < 5 ISM must be attended in all primary and secondary nursery areas and no-trawl areas described in NCMFC Rule 15A NCAC 3R.0106(2), (4), (5), (7), (8), (10), (11), and (12) from May 1 through November 30 (NCDMF 2001).
- It is unlawful to set gill nets in joint waters from midnight on Friday to midnight on Sunday each week, except in Albemarle Sound and Currituck Sound north of the Highway 158 Wright Memorial Bridge (NCDMF 2012).
- The use of gill nets > 6 ½ ISM stretch mesh is prohibited in all waters.
- It is unlawful to use gill nets with a mesh size < 2 ½ inches ISM stretch mesh.

In the figure below (Figure 4.2), interactions with striped bass are more mixed in the small mesh gill net

fishery above the tie-down line. This data is less robust due to lower observation numbers in the small mesh fishery and these data do not indicate whether fish were alive or dead. However, there are attendance requirements in place for small mesh nets above the tie-down line which are put in place to reduce dead discards in the small mesh fishery as outlined above (see map – Figure 12).

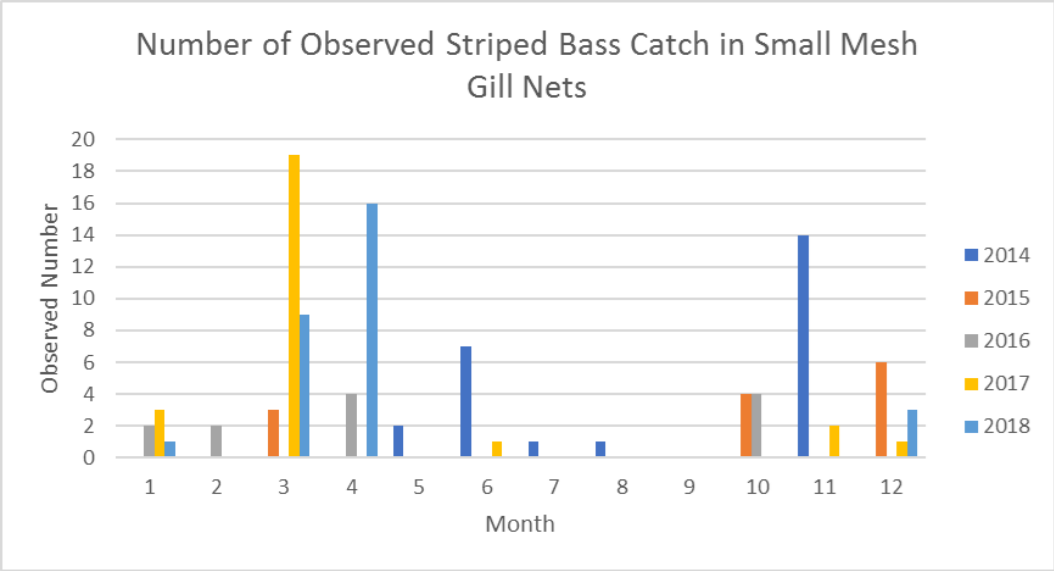

Figure 4.2. Data included are all striped bass (striped bass and hybrid bass) observed during Program 466 trips on the Pamlico, Neuse, Trent, and Pungo rivers. Data are from the previous 5-year period, 2014 to 2018 and are for small mesh gill nets. These data were selected to mirror the area that would be affected by the Proclamation requested at the most recent MFC meeting.

In conclusion, the implementation of gill net restrictions is best served through the continued development of the Estuarine Striped Bass Fishery Management Plan. The Supplement A measures will certainly not stop discards and dead discards from occurring in the commercial or recreational fishery. However, the DMF's data supports that Supplement A will reduce the overall number of fish being removed from the stock, thereby providing additional and more conservative protection to the two successful spawning year classes moving through the area of the CSMA. Observer coverage will continue, and we will try to increase observer coverage as much as is feasible during 2019. If significant spikes of discards are observed, I certainly reserve the right to consider additional measures if warranted.

Sincerely,
Steve Murphey, Director

NC Division of Marine Fisheries

Cc: Marine Fisheries Commission
John Nicholson
Shawn Maier
John Batherson
Gordon Myers

APPENDIX 5: MOTIONS FROM MARCH 13, 2019, N.C. MARINE FISHERIES COMMISSION EMERGENCY MEETING

Motion by Cameron Boltes to approve the agenda. Second by Chuck Laughridge.

Motion carries unanimously.

Motion by Cameron Boltes to direct the director of the Division of Marine Fisheries to issue a proclamation, effective in conjunction with the Supplement, that prohibits the use of gill nets upstream of the ferry lines, dock to dock from the Bayview to Aurora Ferry on the Pamlico River and dock to dock from the Minnesott Beach to Cherry Branch Ferry on the Neuse River, within the Central Southern Management Area. Second by Pete Kornegay.

Motion carries 5-4.

Motion by Chuck Laughridge to ask the N.C. Wildlife Resources Commission to adopt concurrent regulations for recreational harvest in Supplement A in joint coastal waters. Second by Pete Kornegay.

Motion carries with no opposition.

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