Petitions

North Carolina Marine Fisheries Commission

PETITIONS

North Carolina
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Affiliated with the National Wildlife Federation

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Via U.S. and Electronic Mail

Chairman Sammy Corbett
N.C. Marine Fisheries Commission
Division of Marine Fisheries
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Re: Petition for Rulemaking to Amend 15A Admin. Code 3L .0101, 3L .0103, 3M .0522, 3M .0523, 3N .0151, and 3R .0105 to Designate Special Secondary Nursery Areas and Reduce Bycatch Mortality in North Carolina Coastal Fishing Waters

Chairman Corbett:

On behalf of the North Carolina Wildlife Federation ("the Federation"), the undersigned files this Petition for Rulemaking ("Petition") pursuant to and in accordance with the North Carolina Administrative Procedure Act, N.C. Gen. Stat. § 150B-20, and 15A N.C. Admin. Code 3P .0301. These provisions allow any person wishing to adopt, amend, or repeal a rule of the North Carolina Marine Fisheries Commission ("MFC" or "the Commission") to submit a rulemaking petition to the Chairman of the Commission. In order to promote and ensure the viability and sustainability of North Carolina's valuable fisheries resources for all citizens, the Federation seeks amendments to the following sections of Title 15A of the North Carolina Administrative Code: 3R .0105, 3L .0101, 3L .0103, 3N .0151, and 3I .0101. In addition, the Federation urges the adoption of two new sections to Title 15A of the Code: 3M .0522 and 3M .0523 (collectively "proposed rules"). Taken together, the proposed rules will:

(1) Designate all coastal fishing waters not otherwise designated as nursery areas as special secondary nursery areas;

(2) Establish clear criteria for the opening of shrimp season; and

(3) Define the type of gear and how and when gear may be used in special secondary nursery areas during shrimp season.

In this Petition, "coastal fishing waters" include all inshore and ocean waters out to three miles that are currently under MFC jurisdiction.[1] The proposed rules are designed to protect, conserve, and restore North Carolina's valuable marine resources for all users by protecting important habitat areas for finfish and shellfish species in our sounds and estuaries and reducing bycatch of juvenile fish in nursery areas. This Petition advocates a data-driven, research-based approach to identifying existing nursery areas in North Carolina waters and in recommending management strategies most effective in protecting habitat and reducing bycatch.

The Petition proposes expanding special secondary nursery area designations to encompass areas that are essential to juvenile development for numerous recreationally and commercially valuable species in North Carolina waters, including but not limited to weakfish, spot, and Atlantic croaker. By expanding special secondary nursery area designations, more fish will survive the critical juvenile stage, reproduce, and thrive to stock recruitment.

Substantial fishing effort occurs in North Carolina's nursery areas. It is estimated that for every pound of shrimp harvested in North Carolina waters, over four pounds of non-target catch, including juvenile finfish, are discarded.[2] These juvenile finfish and other organisms constitute bycatch, which is defined as "the portion of a catch taken incidentally to the target catch because of non-selectivity of the fishing gear to either species or size differences."[3] In 2014, an estimated 15 million pounds of juvenile Atlantic croaker, spot, and weakfish were caught by trawl nets and thrown overboard.[4] Nearly all of the fish caught in trawl nets die in the net or shortly after culling on board.

The amount of finfish bycatch in the North Carolina shrimp trawl fishery is unsustainably high, and the negative impact of shrimp trawl bycatch is felt coast wide. North Carolina is the *only* state on the east coast to allow shrimp trawling in its sounds and estuaries. Rather than propose an outright ban on shrimp trawling in North Carolina waters, this Petition proposes a balanced approach of defining the type of gear and managing fishing in areas that are essential for juvenile finfish development. These efforts will protect important nursery areas, reduce bycatch of juvenile finfish, and preserve the commercial and recreational fishing industries, which drive North Carolina's coastal economy.

The Federation is a statewide, nonprofit conservation organization established in 1945 and dedicated to the sound, scientific management of North Carolina's fish, wildlife, and habitat

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[1] *See* 15A N.C. Admin. Code 3Q .0103 (2016) (defining "coastal fishing waters" and describing the scope of MFC jurisdiction over fishing waters); *see also* N.C. Gen. Stat. § 113-134.1 (2016) (stating the resources over which the MFC has jurisdiction).

[2] *Unintended Consequences*, N.C. WILDLIFE FED'N JOURNAL 2 (Spring 2014), http://www.ncwf.org/wp-content/uploads/ncwf-journal-spring-2014.pdf; *see also See* Kevin Brown, *Characterization of the commercial shrimp otter trawl fishery in the estuarine and ocean (0-3 miles) waters of North Carolina: Final Report to the National Fish and Wildlife Foundation and the National Oceanic and Atmospheric Administration, National Marine Fisheries Service*, N.C. DEP'T OF ENV'TL QUALITY 14, 17 (Oct. 2015).

[3] Brown, *supra* note 2, at 2 (internal citations and quotations omitted).

[4] See Jack Travelstead & Louis Daniel, A Technical Review of a proposal submitted by the North Carolina Wildlife Federation to reduce mortality of juvenile fishes in North Carolina (Nov. 2016) (Exhibit B), at 11.

resources. The Federation is the state affiliate of the National Wildlife Federation and has offices in Charlotte and Raleigh, in addition to thirteen chapters, thirty eight affiliates, and thousands of members across the state. The Federation believes that North Carolina's marine resources are a public trust resource, and as such must be protected and sustained for use and enjoyment by all citizens. The Federation holds firmly to the position that North Carolina must change its approach to the protection, management, and conservation of its marine resources.

Pursuant to 15A N.C. Admin. Code 3P .0301, this Petition is addressed to the Chairman of the MFC. As required by MFC rules, fifteen (15) copies of this Petition will be submitted via U.S. Mail. The following sections of this Petition shall be organized by and shall provide the information that is required of rulemaking petitions set forth in 15A N.C. Admin. Code 3P .0301(b)(1)-(8).

I. TEXT OF THE PROPOSED RULES

The text of the proposed rules is attached hereto as Exhibit A.

II. THE STATUTORY AUTHORITY FOR THE COMMISSION TO PROMULGATE THE RULES

The Federation urges the adoption of amendments to the following sections of Title 15A of the North Carolina Administrative Code: 3R .0105, 3L .0101, 3L .0103, 3N .0151, and 3I .0101. In addition, the Federation urges the adoption of two new sections to Title 15A of the Code: 3M .0522 and 3M .0523.

The primary purpose of the MFC is to "[m]anage, restore, develop, cultivate, conserve, protect, and regulate the marine and estuarine resources within its jurisdiction."[5] The Commission has a mandatory duty to "adopt rules to be followed in the management, protection, preservation, and enhancement of the marine and estuarine resources within its jurisdiction."[6] The MFC has jurisdiction over the "conservation of marine and estuarine resources . . . and all activities connected with the conservation and regulation of marine and estuarine resources" in North Carolina.[7] Commission rulemaking authority includes regulation of the "[t]ime, place, character, or dimensions of any methods or equipment that may be employed in taking fish" and "[s]easons for taking fish."[8] The MFC must adopt rules to "provide a sound, constructive, comprehensive, continuing, and economical coastal fisheries program" for the State.[9] All regulation of commercial and recreational fishing must be "in the interest of the public,"[10] as the marine and estuarine resources of North Carolina "belong to the people of the State."[11]

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[5] N.C. Gen. Stat. § 143B-289.51(b)(1) (2016).
[6] N.C. Gen. Stat. § 143B-289.52(a) (2016); *see also* N.C. Gen. Stat. § 113-182(a) (2016).
[7] N.C. Gen. Stat. § 113-132(a) (2016); *see also* N.C. Gen. Stat. § 143B-289.51(b)(1) (2016); N.C. Gen. Stat. § 113-134.1 (2016) (clarifying that the MFC has regulatory authority over the conservation of marine fisheries "in the Atlantic Ocean to the seaward extent of the State jurisdiction over the resources").
[8] N.C. Gen. Stat. § 143B-289.52(a)(1)(a)-(b) (2016); *see also* N.C. Gen. Stat. § 113-182(a) (2016).
[9] N.C. Gen. Stat. § 143B-289.51(b)(2) (2016).
[10] N.C. Gen. Stat. § 143B-289.52(a)(2) (2016).
[11] N.C. Gen. Stat. § 113-131(a) (2016).

The Commission defines nursery areas as "areas that for reasons such as food, cover, bottom type, salinity, temperature, and other factors, young finfish and crustaceans spend the major portion of their initial growing season."[12] Nursery areas fall into one of three categories: primary nursery areas ("PNAs"), secondary nursery areas ("SNAs"), and a subset of SNAs, special secondary nursery areas ("SSNAs").[13] PNAs are defined as "those areas in the estuarine system where initial post-larval development takes place . . [and] where populations are uniformly early juveniles."[14] SNAs are "areas in the estuarine system where later juvenile development takes place [and where] [p]opulations are composed of developing sub-adults of similar size that have migrated from an upstream primary nursery area to the secondary nursery area located in the middle portion of the estuarine system."[15] North Carolina rules do not distinguish between permanent SNAs and SSNAs. The rules prohibit the use of trawl nets, swipe nets, dredges, and other gear in PNAs.[16] The rules also prohibit the use of trawl nets in SNAs and SSNAs.[17] SSNAs, however, may be opened to trawling at the discretion of the Fisheries Director.[18] The designation of nursery areas, which triggers additional restrictions on effort and gear in these areas, is a critical component of the MFC's duty to protect and conserve the fisheries resources of the state.

The proposed rules expand the designation of SSNAs to include all inshore and near shore waters under MFC jurisdiction that are not currently protected as PNAs or permanent or special SNAs. In addition, the proposed rules provide guidance to the Fisheries Director regarding the appropriate time to open shrimp season. The proposed rules also limit trawl effort in sensitive and important habitat areas. Finally, the proposed rules establish size limits for Atlantic croaker and spot.

The proposed rules are consistent with—and further the objectives of—the Coastal Habitat Protection Plan ("CHPP"), which was mandated by the Fisheries Reform Act.[19] The MFC, together with the N.C. Coastal Resources Commission and the N.C. Environmental Management Commission, adopted the CHPP and must implement the recommendations contained therein.[20] The CHPP catalogues and describes the diversity of habitats and ecosystems on North Carolina's coast, identifies threats to important coastal habitats, and recommends management actions "to protect and restore habitats" vital to the State's fishery resources.[21] The CHPP repeatedly acknowledges the important role that nursery habitats play in maintaining

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[12] 15A N.C. Admin. Code 3I .0101(4)(f) (2016).
[13] *Id.*
[14] *Id.*
[15] *Id.*
[16] *See* 15A N.C. Admin. Code 3N .0104 (2016).
[17] *Id.* at .0105.
[18] *Id.*
[19] *See* N.C. Gen. Stat §§ 143B-289.52(a)(11), 143B-279.8 (2016). *See also North Carolina Coastal Habitat Protection Plan: Source Document*, N.C. DEP'T OF ENVT'L QUALITY 2 (2016), http://portal.ncdenr.org/c/document_library/get_file?uuid=5d02ccd2-3b9d-4979-88f2-ab2f9904ba61&groupId=38337 [hereinafter *CHPP*].
[20] N.C. Gen. Stat. § 143B-279.8(c) (2016).
[21] N.C. Gen. Stat. § 143B-279.8(a) (2016).

viable fisheries and a healthy coastal ecosystem.[22] Among the CHPP's many stated goals is that of enhancing and protecting habitats from adverse physical impacts. Expanding nursery area designations to accurately account for nursery habitat and affording these habitats additional protection furthers the goals of the CHPP.

Current North Carolina fisheries management policy does not include measures to ensure proper and necessary protection of marine fisheries resources. The proposed rules will ensure that essential habitat areas for commercially and recreationally valuable species are adequately protected by: (1) designating additional special secondary nursery areas in inshore and near shore waters, and (2) limiting effort and restricting gear within designated nursery areas. These measures are consistent with and fulfill MFC's statutory duties to manage, protect, preserve, and enhance the marine and estuarine resources of North Carolina. Moreover, the proposed rules will advance the objectives of the Fisheries Reform Act of 1997.

The MFC is statutorily authorized to enact the proposed rules. Designating nursery areas, regulating the opening and closing of seasons, establishing size limits, and managing the use of gear within designated nursery areas fall squarely within the MFC's authority to regulate the appropriate areas and methods for the taking of fish.[23] In addition, the MFC has explicit authority to establish seasons for the taking of fish.[24] Neither the Fisheries Reform Act nor any other legislation restricts when the Commission may take action on these important issues.[25]

III. A STATEMENT OF THE REASONS FOR ADOPTION OF THE PROPOSED RULES

The lack of adequate habitat protections and declining and depleted status of many of our coastal fish stocks suggests a failure of the MFC, through its existing regulations, to meet its duties to "conserve, protect, and regulate" marine and estuarine resources. While environmental factors and water pollution may affect the status of fish stocks, fishing practices also contribute to decline and depletion of several stocks. Bycatch of juvenile fish in the shrimp trawl fishery in estuarine and near shore waters, as allowed by existing Commission regulations, contributes to the current status of several commercially and recreationally valuable species, including but not limited to Atlantic croaker, spot, and weakfish.

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[22] *See, e.g.*, *CHPP*, *supra* note 19, at 27 (discussing the role of nursery areas for estuarine spawners).
[23] *See* N.C. Gen. Stat. § 143B-289.52(a)(1)(a) (2016).
[24] *Id.* at (a)(1)(b).
[25] The Fisheries Reform Act, N.C. Gen. Stat. § 113-181, *et. seq.*, requires the adoption of fishery management plans for "all commercially or recreationally significant species or fisheries that compromise State marine or estuarine resources." N.C. Gen. Stat. § 113-182.1(a) (2016). Fishery management plans may be species-specific, or may be based on gear or geographic areas. *Id*. at (b). With the exception of the size limits proposed for spot and Atlantic croaker, the proposed rules are not species-specific management measures. Instead, the proposed rules designate special secondary areas and provide for appropriate practices designed to protect these areas for numerous species. Size limits for several species not the subject of a state fishery management plan have been adopted by the MFC. *See, e.g.*, 15A N.C. Admin. Code 3M .0511 (2016) (imposing a per-day catch limit and a size limit for bluefish for recreational purposes). All of the proposed rules may be adopted by the MFC outside of the fishery management plan process outlined by the Fisheries Reform Act.

As discussed in further detail in the attached expert analyses:

(1) Existing primary, secondary, and special secondary nursery area designations fail to protect vital habitat areas within which later juvenile development takes place prior to a fish's first spawning;

(2) N.C. Division of Marine Fisheries ("DMF") data demonstrates that all coastal fishing waters that are not currently designated as nursery areas are, in fact, SSNAs for several finfish species;

(3) Additional gear restrictions and effort limits are necessary to provide adequate protection to juvenile fish that have yet to spawn in SSNAs at this sensitive life stage; and

(4) All coastal fishing waters not otherwise designated must be designated as SSNAs and afforded the protections of SSNA designation.

North Carolina's commercial and recreational fisheries are some of the most productive in the country. Estuarine-dependent species account for more than 90 percent of the State's commercial fisheries landings and over 60 percent of the recreational harvest.[26] The continued success and viability of these fisheries requires protection of important habitat areas on which these species rely for survival. North Carolina's existing nursery program provides important protections to larval and early juvenile populations that inhabit shallow, protected habitat areas. Later stage juveniles—those juveniles that have not yet reached adulthood and therefore have not spawned—however, lose habitat protection once they move into the sounds and ocean waters and are exposed to shrimp trawls and other fishing gear. It is no surprise that the highest levels of bycatch of juvenile species in North Carolina waters are found in the Pamlico Sound, which is a highly productive nursery area for several species of finfish.

The impact of bycatch mortality in North Carolina nursery areas extends to the mid- and south Atlantic coast.[27] Commercially and recreationally valuable species, including Atlantic croaker, spot, and weakfish, are in depleted or declining status, and fisheries managers have struggled to mitigate further decline in these stocks.[28] In fact, these three species also account for the vast majority of finfish bycatch in North Carolina waters.[29] As the experts note, bycatch mortality in North Carolina's shrimp trawl fishery contributes to declining status of these important populations.[30] Currently, tens of millions of juvenile fish fall victim to shrimp trawl bycatch each year, and therefore do not spawn, replace themselves, and contribute to the adult population. Increasing juvenile recruitment is essential to rebuilding the stock of these species.[31]

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[26] *See CHPP*, *supra* note 19, at 11.
[27] *See* Travelstead & Daniel, *supra* note 4, at 20.
[28] *See id*. at 5, 7-9.
[29] *See id.* at 1, 5-9 (citing Brown 2015).
[30] *Id.* at 2.
[31] *Id.*

Critical ecosystem services are also lost as a result of sustained high bycatch levels.[32] Atlantic croaker, spot, and weakfish serve an important role in the trophic structure of the state's fisheries resources. Spot and Atlantic croaker, for example, transfer energy from benthic species (their primary diet component) to other economically valuable species, including spotted seatrout, red drum, and southern and summer flounder. [33] Removing significant levels of juvenile fish in shrimp trawls disadvantages higher-level species. The trawling activity itself compounds this effect, as bottom disturbing gear disrupts bottom habitat and bottom-dwelling benthic communities.[34]

The MFC's efforts to minimize bycatch of juvenile finfish have proven unsuccessful to date, as discussed below. The MFC limited the scope of Amendment 1 to the North Carolina Shrimp Fishery Management Plan ("FMP") to address the significant levels of bycatch in the state's shrimp trawl fishery. The MFC fell far short of taking meaningful action to protect important habitat areas and reduce bycatch of juvenile fish. Decades of inaction by the MFC have led to unsustainable levels of bycatch, and the time for action is now.

A. **Nursery Area Protection is Essential to Achieving Sustainable Fisheries.**

Nursery areas serve as vital habitat areas for the development of finfish and shellfish species from early larval to late juvenile life stages. As discussed in detail in the attached expert reports, nursery habitat supports high abundance levels and diversity of fish species, and the ecological processes that occur in nursery habitat support growth of individual fish. For decades, researchers have recognized the importance of nursery areas for juvenile life stage development. Estuarine nursery areas have been shown to contribute disproportionately to the production of individual fish that recruit into adult populations.[35] Nursery areas must be maintained in their natural state to promote and support species development.

Atlantic croaker, spot, and weakfish, among other estuarine-dependent species, spawn in coastal and near shore ocean waters and recruit as early juveniles in estuarine habitats like the Pamlico Sound.[36] The majority of the individuals found in the Pamlico Sound are juvenile fish that have yet to spawn or have not reached their full spawning potential.[37] As discussed in more detail below and in the attached expert reports, harvesting or otherwise subjecting these juveniles to high levels of fishing mortality before first spawning leads to recruitment overfishing and growth overfishing, and may ultimately impact fishery yields and long-term stock productivity.[38]

[32] *See* Luiz Barbieri, *Technical Review: The Need to Reduce Fishing Mortality and Bycatch of Juvenile Fish in North Carolina's Estuaries* (Nov. 2016) (Exhibit E), at 9.
[33] *See* Travelstead & Daniel, *supra* note 4, at 12.
[34] *See id*. at 15; *see also* Barbieri, *supra* note 32, at 11.
[35] *See* Barbieri, *supra* note 32, at 5 (citing Able 2005, Beck, et. al., 2001, Heck and Crowder 1991).
[36] *See id.* at 9 (citing Lowerre-Berbieri et al. 1995, Barbieri et al. 1994a, Weinstein and Walters 1981, Chao and Musik 1977).
[37] *See id*.
[38] *See id.* at 11-12.

1. The Existing Nursery Area Program Fails to Protect Important Habitat Areas that are Essential for the Viability and Recovery of Fish Stocks.

The first steps in protecting nursery areas are to properly define "nursery area" under North Carolina rules and to designate important habitat areas as nursery areas. In 1988, approximately 3.9 percent of the state's estuarine waters were designated as PNAs; 1.7 percent were designated as SNAs; and 0.7 percent were designated as SSNAs.[39] In sum, approximately 129,000 acres, or 6.3 percent, of the state's estuarine waters were designated as nursery areas at that time.[40] Fast forward almost 30 years and little has changed, despite current and historical data demonstrating that additional areas serve as nursery habitat for several finfish species.[41] As a result, important habitat areas are left unprotected and few gear restrictions apply in these critical areas. Indeed, the CHPP acknowledges that "many shallow soft bottom areas are productive but *not* designated as primary or secondary nursery."[42] The existing nursery area designations fail to protect larger juvenile fish or very young adult fish and shellfish prior to spawning or reaching full spawning potential because existing designations do not account for large swaths of important habitat areas.[43] The MFC may obtain its goal of "balancing competing public trust uses with the goal of habitat protection" by expanding the areas designated as SSNAs and allowing commercial and recreational activities in SSNAs within certain limitations.[44]

DMF conducts several surveys to identify nursery area habitat in North Carolina waters, including the Program 120 ("P120") Survey and the P195 Pamlico Sound Survey. DMF conducted trawling and seine surveys in the 1970s to develop an inventory of the state's estuarine resources and to identify those areas of the state's estuaries that consistently support juvenile populations of shrimp, crab, and finfish.[45] The 1970s trawl surveys served as the initial survey to build DMF's inventory of coastal and estuarine resources and led to the first designation of PNAs, SNAs, and SSNAs. DMF surveys annually through the P120 survey, which provides updated data to identify nursery areas and builds a database of annual juvenile populations of economically beneficial species.[46] The P120 survey is concentrated in shallow, upper estuarine areas. The P195 Pamlico Sound Survey is conducted annually by DMF staff in June and September in the Pamlico Sound. The P195 survey has several objectives, including determining which species utilize the Sound and whether nursery habitats exist in the Sound for identified species.[47] Pamlico Sound Survey stations are located in the deeper parts of the

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[39] Elizabeth Noble and Robert Monroe, *Classification of Pamlico Sound Nursery Areas: Recommendations for Critical Habitat Criteria*, N.C. DEP'T OF ENV'T, HEALTH AND NAT. RES., 5 (1991).
[40] *Id.*
[41] *See* Travelstead & Daniel, *supra* note 4, 14-15 (citing Brown 2015, Casey and Zapf 2015).
[42] *CHPP*, *supra* note 19, at 169.
[43] *See* Travelstead & Daniel, *supra* note 4, at 2, 10-12 ; *see also* Barbieri, *supra* note 32, at 7.
[44] *Amendment 1 to the North Carolina Shrimp Fishery Management Plan*, N.C. DIV. MARINE FISHERIES, 170 (2015), http://portal.ncdenr.org/c/document_library/get_file?uuid=3d0d96c3-05bf-4cb6-84c3-fd119ad25d7e&groupId=38337 [hereinafter *Amendment 1*].
[45] *See id.* at 168; *see also North Carolina Division of Marine Fisheries Primary Nursery Area Designation Protocol*, N.C. DIV. MARINE FISHERIES, 1 (2002) [hereinafter *Protocol*].
[46] *See Amendment 1*, *supra* note 44, at 169.
[47] *See* Travelstead & Daniel, *supra* note 4, at 10 (citing Knight and Zapf 2015).

Pamlico Sound.[48] Generally, the Pamlico Sound Survey and P120 Survey stations do not overlap.

The following criteria are used to determine the presence of nursery areas: abundance, size composition, species diversity, bottom type, and depth.[49] The abundance analysis under the P120 survey, however, is limited to the following species: brown shrimp, blue crab, spot, Atlantic croaker, and southern flounder.[50] As the MFC has acknowledged, 90 percent of commercially and recreationally valuable species in North Carolina waters are dependent on nursery areas during an important life stage.[51] Those areas that "consistently support[] populations of juvenile shrimps, crab, and finfishes" and meet the criteria outlined by DMF should be designated as PNAs, SNAs, and SSNAs.[52]

2. North Carolina's Inshore Waters and Ocean (0-3 miles) Waters are Nursery Areas.

As explained in detail in the expert reports attached hereto as Exhibits B and E, current and historical DMF data clearly demonstrates that inshore and ocean (0-3 miles) waters serve as nursery areas for several species of finfish, including Atlantic croaker, spot, and weakfish. The MFC can no longer ignore its obligation to protect and conserve these areas for juvenile species, which are critical to recruitment and stock recovery.

The results of the annual Pamlico Sound Survey consistently indicate high levels of abundance of Atlantic croaker, spot, and weakfish in the Pamlico Sound.[53] Moreover, length frequency data suggests that the vast majority of the fish found in the Sound are juveniles that have not yet reached maturity.[54] These results are consistent with DMF characterization studies conducted in inshore waters south of the Pamlico Sound, including Bogue Sound and Core Sound, and in ocean waters.[55] In addition, physical habitat characteristics in these areas, including bottom type, salinity, and temperature, support the growth of juveniles into adulthood.[56]

The proposed rules designate all undesignated coastal fishing waters out to three miles offshore as SSNAs, recognizing the important role that these waters play in pre-spawn, late juvenile development. The proposed rules also amend the definition of "secondary nursery areas" to include "ocean waters" that serve as nursery habitat for food and forage species.

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[48] *See id*. at 10, 22 (Fig. 2).
[49] *See Protocol*, *supra* note 45, at 2-3.
[50] *See id*. at 2; *see also Amendment 1*, *supra* note 44, at 169.
[51] *Amendment 1*, *supra* note 44, at 168.
[52] *Protocol*, *supra* note 45, at 1.
[53] *See* Travelstead & Daniel, *supra* note 4, at 10-11 (citing Knight and Zapf 2015).
[54] *See id*. Abundance is the most important variable in determining the presence of nursery areas. *See Amendment 1*, *supra* note 44, at 169.
[55] *See* Travelstead & Daniel, *supra* note 4, at 11 (citing Brown 2015, Knight 2015, Knight and Zapf 2015, Brown 2009, Johnson 2006, Logothetis & McCuiston 2004, Johnson 2003, Diamond-Tissue 1999).
[56] *See id*. at 12.

B. **Gear Restrictions and Reduced Effort Are Necessary to Protect Habitat in Special Secondary Nursery Areas.**

Juvenile populations of Atlantic croaker, spot, and weakfish, among many other species, are subjected to intense fishing pressure in the shrimp trawl fishery in North Carolina waters. Ninety-two percent of shrimp landings in state waters are harvested with otter trawls.[57] Otter trawls catch essentially everything in their path, leading to extraordinarily high levels of bycatch. In addition, otter trawls disturb the sea or sound floor, which are fragile and productive ecosystems. A legislative panel pre-dating the Fisheries Reform Act found that bottom trawling gear, including shrimp trawls, had the greatest potential to impact bottom habitats in estuarine and coastal waters.[58] These impacts include physical disruption of habitat, changes in functional organization of species, increases in total suspended solids and turbidity, destruction of submerged aquatic habitat, and decreases in habitat complexity.[59] In North Carolina, designated PNAs, SNAs, and SSNAs are afforded protection; however, existing designations fail to account for all habitat areas that serve as nurseries. This is in spite of the fact that the MFC has recognized that "nursery areas need to be maintained . . . in their natural state, and the populations within them must be permitted to develop in a normal manner with as little interference from man as possible."[60]

In 2014 alone, approximately 15 million pounds of juvenile spot, Atlantic croaker, and weakfish were caught and discarded in North Carolina waters.[61] The vast majority of commercial shrimp landings from North Carolina are from inshore waters.[62] Substantial numbers of shrimp are also harvested in near shore ocean waters. High levels of juvenile abundance of valuable species have been found in these areas as well.[63] As discussed in detail above, these inshore and near shore areas serve as important habitat areas for an abundant and diverse population of juvenile fish. It is imperative to protect these nursery areas, as they provide "food, protection and proper environmental conditions (salinity and bottom type) for development and growth of young fish and crustaceans."[64]

North Carolina remains the only state on the east coast to allow trawling in inshore waters. A wholesale ban on trawling in inshore waters would substantially reduce bycatch in the commercial and recreational fisheries—but this extreme policy would have a detrimental impact on commercial fishermen, recreational fishermen, and North Carolina's coastal economy. The Federation proposes the following balanced, research-based approach to reduce bycatch mortality of juvenile species and to protect vital habitat areas in North Carolina's estuaries and ocean waters while allowing shrimp trawling to continue under new parameters. These management strategies are intended to apply to both the commercial and the recreational fishing

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[57] *See* Brown, *supra* note 2, at 1.
[58] *See CHPP*, *supra* note 19, at 163.
[59] *See id*. at 163-67.
[60] *See Amendment 1*, *supra* note 44, at 168; *see also* 15A N.C. Admin. Code 3N .0104-0105 (2016).
[61] *See* Travelstead & Daniel, *supra* note 4, at 11.
[62] *See* Brown, *supra* note 2, at 1 ("The majority of landings are from Pamlico Sound (56%), the Atlantic Ocean (24%) and Core Sound (6%), respectively.").
[63] *See* Travelstead & Daniel, *supra* note 4, at 11 (citing Brown 2015).
[64] *Amendment 1*, *supra* note 44, at 168; *see also* 15A N.C. Admin. Code 3I .0101(4)(f) (2016).

industries, including recreational fisherman operating under a recreational commercial gear license.

Taken together, the proposed rules will provide protection to essential habitat areas in which juvenile fish grow and thrive, reduce bycatch of juvenile fishes, and put North Carolina's fisheries on the path to recovery, which will benefit all North Carolinians—commercial and recreational fishermen alike. The Federation recommends that the proposed rules take effect in the shrimp season following their adoption. The following management measures are discussed in more detail in the attached expert reports.

1. Open Shrimp Season Under Established Guidelines.

Currently, the Fisheries Director must open each shrimp season by proclamation. Commission rules, however, provide no guidelines for the opening of the season. The Director should be guided by conservation principles in exercising proclamation authority under MFC rules. The Federation proposes opening shrimp season once the shrimp count in the Pamlico Sound reaches 60 shrimp per pound (heads on), as evaluated by DMF staff.[65]

2. Reduce Headrope Length.

Average headrope length in otter trawls has increased steadily over time, which in turn increased overall yield and higher levels of bycatch.[66] In 2012, average maximum headrope length on commercial otter trawls measured 94 feet.[67] By 2015, average maximum headrope length increased to 134 feet.[68] As discussed in detail in the attached expert reports, a headrope length restriction would reduce the total amount of bycatch by reducing the overall net size on all trawls in state waters.[69] Currently, combined headropes may be as long as 220 feet in some internal coastal waters, while headrope length is restricted to 90 feet in other internal coastal waters.[70]

Other states with significant commercial shrimping industries have established combined headrope length limits well below the current 220 feet maximum in North Carolina waters. For example, the maximum combined headrope length for shrimp trawls in Mississippi waters is 100 feet.[71] In Alabama, recreational shrimp trawl nets cannot exceed 16 feet (only one net per boat)

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[65] *See* Travelstead & Daniel, *supra* note 4, at 18-19.
[66] *See id.* at 17-18.
[67] *Id.* (citing Brown 2015). *See also Amendment 1*, *supra* note 44, at 312-313.
[68] Travelstead and Daniel, *supra* note 4, at 17 (citing Brown 2015).
[69] *See id. See also North Carolina Shrimp Fishery Management Plan*, N.C. DIV. OF MARINE FISHERIES 315 (2006), http://portal.ncdenr.org/c/document_library/get_file?uuid=7dc55c67-c6df-4a39-9ffc-32471c055c23&groupId=38337 (stating that limiting headrope sizes will lead to reduction in bycatch).
[70] Maximum headrope length cannot exceed 90 feet in certain Internal Coastal Waters. *See* 15A N.C. Admin. Code 3L .0103 (2016).
[71] *See* 21-1 MISS. CODE. R. § 15:05 (2014) (restricting individual trawl net sizes in different coastal areas to 12, 25, and 50 feet and placing limitations on the size of trawl doors).

and commercial trawl nets cannot exceed a combined 50 feet in length (limit of two nets per boat).[72]

The Federation proposes a maximum headrope length on all trawls in state waters not to exceed 90 feet. A consistent maximum headrope length not to exceed 90 feet will provide clarity and consistency for all fishermen and result in more efficient fishing practices in state waters.

3. Limit Tow Times.

Mortality of bycatch captured in trawl nets can vary widely based on tow times; longer tow times generally lead to higher bycatch mortality.[73] Conversely, shorter tow times would lead to a reduction in culling time and bycatch mortality.[74] Tow times vary widely in both the commercial and recreational fishery. Overall tow times have increased over the last several years. In 2012, average tow times in the shrimp trawl fishery during an observer study totaled 100 minutes in the Pamlico Sound.[75] By 2015, tow times under the same study increased more than 75 percent and averaged 181 minutes.[76] Maximum tow times likewise increased over the study period from 240 minutes in 2012 to 360 minutes in 2015.[77]

A reduction in tow times is unlikely to have an impact on overall harvest or income for commercial fishermen.[78] Bycatch mortality, however, is expected to decrease, giving juvenile fish caught in nets a higher likelihood of survival. The Federation proposes limiting tow times to 45 minutes in SSNAs.

4. Limit Fishing Days to Three Days per Week During Daylight Hours.

Reducing the number of fishing days each week and limiting trawling to daytime hours will reduce overall effort and, thus, bycatch of juvenile species in state waters. Under existing rules, shrimp trawling is prohibited in inshore waters between 9:00 pm on Friday until 5:00 pm on Sunday evenings.[79] An additional two day closure would reduce overall bycatch, provide fish species the opportunity to move out of trawling areas, and allow fish to recover from encounters with shrimp trawls during fishing days.[80] Shrimp landings are highest immediately after the opening of trawling for the week, suggesting that an additional two days of closure could

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[72] *See* ALA. ADMIN CODE R. 220-3-.01(8) (2014).
[73] *See, e.g., Amendment 1, supra* note 44, at 304 ("Reduced tow times would likely reduce bycatch mortality.").
[74] *See id.*; *see also* Travelstead & Daniel, *supra* note 4, at 18.
[75] Travelstead & Daniel, *supra* note 4, at 18 (citing Brown 2015).
[76] *Id*.
[77] *Id*.
[78] *See Amendment 1*, *supra* note 44, at 306 (noting that implementing a tow time would not likely have an impact on harvest or income and that the Advisory Committees did not consider this management option when developing Amendment 1).
[79] 15A N.C. Admin. Code 3L .0102 (2016).
[80] *See* Travelstead & Daniel, *supra* note 4, at 18; *see also Amendment 1*, *supra* note 44, at 302 (discussing Ingraham's (2003) evaluation of nighttime closure off the coast of Brunswick County and noting that finfish bycatch was higher during nighttime trawling).

improve overall efficiency in the fishery.[81] Limiting trawling to daytime hours further limits effort in the fishery, without sacrificing catch.[82] Monitoring the shrimp trawling fishery is more effective during daylight hours because the trawlers can be more readily seen by DMF officers.

The Federation, therefore, proposes limiting the number of days for trawling in designated SSNAs to three days each week during daylight hours only.

5. *Require the Use of Two DMF-certified Bycatch Reduction Devices.*

No current North Carolina statute, regulation, or proposed regulation requires the use of a BRD by shrimp trawlers in state waters, other than a turtle excluder device.[83] The Fisheries Director may, but is not required to, issue a proclamation mandating the use of BRDs to reduce the number of finfish caught by shrimp trawl nets.[84] The use of one BRD has been required by proclamation since the 2012 shrimp season.[85] After the adoption of Amendment 1 to the Shrimp FMP, the Fisheries Director issued Proclamation SH-2-2015, which requires the use of two DMF-authorized BRDs on all otter and skimmer trawls in coastal fishing waters.[86] Amendment 1 also provided for the convening of a stakeholder group to initiate industry testing of several BRDs, with the target of reducing bycatch by 40 percent and minimizing shrimp loss.[87] DMF, with the support and involvement of the commercial industry stakeholders, has tested several promising BRDs over the last two shrimp seasons that significantly reduce bycatch levels while minimizing shrimp loss. The results of this study support the implementation of this management strategy.

Proclamations are binding on all fishermen fishing in North Carolina waters;[88] however, a proclamation may be rescinded at any time by the Fisheries Director. A rule requiring the use of two BRDs would put in place a permanent and consistent requirement and signal to fishermen MFC's commitment to reducing bycatch in the state's shrimp trawl fishery.

The Federation proposes a rule that requires all fishermen to use two DMF-certified BRDs when trawling in any state waters, which is consistent with Proclamation SH-2-2015.

6. *Establish Size Limits for the Possession of Spot and Atlantic Croaker.*

A size limit will supplement efforts in the commercial fishery to reduce bycatch, preserve habitat, and protect sensitive juvenile finfish populations. Currently, no size limits exist for the

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[81] *See Amendment 1*, *supra* note 44, at 301 (citing Johnson 2006); *see also* Travelstead & Daniel, *supra* note 4, at 18.
[82] *See* Travelstead & Daniel, *supra* note 4, at 18.
[83] 15A N.C. Admin. Code 03L .0103(g) (2016).
[84] 15 N.C. Admin. Code 3J .0104(d) (2016).
[85] *See* Proclamation SH-3-2012 Re: Shrimp Trawling, N.C. Div. of Marine Fisheries (May 22, 2012), *available at* http://portal.ncdenr.org/web/mf/proclamation-sh-03-2012.
[86] *See* Proclamations SH-2-2015 Re: Shrimp Trawl BRD Requirements, N.C. Div. of Marine Fisheries (May 12, 2015), http://portal.ncdenr.org/web/mf/proclamation-sh-02-2015.
[87] Amendment 1, *supra* note 44, at 356.
[88] 15 N.C. Admin. Code 3H .0103(a) (2016).

possession of Atlantic croaker or spot in North Carolina waters.[89] To allow these species to grow to full maturity and spawn at least once, the Federation recommends establishing size limits for spot and Atlantic croaker for the recreational fishery. Specifically, the Federation proposes an 8 inch size limit for the harvest of spot and a 10 inch size limit for the harvest of Atlantic croaker.

IV. A STATEMENT OF THE EFFECT ON EXISTING RULES

The proposed rules will amend the following sections of 15A of the North Carolina Administrative Code: 3R .0105, 3L .0101, 3L .0103, and 3N .0151. The proposed rules also add two additional sections to Chapter 3, Subchapter M of Title 15A of the North Carolina Administrative Code. The proposed rules are not expected to affect any other existing rules.

V. COPIES OF ANY DOCUMENTS AND DATA SUPPORTING THE PROPOSED RULES

Copies of documents supporting the proposed rules are attached hereto as Exhibits B through F. Exhibit B is a technical review provided by Jack Travelstead and Dr. Louis Daniel, and details the important role of nursery areas in juvenile fish development, the stock status of several commercially and recreationally important species, and the contribution of bycatch mortality in nursery areas to overall stock status. In addition, Mr. Travelstead and Dr. Daniel recommend several management strategies that the MFC must adopt to provide adequate protection to nursery areas and mitigate bycatch levels in North Carolina waters. Exhibit E is a technical review provided by Dr. Luiz Barbieri, which outlines the need to reduce fishing and bycatch mortality of juvenile fish in North Carolina's estuaries. Exhibits C, D, and F include the curriculum vitae of supporting experts.

VI. A STATEMENT OF THE EFFECT OF THE PROPOSED RULE ON EXISTING PRACTICES IN THE AREA INVOLVED, INCLUDING AN ESTIMATE OF COST FACTORS FOR PERSONS AFFECTED BY THE PROPOSED RULES

The proposed rule is designed to minimally affect the commercial and recreational fishing industries. Commercial and recreational fishermen would be expected to see increases in the availability of fishes for harvest under the proposed rules. Commercial shrimp trawl fishermen with smaller boats and nets shorter than 45 feet will be minimally affected. Those fishermen who already employ the use of a second BRD will minimally affected by the proposed rules. Fishermen with large boats and nets exceeding the total headrope maximum may be required to discontinue the use of one or two nets while in state waters. In addition, fish dealers may be impacted if the availability, quantity, or price of harvested shrimp is positively or negatively affected by the proposed rules.

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[89] The MFC prohibits the possession of weakfish below 12 inches in the commercial and recreational fishery and limits the catch of weakfish to 1 bag per day in the recreational fishery. *See N.C. Recreational Coastal Waters Guide for Sports Fishermen*, N.C. DIV. OF MARINE FISHERIES, http://portal.ncdenr.org/web/mf/recreational-fishing-size-and-bag-limits (last updated Oct. 13, 2016).

Efficiencies in terms of reduced effort and associated costs would be measureable. As pointed out in the attached expert reports, limiting shrimping during the day and the earlier part of the week results in minimal shrimp loss. Anecdotal evidence suggests that several of the management strategies required by the proposed rules will increase the size, and therefore the value, of shrimp harvested in North Carolina waters, which would benefit the commercial fishing industry. Moreover, all commercial and recreational fisheries will benefit if fish stocks currently in depleted or declining status rebound as a result of the proposed rule. Without an economic analysis that considers the specific proposals contained in this Petition, any prediction of cost is purely speculative.

Cost factors associated with the proposed rule include, but are not limited to, the following: (1) cost of new gear, including a headrope meeting the proposed rule requirements and a second bycatch reduction device, and installation of new gear, if necessary; (2) cost of delaying the shrimp season by a short time to allow shrimp count to reach 60 shrimp per pound (heads on) as determined by the Fisheries Director; (3) cost of reducing tow time to 45 minute tows and trawl effort to three days per week during nighttime hours, if these reductions affect overall effort; and (4) the cost of implementing a size limit on spot and Atlantic croaker.

VII. A DESCRIPTION OF THOSE MOST LIKELY TO BE AFFECTED BY THE PROPOSED RULES

As described above, the proposed rules will affect individuals who participate in the commercial and recreational fishing industries, as well as the general public. The general public will derive substantial benefits from the adoption of the proposed rule changes. Economically valuable North Carolina and coast-wide fish stocks have struggled to rebound after several years, and in some cases decades, of decline. Bycatch mortality in the absence of adequate habitat protection has contributed to declining and depleted stock statuses. By protecting valuable habitats and reducing bycatch levels, the proposed rules will protect marine and estuarine resources for all citizens of the State.

VIII. THE NAME AND ADDRESS OF THE PETITIONER

Tim Gestwicki, Chief Executive Officer
North Carolina Wildlife Federation
1346 Saint Julien Street
Charlotte, NC 28205

IX. CONCLUSION

The Commission has a duty to adopt rules "in the public interest" for the "protection, preservation, and enhancement" of fish stocks adversely affected by bycatch in the shrimp trawl fishery. The Federation has proposed rules that would allow the continuation of a shrimp trawl fishery while protecting habitat, reducing bycatch, and contributing to the restoration of declining and depleted fish stocks. The proposed regulations are within the authority of the Commission and in the public interest, and will enable the Commission to meet its duties under the law to conserve, preserve, protect, and enhance marine and estuarine resources.

For the reasons stated above, the Federation requests that the MFC adopt the proposed rules. Pursuant to 15A N.C. Admin. Code 3P .0303(b), the MFC has 120 days to make a final determination regarding the Petition. The Federation appreciates the opportunity to informally discuss this Petition with the Commission on November 17, 2016.

The Federation welcomes questions from the Commission, and appreciates the Commission's consideration of the Petition. Please direct any questions regarding the Petition to Blakely Hildebrand at bhildebrand@selcnc.org or (919) 967-1450.

Sincerely,

Tim Gestwicki
Chief Executive Officer
North Carolina Wildlife Federation

Blakely E. Hildebrand
Associate Attorney
Southern Environmental Law Center

Enclosures (6)

CC (w/encl.):

Vice Chairman, Commissioner Joe Shute, N.C. Marine Fisheries Commission
Commissioner Rick Smith, N.C. Marine Fisheries Commission
Commissioner Janet Rose, N.C. Marine Fisheries Commission
Commissioner Mike Wicker, N.C. Marine Fisheries Commission
Commissioner Alison Willis, N.C. Marine Fisheries Commission
Commissioner Mark Gorges, N.C. Marine Fisheries Commission
Commissioner Chuck Laughridge, N.C. Marine Fisheries Commission
Braxton Davis, Director, N.C. Division of Marine Fisheries

EXHIBIT A

TEXT OF PROPOSED RULES

The added text is denoted by underline and deleted text is denoted ~~by strike-through~~ below.

15A N.C. Admin. Code 3R .0105: Special Secondary Nursery Areas

The special secondary nursery areas referenced in 15A NCAC 3N .0105(b) are designated in the following coastal water areas:

(1) Roanoke Sound:

(a) Outer Shallowbag Bay--west of a line beginning on Baum Point at a point 35° 55.1461' N--75° 39.5618' W; running southeasterly to Ballast Point to a point 35° 54.6250' N--75° 38.8656' W; including the canal on the southeast shore of Shallowbag Bay; and
(b) Kitty Hawk Bay/Buzzard Bay--within the area designated by a line beginning at a point on the east shore of Collington Creek at a point 36° 2.4360' N--75° 42.3189' W; running westerly to a point 36° 2.6630' N--75° 41.4102' W; running along the shoreline to a point 36° 2.3264' N--75° 42.3889' W; running southwesterly to a point 36° 2.1483' N--75° 42.4329' W; running along the shoreline to a point 36° 1.6736' N--75° 42.5313' W; running southwesterly to a point 36° 1.5704' N--75° 42.5899' W; running along the shoreline to a point 36° 0.9162' N--75° 42.2035' W; running southeasterly to a point 36° 0.8253' N--75° 42.0886' W; running along the shoreline to a point 35° 59.9886' N--75° 41.7284' W; running southwesterly to a point 35° 59.9597' N--75° 41.7682' W; running along the shoreline to the mouth of Buzzard Bay to a point 35° 59.6480' N--75° 32.9906' W; running easterly to Mann Point to a point 35° 59.4171' N--75° 32.7361' W; running northerly along the shoreline to the point of beginning;

(2) In the Pamlico and Pungo rivers Area:

(a) Pungo Creek--west of a line beginning on Persimmon Tree Point at a point 35° 30.7633' N--76° 38.2831' W; running southwesterly to Windmill Point to a point 35° 31.1546' N--76° 37.7590' W;
(b) Scranton Creek--south and east of a line beginning on the west shore at a point 35° 30.6810' N--76° 28.3435' W; running easterly to the east shore to a point 35° 30.7075' N--76° 28.6766' W;
(c) Slade Creek--east of a line beginning on the west shore at a point 35° 27.8879' N--76° 32.9906' W; running southeasterly to the east shore to a point 35° 27.6510' N--76° 32.7361' W;
(d) South Creek--west of a line beginning on Hickory Point at a point 35° 21.7385' N--76° 41.5907' W; running southerly to Fork Point to a point 35° 20.7534' N--76° 41.7870' W; and
(e) Bond Creek/Muddy Creek--south of a line beginning on Fork Point 35° 20.7534' N--76° 41.7870' W; running southeasterly to Gum Point to a point 35° 20.5632' N--76° 41.4645' W;

(3) In the West Bay Area:

(a) West Thorofare Bay--south of a line beginning on the west shore at a point 34° 57.2199' N--76° 24.0947' W; running easterly to the east shore to a point 34° 57.4871' N--76° 23.0737' W;
(b) Long Bay-Ditch Bay--west of a line beginning on the north shore of Ditch Bay at a point 34° 57.9388' N--76° 27.0781' W; running southwesterly to the south shore of Ditch Bay to a point 34° 57.2120' N--76° 27.2185' W; then south of a line running southeasterly to the east shore of Long Bay to a point 34° 56.7633' N--76° 26.3927' W; and
(c) Turnagain Bay--south of a line beginning on the west shore at a point 34° 59.4065' N--76° 30.1906' W; running easterly to the east shore to a point 34° 59.5668' N--76° 29.3557' W;

(4) In the Core Sound Area:

(a) Cedar Island Bay--northwest of a line beginning near the gun club dock at a point 34° 58.7203' N--76° 15.9645' W; running northeasterly to the south shore to a point 34° 57.7690' N--76° 16.8781' W;
(b) Thorofare Bay-Barry Bay--northwest of a line beginning on Rumley Hammock at a point 34° 55.4853' N--76° 18.2487' W; running northeasterly to Hall Point to a point 34° 54.4227' N--76° 19.1908' W;
(c) Nelson Bay--northwest of a line beginning on the west shore of Nelson Bay at a point 34° 51.1353' N--76° 24.5866' W; running northeasterly to Drum Point to a point 34° 51.6417' N--76° 23.7620' W;
(d) Brett Bay--north of a line beginning on the west shore at a point 34° 49.4019' N--76° 26.0227' W; running easterly to Piney Point to a point 34° 49.5799' N--76° 25.0534' W; and
(e) Jarrett Bay--north of a line beginning on the west shore near Old Chimney at a point 34° 45.5743' N--76° 30.0076' W; running easterly to a point east of Davis Island 34° 45.8325' N--76° 28.7955' W;

(5) In the North River Area:

(a) North River--north of a line beginning on the west shore at a point 34° 46.0383' N--76° 37.0633' W; running easterly to a point on the east shore 34° 46.2667' N--76° 35.4933' W; and
(b) Ward Creek--east of a line beginning on the north shore at a point 34° 46.2667' N--76° 35.4933' W; running southerly to the south shore to a point 34° 45.4517' N--76° 35.1767' W;

(6) Newport River--west of a line beginning near Penn Point on the south shore at a point 34° 45.6960' N--76° 43.5180' W; running northeasterly to the north shore to a point 34° 46.8490' N--76° 43.3296' W;

(7) New River--all waters upstream of a line beginning on the north side of the N.C. Highway 172 Bridge at a point 34° 34.7680' N--77° 23.9940' W; running southerly to the south side of the bridge at a point 34° 34.6000' N--77° 23.9710' W;

(8) Chadwick Bay--all waters west of a line beginning on the northeast side of Chadwick Bay at a point 34° 32.5630' N--77° 21.6280' W; running southeasterly to a point near Marker “6” at 34° 32.4180' N--77° 21.6080' W; running westerly to Roses Point at a point 34° 32.2240' N--77° 22.2880' W; following the shoreline in Fullard Creek to a point 34° 32.0340' N--77° 22.7160' W; running northwesterly to a point 34° 32.2210' N--77° 22.8080' W; following the shoreline to the west point of Bump's Creek at a point 34° 32.3430' N--77° 22.4570' W; running northeasterly to the east shore to a point 34° 32.4400' N--77° 22.3830' W; following the shoreline of Chadwick Bay back to the point of origin;

(9) Intracoastal Waterway--all waters in the IWW maintained channel from a point near Marker “17” north of Alligator Bay 34° 30.7930' N--77° 23.1290' W; to a point near Marker “49” at Morris Landing at a point 34° 28.0820' N--77° 30.4710' W; and all waters in the IWW maintained channel and 100 feet on either side from Marker “49” to the N.C. Highway 50-210 Bridge at Surf City;

(10) Cape Fear River--all waters bounded by a line beginning on the south side of the Spoil Island at the intersection of the IWW and the Cape Fear River ship channel at a point 34° 1.5780' N--77° 56.0010' W; running easterly to the east shore of the Cape Fear River to a point 34° 1.7230' N--77° 55.1010' W; running southerly and bounded by the shoreline to the Ferry Slip at Federal Point at a point 33° 57.8080' N--77° 56.4120' W; running northerly to Bird Island to a point 33° 58.3870' N--77° 56.5780' W; running northerly along the west shoreline of Bird Island and the Cape Fear River spoil islands back to point of origin;

(11) Lockwood Folly River--all waters north of a line beginning on Howells Point at a point 33° 55.3680' N--78° 12.7930' W and running in a westerly direction along the IWW near IWW Marker “46” to a point 33° 55.3650' N--78° 13.8500' W; and

(12) Saucepan Creek--all waters north of a line beginning on the west shore at a point 33° 54.6290' N--78° 22.9170' W; running northeasterly to the east shore to a point 33° 54.6550' N--78° 22.8670' W.

(13) All Coastal Fishing Waters under the jurisdiction of the Marine Fisheries Commission, pursuant to N.C. Gen. Stat. § 113-132(a), not otherwise designated as primary, secondary, or special secondary nursery areas under .0103, .0104, or above, respectively.

15A N.C. Admin. Code 3L .0101: Shrimp Harvest Restrictions

(a) It is unlawful to take shrimp until the Fisheries Director, by proclamation, opens the season.

(b) The Fisheries Director may not open the season until the shrimp count reaches 60 shrimp per pound, heads on, in the Pamlico Sound.

~~(b)~~ (c) The Fisheries Director may, by proclamation, impose any or all of the following restrictions on the taking of shrimp:

(1) specify time;
(2) specify area;
(3) specify means and methods;
(4) specify season;
(5) specify size; and
(6) specify quantity.

15A N.C. Admin. Code 3L .0103: Prohibited Nets, Mesh Lengths and Areas

(a) It is unlawful to take shrimp with nets with mesh lengths less than the following:

(1) Trawl net--one and one-half inches;
(2) Fixed nets, channel nets, float nets, butterfly nets, and hand seines--one and one-fourth inches; and
(3) Cast net--no restriction.

(b) It is unlawful to take shrimp with a net constructed in such a manner as to contain an inner or outer liner of any mesh length. Net material used as chafing gear shall be no less than four inches mesh length, except that chafing gear with smaller mesh may be used only on the bottom one-half of the tailbag. Such chafing gear shall not be tied in a manner that forms an additional tailbag.

~~(c) It is unlawful to take shrimp with trawls that have a combined headrope of greater than 90 feet in Internal Coastal Waters in the following areas~~:

~~(1) North of the 35| 46.3000' N latitude line;~~
~~(2) Core Sound south of a line beginning at a point 34| 59.7942' N - 76| 14.6514' W on Camp Point; running easterly to a point 34| 58.7853' N - 76| 9.8922' W on Core Banks; to the South Carolina State Line;~~
~~(3) Pamlico River upstream of a line from a point 35| 18.5882' N - 76| 28.9625' W at Pamlico Point; running northerly to a point 35| 22.3741' N - 76| 28.6905' W at Willow Point; and~~
~~(4) Neuse River southwest of a line from a point 34| 58.2000' N - 76| 40.5167' W at Winthrop Point on the eastern shore of the entrance to Adams Creek; running northerly to a point 35| 1.0744' N - 76| 42.1550' W at Windmill Point at the entrance of Greens Creek at Oriental.~~

~~(d)~~ (c) Effective January 1, 201~~7~~8 it is unlawful to take shrimp with trawls that have a combined headrope of greater than 90 feet in Coastal Fishing Waters. ~~220 feet in Internal Coastal Waters in the following areas:~~

~~(1) Pamlico Sound south of the 35| 46.3000' N latitude line and north of a line beginning at a point 34| 59.7942' N--76| 14.6514' W on Camp Point; running easterly to a point 34| 58.7853' N--76| 9.8922' W on Core Banks;~~
~~(2) Pamlico River downstream of a line from a point 35| 18.5882' N--76| 28.9625' W at Pamlico Point; running northerly to a point 35| 22.3741' N--76| 28.6905' W at Willow Point; and~~
~~(3) Neuse River northeast of a line from a point 34| 58.2000' N--76| 40.5167' W at Winthrop Point on the eastern shore of the entrance to Adams Creek; running northerly to a point 35| 1.0744' N--76| 42.1550' W at Windmill Point at the entrance of Greens Creek at Oriental.~~

~~(e)~~ (d) It is unlawful to use a shrimp trawl in the areas described in 15A NCAC 3R .0114.

~~(f)~~ (e) It is unlawful to use channel nets except as provided in 15A NCAC 3J .0106.

~~(g)~~ (f) It is unlawful to use shrimp pots except as provided in 15A NCAC 3J .0301.

~~(h)~~ (g) It is unlawful to use a shrimp trawl that does not conform with the federal rule requirements for Turtle Excluder Devices (TED) as specified in 50 CFR Part 222.102 Definitions, 50 CFR Part 223.205 (a) and Part 223.206 (d) Gear Requirements for Trawlers, and 50 CFR Part 223.207 Approved TEDs. These federal rules are incorporated by reference including subsequent amendments and editions. Copies of these rules are available via the Code of Federal Regulations posted on the Internet at http://www.gpoaccess.gov/cfr/index.html and at the Division of Marine Fisheries, P.O. Box 769, Morehead City, North Carolina 28557 at no cost.

~~(i)~~ (h) It is unlawful to use a shrimp trawl without two (2) authorized North Carolina Division of Marine Fisheries bycatch reduction devices properly installed and operational in the cod end of each net in Coastal Fishing Waters.

15A N.C. Admin. Code 3N .0105: Prohibited Gear, Secondary Nursery Areas

(a) It is unlawful to use trawl nets for any purpose in any of the permanent secondary nursery areas designated in 15A NCAC 3R .0104.

(b) It is unlawful to use trawl nets for any purpose in any of the special secondary nursery areas designated in 15A NCAC 3R .0105(1)-(12), except that the Fisheries Director, may, by proclamation, open any or all of the special secondary nursery areas listed in 15A NCAC 3R .0105(1)-(12), or any portion thereof, ~~listed in 15A NCAC 3R .0105~~ to shrimp or crab trawling from August 16 through May 14 subject to the provisions of 15A NCAC 3L .0100 and .0200.

(c) It is unlawful to use trawl nets for any purpose in any of the special secondary nursery areas designated in 15A NCAC 3R .0105(13), except that the Fisheries Director, may, by proclamation, open any special secondary nursery areas listed in 15A NCAC 3R .0105(13), or any portion thereof, to shrimp or crab trawling, subject to the provisions of 15A NCAC 3L. 0100 and .0200 and the restrictions described below:

(1) Trawling may only occur during shrimp season;
(2) Trawling is restricted to a total of three days per week;
(3) Trawling is prohibited between sunset and sunrise; and
(4) Tow time may not exceed 45 minutes. Tow time begins when the doors of the trawl enter the water and ends when the doors exit the water.

15A N.C. Admin. Code 3I .0101: Definitions

All definitions set out in G.S. 113, Subchapter IV and the following additional terms apply to this Chapter:

(1) Enforcement and management terms:

(a) Commercial Quota. Total quantity of fish allocated for harvest by commercial fishing operations.

(b) Educational Institution. A college, university, or community college accredited by an accrediting agency recognized by the U.S. Department of Education; an Environmental Education Center certified by the N.C. Department of Environment and Natural Resources Office of Environmental Education and Public Affairs; or a zoo or aquarium certified by the Association of Zoos and Aquariums.

(c) Internal Coastal Waters or Internal Waters. All Coastal Fishing Waters except the Atlantic Ocean.

(d) Length of finfish.

i. Curved fork length. A length determined by measuring along a line tracing the contour of the body from the tip of the upper jaw to the middle of the fork in the caudal (tail) fin.
ii. Fork length. A length determined by measuring along a straight line the distance from the tip of the snout with the mouth closed to the middle of the fork in the caudal (tail) fin, except that fork length for billfish is measured from the tip of the lower jaw to the middle of the fork of the caudal (tail) fin.
iii. Pectoral fin curved fork length. A length of a beheaded fish from the dorsal insertion of the pectoral fin to the fork of the tail measured along the contour of the body in a line that runs along the top of the pectoral fin and the top of the caudal keel.
iv. Total length. A length determined by measuring along a straight line the distance from the tip of the snout with the mouth closed to the tip of the compressed caudal (tail) fin.

(e) Recreational Possession Limit. Restrictions on size, quantity, season, time period, area, means, and methods where take or possession is for a recreational purpose.

(f) Recreational Quota. Total quantity of fish allocated for harvest for a recreational purpose.

(g) Regular Closed Oyster Season. March 31 through October 15, unless amended by the Fisheries Director through proclamation authority.

(h) Scientific Institution. One of the following entities:

(i) An educational institution as defined in this Item;

i. A state or federal agency charged with the management of marine or estuarine resources; or
ii. A professional organization or secondary school working under the direction of, or in compliance with mandates from, the entities listed in Subitems (h)(i) and (ii) of this Item.
iii. Seed Oyster Management Area. An open harvest area that, by reason of poor growth characteristics, predation rates, overcrowding or other factors, experiences poor utilization of oyster populations for direct harvest and sale to licensed dealers and is designated by the Marine Fisheries Commission as a source of seed for public and private oyster culture.

(2) Fishing Activities:

(a) Aquaculture operation. An operation that produces artificially propagated stocks of marine or estuarine resources or obtains such stocks from permitted sources for the purpose of rearing in a controlled environment. A controlled environment provides and maintains throughout the rearing process one or more of the following:

i. food;
ii. predator protection;
iii. salinity
iv. temperature controls; or
v. water circulating, utilizing technology not found in the natural environment.

(b) Attended. Being in a vessel, in the water or on the shore, and immediately available to work the gear and be within 100 yards of any gear in use by that person at all times. Attended does not include being in a building or structure.

(c) Blue Crab Shedding. The process whereby a blue crab emerges soft from its former hard exoskeleton. A shedding operation is any operation that holds peeler crabs in a controlled environment. A controlled environment provides and maintains throughout the shedding process one or more of the following:

i. food;
ii. predator protection;
iii. salinity;

iv. temperature controls; or
v. water circulation, utilizing technology not found in the natural environment. A shedding operation does not include transporting pink or red-line peeler crabs to a permitted shedding operation.

(d) Depuration. Purification or the removal of adulteration from live oysters, clams, or mussels by any natural or artificially controlled means.

(e) Long Haul Operations. Fishing a seine towed between two vessels.

(f) Peeler Crab. A blue crab that has a soft shell developing under a hard shell and having a white, pink, or red-line or rim on the outer edge of the back fin or flipper.

(g) Possess. Any actual or constructive holding whether under claim of ownership or not.

(h) Recreational Purpose. A fishing activity that is not a commercial fishing operation as defined in G.S. 113-168.

(i) Shellfish marketing from leases and franchises. The harvest of oysters, clams, scallops, or mussels from privately held shellfish bottoms and lawful sale of those shellfish to the public at large or to a licensed shellfish dealer.

(j) Shellfish planting effort on leases and franchises. The process of obtaining authorized cultch materials, seed shellfish, and polluted shellfish stocks and the placement of those materials on privately held shellfish bottoms for increased shellfish production.

(k) Shellfish production on leases and franchises:

i. The culture of oysters, clams, scallops, or mussels on shellfish leases and franchises from a sublegal harvest size to a marketable size.
ii. The transplanting (relay) of oysters, clams, scallops, or mussels from areas closed due to pollution to shellfish leases and franchises in open waters and the natural cleansing of those shellfish.

(l) Swipe Net Operations. Fishing a seine towed by one vessel.

(m) Transport. Ship, carry, or cause to be carried or moved by public or private carrier by land, sea, or air.

(n) Use. Employ, set, operate, or permit to be operated or employed.

(3) Gear:

(a) Bunt Net. The last encircling net of a long haul or swipe net operation constructed of small mesh webbing. The bunt net is used to form a pen or pound from which the catch is dipped or bailed.

(b) Channel Net. A net used to take shrimp that is anchored or attached to the bottom at both ends or with one end anchored or attached to the bottom and the other end attached to a vessel.

(c) Commercial Fishing Equipment or Gear. All fishing equipment used in Coastal Fishing Waters except:

i. Cast nets;
ii. Collapsible crab traps, a trap used for taking crabs with the largest open dimension no larger than 18 inches and that by design is collapsed at all times when in the water, except when it is being retrieved from or lowered to the bottom;
iii. Dip nets or scoops having a handle not more than eight feet in length and a hoop or frame to which the net is attached not exceeding 60 inches along the perimeter;
iv. Gigs or other pointed implements that are propelled by hand, whether or not the implement remains in the hand;
v. Hand operated rakes no more than 12 inches wide and weighing no more than six pounds and hand operated tongs;
vi. Hook-and-line and bait-and-line equipment other than multiple-hook or multiple-bait trotline;
vii. Landing nets used to assist in taking fish when the initial and primary method of taking is by the use of hook and line;
viii. Minnow traps when no more than two are in use;
ix. Seines less than 30 feet in length;
x. Spears, Hawaiian slings, or similar devices that propel pointed implements by mechanical means, including elastic tubing or bands, pressurized gas, or similar means.

(d) Corkline. The support structure a net is attached to that is nearest to the water surface when in use. Corkline length is measured from the outer most mesh knot at one end of the corkline following along the line to the outer most mesh knot at the opposite end of the corkline.

(e) Dredge. A device towed by engine power consisting of a frame, tooth bar or smooth bar, and catchbag used in the harvest of oysters, clams, crabs, scallops, or conchs.

(f) Fixed or stationary net. A net anchored or staked to the bottom, or some structure attached to the bottom, at both ends of the net.

(g) Fyke Net. An entrapment net supported by a series of internal or external hoops or frames, with one or more lead or leaders that guide fish to the net mouth. The net has one or more internal funnel-shaped openings with tapered ends directed inward from the mouth, through which fish enter the enclosure. The portion of the net designed to hold or trap fish is completely enclosed in mesh or webbing, except for the openings for fish passage into or out of the net (funnel area).

(h) Gill Net. A net set vertically in the water to capture fish by entanglement of the gills in its mesh as a result of net design, construction, mesh length, webbing diameter, or method in which it is used.

(i) Headrope. The support structure for the mesh or webbing of a trawl that is nearest to the water surface when in use. Headrope length is measured from the outer most mesh knot at one end of the headrope following along the line to the outer most mesh knot at the opposite end of the headrope.

(j) Hoop Net. An entrapment net supported by a series of internal or external hoops or frames. The net has one or more internal funnel-shaped openings with tapered ends directed inward from the mouth, through which fish enter the enclosure. The portion of the net designed to hold or trap the fish is completely enclosed in mesh or webbing, except for the openings for fish passage into or out of the net (funnel area).

(k) Lead. A mesh or webbing structure consisting of nylon, monofilament, plastic, wire, or similar material set vertically in the water and held in place by stakes or anchors to guide fish into an enclosure. Lead length is measured from the outer most end of the lead along the top or bottom line, whichever is longer, to the opposite end of the lead.

(l) Mechanical methods for clamming. Dredges, hydraulic clam dredges, stick rakes, and other rakes when towed by engine power, patent tongs, kicking with propellers or deflector plates with or without trawls, and any other method that utilizes mechanical means to harvest clams.

(m) Mechanical methods for oystering. Dredges, patent tongs, stick rakes, and other rakes when towed by engine power, and any other method that utilizes mechanical means to harvest oysters.

(n) Mesh Length. The distance from the inside of one knot to the outside of the opposite knot, when the net is stretched hand-tight in a manner that closes the mesh opening.

(o) Pound Net Set. A fish trap consisting of a holding pen, one or more enclosures, lead or leaders, and stakes or anchors used to support the trap. The holding pen, enclosures, and lead(s) are not conical, nor are they supported by hoops or frames.

(p) Purse Gill Nets. Any gill net used to encircle fish when the net is closed by the use of a purse line through rings located along the top or bottom line or elsewhere on such net.

(q) Seine. A net set vertically in the water and pulled by hand or power to capture fish by encirclement and confining fish within itself or against another net, the shore or bank as a result of net design, construction, mesh length, webbing diameter, or method in which it is used.

(4) Fish habitat areas. The estuarine and marine areas that support juvenile and adult populations of fish species, as well as forage species utilized in the food chain. Fish habitats as used in this definition, are vital for portions of the entire life cycle, including the early growth and development of fish species. Fish habitats in all Coastal Fishing Waters, as determined through marine and estuarine survey sampling, include:

(a) Anadromous fish nursery areas. Those areas in the riverine and estuarine systems utilized by post-larval and later juvenile anadromous fish.

(b) Anadromous fish spawning areas. Those areas where evidence of spawning of anadromous fish has been documented in Division sampling records through direct observation of spawning, capture of running ripe females, or capture of eggs or early larvae.

(c) Coral:

i. Fire corals and hydrocorals (Class Hydrozoa);
ii. Stony corals and black corals (Class Anthozoa, Subclass Scleractinia); or
iii. Octocorals; Gorgonian corals (Class Anthozoa, Subclass Octocorallia), which include sea fans (Gorgonia sp.), sea whips (Leptogorgia sp. and Lophogorgia sp.), and sea pansies (Renilla sp.).

(d) Intertidal Oyster Bed. A formation, regardless of size or shape, formed of shell and live oysters of varying density.

(e) Live rock. Living marine organisms or an assemblage thereof attached to a hard substrate, excluding mollusk shells, but including dead coral or rock. Living marine organisms associated with hard bottoms, banks, reefs, and live rock include:

i. Coralline algae (Division Rhodophyta);
ii. Acetabularia sp., mermaid's fan and cups (Udotea sp.), watercress (Halimeda sp.), green feather, green grape algae (Caulerpa sp.) (Division Chlorophyta);
iii. Sargassum sp., Dictyopteris sp., Zonaria sp. (Division Phaeophyta);
iv. Sponges (Phylum Porifera);
v. Hard and soft corals, sea anemones (Phylum Cnidaria), including fire corals (Class Hydrozoa), and Gorgonians, whip corals, sea pansies, anemones, Solengastrea (Class Anthozoa);
vi. Bryozoans (Phylum Bryozoa);
vii. Tube worms (Phylum Annelida), fan worms (Sabellidae), feather duster and Christmas treeworms (Serpulidae), and sand castle worms (Sabellaridae);
viii. Mussel banks (Phylum Mollusca: Gastropoda); and
ix. Acorn barnacles (Arthropoda: Crustacea: Semibalanus sp.).

(f) Nursery areas. Areas that for reasons such as food, cover, bottom type, salinity, temperature, and other factors, young finfish and crustaceans spend the major portion of their initial growing season. Primary nursery areas are those areas in the estuarine system where initial post-larval development takes place. These are areas where populations are uniformly early juveniles. Secondary nursery areas are those areas in the ocean and estuarine system where later juvenile development takes place. Populations are composed of developing sub-adults of similar size that have migrated from an upstream primary nursery area to the secondary nursery area located in the middle portion of the estuarine system.

(g) Shellfish producing habitats. Historic or existing areas that shellfish, such as clams, oysters, scallops, mussels, and whelks use to reproduce and survive because of such favorable conditions as bottom type, salinity, currents, cover, and cultch. Included are those shellfish producing areas closed to shellfish harvest due to pollution.

(h) Strategic Habitat Areas. Locations of individual fish habitats or systems of habitats that provide exceptional habitat functions or that are particularly at risk due to imminent threats, vulnerability, or rarity.

(i) Submerged aquatic vegetation (SAV) habitat. Submerged lands that:

i. are vegetated with one or more species of submerged aquatic vegetation including bushy pondweed or southern naiad (Najas guadalupensis), coontail (Ceratophyllum demersum), eelgrass (Zostera marina), horned pondweed (Zannichellia palustris), naiads (Najas spp.), redhead grass (Potamogeton perfoliatus), sago pondweed (Stuckenia pectinata, formerly Potamogeton pectinatus), shoalgrass (Halodule wrightii), slender pondweed (Potamogeton pusillus), water stargrass (Heteranthera dubia), water starwort (Callitriche heterophylla), waterweeds (Elodea spp.), widgeongrass (Ruppia maritima), and wild celery (Vallisneria americana). These areas may be identified by the presence of above-ground leaves, below-ground rhizomes, or reproductive structures associated with one or more SAV species and include the sediment within these areas; or
ii. have been vegetated by one or more of the species identified in Sub-item (4)(i)(i) of this Rule within the past 10 annual growing seasons and that meet the average physical requirements of water depth (six feet or less), average light availability (secchi depth of one foot or more), and limited wave exposure that characterize the environment suitable for growth of SAV. The past presence of SAV may be demonstrated by aerial photography, SAV survey, map, or other documentation. An extension of the past 10 annual growing seasons criteria may be considered when average environmental conditions are altered by drought, rainfall, or storm force winds.

This habitat occurs in both subtidal and intertidal zones and may occur in isolated patches or cover extensive areas. In defining SAV habitat, the

Marine Fisheries Commission recognizes the Aquatic Weed Control Act of 1991 (G.S. 113A-220 et. seq.) and does not intend the submerged aquatic vegetation definition, or this Rule or Rules 3K .0304 and .0404, to apply to or conflict with the non-development control activities authorized by that Act.

(5) Licenses, permits, leases and franchises, and record keeping:

(a) Assignment. Temporary transferal to another person of privileges under a license for which assignment is permitted. The person assigning the license delegates the privileges permitted under the license to be exercised by the assignee, but retains the power to revoke the assignment at any time, and is still the responsible party for the license.

(b) Designee. Any person who is under the direct control of the permittee or who is employed by or under contract to the permittee for the purposes authorized by the permit.

(c) For Hire Vessel. As defined by G.S. 113-174, when the vessel is fishing in state waters or when the vessel originates from or returns to a North Carolina port.

(d) Holder. A person who has been lawfully issued in his or her name a license, permit, franchise, lease, or assignment.

(e) Land:

i. For commercial fishing operations, when fish reach the shore or a structure connected to the shore.
ii. For purposes of trip tickets, when fish reach a licensed seafood dealer, or where the fisherman is the dealer, when fish reach the shore or a structure connected to the shore.
iii. For recreational fishing operations, when fish are retained in possession by the fisherman.

(f) Licensee. Any person holding a valid license from the Department to take or deal in marine fisheries resources.

(g) Logbook. Paper forms provided by the Division and electronic data files generated from software provided by the Division for the reporting of fisheries statistics by persons engaged in commercial or recreational fishing or for-hire operators.

(h) Master. Captain of a vessel or one who commands and has control, authority, or power over a vessel.

(i) New fish dealer. Any fish dealer making application for a fish dealer license who did not possess a valid dealer license for the previous license year in that name. For purposes of license issuance, adding new categories to an existing fish dealers license does not constitute a new dealer.

(j) Office of the Division. Physical locations of the Division conducting license and permit transactions in Wilmington, Washington, Morehead City, Roanoke Island, and Elizabeth City, North Carolina. Other businesses or entities designated by the Secretary to issue Recreational Commercial Gear Licenses or Coastal Recreational Fishing Licenses are not considered Offices of the Division.

(k) Responsible party. Person who coordinates, supervises, or otherwise directs operations of a business entity, such as a corporate officer or executive level supervisor of business operations, and the person responsible for use of the issued license in compliance with applicable statutes and rules.

(l) Tournament Organizer. The person who coordinates, supervises, or otherwise directs a recreational fishing tournament and is the holder of the Recreational Fishing Tournament License.

(m) Transaction. Act of doing business such that fish are sold, offered for sale, exchanged, bartered, distributed, or landed.

(n) Transfer. Permanent transferal to another person of privileges under a license for which transfer is permitted. The person transferring the license retains no rights or interest under the license transferred.

(o) Trip Ticket. Paper forms provided by the Division and electronic data files generated from software provided by the Division for the reporting of fisheries statistics by licensed fish dealers.

15A N.C. Administrative Code 3M .0522: Spot (new section)

It is unlawful to possess spot less than 8 inches in total length.

15A N.C. Administrative Code 3M .0523: Atlantic croaker (new section)

It is unlawful to possess Atlantic croaker less than 10 inches in total length.

EXHIBIT B

A TECHNICAL REVIEW OF A PROPOSAL SUBMITTED BY THE NORTH CAROLINA WILDLIFE FEDERATION TO REDUCE MORTALITY OF JUVENILE FISHES IN NORTH CAROLINA

Prepared by Jack Travelstead and Dr. Louis Daniel

Submitted to the North Carolina Marine Fisheries Commission

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I. INTRODUCTION

The level of bycatch and discard mortality of juvenile marine fishes in shrimp trawls in the coastal and estuarine waters of North Carolina is extraordinary. Though other fisheries contribute to juvenile bycatch, shrimp trawls are the largest source of bycatch mortality, and proper management would have a significant and measureable impact in restoring overfished and declining stocks.

North Carolina is the only state on the east coast of the United States that still allows shrimp trawls to operate in estuarine nursery areas, and its trawling regulations are the most lax nationwide. Despite efforts to reduce the documented bycatch that occurs in this fishery through the use of bycatch reduction devices ("BRDs"), closed seasons, and restricted areas, hundreds of millions of juvenile fish continue to die each year from shrimp trawls, which contributes to declining stocks. The critical importance of all these species to the recreational and commercial fisheries of North Carolina, as well as their ecosystems function as forage and energy transfer, cannot be overstated.

Viable fish populations depend on the recruitment of juvenile fish into the adult population so that they can spawn and replace themselves before being harvested or dying. This is the essential tenet behind the "sustainable harvest" objective of North Carolina's Fisheries Reform Act of 1997. Juvenile fishes first enter the estuary at the larval or early juvenile stage and move into shallow protected habitats inside North Carolina's expansive estuarine system. In defined Primary and Secondary Nursery Areas, these fishes are partially protected from recognized, destructive fishing practices such as shrimp trawling. Natural mortality during these early life stages is extremely high. Fishes that survive the high natural mortality rates during these stages move out of the confines of North Carolina's limited nursery area system and into the open rivers and sounds where fish receive far less regulatory protection. Though natural mortality declines during this time, mortality in the form of discard mortality from shrimp trawls progressively increases, thus depressing recruitment of juvenile fish into the adult population.

Many of the adult populations of fish stocks subjected to shrimp trawl bycatch have declined significantly, which means that increased juvenile recruitment to rebuild those populations is more important today than ever. Specifically, spot, Atlantic croaker, and weakfish were critical components of North Carolina's estuarine commercial and recreational fisheries prior to their dramatic declines in the late 1980s. In 1981, the commercial landings of these three species were 37.6 million pounds. In 2015 that number dropped to 2.3 million pounds, a 95 percent decline. The recreational fishery shows a similar trend: in 1981 recreational landings were 5.3 million pounds compared to 1.6 million pounds in 2015, a 70 percent decline. This precipitous decrease comes despite increases in angler effort in terms of numbers of fishermen. Primarily, the high juvenile mortality from bycatch, along with overfishing of adult stocks in directed fisheries, confound efforts to rebuild these populations. Declining spawning stock biomass and continued high discards must be addressed immediately to restore the viability of these important fisheries to North Carolina and the east coast.

The purpose of this paper is to provide a review of the management history, concerns, and impacts of the shrimp trawl fishery on important stocks. In addition, this paper proposes solutions to existing issues that should be considered and addressed to restore severely depleted fish stocks in the estuarine waters of North Carolina.

II. BACKGROUND

The Atlantic Coastal Fisheries Cooperative Management Act (1993) and the North Carolina Fisheries Reform Act (1997) were passed 20 years ago. The intent of these legislative mandates was to restore overfished fish stocks and provide ongoing protections to facilitate responsible and sustainable fishing. The general concept is simple: coordinated management of fish stocks would yield healthy fishery resources that benefitted all users as well as the ecosystem. A review of the stock status of many of the fisheries managed under these laws indicates these goals have not been achieved. Today, many stocks remain in an overfished or overfishing status or fall into a category of concern as population measurements either languish at low levels or are in decline.

Government agencies and stakeholders involved in the early development and passage of this legislation expected more tangible results than what has been achieved. Whether the issue is uncertainty in stock assessments, continued overharvest, failure to adequately characterize and address substantive bycatch issues, or the inter- and intra-state concerns over allocation, many south and mid-Atlantic fish stocks are no better off, and are likely in worse condition, than they were 20 years ago. Most nearshore, state waters fisheries of importance to North Carolina and the mid- and south Atlantic states have declined to either concern, depleted, or unknown status. The common thread for these fish stocks is that virtually all are subjected to intense juvenile mortality and many lack any protective size limits.

Alverson et al. (1996) indicate that the global impacts of trawl bycatch are enormous. Shrimp trawls generate more bycatch than any other gear leading to declining fish stocks on a global scale. It is undisputed that discarded finfish species rarely survive their encounter with a shrimp trawl. Moreover, the research consistently indicates that discards from fisheries that impact large quantities of juvenile fish can generate significant population effects. The combined effects of overfishing, discard mortality on natural species assemblages, altered predator/prey dynamics, and modified structure and function of benthic communities contribute to population declines. Even 20 years ago, it was believed that Atlantic croaker in the Gulf of Mexico declined by more than 40 percent as a result of shrimp trawl bycatch. Estimated bycatch during the 1980s was 7.9 billion fish per year. In addition, the Gulf of Mexico Fishery Management Council recognized that shrimp trawl bycatch was the primary source of mortality for red snapper in 1990 (Alverson et al. 1996). Despite the implementation of BRDs since the 1990s, the evidence presented in Alverson et al. (1996) indicates that many of the ecological impacts of shrimp trawl bycatch and other bycatch fisheries have yet to be studied but likely have negative consequences on stock dynamics. Researchers suggest that “[t]he single action that will provide the greatest improvement to the bycatch and discard problem will be the reduction in these efforts levels. Without such control, other solutions to the bycatch and discard problem will be less effective and real success in our efforts to better manage the ocean’s resources much more difficult” (Alverson et al. 1996). Bycatch and discard mortality continue to negatively impact fish stocks along the east coast, especially in North Carolina waters.

North Carolina is unique along the east coast in that it allows significant fishing effort in its estuaries, which results in excessive fish mortalities, especially among juvenile fish. In fact, North Carolina is the *only* state on the east coast that permits trawling in inshore waters. Despite efforts to mitigate those impacts by fisheries managers, North Carolina shrimp trawling is the leading contributor to bycatch mortality (Brown 2015, ASMFC Fishery Management Plans for spot, Atlantic croaker, weakfish). However, it is worth noting that other fisheries also contribute to high levels of bycatch. For example, hook and line, large and small mesh gill nets, long haul seines, and unlimited crab pot efforts contribute to bycatch mortality. Though some of these fish are sold, many others are discarded. Many of these fisheries are either prohibited or significantly limited in other states.

Many of the stocks deemed overfished, overfishing, or of concern in the North Carolina Stock Status Report are impacted by shrimp trawl bycatch, including spot, Atlantic croaker, weakfish, summer flounder, and southern flounder. The hundreds of millions of juvenile fishes discarded from fishing activities prior to reaching adulthood and having the opportunity to contribute to the spawning stock biomass are a significant threat to the health and productivity of these important fish populations.

III. METHODS

We relied heavily on published reports, stock assessments, journal articles, and data sets from the North Carolina Division of Marine Fisheries ("NC DMF") and the Atlantic States Marine Fisheries Commission ("ASMFC") to conduct this review. The ASMFC is a compact of the east coast states that manage fisheries that migrate up and down the coast. The ASMFC's mission is to ensure healthy, self-sustaining fisheries. All data sources are readily available to the public and most, if not all, have undergone peer-review or ASMFC approval. In several cases, we used our experience and expertise in managing east coast fisheries to make suggestions or point out issues that are unavailable in the literature we reviewed.

IV. DATA REVIEW

What follows is an examination of the status of the three finfish species—Atlantic croaker, spot, and weakfish—that are most impacted by shrimp trawl bycatch in North Carolina.

A. Atlantic croaker

The life history of most members of the drum family (*Sciaenidae*), including Atlantic croaker, is characterized by cyclical abundance: it is natural for these fish populations to fluctuate over time. However, periods of low abundance have lasted longer than normal in recent years. While landings may be naturally cyclical as a result of environmental conditions and population abundance, fishing effort also plays a role. At periods of high abundance, effort increases and Atlantic croaker are harvested in large amounts with no constraints. Catches can exceed 100,000 pounds in a single trip. The most recent landings peak in 2001 (43 million pounds) has been followed by a persistent decline through 2014 (10 million pounds). The ASMFC (2015) recently raised concern over declining trends in fishery-independent indices and commercial and recreational landings of Atlantic croaker.

a. Stock Status of Atlantic croaker

North Carolina and Virginia account for approximately 90 percent of the commercial landings of Atlantic croaker along the east coast (ASMFC 2015). Trawling is prohibited in Virginia state waters, while neither state has any size or possession limits. From the mid-1960s until the early 1990s, North Carolina dominated landings with a single year high of 21.1 million pounds in 1980. By 2015, however, that number had fallen to 1.8 million pounds. Today, Virginia ranks number one in Atlantic croaker commercial landings while landings in the south Atlantic, including North Carolina, South Carolina, Georgia, and Florida, have significantly declined.

The recreational fishery for Atlantic croaker in North Carolina and the south Atlantic has also declined. In 1990, North Carolina accounted for 22 percent of the recreational Atlantic croaker harvest, while all the south Atlantic states accounted for 48 percent of recreational landings. By the last year of the benchmark stock assessment, North Carolina recreational harvest had fallen to 4 percent, and the recreational harvest in the south Atlantic to just 12 percent of the coast wide harvest (ASMFC 2010a).

Ideally, one would see a distribution of all sizes and ages in a healthy fishery. However, the 2010 ASMFC stock assessment's (ASMFC 2010a) summary of information on reproductive ecology based on fish collected in North Carolina and Virginia shows that state fisheries are increasingly relying on juvenile fishes. The midpoint of the published estimates of L100%[1] for Atlantic croaker is approximately 270 mm TL. In 2004, Atlantic croaker taken below L100% in the North Carolina recreational fishery comprised 68 percent of the harvest. In 2015, 90 percent of the Atlantic croaker harvest had yet to reach L100%. This increasing reliance on juvenile fish in the catch is indicative of a stock in decline.

To address concerns with declining landings, the ASMFC developed and approved Addendum II to the Atlantic croaker Fishery Management Plan ("FMP") in 2014. Addendum II takes a precautionary approach in managing the Atlantic croaker in light of the current and persistent decline in the stock. The addendum tracks trends in abundance, life history characteristics, and responses to fishing pressure. Based on the 2015 stock status review (ASMFC 2015b) all characteristics are trending down with some above the threshold for management action. While further action may be forthcoming from the ASMFC, it will likely not address the biggest source of mortality in the fishery—shrimp trawl—because those concerns rest primarily within the jurisdiction of North Carolina.

b. Impact of bycatch on Atlantic croaker stock

The estimated bycatch of Atlantic croaker in the south Atlantic peaked in 1995 at approximately 46.3 million pounds. Since 1950, estimates of Atlantic coast bycatch in all fisheries has exceeded harvest (ASMFC 2010a). Atlantic croaker are extremely resilient and can be very productive when environmental conditions are favorable, hence the boom and bust fisheries we have observed. By reducing the level of discards, especially for those fish that have yet to contribute to the population through at least one spawning event, the busts become more

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[1] L100% is the length at which 100 percent of the sampled fish were mature as evidenced by developing, developed, or spent gonads.

infrequent and the fishery becomes more stable. More spawning fish impact not only the ecological value of Atlantic croaker but generally produce higher average recruitment. Higher recruitment means more yield for the benefit of the fishery and the ecosystem.

Atlantic croaker are the dominant bycatch species by number and weight in the North Carolina shrimp trawl fishery. In fact, Brown et al. (2015) found that Atlantic croaker dominated the shrimp trawl catches during virtually every season from 2012 to 2015 in their estuarine and coastal ocean bycatch characterization study, regularly exceeding the harvest of shrimp. During the four-year study period (August 2012 toAugust 2015), observers covered 1.2 percent of all commercial estuarine and ocean (0-3 miles) trips (n = 388, including 227 estuarine and 161 ocean trips). The total number of commercial trips reported to the North Carolina trip ticket program during the study period was 32,388. The total weight of all Atlantic croaker taken from observed trips during the study period was 322,883 pounds, which amounts to approximately 5.1 million fish. All of these fish were discarded as unmarketable and ranged in size from 70 to 200 mm TL, and were primarily juvenile fish (Brown 2015).

Brown et al. (2015) estimated that the average at-net mortality of Atlantic croaker was 23.4 percent. These estimates, including those for spot and weakfish, should be viewed with caution as extremely low. By contrast, the 2010 benchmark stock assessment for Atlantic croaker by the ASMFC uses a discard mortality rate of 100 percent for fish discarded from both gill nets and trawls (ASMFC 2010a). Brown (2015) characterized fish on deck as alive or dead immediately upon dumping the nets. However, as Brown (2015) correctly points out, “delayed mortality associated with discarded bycatch in the commercial shrimp otter trawl fishery will likely be much higher than at-net mortality due to factors including sorting time of catch, physical injury associated with capture, and indirect predation from birds, sharks, and dolphins.” Culling time, delayed mortality from injuries, and increased predation once discarded likely result in these estimates being unreasonably optimistic.

The magnitude of unmarketable Atlantic croaker discards in the North Carolina estuarine and ocean shrimp trawl fishery greatly exceeds the directed harvest. Assuming that observer data are representative of the fishery, summary tables in Brown (2015) indicate that 322,883 pounds of Atlantic croaker representing approximately 5,141,487 individuals were observed in the shrimp trawl during the study period. Expanding the observed trips to approximate total fishery-wide bycatch based on average catch per trip (322,883 pounds per 388 trips = 832 pounds per trip) and total trips reported during the four-year study period (n = 32,388), indicates that nearly 27 million pounds of Atlantic croaker were taken in the shrimp trawl fishery during the study period. The average weight of Atlantic croaker varied by year and season (0.05-0.11 lbs.) and averaged .076 lbs. (Brown 2015). Larger juveniles were taken in the ocean fishery. Employing a range of estimates (10-20 fish/pound) provides a total estimated bycatch of Atlantic croaker during the study period from 270 to 540 million fish. Using discard mortality rates ranging from 23.4 percent (Brown 2015) to the more defensible 100 percent estimated for trawls in the benchmark stock assessment (ASMFC 2010a), Atlantic croaker mortality in the North Carolina shrimp trawl fishery during the study period ranges from 63 to 540 million dead fish.

B. Spot

Spot have been a very popular and culturally important fish along the east coast for decades. The North Carolina Spot Festival occurs in Hampstead, North Carolina each September to celebrate the arrival and significance of this little fish. Many of the coastal ocean fishing piers were constructed, in part, so that anglers could intercept their fall runs. Like Atlantic croaker and weakfish, spot appeal to a huge demographic in the fishery because they are easy to catch and inexpensive to pursue when they are abundant.

a. Stock Status of Spot

A coast-wide stock assessment is underway for spot and results are expected in late 2016. Current data indicate concerns related to declines in the juvenile abundance index for spot from 1990 until the mid-2000s, with improvements noted in 2011 and 2012. While the ASMFC technical committee report for spot indicates that triggers were not tripped for management action in 2014, analysis shows concerning declining trends in abundance indices and harvest (ASMFC 2015).

The most recent status review for spot continues to show that spot harvest varies in terms of quantity landed and fishing sector. In some years, the recreational harvest dominates and, in other years, the commercial fishery catches the larger amount. North Carolina currently accounts for just 14 percent of the current commercial landings of spot on the east coast, down from 50 percent in the 1980s. North Carolina landings have steadily declined from 3.0 million pounds in 2001 to 0.76 million pounds in 2014. As with Atlantic croaker, North Carolina dominated commercial landings up until the early 1990s when Virginia took over the top spot (ASMFC 2015a).

Recreational landings data show a similar, but less pronounced, declining trend since data was first recorded in 1981. The recreational contribution of North Carolina to coast-wide spot landings in 1985 was 52 percent (3.1 million pounds), compared to 24 percent (704,445 pounds) in 2014. Coast-wide recreational landings have declined by 50 percent since 1985, however, the decline in the south Atlantic is the most pronounced. In 1985, the south Atlantic states accounted for 64 percent of the coast-wide recreational catch, compared to 34 percent in 2014 (ASMFC 2015a).

Spot mature at sizes between 184 and 292 mm TL for both sexes. Males mature at slightly smaller sizes, and full maturity (the L100%) for both sexes is 220 mm TL or greater (ASMFC 2010b). Length-frequency information on the commercial gill net fishery for spot in North Carolina indicates an average size of 213 mm TL, with 65 percent of the harvest less than the L100%. Because there is no size limit in North Carolina, unmarketable spot and Atlantic croaker can be included as bait and are typically sold to participants in both the crab pot and recreational fisheries. Sizes of spot taken in the recreational fishery range from 120 to 410 mm TL. In 2005, 2 percent of the spot harvested were greater than 300 mm TL, compared to 0.04 percent in 2015. Recreational landings statistics from 2015 in North Carolina indicate that 69 percent of the spot harvested were less than its L100% value (NC DMF Marine Recreational Information Program

("MRIP") data request), compared to 58 percent in 2005. It should be noted that in a healthy population, a significant percentage of the population should be larger than the L100%. The fact that so few mature fish have occurred in the population for over a decade raises concern about maintaining a healthy, spawning stock biomass.

b. Impact of bycatch on spot stock

While juvenile spot are known to be a bycatch component of many fisheries, "the largest bycatch component for spot comes from the south Atlantic shrimp trawl fishery" (ASMFC 2015). Spot are second only to Atlantic croaker in abundance among bycatch species in the North Carolina shrimp trawl observer program (Brown 2015). During the study period, researchers observed 110,113 pounds of spot as unmarketable discards in the observed trips (284 lbs./trip). Sizes generally ranged from 70 to 200 mm TL, and mean weight for all years and seasons was 0.065 pounds (ranging from 10 to 25 fish per pound). Researchers observed a total of 2 million spot. The at-net mortality of spot was much higher than for Atlantic croaker at 66 percent, without factoring in delayed mortality as described above for Atlantic croaker. Using the same method as above for Atlantic croaker, the number of spot observed in the North Carolina shrimp trawl fishery (32,388 trips) during the four-year study period ranged from 92 to 230 million fish.

C. <u>Weakfish</u>

The management history of weakfish is complex. The states took significant actions to reduce the directed and by-catch mortality of weakfish in the mid-1990s with Amendment 3 to the Interstate FMP for Weakfish (ASMFC 1996). Many felt certain that increased size limits, reduced bag limits, bycatch reduction in the south Atlantic shrimp trawl fishery, and the closure south of Cape Hatteras to flynets would result in recovery. While monitoring of the fishery showed positive early signs, the stock had lost all gains by the mid-2000s and was again declared depleted. Years of technical analysis indicated something had changed in terms of natural mortality as fishing mortality was estimated to be very low. Addendum IV to the Weakfish FMP closed the fishery to all but a minimal bycatch allowance, which is where it has remained since (ASMFC 2009).

a. Stock status of Weakfish

North Carolina and Virginia have historically dominated the commercial fishery for weakfish. Throughout the 1980s and 1990s, North Carolina accounted for 60 to 70 percent of the coast wide commercial harvest. The percentage declined to 19 percent in 2007. Since 2010, commercial fisheries have been limited to a 100 pound bycatch allowance likely resulting in an increase in discards in many fisheries that go unreported (ASMFC 1996, 2009).

The commercial fishery in North Carolina operates under a 12 inch TL minimum size limit, except the estuarine long haul seine and pound net fisheries, which are held to a 10 inch TL size limit. The recreational fishery operates under a 12 inch TL limit and a one fish bag limit. These size limits, unique among the three fishes reviewed, prevent directed harvest of juvenile fish, however, undersized and regulatory discards still consist of juvenile fish (ASMFC 1996; 2009).

Age frequency distribution of weakfish in the North Carolina recreational fishery is truncated. The current size distribution taken in the North Carolina recreational fishery range from 310 to 480 mm TL. Weakfish can live well into their teens, however, current catch levels reveal less than 5 percent of the catch is greater than 430 mm TL (age IV) (NC DMF MRIP data request). Analysis of the coast wide recreational fishery likewise shows a truncation in the age structure with 0.01 percent of weakfish harvested recreationally at age V+ compared to 46 percent in 1998 (ASMFC 2016). Similar to Atlantic croaker and spot, the weakfish harvest is increasingly reliant on smaller fish, many of which are juveniles or the least fecund.

Though weakfish grow rapidly and often mature and spawn at age I, their fecundity greatly increases with age. The 2016 peer review report on weakfish (ASMFC 2016) cited Nye et al. (2008) and noted that "despite maturing early, first spawn weakfish at age I spawned less frequently, arrived later to the estuarine spawning grounds, and had lower batch fecundity than older fish, likely resulting in an overly optimistic assumption about the contribution of age I fish to the overall reproductive success of the stock. This is currently amplified by the fact that larger, older fish comprise a small proportion of the overall population." Lowerre-Barbieri et al. (1996) found that 90 percent of weakfish were mature at age I and that the eggs to female ratio significantly increased with both total length and weight. Specifically, batch fecundity (the number of eggs per spawning event) estimates ranged from 75,289 to 517,845 eggs per female. Lowerre-Barbieri noted that the fecundity increased significantly with both total length and weight. Consequently, while weakfish are afforded more protection to spawn at least once in the directed fisheries, the reproductive capacity of these young fish is slight compared to the larger and older fish.

b. Impacts of bycatch on weakfish

There is significant bycatch of weakfish associated with the south Atlantic shrimp trawl fishery. Brown (2015) reported 29,688 pounds of weakfish in the North Carolina shrimp trawl characterization study (77 lbs. per trip) over four years. Additionally, the at-net mortality for weakfish was the highest of the three species examined in their analysis at 87 percent. Like Atlantic croaker, the less conservative ASMFC benchmark assessment employs a 100 percent mortality rate for trawls. The weakfish taken in the Brown (2015) study were all characterized as regulatory discards with sizes ranging from approximately 70 to 280 mm TL, with most falling between 110 and 180 mm TL size classes (age 0). Weakfish averaged 7 to14 fish per pound during the study period, yielding an estimated number of weakfish observed from 17 to 34 million fish over the four-year study period. Based on the most conservative estimates, weakfish mortality due to trawling during Brown's study period totaled over 15 million fish, most of them age 0 and juvenile. However, it is worth noting that, while less common, higher fecundity weakfish age I and age II are also subjected to shrimp trawl mortality (Brown 2015).

D. Importance of Nursery Areas to Juvenile Fish

The abundance and distribution of juvenile fishes reported by Brown (2015) are supported by the data collected during the time series of the NC DMF Pamlico Sound Survey that has occurred for decades (e.g., Knight 2015, Knight and Zapf 2015). Numerous Pamlico Sound Survey reports are available and consistently provide evidence that the majority of the species encountered in the Pamlico Sound are juvenile finfishes. The Brown (2015) study occurred over a four-year period in the primary shrimping grounds of the state (Figures 3 and 4), including the Pamlico Sound and waters south. Another characterization study was conducted from Carteret County to Brunswick County in North Carolina (Brown 2009), which found results similar to the more recent study (Brown 2015). In the 2009 study, Spanish mackerel and flounders were taken in higher numbers in the southern estuaries and catches were dominated by juvenile fishes, primarily Atlantic croaker and spot. Multiple surveys and characterization studies referenced in Brown (2015) and NCDMF (2006, 2015) have also occurred in these same general locations. NCDMF (2015) points out that blue crab, weakfish, Atlantic croaker, and spot have accounted for the majority of all shrimp trawl bycatch since studies began in the 1950s and that situation continues today. All available data reviewed provide solid evidence that all regions and locations surveyed using trawls are dominated by the presence of juvenile fishes.

The Pamlico Sound Survey occurs in June and September each year within Pamlico Sound and has the following objectives:

> (1) To determine and monitor the distribution, relative size abundance, and size composition of fish, shrimp, and crab in the survey area and how they vary temporally and spatially.
>
> (2) To provide data to ascertain fishery-independent estimates of mortality and population size to compare to commercial fishery samples and landings data.
>
> (3) *To determine which species utilize (and to what extent) the sound during their early life development and identify nursery areas for those species (i.e.* Cynoscion sp., Paralichthys sp*. etc.).*
>
> (4) To determine if catch rates of various species are correlated with indices of juvenile abundance derived from the juvenile trawl survey.
>
> (5) To determine if species distributions are correlated with each other or with some other measured parameter(s).
>
> (6) To monitor the movement of organisms out of the nursery area and into the open waters of Pamlico Sound where they are available for commercial and recreational exploitation.

(Knight and Zapf 2015). The survey is conducted within Pamlico Sound and extends up into the Neuse, Pamlico, and Pungo Rivers. Stations are sampled during each cruise period from an established survey grid (Figure 2). As an example, during a single nine day cruise in September 2014, 54 randomly selected stations were sampled with two 30-foot mongoose nets outfitted with small mesh (approximately 1 inch) for 20 minutes. The estimated area of the sound floor swept by each net was estimated at 97,500 square feet. Forty-seven species of finfish were observed, and the most abundant species observed are considered economically important and include: spot, Atlantic croaker, blue crab, weakfish, brown shrimp, summer flounder, southern flounder, bluefish, southern kingfish, white shrimp, and pink shrimp. Spot were present in all strata, and were the most abundant species collected. Atlantic croaker were also present in all strata, and were the second most abundant species collected. Weakfish were present in all but the Neuse River stratum, and were the sixth most abundant species collected and fourth most abundant amongst the economically important species. Length frequency data for the species listed above indicate that all specimens were juvenile fish taken within the Pamlico Sound during shrimp season (e.g., Casey and Zapf 2015).

The Pamlico Sound Survey data (e.g., Knight 2015, Knight and Zapf 2015), combined with the shrimp trawl characterization studies of Brown (2009, 2015), and numerous other studies and surveys provide substantial evidence that all estuarine and nearshore ocean waters of North Carolina function as important nursery habitat for hundreds of species of finfish and crustaceans. Many of these species (e.g., spot, Atlantic croaker, weakfish, flounders, blue crab) are valuable components of the commercial and recreational fisheries of North Carolina and are all in decline. The persistent loss of these fishes at juvenile life stages as discard mortality greatly affects fishing success and yield.

The studies of Brown (2009, 2010, 2015), Diamond-Tissue (1999), Johnson (2003, 2006), and Logothetis and McCuiston (2004) all corroborate our concerns that shrimp trawl bycatch in waters south of the Pamlico sound, in addition to the Pamlico Sound and nearshore coastal ocean, is comprised of primarily juvenile fishes. The bycatch levels found in these studies are extraordinary and exceed the directed harvest for many species impacted, particularly spot, Atlantic croaker, and weakfish. From the Intracoastal Waterway in Brunswick County to the upper reaches of the Pamlico Sound and various water bodies in between, the problem is systemic and must be addressed if the affected stocks are to show meaningful recovery.

While we understand the difficulties in quantitatively assessing the impacts of juvenile bycatch in shrimp trawls and other fisheries in stock assessments, the issue is a matter of scale. Diamond (2003) suggests that bycatch estimates are meaningless without an estimate of population abundance. However, when the bycatch of juvenile fishes approaches or exceeds the annual, directed removals, particularly for stocks in decline or depressed, the likelihood of negative impacts is great. Additionally, when a large percentage of the fishes harvested are also juvenile fishes, the problem is magnified. We believe it unwise to ignore this major component of fishing mortality any longer, based on simulated modeling exercises that fail to provide a direct link to the magnitude of this problem or require an unattainable population abundance estimate in order to act. If even a fraction of the 15 million pounds of spot, Atlantic croaker, and weakfish taken as shrimp trawl bycatch in 2014 had been afforded the protection to grow to maturity and spawn, it is hard to imagine a scenario in which the stocks would not respond favorably.

Nursery areas in North Carolina are currently defined (15A NCAC 03I.0101) as

> "areas that for reasons such as food, cover, bottom type, salinity, temperature, and other factors, young finfish and crustaceans spend the major portion of their initial growing season. Primary nursery areas are those areas where in the estuarine system where initial post-larval development takes place. These are areas where populations are uniformly early juveniles. Secondary nursery areas are those areas in the

> estuarine system where later juvenile development takes place. Populations are comprised of developing sub-adults of similar size that have migrated from an upstream primary nursery area to the secondary nursery area located in the middle portion of the estuarine system."

Based on our analysis, it is evident that all estuarine and nearshore ocean waters of North Carolina meet these criteria and function as secondary nursery areas. All of North Carolina's estuarine and nearshore waters provide the necessary physical conditions in terms of salinity and temperature required for development of several commercially and recreationally valuable species. Further, the soft organic sediments, along with shell bottom, oyster reefs, live bottom, and other structures present in inshore and nearshore areas provide essential habitat for feeding and cover. The currently designated secondary nursery area contain but a small fraction of those important habitats. Consequently, growth, development, and maturity of these sensitive life history stages are severely compromised by the lack of protection afforded to these nursery areas, limiting the ability of these fisheries to measurably improve. In addition, the failure to protect these juvenile fishes by significantly reducing the anthropomorphic sources of mortality compromises the ecosystems effects of these life stages by their premature loss and inability to either provide energy exchange to higher trophic levels or contribute to the spawning stock.

We believe that further protection of these vital nursery habitats from harm is critical. Moreover, additional protection of nursery areas is consistent with the recommendations of the North Carolina Coastal Habitat Protection Plan (NC DEQ 2015) and the ASMFC.[2] Specifically, the ASMFC designates all estuaries as Habitat Areas of Particular Concern for spot and Atlantic croaker and advises that any fishing gear determined by management agencies to have a negative impact on the habitat for these species should be prohibited. The ASMFC states that "in addition to losses of abundance as target and bycatch some fishing gears, particularly dredges and trawls, can impact sciaenid habitats. These gears remove epifauna, alter bathymetry, re-distribute substrates, and change organism assemblages. Habitat loss by fishing gears can take months to years to recover."

E. <u>Ecosystems impacts of shrimp trawl bycatch</u>

The value of the hundreds of millions of juvenile finfish and crustaceans to the ecosystem as forage is high. The Food and Agriculture Organization of the United Nations ("FAO") Technical Guidelines for Responsible Fisheries adopted an ecosystem approach to fisheries management and suggested that where there are threats of serious and irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent degradation (FAO 2003).

The ecosystems approach to fisheries management recognizes that fisheries should be managed to limit their impact on the ecosystem and that management strategies should be

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[2] *See* Atlantic Sciaenid Habitats: A review of utilization, threats, and recommendations for conservation, management, and research (2016). This document is available in the meeting materials contained on the ASMFC website for the Annual Meeting in 2016, but has not yet been published. Proceedings of the 2016 ASMFC Annual Meeting may be accessed at the following link: http://www.asmfc.org/home/2016-annual-meeting.

precautionary because our knowledge of the ecosystem is incomplete. The impacts of shrimp trawls on bottom habitat, particularly structural components such as live bottom and shell bottom habitats, is well established.

Numerous studies have been conducted that demonstrate that juvenile spot and Atlantic croaker are important components in the diet of many fishes of importance to commercial and recreational fisheries (Mercer, 1987). Specifically, juvenile spot and Atlantic croaker are important ecosystem components for energy transfer because their early diets consist mostly of benthic invertebrates that they convert into fish flesh for higher trophic level predators. In a study of juvenile red drum and spotted seatrout, Daniel (1988) found that spot was the second most important prey item to the diet of young-of-the-year red drum, second only to grass shrimp in the tidal creeks of coastal South Carolina. Spot were also documented as an important prey item to juvenile spotted seatrout. In a broader study, Wenner et al. (1990) found spot to be the most important component of the diet of southern flounder by frequency, volume and number, while spot also contributed to the diet of summer flounder. Fish and crustaceans dominate the diet of spotted seatrout. Grass shrimp were the dominant crustacean and spot were the dominant finfish species observed. The diet of red drum is more varied than the other species in this study. Various species of shrimp and crabs dominated the red drum diet. Fishes (Atlantic menhaden and spot) were second in importance to larger red drum. Additional diet studies, mostly lacking in North Carolina, would further show the importance of many shrimp trawl bycatch components to the diets of most estuarine and nearshore predators so important to east coast fisheries (*see* Mercer 1987 for review).

In summary, more conservative management of important forage based fishes (e.g., spot, Atlantic croaker, weakfish), to provide for maximum abundance rather than maximum yield, is necessary to allow them to achieve their important role in the trophic balance of the ecosystem, as well as provide the necessary surplus production to support valuable fisheries in North Carolina and elsewhere.

V. ANALYSIS

All states in the mid-Atlantic and south Atlantic regions have taken different approaches to fisheries management. North Carolina stands alone as the only state on the east coast that allows trawling in estuarine waters. The specific impacts of this fishery on several species are provided above. Virtually all east coast states have some type of juvenile survey in estuarine waters to document the abundance and diversity of fishes that occur there. These surveys provide solid evidence that estuarine waters are critical nursery habitat. Other states have acted on these data by protecting those important areas. For example, the Virginia Institute of Marine Science trawl survey has occurred since 1955. The species composition and relative abundance of fishes in Virginia waters are similar to those found in trawl research conducted in North Carolina. Atlantic croaker, weakfish, and spot were exceeded in abundance only by bay anchovy, hogchoker, and white perch during their survey periods. Trawling has been prohibited in the Chesapeake Bay for decades.

The bycatch associated with shrimp trawling confounds fisheries managers in North Carolina and impacts fisheries along much of the east coast that rely on spillover from the important nursery that is North Carolina's sounds. The persistent harvest and mortality of juvenile fishes in North Carolina upsets the natural migration of inter-jurisdictional fishes that move to feeding and spawning areas outside of North Carolina waters. In many instances, these fish would normally return to North Carolina as larger fish. North Carolina also receives recruits from sister states to its south and north, which have provided far greater protection for its juvenile fish resources in the past.

The data is clear that substantive rule changes to minimize mortality, particularly juvenile mortality, in the North Carolina shrimp trawl fishery are necessary in order to build on the management programs already in place at the interstate level. The amount of effort and the bycatch that continues in the commercial fisheries is extraordinary and especially concerning for stocks in decline or at low levels of abundance. Likewise, the discard mortality in the growing recreational fishery and lack of controls such as size and bag limits, particularly on the larger juveniles, is a concern. Though progress has been made— turtle excluder devices and BRDs are required in shrimp trawls, the long haul seine fishery has declined in participants, and gill nets have been much reduced in some areas as a result of Incidental Take Permits for Atlantic sturgeon and sea turtles—efforts to control substantive bycatch issues to date, particularly in the shrimp trawl fishery, are inadequate.

North Carolina's important, but rudimentary, nursery area program, illustrated in Figure 1, fails to consider and protect those areas in the estuarine and nearshore coastal waters where juveniles are abundant and need protection in order to develop into adults, and where habitat conditions are ideal for juvenile life stage development. Outside of the designated nursery areas of North Carolina, fish populations in Pamlico Sound and other estuarine areas are clearly comprised of larger juveniles that will soon put energy into reproductive growth for their first spawn (e.g., Casey and Zapf 2015). These largest juveniles have migrated out of the designated Primary and Secondary Nursery Areas located in the more upper and middle portion of the estuarine system to the middle and lower portions of the estuarine system and waters. Juveniles of species important to commercial and recreational fishermen dominate commercial and fishery-independent trawl catches. Fishes generally remain in these areas until they spawn or move to overwintering nursery areas offshore. The fact that extensive commercial and recreational fisheries are allowed in these critical areas compromises the ability of numerous fish stocks and forage species to rebuild.

It is counterproductive to protect the smallest juveniles that already face high natural mortality rates in the current nursery area and not continue that protection until these individuals actually contribute to the health of the population by spawning. The only difference between the limited areas currently defined as nursery habitat in North Carolina and the rest of North Carolina's estuarine and nearshore coastal ocean waters is the size of the juveniles encountered. Multiple sampling efforts in North Carolina, which include extensive trawl and gill net surveys, along with samples of recreational and commercial catches show a very large and variable preponderance of juvenile fishes throughout North Carolina waters. The survey grid for the Pamlico Sound Survey (Figure 2) is expansive and catches are almost exclusively juvenile fishes, in much the same area as the commercial shrimp trawl fishery operates (Figures 3 and 4). As juvenile fishes, "protected" in the current and geographically limited nursery areas grow in North

Carolina, their natural tendency is to move to the more open, higher salinity waters of larger sounds and bays. It is at this time that these fishes, fit enough to survive, are subjected to intense anthropomorphic sources of mortality in the form of shrimp trawls. In some circumstances, fishes with healthy abundance levels can withstand high levels of mortality and still produce a surplus. Such is not the case for most species of concern in North Carolina's estuaries. Consequently, all North Carolina inshore and nearshore waters are indeed nursery areas and should be afforded maximum protection. Doing so would allow the vulnerable species currently subjected to shrimp trawls the opportunity to spawn at least once.

Some might suggest that fishing mortality of juvenile fishes has a negligible impact on population viability and that those fishes would have likely died anyway. During various opportunities for public comment others suggest that bycatch provides a service to the ecosystem by providing needed food to the members of the system. However, diet studies of most predatory fishes indicate that these fishes are visually-oriented, opportunistic predators that focus on the weakest of the particular prey items for their meal, e.g., the survival of the fittest (*see* Mercer 1987 and Wenner et al. 1990 for review). With bycatch and discards the fittest are no more fit than the weakest, throwing the ecosystem off balance. Species that reportedly benefit from this "free lunch" do not appear to be benefiting as one might expect. For example, the North Carolina Marine Fisheries Commission recently revised their FMP schedule to update the blue crab FMP sooner than expected as a result of the fishery decline and concerns over the health of the stock. One might expect that if blue crab were a beneficiary of the significant bycatch in North Carolina fisheries, the stock would be viable. We are unaware of any positive link between bycatch in shrimp trawls and stock status.

Because absolute estimates of age-specific discard mortality are highly variable and difficult to quantify, some argue that the absence of this data in quantitative stock assessments lessens its importance or cautions against management actions. This conclusion is erroneous and dangerous, particularly when one reviews the stock status and landings history of many of the species that are particularly vulnerable to significant bycatch and discard mortality. Spot, Atlantic croaker, and weakfish all suffer from low trends in biomass and harvest (*see* ASMFC FMP citations above). During the shrimp trawl characterization study alone, during a time when all three of these key species were at low and declining abundance, the estimated number of discards from the shrimp trawl fishery was conservatively estimated at approaching ½ billion fish. This is despite the fact that shrimp trawl nets were outfitted with turtle excluder devices and BRDs (Brown 2015). The Atlantic croaker, spot, and weakfish stocks are highly productive and could provide tremendous access, opportunity, economic value, and ecosystem function if further protected.

This analysis focused on spot, Atlantic croaker, and weakfish, however, concern is not limited to those three species. The impacts on numerous other components of the ecosystem that succumb to pre-spawn mortality are likely in the same position, not to mention the disruption to the bottom structure and critical benthic communities resulting from fishing efforts. Other species of recreational and commercial importance taken in the North Carolina shrimp trawl fishery include kingfishes, pigfish, southern and summer flounder, and king and Spanish mackerel (Brown 2009, 2015).

The concept that first spawn fishes that may naturally spawn over a decade or more can somehow rebuild populations is outdated. The reproductive capacity of first spawn fishes is but a fraction of their true capacity (Lowerre-Barbieri et al. 1995, Nye et al. 2003). The fecundity, fitness, and survivability of the eggs of a virgin spawner simply cannot compare to the fecundity of their larger counterparts in the population. The more fecund, and presumably valuable, older fishes in the population are mostly absent from these populations today (see ASMFC annual reports on spot, Atlantic croaker, and weakfish for review, NC DMF MRIP data request 2016). Proper management should be implemented that allows for an expansion in the age structure of these populations, and thereby spawning stock biomass, by utilizing measures that allow these fishes to spawn at least once, and preferably twice, before any allowable harvest.

In summary, bycatch and discard mortality, along with the directed harvest, of juvenile and pre-spawn adult fishes in North Carolina is alarming. Current trawling practices lead to the discard of billions of juvenile fish each decade, decimating populations and seriously impacting local, fishery dependent economies and communities. Using only the data from 2014 in Brown (2015), when observer coverage was greatest and covered all seasons, the estimated discards of spot, Atlantic croaker, and weakfish from shrimp trawls was 15 million pounds of nearly all juvenile fish. For comparison, the commercial and recreational harvest of these three species in North Carolina in 2014 was 4.6 million pounds and greater than 50 percent were juvenile fishes. The coast wide commercial and recreational harvest of these three species, all designated as depleted or depressed, was 18.7 million pounds. The potential yield of these small fishes, if they were afforded the protection to grow to adulthood, is staggering: the benefits of protecting juvenile fish far outweigh the costs in terms of fishery yield and success for commercial and recreational fisheries alike. Furthermore, an expansion of the range of these fishes into other jurisdictions, which will come with further regulation of bycatch, is entirely consistent with the basic tenants of inter-jurisdictional fisheries management.

The commercial fishery in the estuarine waters of North Carolina has limited restrictions on extraordinary amounts of commercial gear. The health of both species that exclusively call North Carolina home and many inter-jurisdictional fisheries depends on the concerted conservation efforts of all.

VI. MANAGEMENT RECOMMENDATIONS

The need to substantially reduce discards in North Carolina fisheries cannot be overstated. While measures to date have helped, they have fallen short of meaningful changes in bycatch rates. Based on this review, the following recommendations are offered to measurably address this systemic problem in North Carolina. The recommendations are based on what is best for the long-term economic viability of these fish stocks. Closing the shrimp trawl fishery in North Carolina inshore and nearshore waters, as other states on the east coast have done, would be the most effective single strategy to protect important nursery areas and juvenile fishes. This solution, however, is unreasonable; thousands of North Carolinians rely on the commercial shrimp industry for their livelihood. These measures balance conservation goals with current fishing practices to mitigate the effects of bycatch mortality while still providing for a productive commercial and recreational fishery.

A. Designate all inshore and ocean (0-3 miles) waters as nursery habitat

Because these areas function as important nursery habitats, bycatch and mortality issues from the shrimp trawl fishery in estuarine waters is unique to North Carolina in the south Atlantic. Data collected by NC DMF regarding the occurrence of juvenile fishes in inside waters is adequate, appropriate, and clear to support nursery area designation for all inshore, estuarine and ocean waters (0-3 miles offshore). The preponderance of data regarding juvenile life stages of fishes in these programs illustrate that all inside waters serve as important locations where juvenile fishes feed and grow to maturity. Juvenile fish are defined here as fishes that have yet to spawn at least once. While some fishes may be harvested and possess mature gonads, if they are harvested prior to spawning, their contribution to the population is zero, threatening population stability and population growth. In fact, there is no evidence that any areas within the estuarine system of North Carolina do *not* function as a nursery area. These data, along with the Pamlico Sound survey and the decline of Atlantic croaker and spot in the south Atlantic, provide unequivocal support to the argument that the area functions as critical nursery habitat.

B. Implement strategies to reduce shrimp trawl bycatch of juvenile fishes in all designated nursery areas

Shrimp trawl bycatch, particularly in nursery areas, confound efforts to protect important inter-jurisdictional fishes. Although limited data are available to unequivocally prove the effectiveness of various strategies to reduce bycatch, the critical importance of such reductions is logical, particularly for species of concern. The only estuarine shrimp trawl fishery on the east coast exists in North Carolina; however, concerns related to its impact on fish stocks are enormous.

While no shrimp trawling in newly designated nursery areas would yield the best result biologically, if it is to continue, effort needs to be significantly reduced by employing the following suite of management strategies.

a. Reduce maximum headrope length in shrimp trawl fishery

First, reduce the maximum combined headrope length from 220 feet to 90 feet for all nets combined. Headrope length is a measure of the size of the shrimp trawl, with larger vessels tending to use larger nets to catch more shrimp. While improved efficiency and overall yield are the primary objectives, bycatch also increases. A reduction in the allowable headrope length is necessary to reduce effort, and subsequent bycatch in this fishery.

During the development of the original North Carolina Shrimp FMP (NC DMF 2006), the recognition of specific problems related to juvenile southern flounder bycatch resulted in rules to limit sensitive areas to trawling by closing some areas and limiting others to a 90 foot headrope maximum. The NC DMF points out in their plan (NC DMF 2006, p. 315) that headrope restrictions reduce bycatch and the fishing power of larger vessels. Further, no other south Atlantic or Gulf Coast state allows shrimp trawls over 60 feet in their jurisdictional waters. During the Brown (2015) study, maximum headrope lengths ranged from 220 to 240 feet. The average headrope length increased from 94 feet in 2012 to 134 feet in 2015. While this increase in headrope size may not be completely reflective of all fleet activities, the study reports these trips as representative of the fishery. These data also suggest that many vessels in the fleet already employ nets less than 90 feet, thereby mitigating the impacts of the proposed reduction. A 90 foot maximum headrope for all nets combined in all estuarine and nearshore ocean waters is recommended to reduce the bycatch of *all* fishes impacted by shrimp trawls.

b. Require the use of two bycatch reduction devices ("BRDs") on all shrimp trawls

Second, require the mandatory use of a second, federally certified BRD or device tested by DMF and certified to further reduce bycatch by at least 25 percent. Recent studies by NC DMF, pursuant to Amendment 1 to the N.C. Shrimp FMP (NC DMF 2015), indicate that a second Florida Fish Eye BRD placed next to the currently required single BRD shows great promise in further reducing bycatch in the brown shrimp fishery while limiting shrimp loss. The N.C. Marine Fisheries Commission ("MFC") contemplated the requirement of a second BRD in Amendment 1. The MFC should require the use of a second BRD with documented, additional bycatch reduction.

c. Limit tow times to 45 minutes

Third, limit tow times to 45 minutes. Reducing tow times to a maximum of 45 minutes would reduce bycatch, culling time, and discard mortality. Logothetis and McCuiston (2006) reported that survivability of bycatch increased with reduced culling time. Shorter tow times generally mean less catch and shorter culling time. This regulation is especially important in light of rapidly increasing tow times in recent years: Brown (2015) reported an increase in average tow times over his study period from 100 minutes in 2012, 142 minutes in 2013, 187 minutes in 2014, and 181 minutes in 2015. Maximum tow times likewise increased from 240 minutes in 2012 to 360 minutes in 2015.

d. Limit shrimp trawl effort to three days per week, during daylight hours only

Fourth, limit all shrimp trawl effort to three days per week during daylight hours only. Fishermen are known to fish harder in the wake of restrictions to make up for lost opportunities due to measures such as tow times and reduced net size. A limit of three days per week of trawling during daylight hours would significantly reduce attempts at fishing harder and allow some fishes to move out of trawling areas or recover from encounters during open days. Lay days may also serve to limit the number of out of state vessels that may travel to North Carolina in order to participate in this unique estuarine fishery.

This time restriction would both reduce bycatch and improve the efficiency of the shrimp trawl industry. Finfish bycatch is significantly higher at night while shrimp catches are higher during the day (Ingraham 2003). Additionally, Johnson (2003) reported that far more shrimp are taken early in a fishing week than later (cited in NC DMF 2015).

Brunswick County provides a template for success: it is currently unlawful to shrimp during nighttime hours in the ocean off Brunswick County. This rule was implemented to reduce bycatch (NC DMF 2015). The current restrictions off of Brunswick County should be expanded to all estuarine and coastal waters of North Carolina.

e. Delay the opening of shrimp season

Seasonal openings should be based on a shrimp count size. Delaying the harvest season until shrimp are larger provides not only a more valuable product to the industry, but reduces the length of the season when gear is in the water, thereby reducing bycatch. While determining count size for all North Carolina waters is impractical, delaying harvest in Pamlico Sound until shrimp count reaches 60 shrimp per pound (heads on) is prudent and reduces concerns from fishermen and dealers that shrimp are either too small or that bycatch is too high when the fishery traditionally opens in early to mid-May.

These five actions must be implemented together in order to achieve the desired effect of meaningful bycatch reduction in the shrimp trawl fishery. While it is beyond our ability to determine, or even speculate, on the absolute reductions that would be realized by taking this course of action, it is a step in the right direction and would measurably reduce bycatch in our judgment.

f. Establish size limits and bag limits for spot and Atlantic croaker

In the event North Carolina makes these important changes in the shrimp trawl fishery, the abundance and subsequent encounters with juvenile fishes in other fisheries should dramatically increase. Hilborn and Walters (1992) point out the need to allow fish to grow to a reasonable size before they are harvested. Size limits developed to delay harvest to allow juvenile fish to spawn at least once has been a common sense management approach used for decades. The fishery management plans of the ASMFC, federal Councils, and North Carolina are replete with examples of the impacts, not only on increasing spawning stock biomass, but yield per recruit as well. We recommend strategies to reduce this potential increase in the bycatch of juvenile and pre-spawn adult fishes in all fisheries. Many of the species of concern in North Carolina and coast wide either have no size limits or size limits have proven to be ineffective. This is certainly the case for Atlantic croaker and spot. An 8 inch size limit for spot and a 10 inch size limit for Atlantic croaker in all North Carolina fisheries are slightly below the L100% for these two species and would allow nearly all fish to reach maturity and spawn at least once. An alternative to size limits in the higher volume commercial fisheries could be changes to mesh sizes in primary gears such as gill nets and trawls to minimize interactions altogether in those fisheries. The positive impacts in terms of increased spawning stock biomass and yield to the fishery would be enormous and go a long way towards sustainable fishing in the future.

VII. CONCLUSION

The only difference between the limited areas currently defined as nursery habitat in North Carolina and the rest of North Carolina’s estuarine and nearshore coastal ocean waters is the size of the juveniles encountered. The majority of fishes in the unprotected areas of North Carolina’s estuarine and nearshore waters are juveniles, have not yet reached maturity, and therefore have not yet reproduced and contributed to the population. It makes no sense to protect the smallest juveniles that already face high natural mortality rates in the current nursery area and not continue that protection until they actually contribute to the health of the population by spawning at least once.

Spot, Atlantic croaker, and weakfish were critical components of North Carolina’s estuarine commercial and recreational fisheries prior to their dramatic decline in the fisheries late 1980s.

The combined landings of these three species in the commercial fishery in 1981 were 37.6 million pounds. In 2015, commercial landings were 2.3 million pounds, a 95 percent decline. A similar trend is observed in the recreational fishery when, in 1981, recreational landings were 5.3 million pounds compared to 1.6 million pounds in 2015, a 70 percent decline.

During the 2014 season, 149 of the 8,670 (1.72 percent) reported shrimping days in the estuary and ocean waters were observed. Spot, Atlantic croaker, and weakfish accounted for 268,116 pounds of the 415,283 total pounds, or 65 percent, of catch observed, including shrimp. Expansion of these observed numbers to the total estimated catch of the shrimp trawl fishery in 2014 yields 15.6 million pounds of spot, Atlantic croaker, and weakfish, primarily juveniles, discarded as bycatch by shrimp trawlers. This level of bycatch is four times the combined commercial and recreational harvest in North Carolina (3.9 million pounds) and nearing the coast wide harvest of all three species in 2014 (18.7 million pounds).

This goal of sustainable and healthy fisheries is severely compromised by the magnitude of juvenile mortality that occurs in North Carolina fisheries. The fact that North Carolina remains the lone state to allow shrimp trawl activity in coastal and estuarine nursery areas provides a common denominator that may explain the dramatic shift in landings from the south Atlantic to the mid-Atlantic region. The current boom or bust cycle in our fisheries will persist with longer gaps between boom years unless measures are taken to reduce juvenile mortality and improve spawning stock biomass.

Sound science points to shrimp trawl bycatch, despite efforts to reduce it, as the primary factor that is impacting North Carolina’s fisheries. Measures taken to date to reduce shrimp trawl bycatch in North Carolina have skirted around the edges of a complex problem. The data provided in the North Carolina Shrimp FMP and Amendment I clearly indicate that the magnitude of shrimp trawl bycatch is significant and impacts to fish populations are concerning. The North Carolina Shrimp FMP (NC DMF 2015) states that it is commonly known that harvesting a fish before it matures and spawns can lead to recruitment overfishing and impair the stock’s ability to sustain itself. Further, harvesting a fish before it reaches some optimal size leads to growth overfishing and reduced overall yield from the fishery. Measureable improvements in North Carolina fisheries and the fragile ecosystems they rely on for food, protection, growth, and reproduction will languish until shrimp trawl bycatch is properly addressed.

Figure 1. Nursery area map, with locations of the various nursery area locations for estuarine waters of North Carolina. The N.C. Marine Fisheries Commission prohibits trawling in primary nursery areas, however, the mesh sizes and size constraints of these areas preclude significant activity or potential juvenile fish mortality. Further, the fishes utilizing these areas are typically far too small to be retained in traditional shrimping gear. Consequently, we argue that the nursery area protections are far more habitat-related than fisheries-resources related.

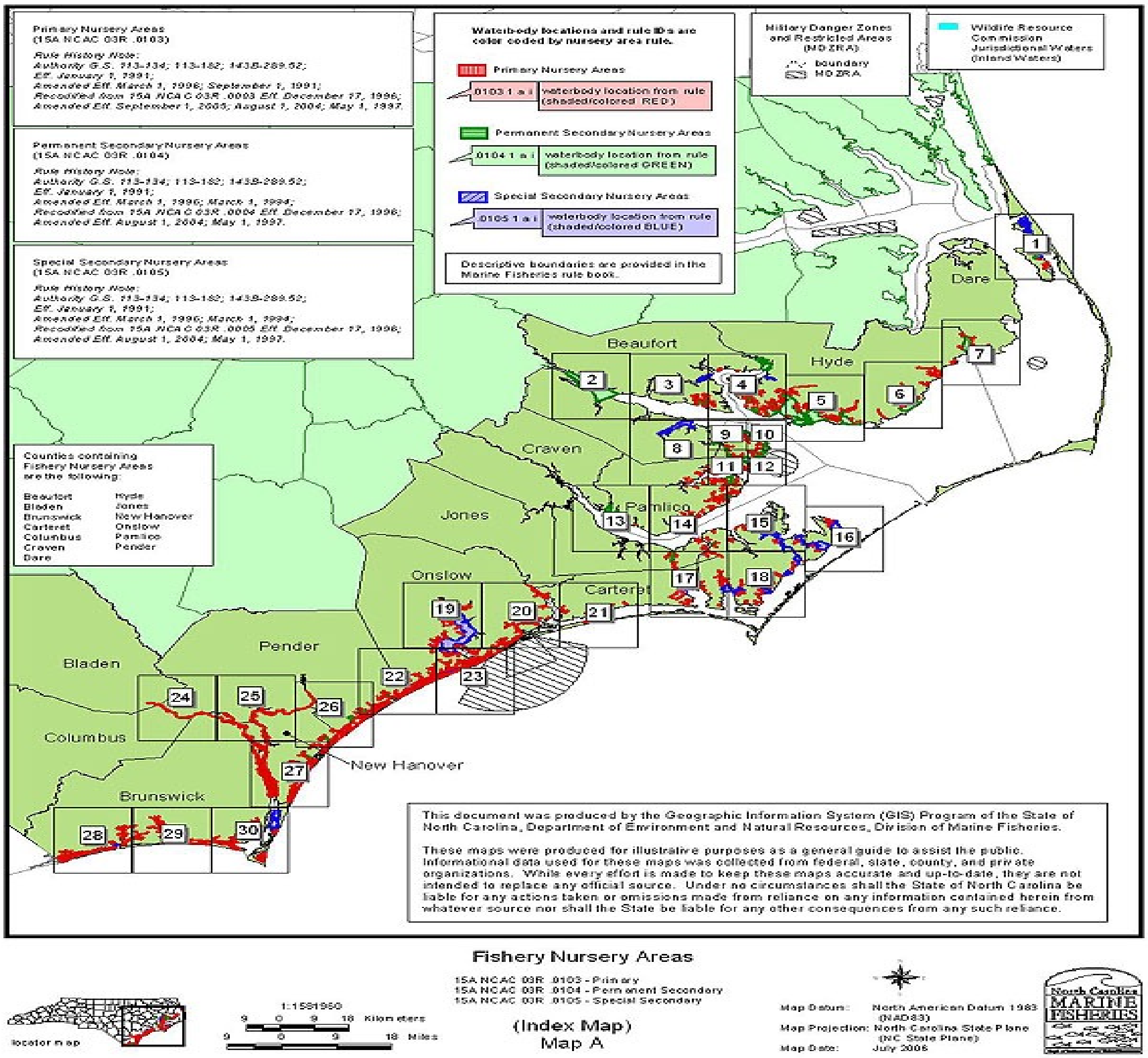

Figure 2. Randomized sample locations of the Pamlico Sound survey are obtained from areas outside of any of the designated nursery areas. With few exceptions, these areas are subjected to intense fishing pressure by all sectors of the fishery, including trawls, long haul seines, gill nets, and hook and line, all of which harvest and/or discard substantial quantities of juveniles fishes.

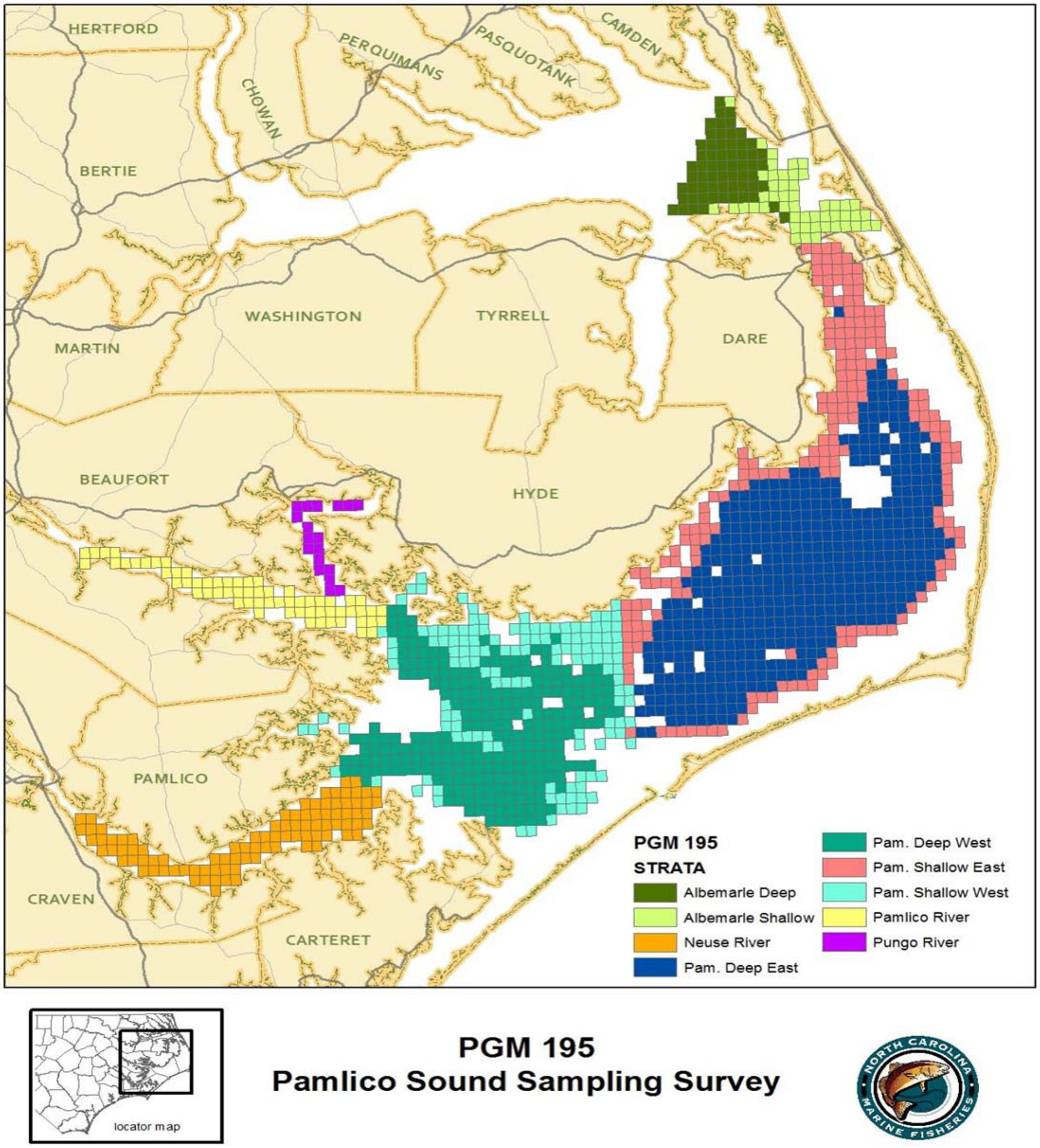

Figure 3. Location of commercial shrimp trawl observations made in northern North Carolina, January–December 2014 (Brown 2015).

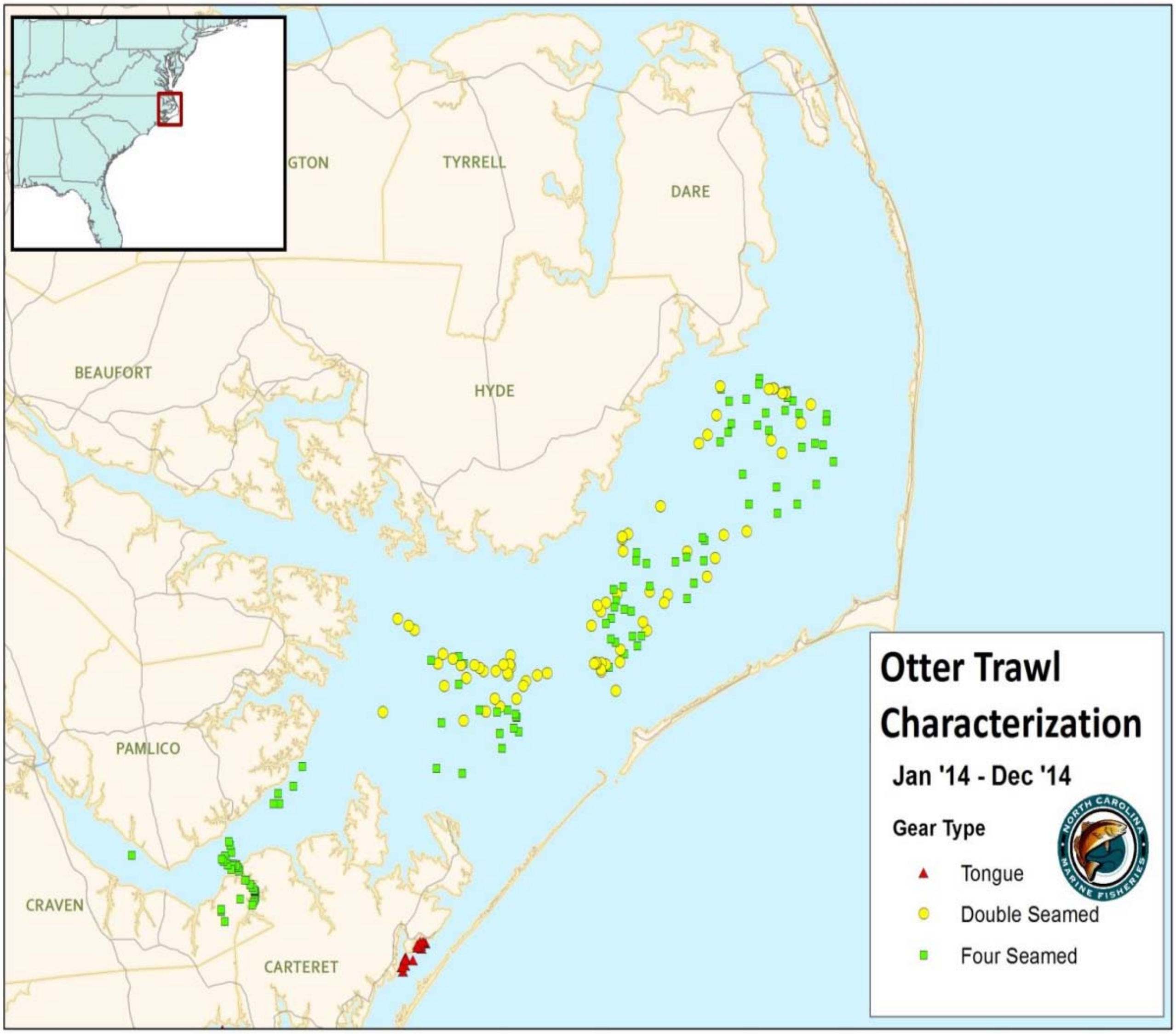

Figure 4. Location of commercial shrimp trawl observations made in southern North Carolina, January–December 2014 (Brown 2015).

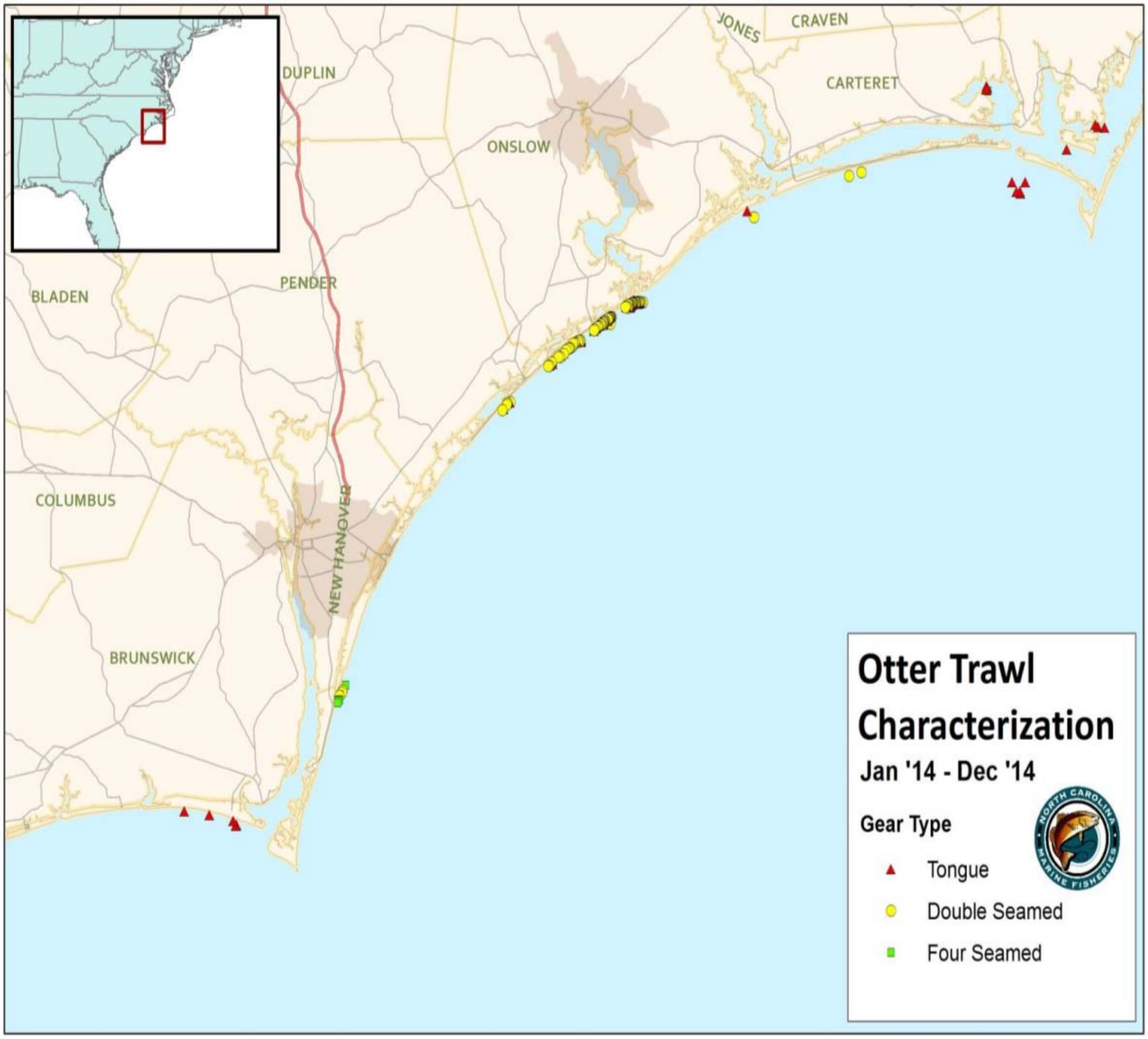

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EXHIBIT C

Jack G. Travelstead

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Wolcott, Vermont 05680 (757) 636-9105 Cell
jgtravel54@gmail.com

EDUCATION:

B.S. Biology, Old Dominion University, 1976. Summa Cum Laude.

M.A. Marine Science, College of William and Mary, Virginia Institute of Marine Science, 1980.

Virginia Executive Institute, 1989.

EMPLOYMENT HISTORY:

2014-2016 Consultant to the Coastal Conservation Commission and other organizations. Monitor activities of the Atlantic States Marine Fisheries Commission.

2012-2014 Commissioner, Virginia Marine Resources Commission. Served as Agency Head and Chairman of the Agency's dual regulatory board. Directed the work of four Divisions, consisting of 160 employees: Fisheries Management, Habitat Management, Law Enforcement (Virginia Marine Police), and Administration and Finance. Responsible for an annual agency budget of $23 million.

2006-2012 Chief Deputy Commissioner, Virginia Marine Resources Commission. Served as second in command of the agency. Advised the Commissioner and Regulatory Board on agency policies and programs. Provided policy guidance to the Division Chiefs.

1984-2012 Chief, Fisheries Management Division, Virginia Marine Resources Commission. Directed the Fisheries Management Division of the Agency. Provided fishery management guidance to the Regulatory Board. Directed the collection and analysis of scientific, biological, economic and sociological information pertaining to Virginia fisheries. Supervised departments pertaining to fishery planning and statistics, fishery management plan development, shellfish conservation and replenishment, artificial reef construction

	and the promotion of recreational fisheries. Served as the agency's representative to the Atlantic States Marine Fisheries Commission and the Mid-Atlantic Fishery management Council.
1982-1984	Fisheries Manager, Head of the Department of Fisheries Plans and Statistics, Virginia Marine Resources Commission. Investigated and reported on the conditions of Virginia's commercial and recreational fisheries. Recommended regulatory options for the conservation and management of Virginia's fisheries to the agency regulatory board. Served as the agency alternate to the ASMFC and MAFMC.
1981-1982	Fisheries Liaison Officer, Virginia Marine Resources Commission. Served as agency alternate to the MAFMC. Investigated and reported to the Commissioner on special fishery issues.

AWARDS AND COMMENDATIONS

2003, Captain David H. Hart Award of the Atlantic States Marine Fisheries Commission, for outstanding leadership and contributions to the management of Atlantic coastal fisheries.

2009, Commander's Award for Public Service, Department of the Army. For outstanding effort and dedication while serving on the Management Team for the production of the Chesapeake Bay Oyster Programmatic Environmental Impact Statement.

2011, Conservation Award, Tidewater Chapter, American Fisheries Society.

2012, Ricks E. Savage Award of the Mid-Atlantic Fishery Management Council, for positive influence and contributions to the conservation and management of mid-Atlantic fisheries.

EXHIBIT D

CURRICULUM VITAE

LOUIS BROADDUS DANIEL, III

Birth date: February 14, 1963

Current Address: 109 Barringer Drive, Newport, North Carolina 28570

Telephone: 252-808-8147 *Fax: 252-726-0254*

Email: *sciaenops1@gmail.com*

Education:

College of William and Mary, School of Marine Science, Virginia Institute of Marine Science, Gloucester Point, Virginia, Ph.D., Marine Science, Graduated 1995.

College of Charleston, Charleston Higher Education Consortium, Charleston, South Carolina, M.S., Marine Biology, Graduated 1988.

Wake Forest University, Winston-Salem, North Carolina, B.A., Biology, Graduated 1985.

Employment History:

June 2016 to present
Position: Environmental/Fisheries consultant
Description: Administer various grants and contracts.
Supervisor: Self
Employer: Self

January 2016 to present
Position: Adjunct Professor
Description: Developed a marine resources policy and management curriculum for the sea semester at the NC State Center for Marine Sciences and Technology.
Supervisor: Dave Eggleston
Employer: North Carolina State University

March 2016 to June 2016
Position: Assistant Section Chief, Shellfish Sanitation
Description: Transitioned out of Director role, assisting section in day to day operations and sampling programs. Developed good understanding of general program requirements.
Supervisor: Shannon Jenkins
Employer: North Carolina Division of Marine Fisheries

February 2007 to March 2016
Position: Director of the North Carolina Division of Marine Fisheries
Description: Represent North Carolina on the ASMFC that oversees the management of fisheries resources along the Atlantic coast. Implement the North Carolina Fisheries Reform Act, Coastal Recreational Fishing License, Waterfront Access and Marine Industry Fund. Coordinate the development of Fishery Management Plans and Coastal Habitat Protection Plan. Responsible for management of Marine Fisheries headquarters and 5 field office with nearly 300 staff in 8 sections including Marine Patrol and a $30+ million budget.
Supervisor: Secretary Donald van deer Vaart

Employer: North Carolina Division of Marine Fisheries

February 1998 to 2007

Position: Executive Assistant for Councils

Description: Represent North Carolina on the South Atlantic Fishery Management Council that oversees the management of fisheries resources in the south Atlantic EEZ. Assist the Fisheries Director in implementation of the North Carolina Fisheries Reform Act and serve as a technical advisor to the North Carolina Marine Fisheries Commission (NCMFC). Coordinate the development of Fishery Management Plans. Write and present numerous technical issue papers for action by the NCMFC and Joint Legislative Committee on Seafood and Aquaculture. Serve as the North Carolina representative on several ASMFC management boards.

Supervisor: Preston P. Pate, Jr.

Employer: North Carolina Division of Marine Fisheries

April 1995 to February 1998

Position: Marine Fisheries Biologist Supervisor

Description: Supervise 5 biologists and 5 technicians in various studies on North Carolina finfish and shellfish fisheries (i.e., long haul seine, otter trawl, gill net, pound net), bycatch reduction, and the population dynamics of important commercial and recreational fish species. Serve as the North Carolina representative on numerous ASMFC and SAFMC technical committees, stock assessment subcommittees, and plan development teams. Serve as the Chairman of the North Carolina Division of Marine Fisheries Biological Review Team, whose purpose is to review all biological activities performed by the Division.

Supervisor: David L. Taylor

Employer: North Carolina Division of Marine Fisheries

Selected Presentations, Reports, and Publications:

Since 2002, prepared, edited, and reviewed approximately 40 fishery management plans, amendments, and supplements for public hearings and recommendations to the Marine Fisheries Commission.

Since 2002 have given numerous presentations to academic, public, and legislative gatherings related to the management of marine fisheries.

Daniel, L.B., III. 2002. North Carolina Interjurisdictional Fisheries Management Plan. North Carolina Division of Marine Fisheries, Morehead City, NC 28557.

Daniel, L.B., III and Lee Parramore (with Plan Development Team). 2001. North Carolina Red Drum Fisheries Management Plan. North Carolina Division of Marine Fisheries, Morehead City, NC 28557.

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Daniel, L.B. 1997. Moderator and speaker for a symposium on the North Carolina weakfish fishery and its management. Tidewater Chapter, American Fisheries Society, Beaufort, North Carolina.

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Daniel, L.B.,III and J.E. Graves. 1994. Morphometric and genetic identification of eggs of spring spawning sciaenids in lower Chesapeake Bay. Fish. Bull. U.S. 92(2): 254-261.

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Daniel, L.B. 1987. Aspects of the early life history of the spotted seatrout, Cynoscion nebulosus, in South Carolina. 67th Annual Meeting, ASIH, Albany, New York.

Field Experience:

March 1998 to June 2016

Participated in various aspects of division operations as needed and available. Lead or participated in various field trip exercises for legislative members and staff.

April 1995 to February 1998

Supervise and assist in sampling programs including a juvenile trawl survey, seine survey for juvenile red drum, fishery dependent port and on-water surveys, gear development, shrimp sampling, by-catch reduction, and tagging studies.

1989 to 1991

Chief scientist on 20 cruises aboard the R/V Bay Eagle to sample ichthyoplankton using an in situ silhouette photography system.

1986 to 1988

Participated in weekly rotenone, stop net, trammel net and gill net collections for juvenile and adult inshore recreational fishes in South Carolina. Extensive small (<25 ft.) boat use.

Selected Awards and Professional Offices:

2011-2015

Chairman and vice-Chairman of Atlantic States Marine Fisheries Commission

2002-2006

Chairman and vice-Chairman of the South Atlantic Fishery Management Council

1998 to 2007

North Carolina representative on South Atlantic Fishery Management Council.

1998 to 2016

North Carolina representative on Atlantic States Marine Fisheries Commission

Management Boards (Weakfish (Chairman 2003-2006), Coastal Sharks, Horseshoe Crabs, South Atlantic Board (Chairman 1999-2002)).

2002 to 2007
North Carolina representative on the National Marine Fisheries Service Highly Migratory Species Advisory Panel.

2000
DENR Distinguished Service Award

1995
USFWS Outstanding Service Award

1997 to Present
Adjunct Assistant Professor with the University of North Carolina at Chapel Hill, Institute of Marine Science.

2003 to Present
Adjunct Assistant Professor with North Carolina State University. Developed and taught Marine Resources Management and Policy (ES 295-2) during spring 2016.

1998 to 2007
Chairman of the North Carolina DMF Management Review Team

1995 to 1998
North Carolina Division of Marine Fisheries (NCDMF) representative on the ASMFC weakfish technical (Chairman) and stock assessment committees, bluefish technical and stock assessment committees and alternate for Science and Statistics Committee. Member of SAFMC Science and Statistics Committee, Bycatch Reduction Subcommittee, and Red Drum Assessment Committee.

1995 to 1998
Chairman of the North Carolina Division of Marine Fisheries Biological Review Team.

1998 to 2003
South Atlantic Representative on MARFIN Panel

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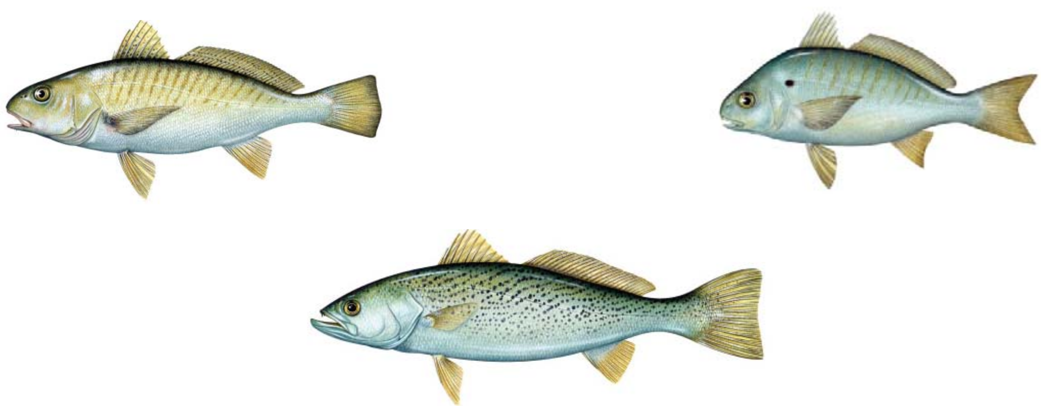
EXHIBIT E

TECHNICAL REVIEW: THE NEED TO REDUCE FISHING MORTALITY AND BYCATCH OF JUVENILE FISH IN NORTH CAROLINA'S ESTUARIES



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Submitted to the North Carolina Marine Fisheries Commission

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I. INTRODUCTION

The recreational and commercial fisheries in the state of North Carolina play an important role in the state's economy and culture, supporting a multi-million-dollar industry. Unfortunately, these fisheries have been facing increasing stressors caused by habitat alteration, juvenile bycatch, high levels of discards, and the effects of climate change. Given the recurrent concerns regarding population status and decreased fisheries landings for economically important species such as Atlantic croaker, spot, and weakfish (ASMFC 2010, 2015, 2016), a critical review of the factors contributing to long-term fisheries sustainability and population health is warranted. However, the problems caused by high levels of juvenile bycatch and nursery habitat alteration go beyond just these species. Even species that are not directly impacted by these stressors are likely affected by the removal of a substantial proportion of their prey biomass and the emergence of other ecosystem-level impacts (Hall 1999).

In North Carolina, the lack of sufficient nursery habitat protection and the need for a more rigorous and scientifically-informed process for protection of habitats not only for very early life stages (e.g., eggs, larvae, and post-settlement early juveniles) but also for juveniles, sub-adults, and first-time spawners is clear. From a fisheries management perspective, the problem of juvenile bycatch is a major impediment to sound practice, primarily because the magnitude of discards is not usually recorded and, therefore, not properly incorporated in fisheries stock assessments. Since most fisheries assessment methods rely on catch data for their operation, the uncertainty associated with unknown levels of bycatch can be enormous. Indeed, the problems are so great that some assessment scientists feel that without proper integration of bycatch mortality, the data used to conduct assessments is of questionable utility (Hall 1999, Walters and Martell 2004). From a practical perspective, this means that the true condition of croaker, spot, and weakfish stocks is likely to be even worse than we know because a significant source of mortality is not properly accounted for.

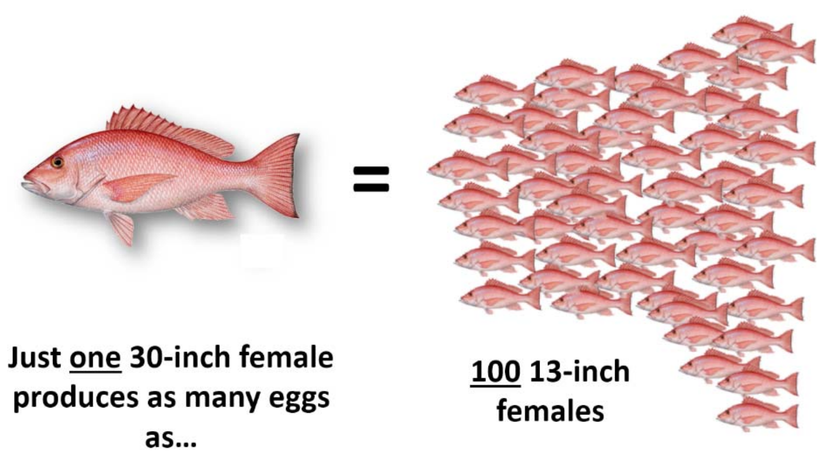
On many grounds, therefore, finding solutions to the high discard and bycatch problem is highly desirable by many sectors of the fisheries that depend on the long-term sustainability of fisheries resources. This paper provides a summary technical review of *how* and *why* a more comprehensive and inclusive designation of nursery habitat in North Carolina estuarine waters would greatly benefit not just the greater Pamlico Sound ecosystem but the many fisheries that depend on its productivity and health.

II. SCIENTIFIC DEFINITION OF "JUVENILE" AND "ADULT" FISH

In the scientific literature that deals with fisheries biology, the term "juvenile" is used to designate the young and relatively small individuals in the population that have not yet reached sexual maturity and therefore are not capable of spawning—i.e., they have not yet developed active reproductive organs such as ovaries and testes. It follows from this that individuals in the population reach "adulthood" (i.e., turn into adults) when they become sexually mature and are capable of reproducing (Lowerre-Barbieri 2009, Brown-Peterson et al. 2011).

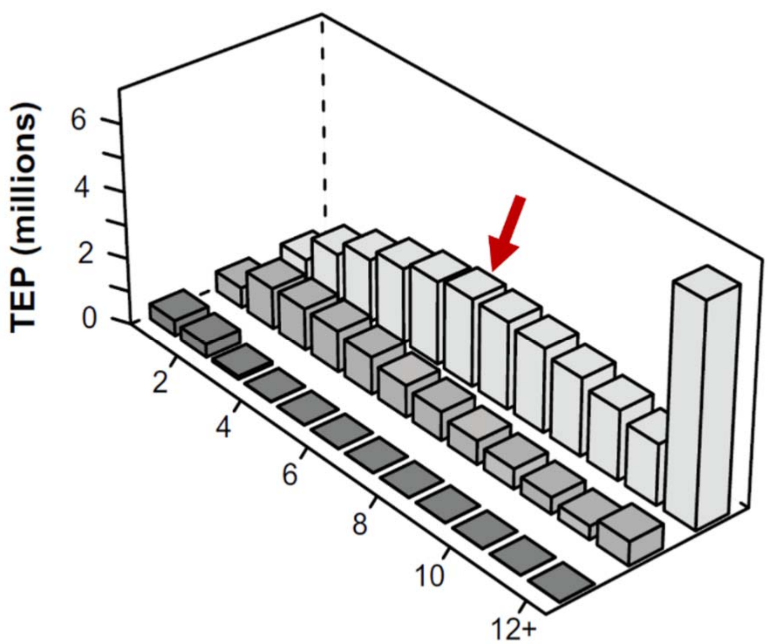
Some species reach sexual maturity relatively early in life (e.g., in weeks, months, or one year), while others can take from a few years to decades to become sexually active (Stearns 1992, Lowerre-Barbieri, 2009). The specific reproductive strategy utilized by each individual species results from evolutionary processes and selective pressures that take place over millions of years (Stearns 1992, Lowerre-Barbieri 2009, Brown-Peterson et al. 2011, Lowerre-Barbieri et al. 2011, Lowerre-Barbieri et al. 2016). For example, common species found in North Carolina estuaries such as Atlantic croaker, weakfish, and spot mature relatively early in life. About 50 percent of individuals are sexually mature at age 1, and 80 to 90 percent are mature by age 2 (Barbieri et al. 1994a, Lowerre-Barbieri et al. 1996). However, first time spawners—females just reaching sexual maturity and spawning for the first time—have significantly lower fecundity and, therefore, much lower reproductive value than larger, older females (Stearns 1992, Lowerre-Barbieri 2009, Lowerre-Barbieri et al. 1998, Lowerre-Barbieri et al. 2016). Here the term "reproductive value" is used to denote higher reproductive capacity, usually measured by higher fecundity, higher egg quality, and the production of better fit larvae that have a higher probability of survival (Stearns 1992, Berkeley et al. 2004, Lowerre-Barbieri et al. 2016). The consequence is that by killing large numbers of juvenile, sexually immature, or even first time spawners, bycatch and discard mortality in North Carolina estuaries is likely to be severely impacting the egg production and reproductive capacity of these stocks. How does this work?

The example in the graphic below illustrates the concept of "size, age, and reproductive value" for red snapper, another important commercial and recreational fisheries species in the southeastern United States. Since body weight increases as a power function of fish length, the egg production of larger, older females is disproportionally larger than that of smaller, younger females (Berkeley et la. 2004, Hixon et al. 2014). The results are astonishing. Just one 30-inch female red snapper can produce as many eggs as <u>100</u> 13-inch females (Porch *et al*. 2015).



Further, the idea of relying on first time spawners to maintain a population's egg production and reproductive capacity is completely flawed and without scientific support (Cooper et al. 2013, Hixon et al. 2014, Lowerre-Barbieri et al. 2015). As seen in the red snapper example above, the reproductive capacity of first time spawners is exponentially lower than that of older females. A growing body of fisheries research shows that big, old, fat, fertile female fish—what scientists call BOFFFF's—are critically important to sustainable management of marine fisheries because their reproductive capacity is so large (Hixon et al. 2014). BOFFFF's are so vital because they produce a higher quantity of larger eggs that have a better chance of developing into larvae that can withstand environmental impacts and other threats (Berkeley et al. 2004, Hixon et al. 2014). BOFFFF's also tend to have longer spawning sessions, may spawn in a wider range of locations than smaller fish, and are more likely to survive bad years, reproducing feverishly when conditions improve (Cooper et al. 2013, Hixon et al. 2014). Since smaller females are also more susceptible to predation they are usually more restricted to safer habitats and thus different food supplies (Hixon et al. 2014). Smaller, younger females must also devote more energy to growth than larger females, which can devote more energy to reproduction (Stearns 1992, Cooper et al. 2013, Hixon et al. 2014, Lowerre-Barbieri et al. 2015, 2016).

Another example of the importance of letting enough fish mature, grow, and age to achieve their maximum reproductive potential can be found in the spotted seatrout (speckled trout), a close cousin to the weakfish or gray trout. A recently published study (Cooper et al. 2013) looked at the effect of age truncation and size-dependent timing on the spawning potential of spotted seatrout. In the fisheries biology scientific literature, the term "age truncation" means the removal of older age classes, leaving the population "juvenesced," or lacking the larger, older fish that produce the most eggs. Size-dependent timing of spawning means that females of different sizes (and presumably different ages) spawn at different time intervals during the



spawning season. The results of the Cooper et al. (2013) study are consistent with the pattern shown by red snapper: larger, older females were reported to have disproportionally larger total egg production (TEP) than their smaller, younger counterparts (Lowerre-Barbieri et al. 2015, Porch et al. 2015). The graph above shows the estimated TEP of spotted seatrout by age for different fishing mortality regimes: the light gray bars indicate stocks under no fishing pressure; the middle, a bit darker gray bars show results under a moderate level of fishing mortality; and the darker gray bars represent stocks under a relatively high level of fishing mortality. First, it is clearly noticeable that fish under no fishing pressure reach maximum TEP between the ages of five and seven years (red arrow) (Cooper et al. 2013). As seatrout stocks are subject to higher fishing mortality, fewer of the older fish survive and the population's egg production becomes progressively more dependent on younger females that, as shown above, have much lower reproductive capacity.

III. THE IMPORTANCE OF HABITAT PROTECTION FOR JUVENILE FISH

The nursery-role concept was first applied nearly a century ago to motile invertebrates and fishes with complex life cycles, in which larvae are transported to estuaries, metamorphose, grow to sub-adult stages, and then move to adult habitats offshore (Heck and Crowder, 1991). Some scientists trace this idea to work done between the early to mid-1900s on blue crabs, shrimp, and several finfish species (Beck et al. 2001). The concept became so pervasive that from a fisheries ecology perspective it has been termed a "law." For example, Deegan (1993) states that "estuarine fish faunas around the world are dominated in numbers and abundance by species which move into the estuary as larvae, accumulate biomass, and then move offshore."

Nearshore estuarine ecosystems—e.g., seagrass meadows, marshes, and mangrove forests—serve many important functions in coastal waters. Most notably, they have extremely high primary and secondary productivity and support a great abundance and diversity of fish and invertebrates. Because of their effects on the diversity and productivity of macrofauna, these estuarine and marine ecosystems are often referred to as nurseries in numerous papers, textbooks, and government-sponsored reports (Beck et al. 2001, Able 2005). The underlying premise of most studies that examine nursery-role concepts is that some nearshore, juvenile habitats contribute disproportionally to the production of individuals that recruit to adult populations (Heck and Crowder 1991, Beck et al. 2001, Able 2005). Therefore, the ecological processes operating in nursery habitats, as compared with other habitats, support greater contributions to adult recruitment (Beck et al. 2001). Indeed, the role of these nearshore ecosystems as nurseries is an established ecological concept accepted by scientists, conservation groups, managers, and the public, and is cited as justification for the protection and conservation of these areas (Able 2005).

IV. REVIEW OF NORTH CAROLINA'S NURSERY AREA PROGRAM

North Carolina regulations define "nursery areas" as "those areas in which for reasons such as food, cover, bottom type, salinity, temperature and other factors, young finfish and crustaceans spend the major portion of their initial growing season." 15A N.C. Admin. Code 3I.0101. Nursery areas in North Carolina are categorized based on various stages of juvenile development and life history strategy. The map below (Fig. 1) provides the locations of the various nursery areas mapped for estuarine waters of North Carolina, which includes a very small fraction of the vast estuarine habitats of the state. For fisheries management purposes these areas are designated as:

(1) Primary Nursery Areas (PNAs), which are those areas of the estuarine system where initial post-larval development takes place. These areas are located in the uppermost sections of a system where populations are uniformly very early juveniles. 15A N.C. Admin. Code 3I.0101. Since 1978, PNAs have been designated by the N.C. Marine Fisheries Commission to protect areas where initial post-larval development takes place. The PNA designation is intended to maintain these habitats, as much as possible, in their natural state to allow juvenile populations to develop in a normal manner with as little interference from man as possible. Approximately 80,000 acres have been designated as PNAs in North Carolina.

(2) Secondary Nursery Areas (SNAs) are those areas of the estuarine system where later juvenile development takes place. Populations are usually composed of developing sub-adults of similar size which have migrated from upstream primary nursery areas to the secondary nursery areas located in the middle portion of the estuarine system. 15A N.C. Admin. Code 3I.0101.

(3) Special Secondary Nursery Areas (SSNAs) are areas adjacent to secondary nurseries. It is unclear how SSNAs are distinguishable from SNAs. North Carolina rules do not define SSNAs.

The logical conclusion after examination of the definitions above is that North Carolina regulations does not include habitat designations to protect larger juveniles (i.e., sub-adults in pre-spawning condition) or the very young fish and shellfish that have perhaps spawned once but have not yet reached even a fraction of their reproductive potential (Barbieri et al. 1994a, Lowerre-Barbieri et al. 1995, Lowerre-Barbieri et al. 1998). This raises a major fisheries management concern because it is these sub-adults and first time spawners that will eventually recruit into the main spawning stock to maintain the egg production and juvenile recruitment needed for sustainable fisheries (Lowerre-Barbieri et al. 1998, Lowerre-Barbieri 2009, Cooper et al. 2013).

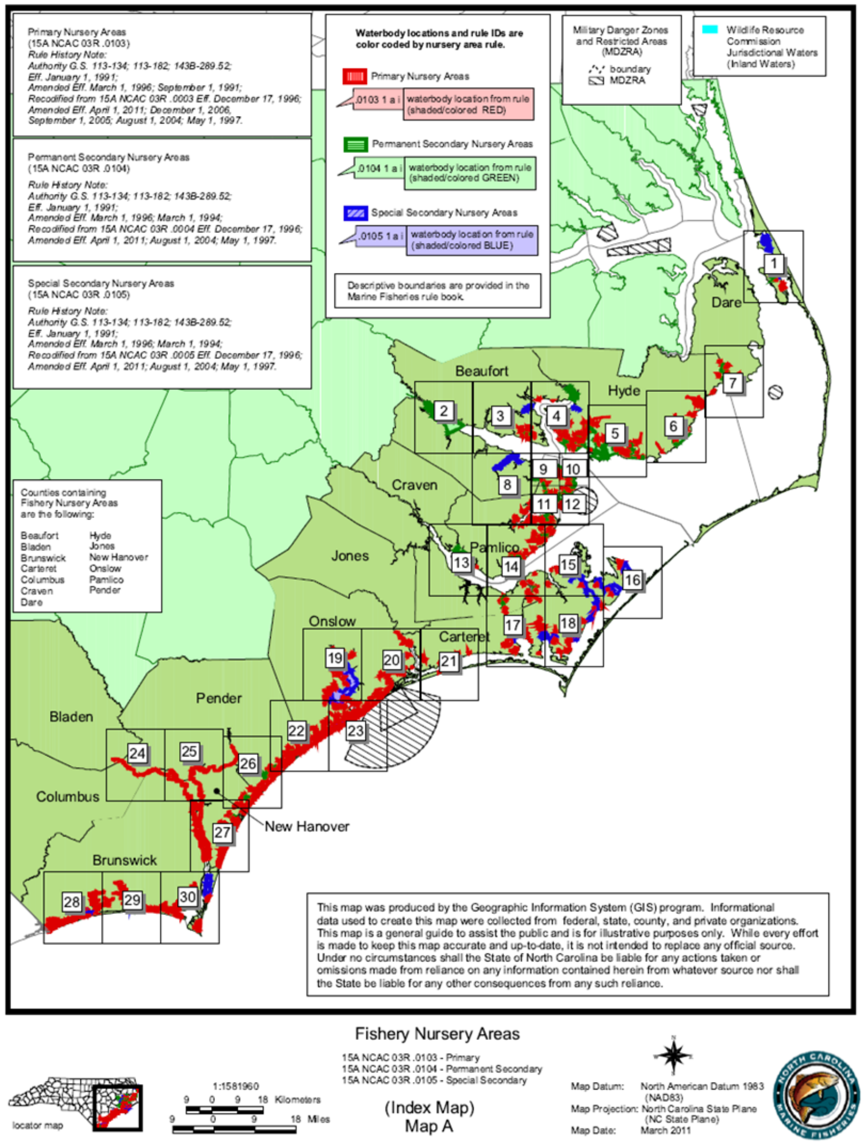


Fig. 1 – Locations of the various nursery areas for estuarine waters of North Carolina

Even a cursory review of the main fisheries that operate in North Carolina estuaries unequivocally indicate that the current nursery habitat designations do not provide adequate protection to the early life history stages of finfish and crustaceans that use these systems as nursery habitats (Broome et al 2011). Specifically, the North Carolina Division of Marine Fisheries Primary Nursery Area Designation Protocol, (also known as the P120 protocol) issued in 2002 mentions that of the approximately 2.1 million acres of open water and 200,000 acres of wetlands in coastal North Carolina, only 162,265 acres (or approximately 8 percent of the total estuarine waters) have been designated as nursery areas. Designations of estuarine areas that consistently support populations of juvenile shrimps, crab, and finfish—and, therefore, provide the basis for nursery area designation—is based on surveys conducted in the early 1970s (NCDMF 2002) and have not been substantially updated since.

People from other states are usually surprised by these facts. Most states prohibit trawling inside bays or other inshore areas deemed as estuarine nursery habitats. In North Carolina, with few exceptions, estuarine nursery areas are subject to intense fishing pressure by all sectors of the fishery (trawls, long-haul seines, gill nets, and hook and line), all of which harvest and/or discard substantial quantities of juvenile fish species such as Atlantic croaker, spot, weakfish, summer flounder, and blue crabs (Murray et al. 1992, Broome et al. 2011). Technically, trawling in North Carolina is prohibited in designated nursery areas. However, the problem is that Pamlico Sound and other estuarine areas providing nursery habitat have not been designated as nursery areas. Data derived through the N.C. Division of Marine Fisheries Pamlico Sound Survey are obtained from areas outside of any of the designated nursery areas (Fig. 2). In other words, although DMF conducts surveys in the Pamlico Sound, scientific sampling to properly designate the location, geographic extent, and ecological function of estuarine nursery areas in the Sound is lacking.

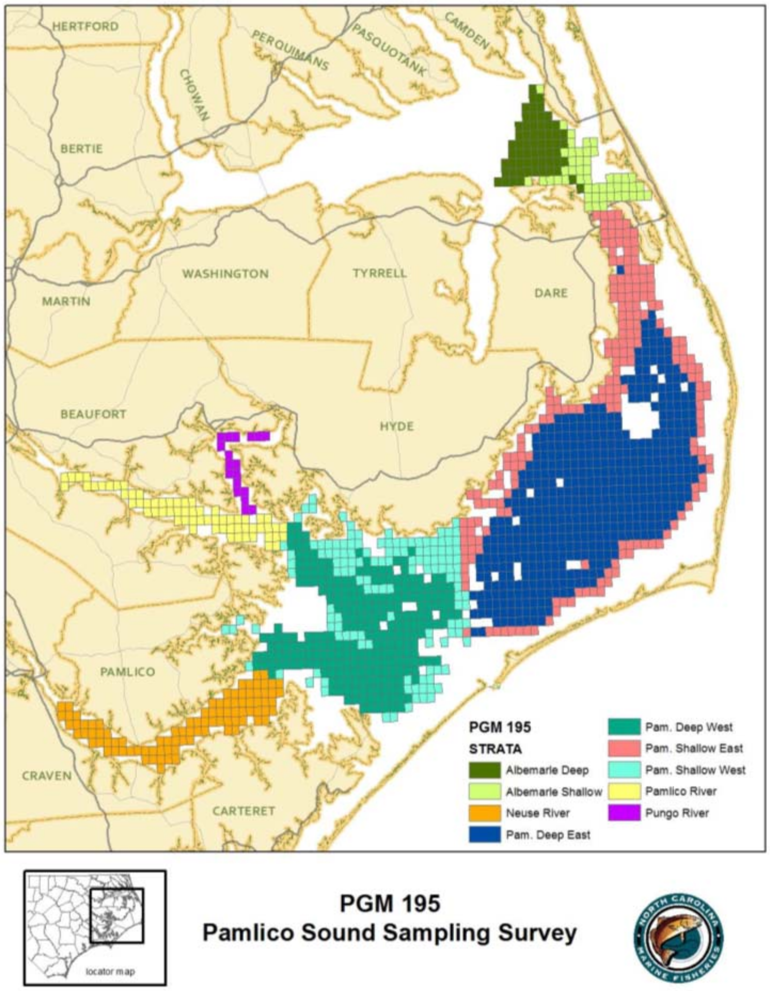


Fig. 2 – Locations of the North Carolina DMF random-stratified sampling program for estuarine waters of North Carolina.

Because of the estuarine-dependent nature of their life history, Atlantic croaker, spot, and weakfish spawn primarily in coastal and nearshore shelf waters (Barbieri et al. 1994a, Lowerre-Barbieri et al. 1995) and recruit as early juveniles into Pamlico Sound nursery habitats (Chao and Musick 1977, Weinstein and Walters 1981). Although adults of these species use open waters of the Sound as feeding grounds, the bulk of croaker, spot, and weakfish found in Pamlico Sound are small, young fish that have not had a chance to spawn or have spawned perhaps once before reaching maximum egg production and spawning capacity. If we follow the nursery habitat concept described by Heck and Crowder (1991) in which larvae are transported to estuaries, metamorphose, grow to sub-adult stages, and then move to adult habitats offshore, then there is no question that Pamlico Sound constitutes a major nursery habitat for these species.

Another serious concern with the current lack of protection for the main areas of Pamlico Sound and other inshore waters is the impact of shrimp trawling on the bottom. When attempting to assess the impact of trawling, two key pieces of information are required—the type of gear used and the frequency of disturbance (Hall 1999). Unfortunately, the lack of data on rates, distributions and intensities of fishing disturbance on the Pamlico Sound floor prevents a more quantitative analyses of these impacts. However, what we do have is a fairly clear picture of how bottom communities respond to fishing disturbance. For the most part this response is consistent with the generalized model of how biological benthic communities respond to perturbation: loss of erect and sessile *epifauna* (the invertebrates and small fishes that live on the bottom), increased dominance by smaller, faster-growing species, and a general reduction in species diversity and ecosystem services (Hall 1999).

Ecosystem services are the benefits people obtain from ecosystems (Palumbi et al. 2008). These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth. People seek many services from ecosystems and thus perceive the condition of an ecosystem in relation to its ability to provide desired services. In a narrow sense, the sustainability of a particular ecosystem service can refer simply to whether the biological potential of the ecosystem to sustain the yield of that service (such as food production) is maintained. Thus, a fish provision service is sustainable and promotes resilience if the *surplus* but not the *resource base* is harvested, and if the *fish's habitat* is not degraded by human activities. In fisheries management, this is what we call "sustained yield management." (Hilborn and Walters 1992, Walters and Martell 2004, Lowerre-Barbieri et al. 2016). The continued bottom trawling impacts on Pamlico Sound estuarine communities (Broome et al. 2011) and habitats is likely to seriously impact ecosystem health and interfering with essential ecosystem services.

V. THE CONSEQUENCES OF NOT PROTECTING JUVENILE, PRE-SPAWNING FISH IN PAMLICO SOUND

By imposing significant mortality on juvenile and pre-spawning fish, contributions to their respective populations in terms of both fishery yield and spawning potential are severely compromised. How and why does this happen?

A. Losses in Fishery Yield

In general, fishery harvest is similar to agriculture or farming. For example, to raise chickens, the farmer must wait until the chicks reach a certain size and weight before selling the chicks for meat. Obviously, killing small chicks for meat would be incredibly unprofitable because the chicks have not grown to the point that they have enough meat to be of any marketable value. Most fish follow this same rule of thumb. Fish grow fast when they are young, and it is much better to wait until fish reach an ideal size and weight to be harvested (Barbieri et al. 1997, Walters and Martell 2004). Growth overfishing results when a fish is harvested before it reaches this ideal weight (Hilborn and Walters 1992). Growth overfishing a stock is literally throwing away or wasting fishery yield production, not unlike the example with the chicks and chickens above (Hilborn and Walters 1992, Barbieri et al. 1997, Walters and Martell 2004). It's that simple. Now, multiply this loss in fishery yield (actual pounds of fish meat) by the hundreds of millions of juvenile Atlantic croaker, weakfish, and spot killed by fishing gear in Pamlico Sound, and one gets an idea of the huge economic loss this is causing in North Carolina (Broome et al. 2011). A study conducted by the North Carolina Sea Grant program determined that of the top ten bycatch species by weight, five were commercially or recreationally important species such as blue crab, Atlantic croaker, weakfish, spot, and summer flounder (Broome et al. 2011).

B. Losses in Spawning Potential

Perhaps the greater concern is the extraordinary quantities of Pamlico Sound forage and food fishes that succumb to fishing-induced mortality prior to spawning at least once. Drawing on the same chicken farm example, it is easy to see that to have sustainable long-term production some level of egg production to generate enough chicks that can grow into full size chickens must be maintained. Killing a large number of chicks before they can lay eggs will eventually lead to trouble. In fisheries, this is what we call "recruitment overfishing" (Hilborn and Walters 1992, Walters and Martell 2004). This type of overfishing is just as detrimental to the fishery as growth overfishing, but it is much more dangerous because it depresses annual fishery yields, damages long-term stock productivity, and renders fisheries as economically unviable (Hilborn and Walters 1992, Lowerre-Barbieri 2009, Walters and Martell 2004, Lowerre-Barbieri et al. 2016). In other words, killing so many juveniles before their first spawning severely reduces the stocks' reproductive capacity and compromises the annual production of new recruits (i.e., fingerlings coming into the population). The consequences are manifold, but can be summarized into two main impacts: (1) the amount of spawning is inadequate to generate new recruits and keep the stock in a sustainable state, and (2) the reduced spawning and juvenile recruitment cause a reduction in the populations to a small fraction of its original size and allows other species (competitors) to take advantage of the open space and fill in the void (Botsford et al. 1997). For example, starting in the early 1900s, the California sardine fishery became the largest fishery in North America and supported a major industry (Radovich 1982). Due to overfishing, sardine populations in the area declined until it was no longer economical to fish sardines in Pacific North America. With the decline in the population of the California sardine came an increase in the population of its primary competitor, the anchovy (Radovich 1982). This only added fuel to the problem. The California Fish and Game Commission took lessons from the death of the sardine industry and since then has embraced scientifically-based fisheries management (Radovich 1992)

Although direct scientific evidence is lacking, the similarity with the phenomenal collapse of the weakfish fishery in the mid-Atlantic is instructive. Once a thriving commercial and recreational fishery throughout the mid-Atlantic, weakfish stocks started to steadily decline in the 1980s and by the mid-1990s were considered to be in serious trouble—landings dropped from over 19 million pounds in 1982 to roughly 200,000 pounds in 2014 (ASMFC 2016). The majority of landings occur in North Carolina and Virginia and, since the early 1990s, the primary gear used to harvest has been gillnets (ASMFC 2016). Discarding of weakfish by commercial fishermen is known to occur, especially in the northern trawl fishery, and the discard mortality is assumed to be 100 percent (Broome et al. 2011).

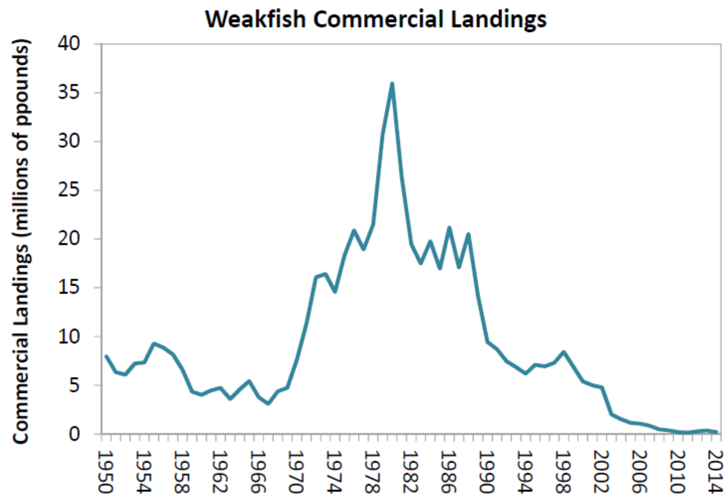


Fig. 3 – Weakfish Commercial Landings, 1950 – 2014

By 1996, the Atlantic States Marine Fisheries Commission (ASMFC) had adopted Amendment 3 as a long-term recovery plan to restore weakfish to healthy levels in order to maintain commercial and recreational harvests consistent with a self-sustaining spawning stock (ASMFC 2016). Unfortunately, while managers were preparing for a weakfish resurgence, something else was happening—unbeknownst to anyone—which would eventually cause a rapid increase in weakfish mortality. Increased predation from other species such as striped bass and spiny dogfish as well as competition with Atlantic croaker, decreasing prey items such as bay anchovy and Atlantic menhaden, and increasing water temperatures may all have been playing key roles in the weakfish decline (ASMFC 2016).

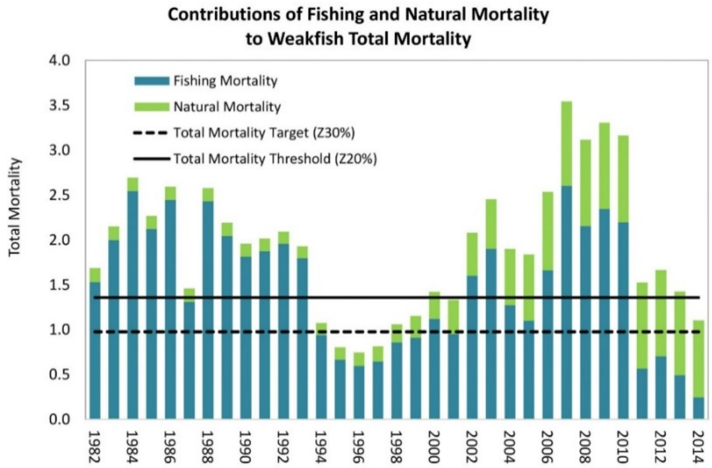


Fig. 4 – Fishing and Natural Mortality of Weakfish, 1982 - 2014

How many more productive North Carolina fisheries must go through this same precipitous decline before managers recognize that sustained injury to nursery habitats and the lack of adequate protection for juveniles and first time spawners is likely causing serious harm to the very ecosystem responsible for keeping North Carolina fisheries in business? In other words, although the main fisheries for weakfish and croaker take place in nearshore waters (Barbieri et al. 1994a, 1994b, Lowerre-Barbieri et al. 1995,1996), juvenile bycatch and nursery habitat destruction in Pamlico Sound will impact the fisheries by either increasing mortality of juvenile life stages or by destroying the habitats they inhabit (Broome et al. 2011).

VI. SOURCES OF MORTALITY FOR WEAKFISH, SPOT, CROAKER, AND OTHER SPECIES COMMONLY FOUND IN NORTH CAROLINA WATERS

Some people suggest that high fishing mortality on juvenile fishes has a negligible impact on population viability because natural mortality is already so high that, most likely, those fish would have died anyway. The key difference here is natural mortality versus fishing mortality. Natural mortality is the mortality fish populations experience due to natural causes such as old age, predation, disease, and environmental impacts. Fishing mortality is the mortality caused by any kind of fishing-related activity, including harvest, bycatch, and release mortality, to name a few (Hilborn and Walters 1992, Stearns 1992, Walters and Martell 2004). There is no question that early juvenile stages (i.e., young-of-the-year fingerlings) of weakfish, spot, croaker, and other species commonly found in Pamlico Sound have very high natural mortality (Barbieri et al. 1994b, Lowerre-Barbieri et al. 1995). This is due to a life history strategy selected (by natural selection) to produce huge numbers of eggs and larvae that can account for the high predation most fish species experience in early life. In other words, to compensate for the fact that most eggs, larvae, and early juveniles will be heavily preyed upon by larger-sized fish (sometimes other species but cannibalism is not uncommon) these fish have, over millions of years, evolved to produce very large numbers of young (Lowerre-Barbieri 2009). A good way to look at natural mortality in animals is to compare what is called their "Survivorship Curves" (Deevey 1947, Stearns1992, Walters and Martell 2004). Figure 3 below shows the typical shapes of survivorship curves for fish, reptiles, and mammals. Type I survivorship curves are characterized by high age-specific survival probability in early and middle life, followed by a rapid decline in survival in later life. They are typical of species that produce few offspring but care for them well, including humans and many other large mammals (Deevey 1947, Stearns 1992, Walters and Martell 2004). Type II curves are an intermediate between Types I and III, where roughly constant mortality rate/survival probability is experienced regardless of age. Some birds and some lizards follow this pattern (Deevey 1947, Stearns 1992). In Type III curves, the greatest mortality (lowest age-specific survival) is experienced early in life, with relatively low rates of death (high probability of survival) for those surviving this bottleneck. This type of curve is characteristic of species that produce a large number of offspring (see r/K selection theory, Stearns 1992, Winemiller and Rose 1992). This includes most fish and marine invertebrates.

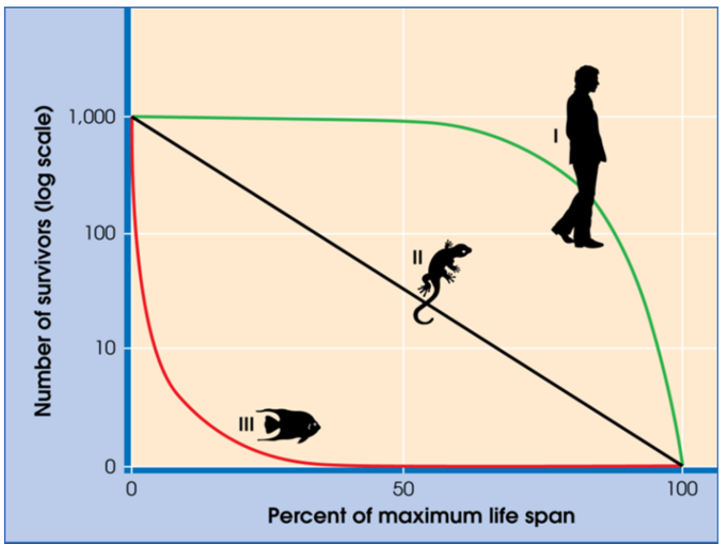


Fig. 5 – Most fishes (including Atlantic croaker, spot, and weakfish) have a type III natural survivorship curve, i.e., they experience exponentially higher mortality early in life (egg, larval, and juvenile stages).

Extrapolating this expected high rate of natural mortality to these species' ability to also withstand large rates of fishing induced mortality is nonsensical. Why is that?

Many decades of studies on fish population dynamics (e.g., Beverton and Holt 1957, Hilborn and Walters 1992, Walters and Martell 2004) clearly indicate that:

$$Z = M + F$$

Where, Z = total mortality, M = natural mortality, and F = fishing mortality.

Clearly, fishing mortality is *additive* to natural mortality, not a replacement for it. In other words, even though larvae and early juveniles of species that utilize nursery habitats in Pamlico Sound have been selected to have high rates of natural mortality this doesn't mean they are capable of also withstanding an additional source of mortality, especially at the magnitudes observed in North Carolina estuaries (Murray et al. 1992, Broome et al. 2011). The result is literally the meaning of adding insult to injury. As juveniles inhabiting more protected nursery areas grow, their natural tendency is to move to more open, higher salinity waters of the larger sounds and bays (Barbieri et al. 1994b). These fishes have survived during periods of the highest natural mortality and the level of mortality drops exponentially as they grow (Deevey 1947, Winemiller and Rose 1992; Walters and Martell 2004; Able 2005). It is at this time that these fishes, fit enough to have survived the early period of high mortality, become subjected to intense sources of fishing mortality—either by direct harvest or bycatch mortality (Murray et al. 1992, Broome et al. 2011).

The fish and invertebrate species that inhabit North Carolina estuaries are part of a complex ecosystem that fuels the productivity of fisheries in state waters and beyond (Barbieri et al. 1994a, 1994b, 1997; Lowerre-Barbieri et al. 1995, 1996, 1998). With adequate management and habitat protection—i.e., designation of Pamlico Sound as nursery habitat—these fisheries can support long-term sustainable harvest, generating fresh local seafood, business opportunities and jobs for millions of people. The consequences of continuing the current pattern of juvenile bycatch and discard mortality in North Carolina estuaries is irreparable harm to the ecosystem and destruction of the businesses that rely on fish and shellfish species that use these areas as nursery habitats.

VII. THE STATUS OF SPOT, CROAKER, AND WEAKFISH IN NORTH CAROLINA WATERS

Juvenile spot, croaker and weakfish dominate the finfish bycatch, making up a majority of the total bycatch in North Carolina estuaries (Broome et al. 2011). Not surprisingly, the stock status of these three species is considered poor (ASMFC 2010, 2015, 2016). Spot and croaker are classified by the North Carolina Division of Marine Fisheries as being of "concern," and weakfish are classified as "depleted." Stock assessments and other data summary reports conducted by ASMFC show the same pattern (ASMFC 2010, 2015, 2016). This is not surprising. It is estimated that each year, approximately 100 million juvenile Atlantic croaker, 50 million juvenile spot, and 25 million juvenile weakfish are caught and killed by otter trawls in Pamlico Sound (Broome et al. 2011). All are shoveled back into the Sound where they either get eaten or rot (Broome et al. 2011). The impact of this bycatch is uncertain, but because of the large number of pre-spawning age fish that are killed, common sense points to it being a major factor in the decline of these fish populations (ASMFC 2010, 2015, 2016; Broome et al. 2011).

In fisheries management the practice of implementing a minimum size limit is based on the concept that stock productivity relies on having enough spawning and egg production to maintain the surplus production above the replacement line (see Figure 6 below).

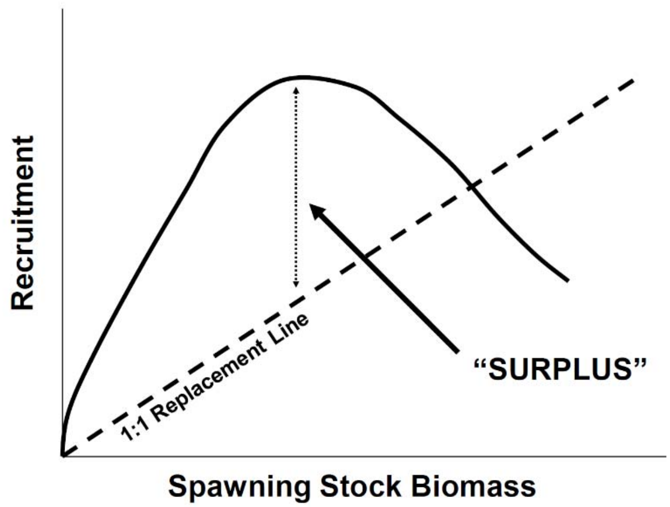


Fig. 6 – Recruitment and spawning stock biomass.

When fishing mortality removes too many young fish from the population, the result is a much smaller proportion of the population reaching sexual maturity and contributing to future stock productivity. Tropical and temperate fish populations like croaker, spot, and weakfish have the ability to withstand this type of negative impact for a short time given their high compensatory capacity (Kindsvater et al. 2016), but over time the ability of the stock to maintain long-term resilience is severely compromised (Lowerre-Barbieri et al. 2016). Consider the reproductive output (i.e., spawning potential, egg production) produced by a cohort of fish over its lifespan (by "cohort" we mean the fish born in a certain year). The equilibrium spawning potential (SP) per recruit is given by:

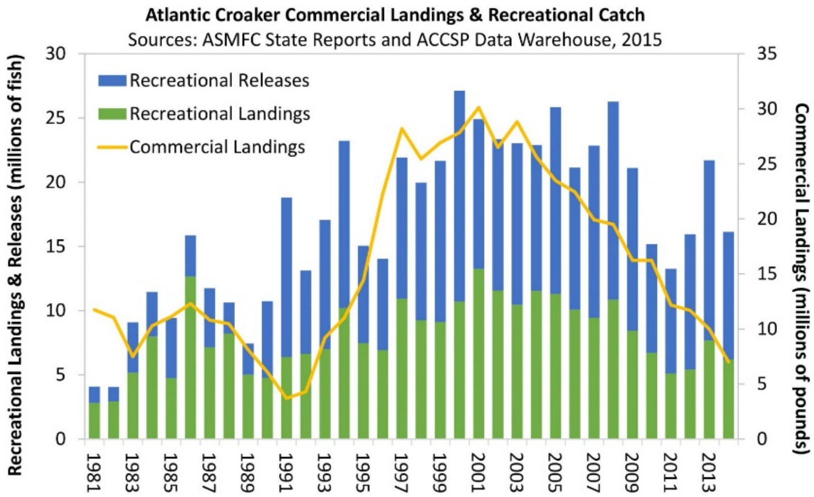
$$SP = \int_0^\infty B(a) \cdot Mat(a) \cdot \%Eggs \, da$$

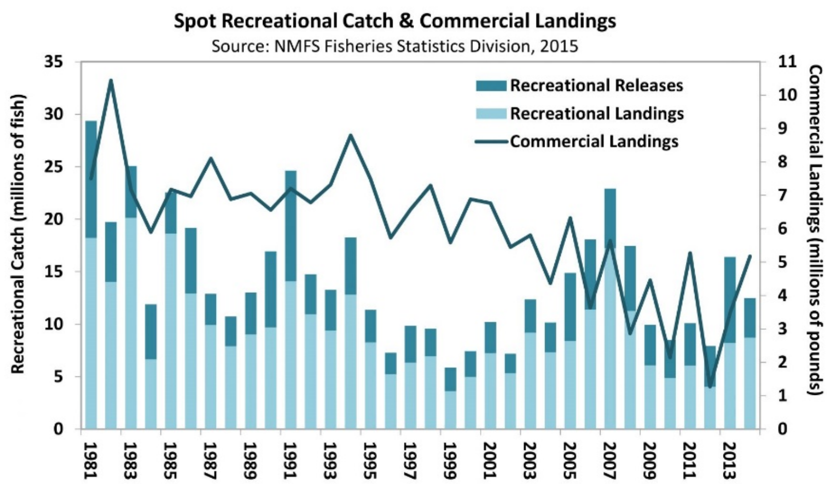
$$\frac{SP}{R} = \int_0^\infty \exp[-(M + F(a)) \cdot a] \cdot W(a) \cdot Mat(a) \cdot \%Eggs \, da$$

Where: **B(a)** is biomass at age of females, **Mat(a)** is the proportion mature at age, **%Eggs** is the proportion of a female's body mass that is ovaries.

It is clear from the equation above that the biomass of females at age, the proportion of females sexually mature at age, and the proportion of a female's body mass dedicated to reproduction (i.e., ovary tissue mass) are very important factors in maintaining the levels of reproduction needed to support long-term fisheries sustainability. Further, as discussed above, preventing fish from growing to their ideal size and weight has tangible consequences in terms of fisheries yield. For example, the figure below shows the equilibrium fishery yield expected under two scenarios. The levels of yield produced at different fishing mortality rates are much higher when the fish selected by the gear have grown to their ideal size and weight (black line). When the fish selected by the fishing gear are too young—and therefore too small—the yields produced are much lower.

Unfortunately, the negative impact on weakfish has been massive. Although Atlantic croaker and spot are not in such critical condition as compared to weakfish, landings of both these species are a fraction of what they once were (ASMFC 200, 2015). For all practical purposes, stocks of Atlantic croaker and spot in North Carolina and the mid-Atlantic region are in a state fisheries biologists call “sustainably overfished.” (Walters and Martell, 2004). This means that although their current level of depletion has not reached catastrophic levels and these stocks still support some level of fisheries harvest, the productivity of these stocks has been sapped to the point that they no longer support the fisheries and associated businesses that once thrived in the region (Hall 1999, Walters and Martell 2004).





Figs. 7, 8 - Atlantic Croaker and Spot Recreation and Commercial Landings, 1981 - 2013

As a result, the future of sustainable fisheries in North Carolina is at stake. Even with some fish populations displaying an extraordinary capacity for recovery, human interferences should never cause such drastic changes in the marine ecosystems we depend on (Walters and Martell 2004, Lowerre-Barbieri et al. 2015). Besides, the impacts caused by juvenile bycatch and discard mortality are multidimensional. For the economist, the impacts of these practices generate additional costs without affecting the revenues, and may hinder profitability. For the fishermen, these fishing practices cause conflicts among fisheries, give fishers a bad public image, generate regulations and limitations on the use of resources, and effect future yield.

In an article entitled "The Historical Collapse of Southern California Fisheries and the Rocky Future of Seafood," Katie Lee describes how economically valuable southern California fisheries (kelp and barred sand bass) collapsed "right under the noses of management agencies." Though the media tends to focus on the effects of pollution, climate change, or overfishing, outdated systems of management that do not explicitly incorporate habitat protection as part of a broader conservation strategy are actually the main cause of the collapse in many cases. In the particular case of North Carolina, a combination of improved and updated regulations that can provide the habitat protection needed for early life stages, late juveniles, and first time spawners throughout Pamlico Sound and other estuarine waters must be incorporated into fisheries management *before* fish populations collapse. Further, this added habitat protection would certainly benefit stocks already impacted and at low abundance and greatly assist their rebuilding to a healthy condition.

VIII. CONCLUSION

Dead discards and bycatch are major problems for fisheries in the southeastern United States. In North Carolina, extensive trawling and the use of other non-selective fishing methods are likely impacting the abundance and productivity of important commercial and recreational species such as Atlantic croaker, spot, and weakfish. These fishing practices lead to high levels of juvenile bycatch and discards, as well as ecosystem-level impacts such as the destruction of bottom habitats and the disruption of trophic interactions.

It is difficult to imagine that fishermen and fisheries managers are not very aware of this problem and have a strong desire to do something about it. The scientific evidence discussed throughout this paper shows clear evidence that:

(1) There is a definite need for a more inclusive, expanded nursery habitat designation in North Carolina estuarine systems. The system currently in place is outdated and does not follow a rigorous and scientifically-informed process.

(2) This problem is causing large bycatch mortality of economically and ecologically important species that support valuable fisheries (e.g., Atlantic croaker, spot, weakfish, and summer flounder). Further, shrimp trawling in large expanses of Pamlico Sound is very likely disrupting the bottom and negatively impacting the benthic communities needed to maintain ecosystem health.

(3) The Primary Nursery Areas (PNAs) designation in North Carolina affords some level of protection to upper estuarine habitats used by the very early life stages of fishes and macroinvertebrates (e.g., eggs, larvae, and post-settlement early juveniles). However, late juveniles, sub-adults, and first-time spawners moving into more open areas of Pamlico Sound are still subject to fishing mortality due to shrimp trawl bycatch and discards by other fisheries activities.

(4) Designation of the entire Pamlico Sound as a nursery habitat area would expand the protection of larger juveniles, sub-adults, and first-time spawners from shrimp trawling and other fishery mortality impacts. This action would also prevent or substantially decrease the ecosystem-level impacts of habitat alteration and food-web disruptions in

Pamlico Sound caused by bycatch, discards, and physical damage to benthic communities.

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EXHIBIT F

CURRICULUM VITAE

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EDUCATION

Ph.D. in Marine Science, The College of William and Mary, Virginia Institute of Marine Science, 1993
M.Sc. in Biological Oceanography, Rio Grande University, Brazil, 1986
B.S. in Biology, Santa Ursula University, Brazil, 1981

PROFESSIONAL EXPERIENCE

2003-present	Program Administrator, Marine Fisheries Research Program, Fish and Wildlife Research Institute, FWC
2000- present	Adjunct Graduate Faculty, Division of Marine and Environmental Systems, Florida Institute of Technology
1999-2003	Senior Research Scientist, Florida Marine Research Institute, FWC
1997-1999	Research Administrator, Florida Marine Research Institute, FWC
1995-1997	Assistant Research Scientist, Marine Institute, The University of Georgia
1993-1995	Postdoctoral Research Associate, Marine Institute, The University of Georgia

SCIENTIFIC PANELS AND COMMITTEES

2016-present	Co-Chair, 2016 Committee on Review of the Marine Recreational Information Program, Ocean Studies Board, National Academies of Science
2015-present	Chair, Scientific and Statistical Committee (SSC), Gulf of Mexico Fisheries Management Council
2012-present	Member, SSC, South Atlantic Fisheries Management Council
2012-2016	Chair, SSC, South Atlantic Fisheries Management Council
2010-2015	Florida Institute of Oceanography, Oil Spill Research Advisory Committee
2008-2012	Vice-Chair, SSC, South Atlantic Fisheries Management Council
2009-2010	Chair, ABC Control Rule Working Group, Gulf of Mexico Fishery Management Council
2009-2011	National SSC Working Group on Development of ABC Recommendations for Data Poor Stocks
2002-2008	Management and Science Committee, Atlantic States Marine Fisheries Commission

1998-2000 Marine Protected Areas Advisory Panel, South Atlantic Fisheries Management Council

SYNERGISTIC ACTIVITIES AND SERVICE

2015-present Fisheries Forum Advisory Group – Fisheries Leadership & Sustainability Forum, Nicholas Institute for Environmental Policy Solutions at Duke University.

2014-present Steering Committee – Southeast Marine Resource Education Program (MREP)

2013-present Board of Directors – Gulf Wild Program, Gulf of Mexico Reef Fish Shareholders Alliance.

2009 Keynote Speaker – Ibero-American Symposium on Reproductive Ecology, Recruitment, and Fisheries Management (SIBECORP), Nov. 23-27, Vigo, Spain.

HONORS AND AWARDS

2015 Captain Phil Chapman Conservation Award – awarded by the Florida Guides Association.

2013 The Aylesworth Award – awarded by the Southeastern Fisheries Association for outstanding service as a government employee.

RESEARCH GRANTS

Synthesizing spatial dynamics of recreational fish and fisheries to inform restoration strategies: red drum in the Gulf of Mexico – Gulf Research Program Data Synthesis Grant. Co-PI with K. Lorenzen, C. Adams, R. Ahrens, M. Allen, E. Camp, J. Dutka-Gianelli, S. Larkin, W. Pine, J. Struve, S.K. Lowerre-Barbieri, M. Murphy, and J. Tolan. October 1, 2015-September 31, 2018. $480,000.

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Assessment of Florida's Marine Hatchery Programs – U.S. Fish and Wildlife Service, Federal Aid in Sport Fish Restoration Program. Co-PI J. Estes. April 2009-March 2015. $1,103,333.

An evaluation of the effects of catch and release angling on survival and behavior of goliath grouper (*Epinephelus itajara*) with additional investigation into long-term residence and movement patterns – National Marine Fisheries Service, NOAA, Marine Fisheries Initiative (MARFIN) Program. Co-PI A. Collins. September 1, 2010 - August 31, 2013. $184,777.

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Development of standard methodologies to support a coast-wide approach to age determination of marine fishes – Atlantic Coastal Cooperative Statistical Program, ASMFC, NOAA. Co-PI with A.G. Woodward and D. DeVries. July 2002-June 2003. $61,661.

Fisheries habitat: identifying larval sources and essential fish habitat of juvenile snappers along the southeastern coast of the United States – National Sea Grant College Program, NOAA. Co-PI with S.R. Thorrold, R.K. Cowen, J.A. Hare, C.M. Jones and S. Sponaugle. August 2000-April 2003. $404,550.

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Reef Fish Abundance and Biology in Southeast Florida – U.S. Fish and Wildlife Service, Federal Aid in Sport Fish Restoration Program. April 1997-March 2001. $1,541,825.

Reproductive Parameters Needed to Evaluate Recruitment Overfishing of Spotted Seatrout in the Southeastern U.S. - National Marine Fisheries Service, NOAA, Saltonstall-Kennedy Program. Co-PIs S.K. Lowerre-Barbieri and J.J. Alberts. January-December 1997. $97,338.

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SELECTED PEER-REVIEWED PUBLICATIONS

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Barbieri, L.R., R.P. dos Santos and J.V. Andreata. 1992. Reproductive biology of the marine catfish, *Genidens genidens* (Siluriformes, Ariidae) in the Jacarepaguá Lagoon system, RJ, Brazil. Envir. Biol. of Fishes 35:23-35.

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