APPENDIX 4: SUSTAINABLE HARVEST OF STRIPED BASS IN THE CAPE FEAR RIVER SYSTEM

ISSUE
Consider existing factors that prevent a self-sustaining population in the Cape Fear River and implement management measures that provide protection for and access to the striped bass resource.

The 2020 Central Southern Management Area (CSMA) matrix and tagging models show a consistent decline in abundance estimates for striped bass in the Cape Fear River from 2012 – 2018, even with a total harvest moratorium for striped bass in place since 2008. Population abundance is maintained through stocking efforts but genetic testing and young-of-the-year (YOY) surveys suggest limited natural striped bass reproduction occurs in the system.

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

BACKGROUND
Overview

Historically the Cape Fear River system supported self-sustaining populations of multiple anadromous fish species, including striped bass (Yarrow 1874; Earl 1887). Multiple factors are attributed to declines in anadromous fish stocks, including overfishing, loss of habitat, declining water quality, and blockage of upstream spawning migrations (ASMFC 2007; Limburg and Waldman 2009). Construction of three locks and dams on the mainstem of the Cape Fear River between Riegelwood and Tar Heel NC was completed between 1915 and 1935 (Figure 1). These impediments to migration severely reduced the ability of striped bass to reach historic spawning areas near Smiley's Falls at the fall line in Lillington, NC (Nichols and Louder 1970). In an effort to enhance striped bass abundance in this system, hatchery reared fish have been stocked into the Cape Fear River by management agencies since at least the 1950s (Woodroffe 2011; *Stocking Information Paper*). In 1974, DMF began a study to document and protect critical spawning habitat for anadromous fishes, resulting in the designation of Anadromous Fish Spawning Areas throughout North Carolina. Spawning areas were identified in the Cape Fear River from the mouth of Town Creek upstream to Lillington, NC (Sholar 1977). As a response to low numbers of documented spawning adults and limited evidence of juvenile recruitment, the current commercial and recreational harvest moratorium of striped bass in the Cape Fear River was implemented in 2008.

Although evidence of successful striped bass spawning in the Cape Fear River system has been documented by the collection of adult fish in spawning condition and eggs in the water column, few larvae or YOY juveniles have been observed (Hawkins 1980; Winslow et al. 1983; Smith 2009; Smith and Hightower 2012; Dial Cordy and Associates 2017; Morgeson and Fisk 2018; Rock et al. 2018). Limited natural reproduction of striped bass in the Cape Fear River Basin suggests the sustainable harvest of a self-sustaining population of wild fish is not possible at this time (Mathes et al. 2020). Evaluation of stocking efforts using PBT analysis has shown most striped bass sampled in the Cape Fear River during spawning surveys are of hatchery origin.

Restricted access to historic spawning grounds in the mainstem Cape Fear River is likely the primary factor preventing striped bass population recovery in this system. A small amount of natural reproduction is likely occurring in the Northeast Cape Fear River, but the overall contribution to total possible production of striped bass remains unknown. Until passage of striped bass is achieved at all three locks and dams, it is unlikely sustainable harvest of wild fish will be attainable. While strategies are developed to meet passage goals, the potential for harvest of the hatchery supported population of striped bass in the Cape Fear River may be evaluated. For more information on stocking analysis see Appendix XX: Stocking in Coastal North Carolina.

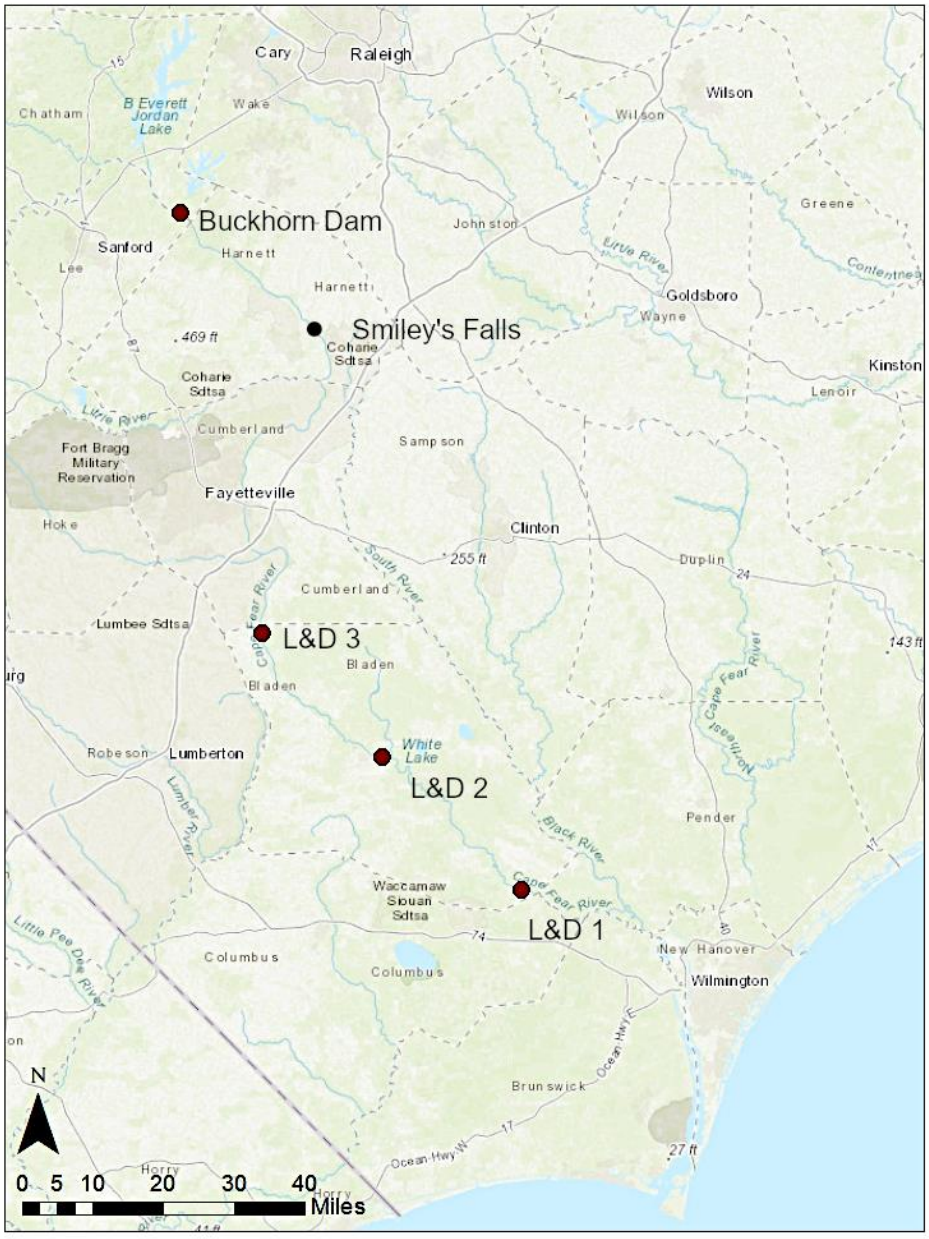

Figure 1. A map showing the locations of the three locks and dams on the mainstem of the Cape Fear River downstream of the historic spawning area near Smiley's Falls.

Cape Fear River Striped Bass Stock

For a comprehensive review of striped bass life history in North Carolina, as well as the Cape Fear River, see Mathes et al. (2020) and NCDMF (2020). Striped bass populations in the CSMA are generally considered to have an endemic riverine life history and typically do not make any oceanic migrations (Rulifson et al. 1982; Callihan 2012). Acoustic tagging studies in the Cape Fear River Basin show adult fish making seasonal migrations within the drainage and minimal emigration out of the system (Rock et al. 2018; Prescott 2019). Striped bass move upstream during the spawning season (March – May), then return to a core residency area (June – February) focused within 10 kilometers around the confluence of the Northeast and mainstem Cape Fear rivers (Rock et al. 2018; Prescott 2019). Striped bass are observed to show fidelity to either the Northeast or mainstem Cape Fear River for spawning migrations, making spring migrations up the same branch which they used the previous year before returning and mixing in the core residency area (Prescott 2019).

The WRC has conducted annual monitoring of the spawning stock of striped bass on the mainstem of the Cape Fear River since 2006. Sampling occurs weekly below each of the three locks and dams from late February through May. Adult abundance is typically much higher for the station below Lock and Dam #1 compared to the remaining stations, and peak abundance occurs in mid to late May (Figure 2). Very few striped bass eggs are collected above Lock and Dam #3 where the historic spawning area is located, with most eggs being collected below Lock and Dam #1 (Dial Cordy and Associates 2017). In 2017, DMF juvenile abundance trawl and seine survey stations were developed for the Cape Fear River system. Zero YOY striped bass have been collected in mainstem sampling. The last documented YOY striped bass collected in the mainstem Cape Fear River were in July 1977 (Hawkins 1980).

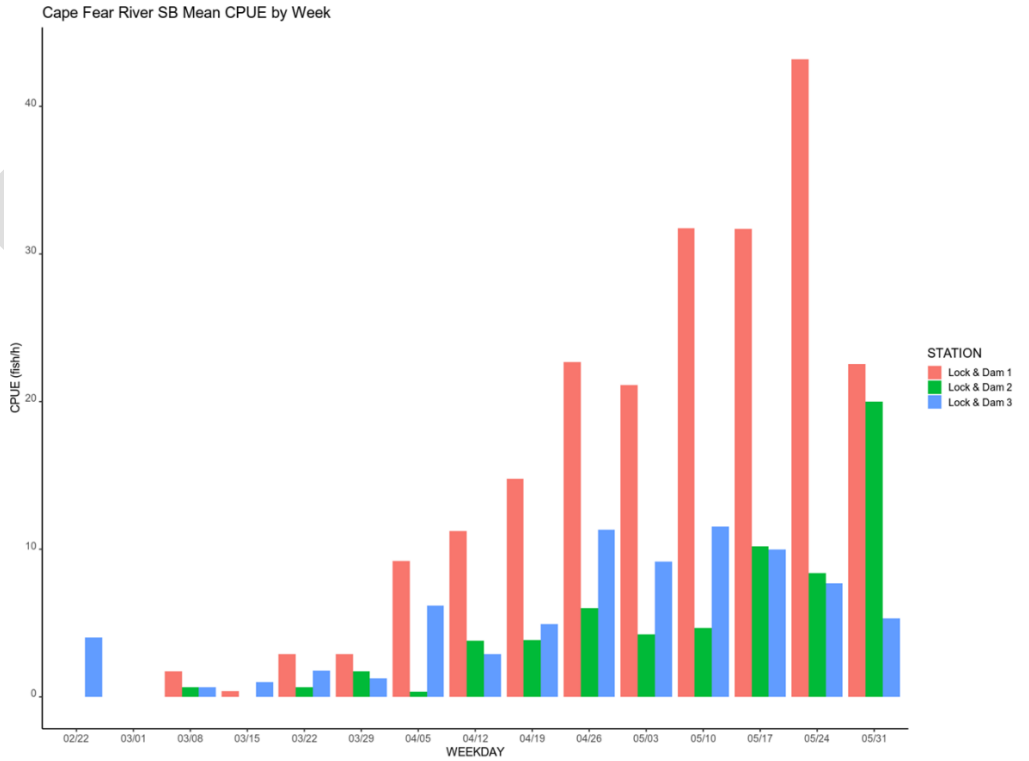

Figure 2. Weekly striped bass catch-per-unit-effort (CPUE) by sample site February through May 2008 - 2019.

In the Northeast Cape Fear River, adult striped bass have been captured and acoustically tagged during the spawning season (April – May) between White Stocking, NC (kilometer 118) and Chinquapin, NC (kilometer 168), with potential spawning occurring as far upstream as Hallsville, NC (kilometer 183) (Rock et al. 2018). Winslow et al. (1983) documented small numbers of YOY striped bass in the lower Northeast Cape Fear River. DMF sampling collected 24 YOY striped bass in 2018, four were collected in 2019, and two were collected in 2020 at stations in the Northeast Cape Fear River (Darsee et al. 2020).

The first well documented stocking of hatchery origin striped bass into the Cape Fear system began in the 1950s (Wodroffe 2011). For a history of stocking in the Cape Fear River system see Appendix 1 Stocking in Coastal River Systems information paper. State and federal hatcheries have produced striped bass released into the system, and ongoing stocking efforts are made by a cooperative agreement between the USFWS, DMF, and WRC, which has been in place since 1986. Between 1980 and 2009, over 629,000 "phase-II" Roanoke River strain striped bass (approximately 5 – 7 inches total length), were stocked into the Cape Fear River system. Since 2010, an average of 144,000 phase-II striped bass were stocked into the system annually (see Appendix 1 Table 1 and 2). Starting in 2010, adult striped bass captured in the Cape Fear River were used as broodstock for stocking efforts into the system. No genetic difference was detected between Cape Fear and Roanoke fish sampled between 2009-2011, and this was attributed to the previous stocking history of Roanoke hatchery origin fish into the Cape Fear system (Anderson et al. 2014). The extent of impacts from stocking striped bass originating in the Roanoke River into other striped bass populations remain relatively unknown (Rulifson and Laney 1999; Bergey et al. 2003). However, Anderson et al. (2014) suggested that, despite genetic similarity between Roanoke and Cape Fear river fish, natural reproduction of striped bass was likely occurring in the Cape Fear River.

Jordan Reservoir, a large impoundment in the Cape Fear basin above the fall line and known historic spawning grounds for striped bass, was stocked with hybrid striped bass (*M. chrysops x M. saxatilis*) until the early 2000s. The WRC stopped stocking hybrid striped bass in Jordan Reservoir due to escapement of these fish into the lower Cape Fear River, and concern escaped fish would interfere with striped bass restoration efforts (e.g., interbreed with, and/or outcompete for resources). Striped bass were stocked into Jordan Reservoir as a replacement for the hybrid striped bass recreational fishery from the mid-2000s until 2020. Evaluation of the stocked striped bass fishery in Jordan Reservoir suggested low survival and low angler participation, resulting in WRC discontinuing this reservoir stocking effort.

Parentage-based tagging (PBT) was implemented by the WRC as a means to determine percent hatchery contribution to the striped bass spawning populations in the CSMA systems starting in 2010. Using known genetic markers from parent brood stock, this method can determine if a fish was produced in a hatchery (Denson et al. 2012). In 2011, WRC analyzed all striped bass captured in their Cape Fear River spawning survey. In 2017, DMF began collecting additional samples in the lower portion of the Cape Fear River and in the Northeast Cape Fear River and mainstem mixing area. Additionally, a subset of the YOY captured in the Northeast Cape Fear River during 2018 and 2019 were tested, and all YOY analyzed were determined to not to be of hatchery origin and likely wild spawned. PBT results show hatchery origin fish comprise between 63% and 93% of the fish tested each year, and the percentage of fish determined to be of hatchery origin

increasing annually (see Appendix 1 Table 4). Fish determined to be of unknown origin are not necessarily wild-spawned since parentage-based markers are only available back to the 2010 year-class of stocked fish. The 89% hatchery contribution indicated in 2018 PBT analysis is likely an accurate reflection of actual hatchery contribution to the 2018 Cape Fear River striped bass population, as striped bass aged in the system are typically less than 10 years old. Additionally, an increasing proportion of fish stocked into the upriver reservoirs are represented in the Cape Fear River system (Figure 3). Proportion of Jordan Reservoir stocked fish increases upriver and fish collected below Buckhorn Dam are entirely reservoir origin (Figure 4).

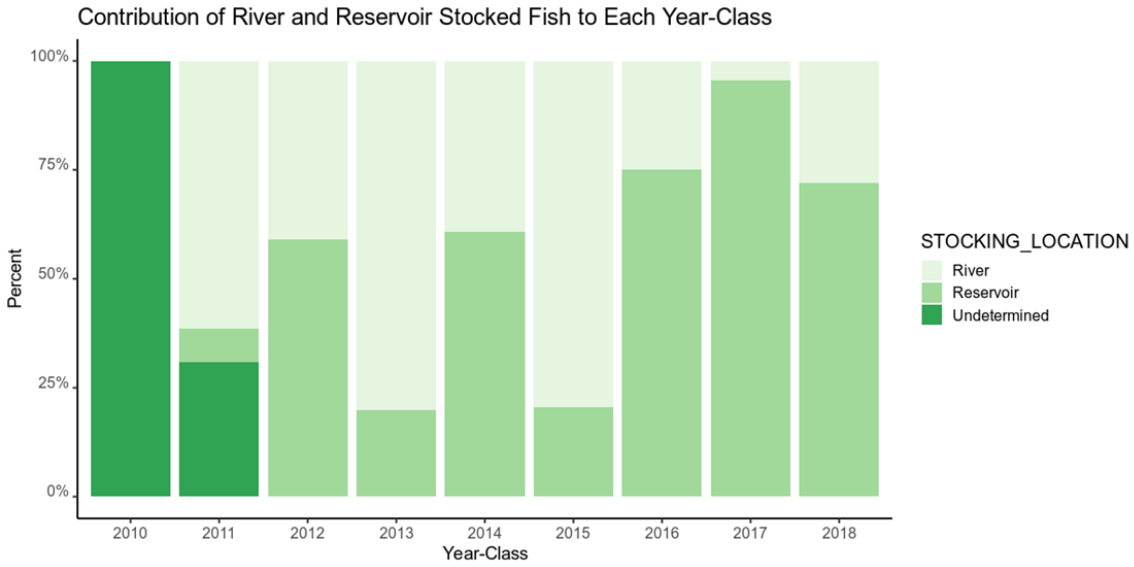

Figure 3. Relative contribution of hatchery-origin fish to the hatchery-origin year-class, by stocking location, 2010-2018.

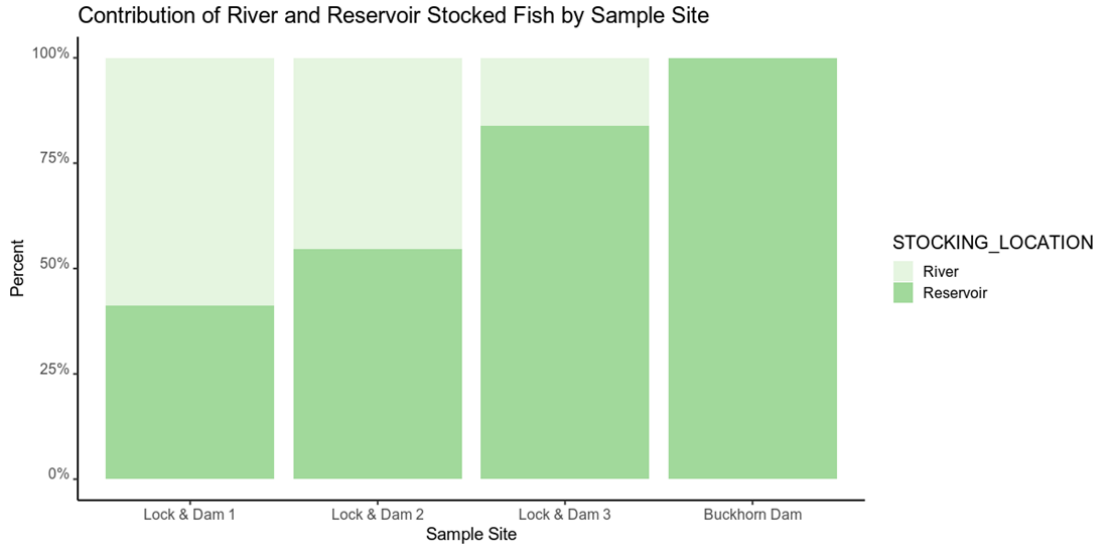

Figure 4. Relative contribution of hatchery-origin fish by stocking location to each electrofishing sample site, 2015-2019.

Striped Bass Fisheries

A total harvest moratorium on striped bass was enacted in 2008 as a management strategy in response to low numbers of documented spawning adults and limited evidence of juvenile recruitment in the Cape Fear River system (NCDMF 2013).

Recreational

Striped bass provide an important and popular recreational angling opportunity in the Cape Fear River. Despite the harvest moratorium, striped bass are targeted by anglers and support a catch-and-release fishery in the system. Recreational charter vessels target Cape Fear River striped bass during the winter months and are hired by recreational fisherman to guide in this catch-and-release fishery; by April effort typically shifts to other fisheries.

Since 2013, the DMF Coastal Angling Program (CAP) has partnered with WRC on an anadromous creel survey to interview recreational anglers in the Cape Fear River for the purpose of producing effort and catch estimates for striped bass and American shad. Within the Cape Fear River, annual striped bass catch estimates are highly variable and imprecise, ranging between 14 and 1,551 fish from 2013 – 2018 (Table 1).

Table 1. Effort and catch estimates for Cape Fear River striped bass from Coastal Angling Program anadromous creel survey. PSE values are in parenthesis.

Year	Number of Striped Bass Trips	Striped Bass Trip Hours	Total Striped Bass Catch
2013	257 (48.6)	870 (63.1)	355
2014	433 (42.9)	2140 (45.9)	1,551
2105	209 (50.1)	702 (53)	199
2016	391 (46.4)	1464 (44.4)	628
2017	26 (100)	159 (100)	14
2018	24 (77.1)	61 (71.5)	140

Commercial

Between 1994 and 2008, annual commercial striped bass landings from the Cape Fear River averaged 1,206 pounds and ranged from 68 to 4,138 pounds (Table 2). Cape Fear River landings on average comprised less than 5% of the 25,000-pound CSMA Total Allowable Landings (TAL). Additionally, trips which contained striped bass comprised between 0.60% and 11.8% of total annual trips from the Cape Fear River which landed finfish during this time (Table 2). Gill nets accounted for 99.9% of the total landings of Cape Fear River striped bass, with the remainder of the landings from hook and line and crab pots (Table 3).

Stock Concerns

In the 2020 Central Southern Management Area (CSMA) Striped Bass Stocks report, Cape Fear River striped bass abundance estimates ranged from 1,578 (2017) to 10,983 (2012) between 2012 and 2018 (Mathes et al. 2020). Abundance estimates consistently declined over this time period,

and by 2018 striped bass abundance was reduced to less than 20% of what it was in 2012 (Mathes et al. 2020).

Table 2. Cape Fear River striped bass annual commercial landings in pounds from all gears, percentage that striped bass contributed to the total annual Cape Fear River finfish commercial landings, and percentage of all finfish trips with striped bass landings 1994 – 2008. DMF Trip Ticket Program.

Year	Landings (lbs.)	% of Total CFR Finfish Landings	% of CFR Finfish Trips With STB Landings
1994	480	0.01	2.21
1995	264	0.26	1.85
1996	4,139	3.81	11.42
1997	2,187	2.21	8.38
1998	501	0.67	6.53
1999	1,001	1.72	8.35
2000	567	0.70	5.75
2001	129	0.18	2.15
2002	173	0.22	2.51
2003	68	0.08	0.60
2004	2,364	2.96	11.80
2005	2,721	3.36	10.86
2006	1,057	1.61	4.64
2007	1,601	2.02	8.59
2008	831	1.07	6.10

Table 3. Percentage of total Cape Fear River commercial striped bass landings (weight) by gear for 1994 -2008.

Gear	%
Set sink gill net	93.09
Set float gill net	3.58
Drift gill net	3.15
Runaround gill net	0.08
Crab pot	0.06
Hook and line	0.04

No legal recreational or commercial harvest of striped bass has occurred in the Cape Fear River system since before the harvest moratorium was established in 2008, yet adult abundance estimates have continued to decline, indicating natural reproduction in the system has been limited. Specific estimates of discard mortality are unknown in this system.

Water quality impacts in the Cape Fear River may contribute to poor recruitment of striped bass in this system. Striped bass require dissolved oxygen (DO) levels greater than 5 mg/L (Funderburk et al. 1991), and specific flow conditions are required for the survival of egg, larvae, and juvenile

life stages (Rulifson and Manooch 1990). Impacts from urban and agricultural development in the Cape Fear River Basin can negatively impact water quality parameters, and the percentage of land developed for urban and agricultural uses is generally increasing in this system. Nearly 23% of the land in the basin is used for agriculture, such as pork and poultry production (Xian and Homer 2010). Conditions such as elevated temperatures combined with nutrient loading from agricultural and stormwater runoff creates high biological oxygen demand (BOD) and low DO (below 5 mg/L) conditions the Cape Fear River (Mallin et al. 2006). Striped bass mass mortality caused by poor water quality in the Cape Fear River associated with large storm events have also been observed. In September 2018, water quality impacts from Hurricane Florence led to fish kills in the Cape Fear River. DMF staff observed dead striped bass at multiple locations from Lock and Dam #1 to the Cape Fear River inlet at Caswell Beach and 574 dead striped bass were recovered from Battleship Park (Wilmington, NC) in the week after the storm. Numerous chemical contaminants such as endocrine disrupting compounds (EDCs), heavy metals, per- and polyfluoroalkyl chemicals (PFAS), and other organic pollutants have been found in both the fish and the water of the Cape Fear River (Mallin et al. 2011; Black and Veatch 2018; Guillette et al. 2020). Guillette et al. (2020) found concentrations of PFAS to be 40 times higher in Cape Fear River striped bass than a control group, and these elevated levels were associated with changes to the liver and immune system of the fish.

The construction of the three locks and dams on the mainstem Cape Fear River has significantly reduced the ability of striped bass to reach historic spawning habitat at the fall line. The lowermost lock and dam (river kilometer 95) was completed in 1915 and is located approximately 160 river kilometers downstream of the striped bass spawning habitat at Smiley Falls. By 1935 two more locks and dams were completed above Lock and Dam #1, further restricting possible upriver access to spawning habitat. Fish ladders were constructed at each dam, but striped bass did not successfully use them, and passage over the dam was limited to extreme high flow or locking events (Nichols and Louder 1970). From 1962-2012, the Army Corps of Engineers (ACOE) operated a daily locking schedule developed by WRC from March through May, with the goal of passing anadromous fish over the dams; however, studies have shown that a large proportion of fish below each dam are unable to pass using the lock chamber (Moser et al. 2000; Smith and Hightower 2012). Based on acoustic telemetry results while the ACOE was operating the locking schedule, Smith and Hightower (2012) estimated 77% of striped bass could pass Lock and Dam #1, and only 25% were able to pass all three locks and dams.

In 2012, a rock arch ramp was constructed at Lock and Dam #1 to allow for continuous passage of anadromous fish over the dam without the need for locking. Success criteria for the rock arch ramp was set as 80% passage efficiency for target species by project biologists. Subsequent evaluation of passage at the rock arch ramp resulted in only 25% successful passage of striped bass (Raabe et al. 2019). Despite its failure to improve passage, ACOE has not conducted anadromous fish locking at Lock and Dam #1 since construction of the fishway in 2012. Additionally, the lock structures at Lock and Dam #2 and #3 were damaged by Hurricanes Matthew and Florence and have been inoperable since 2018. The existing rock arch ramp design at Lock and Dam #1 does not meet physical design criteria (e.g., slope, pool dimensions, weir openings) later determined to be required for successful striped bass passage by Federal Interagency Nature-like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes (Turek and Haro 2016). Cape

Fear River Watch has received a Coastal Recreational Fishing License grant from DMF to modify the rock arch ramp to better meet the required criteria, and construction is set to begin in 2021.

Beginning in 2020, the ACOE modified dam release patterns during rainfall events to purposefully release flow from Jordan Reservoir during the anadromous fish migration period (March-April) and to fully submerge all three locks and dams. With the dams submerged, it is believed that fish may pass without locking or the use of a fishway. This strategy has yet to be evaluated for efficacy in the passage of striped bass.

AUTHORITY

North Carolina's existing fisheries management system for striped bass is adaptive, with rulemaking authority vested in the North Carolina Marine Fisheries Commission (MFC) and the North Carolina Wildlife Resources Commission (WRC) within their respective jurisdictions. The MFC also has the authority to delegate to the fisheries director the ability to issue public notices, called proclamations, suspending or implementing particular commission rules that may be affected by variable conditions. Management of recreational and commercial striped bass regulations within the Cape Fear River is the responsibility of the MFC in Coastal and Joint Fishing Waters, and recreational regulations are the responsibility of the WRC in Joint and Inland Fishing Waters. It should also be noted that under the provisions of the North Carolina Estuarine Striped Bass FMP Amendment 1 the DMF Director maintains proclamation authority to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas as deemed necessary to maintain a sustainable harvest. The WRC Executive Director maintains proclamation authority to establish seasons.

NORTH CAROLINA GENERAL STATUTES

N.C. General Statutes

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

NORTH CAROLINA RULES

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

15A NCAC 03M .0201	GENERAL
15A NCAC 03M .0202	SEASON, SIZE AND HARVEST LIMIT: INTERNAL COASTAL FISHING 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 03R .0201	STRIPED BASS MANAGEMENT AREAS
15A NCAC 10C .0107	SPECIAL REGULATIONS: JOINT 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

Maintain Cape Fear River Harvest Moratorium

Despite a total harvest moratorium and annual hatchery support, the 2020 CSMA striped bass stock report shows continued decline in abundance estimates from 2012 – 2018. Passage efficiency has been demonstrated to be poor over the current configuration of the passage structure at the lowermost dam in the Cape Fear River (Raabe et al. 2019) and egg collection studies indicate most striped bass spawning activity in the mainstem occurs below Lock and Dam #1 (Dial Cordy and Associates 2017). PBT analysis suggests low successful recruitment from wild spawned fish and shows increasing proportions of reservoir stocked fish captured in the river, with fish collected below Buckhorn Dam entirely of reservoir origin. Limited upriver access to appropriate spawning habitat may be preventing stock recovery despite limiting fishing mortality via a moratorium. Modifications for the fish passage structure at Lock and Dam #1, designed to improve passage for striped bass (construction in 2021), will potentially allow striped bass to easily migrate an additional 90 river kilometers upstream before reaching Lock and Dam #2. Anecdotal evidence suggests that fish may be able to pass over Lock and Dam #2 during higher flow conditions. Through NGO and management agency partnerships, millions of dollars to construct passage at both Lock and Dams #2 and #3 have been secured and engineering and design options have been completed. However, ACOE permits have not been acquired and the total funding to construct passage at both dams remains incomplete, resulting in an undetermined construction timeframe.

The Northeast Cape Fear River does not have blockages to fish passage. However, the importance of this river for striped bass reproduction has remained relatively unexamined. Acoustic telemetry has shown repeated spring spawning migrations and YOY have been captured in this tributary. Acoustic telemetry data also shows that the contingent of fish which show fidelity for the Northeast Cape Fear for spawning migrations return to the core residency area focused within 10 kilometers around the confluence of the Northeast and mainstem Cape Fear Rivers for the rest of the year (Rock et al. 2018; Prescott 2019). This suggests a small subset of striped bass in the Cape Fear River Basin are successfully spawning in the Northeast Cape Fear and are protected from harvest under the current moratorium.

High levels of PFAS have been found in Cape Fear River striped bass (Guillette et al. 2019). While the specific biological impacts to striped bass remain unknown, the consumption of fish is linked to human PFAS exposure (Haug et al. 2010). The Environmental Protection Agency has established the health advisory levels at 70 parts per trillion in drinking water, and the Great Lakes Consortium for Fish Consumption Advisories states for fish with concentrations of greater than 200 µg/kg as "DO NOT EAT". Under a harvest moratorium, striped bass are not retained for

consumption. However, DMF and WRC have not placed harvest restrictions on finfish due to consumption advisories, and no specific consumption advisory has been issued for PFOS in striped bass by the Occupational and Environmental Epidemiology Branch of the North Carolina Division of Public Health.

PBT analysis results demonstrate that most of the striped bass sampled in the Cape Fear River are of hatchery origin, and most of the fish sampled above Lock and Dam #1 are hatchery reared fish which have been stocked into the upriver reservoirs. Current WRC inland fishing regulations allow for harvest in the hatchery supported striped bass fisheries of the reservoirs in the Cape Fear basin above Buckhorn Dam. However, as the reservoir stocking of striped bass has been discontinued, the downriver migration of reservoir fish into the Cape Fear River will no longer occur.

Allow Seasonal Harvest in All Cape Fear River Fishing Waters

Removing the harvest moratorium for striped bass in the Cape Fear River would require a change to or suspension of MFC Rules 15A NCAC 03M .0202 (a)(b), and 15A NCAC 03Q .0107 (1)(d), as well as a change to WRC Rules 15A NCAC 10C .0107 (1)(d), and 15A NCAC 10C .0314 (h). The remaining MFC rule language would allow commercial or recreational harvest in Joint and Coastal Fishing Waters (Figure 5) between October 1 through April 30 and would cap the potential minimum size limit at no less than 18 inches. This rule would also allow for a recreational bag limit of no more than two fish per day. More conservative season dates, size or bag limits, and area restrictions may be specified by proclamation. Any commercial landings of striped bass from the Cape Fear River could count toward a TAL applicable to the CSMA, be managed under a separate TAL, or another strategy depending on other management actions adopted.

Allowing harvest under a hatchery supported striped bass fishery management strategy in the lower river would create equity in management throughout the system. As very few striped bass in the Cape Fear basin appear to be of wild origin, and current impediments to passage limit the ability of striped bass to reach appropriate spawning habitat in the mainstem Cape Fear, fishing mortality would likely have little impact on the amount of wild spawned fish in the system. However, an increase in fishing mortality may exacerbate the decline in abundance of striped bass observed in recent years and potentially further truncate the age structure of the population. Size and possession limits could be established to protect certain age or size classes and could potentially mitigate impacts to population demographics from increased fishing mortality. As strategies to improve passage at the locks and dams are implemented, maintaining sufficient spawning stock biomass with an expanded age structure available to migrate to the spawning grounds will be necessary for striped bass recovery efforts in the Cape Fear River.

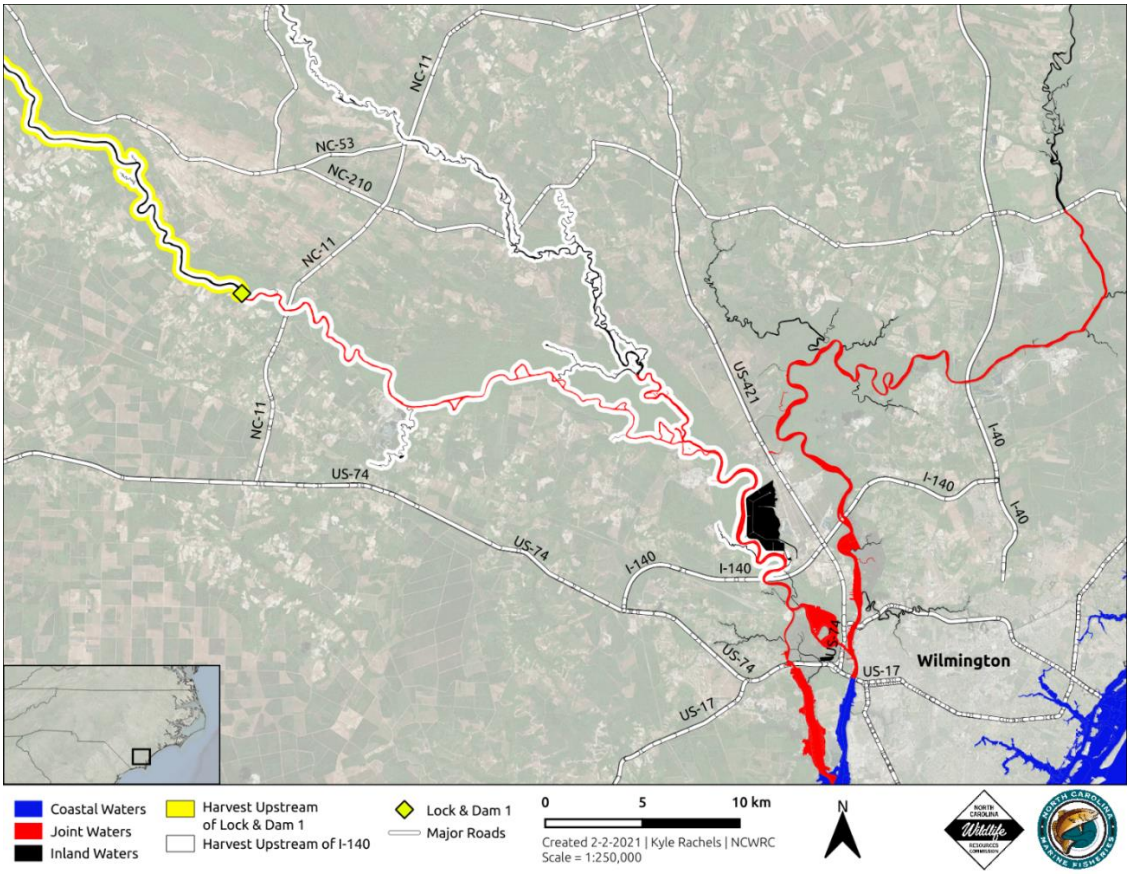

Figure 5. A map showing Inland, Joint, and Inland Fishing waters, as well as the harvest area boundaries for the proposed management options.

Allowing recreational harvest of the predominantly hatchery supported striped bass in the Cape Fear River may be viewed by recreational anglers as a suitable use of the hatchery produced fishery resource. However, opening the Joint and Coastal Fishing Waters to the taking of striped bass would potentially allow for the commercial harvest of this hatchery supported population. Commercial harvest of hatchery supported fish may create user conflicts or be perceived as a poor use of the resource by recreational anglers. While striped bass from the Cape Fear River did not historically contribute much to the overall statewide commercial landings, they were a consistent component of finfish landings from the system. With increased regulation in other commercial fisheries, opening striped bass for commercial harvest in the Cape Fear River may result in a larger percentage of the finfish landings from this waterbody than before the harvest moratorium.

Allowing harvest of striped bass from all waters of the Cape Fear system would increase fishing mortality on the small and relatively unstudied contingent of potentially naturally reproducing fish in the Northeast Cape Fear River, possibly leaving them vulnerable to overharvest or depletion.

<u>Allow Seasonal Harvest in Joint and Inland Fishing Waters in the Mainstem Cape Fear River Above 140 Bridge</u>

Harvest area boundaries can be set with the goal of allowing harvest on hatchery supported striped bass in the Cape Fear River, while protecting the relatively small and unstudied contingent of fish

that may spawn in the Northeast Cape Fear. Allowing harvest of striped bass only in the Joint and Inland Fishing Waters above the Highway 140 Bridge (Figure 5), would limit the harvest of the Northeast Cape Fear contingent of fish. Opening Joint Fishing Waters above the Highway 140 Bridge to striped bass harvest could allow for the commercial harvest of striped bass in this section of river. A commercial shad drift gillnet fishery operates between February 20 and April 11 each year. Due to protected species interactions, set gill net gear has been prohibited in this section of river. Striped bass may be targeted in this fishery if harvest is allowed. A hook and line commercial fishery could be developed. For more information on hook and line as a potential commercial gear, see Appendix 2.4 Use of Hook and Line as a Commercial Gear in the Estuarine Striped Bass Fishery.

Allow Seasonal Harvest in Inland Fishing Waters only above the Joint / Inland Fishing Waters boundary on the Mainstem of the Cape Fear River

The Cape Fear River above Lock and Dam #1 is classified as Inland Fishing Waters and the commercial harvest of Inland Game Fish is prohibited in Inland Fishing Waters. Since striped bass is considered an Inland Game Fish, harvest above Lock and Dam #1 would be limited to recreational hook and line only, per inland fishing regulations. Most striped bass captured at stations above Lock and Dam #1 were determined to be hatchery origin fish which had moved down river from reservoirs. However, the discontinuation of striped bass stocking in Jordan Lake may reduce the number of fish in the Cape Fear River upstream of Lock and Dam #1. Stocking locations may be modified in the Cape Fear River to continue to supply hatchery origin fish to locations upriver of the locks and dams.

Adaptive Management

Adaptive management allows managers to pivot and change management strategies when new information or data becomes available. Management options, which are selected during the FMP process, take into account the most up to date data on the biological and environmental factors which affect the stock. After the implementation of the FMP, if additional data is available about a fishery or key factors change, adaptive management provides the flexibility to incorporate this new information to inform alternative and/or additional actions needed for sustainable fisheries management. A range of adaptive management actions, as well as criteria for their application can be established within the FMP management framework to improve both short- and long-term management outcomes.

Results from YOY juvenile abundance and distribution surveys, as well as PBT analysis can be used to evaluate natural reproduction of striped bass in the Cape Fear River system. The collection of YOY striped bass from the mainstem Cape Fear or Northeast Cape Fear rivers will be considered evidence for natural reproduction occurring in the branch where the juveniles were collected. The proportion of fish determined to be of unknown origin by PBT analysis will be used to determine the percentage of hatchery contribution to the Cape Fear River striped bass stock.

The proposed adaptive management framework for sustainable harvest of striped bass in the Cape Fear River system consists of the following:

1. Continue YOY surveys and PBT analysis after the adoption of the FMP.

a. If adopted management measures include allowing harvest of striped bass in any waters of the Cape Fear River, and YOY surveys and/or PBT analysis suggest levels of natural reproduction greater than observed up to the time of FMP adoption, then management measures may be re-evaluated and adjusted by proclamation using the authority granted to DMF and WRC directors. Rule changes or suspensions required to allow harvest.

b. If adopted management measures do not allow for harvest of striped bass in the Cape Fear River, and YOY surveys and/or PBT analysis suggest levels of natural reproduction less than observed up to the time of FMP adoption, then management measures may be re-evaluated and harvest adjusted by proclamation using the authority granted to the DMF and WRC directors. Rule changes or suspensions required to allow harvest.

2. Management measures which may be adjusted include: means and methods, harvest area, as well as season, size and creel limit (as allowed for in rule).

3. Use of the DMF director's proclamation authority for adaptive management is contingent on evaluation of adaptive management measures by the Striped Bass Plan Development Team and consultation with the Finfish Advisory Committee.

PROPOSED MANAGEMENT OPTIONS

The NC Marine Fisheries Commission adopts rules and implements management measures effective in Coastal and Joint Fishing Waters. The NC Wildlife Resources Commission adopts rules and implements management measures effective in Inland Fishing Waters. Management options available to each commission are limited to application within their respective jurisdictions.

1. MAINTAIN CAPE FEAR RIVER HARVEST MORITORIUM (STATUS QUO)
   - \+ maintains protection for Northeast Cape Fear River wild spawning contingent
   - \+ does not increase fishing mortality to population declining in abundance
   - +/- no harvest of a primarily hatchery supported stock
   - +/- continues current catch and release recreational fishery

2. ALLOW SEASONAL HARVEST IN ALL CAPE FEAR FISHING WATERS
   - \- potential user conflicts around hatchery supported stock
   - \- allows harvest of Northeast Cape Fear River wild spawning contingent
   - \- may increase fishing mortality to population declining in abundance
   - \+ equity in harvest regulation across the system and user groups
   - +/- allow harvest of a primarily hatchery supported stock

3. ALLOW SEASONAL HARVEST IN JOINT AND INLAND FISHING WATERS IN THE MAINSTEM CAPE FEAR RIVER ABOVE 140 BRIDGE
   - \- creates additional management boundary and regulation complexity
   - \- inequity in harvest regulation across the system by user groups
   - \- potential user conflicts around hatchery supported stock
   - \- may increase fishing mortality to population declining in abundance

+ offers protection to Northeast Cape Fear River wild spawning contingent
+/- allow harvest of a primarily hatchery supported stock

4. ALLOW SEASONAL HARVEST IN INLAND FISHING WATERS ONLY ABOVE THE JOINT / INLAND WATERS BOUNDARY ON THE MAINSTEM OF THE CAPE FEAR RIVER
   - creates additional regulation complexity using existing management boundary
   - inequity in harvest regulation across the system by user groups
   - may increase fishing mortality to population declining in abundance
   + offers protection to Northeast Cape Fear River wild spawning contingent
   +/- allow harvest of a primarily hatchery supported stock

5. ADAPTIVE MANAGEMENT

RECOMMENDATIONS

Striped Bass PDT

The Striped Bass Plan Development Team (PDT) has not come to a consensus on a recommendation for this issue. PDT members from the WRC generally support allowing some amount of harvest in specific areas of Cape Fear River, while DMF members are generally against allowing any harvest in Joint Fishing Waters, and mixed on allowing any harvest. All PDT members agree that if any harvest is allowed, the Northeast Cape Fear River fish should continue to be protected from harvest until more is known about this population. The PDT would like the opportunity to consider Advisory Committee input, as well as public comment on this issue to better assess the need and benefit of allowing harvest.

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