FISHERY MANAGEMENT PLAN UPDATE
BLUE CRAB
AUGUST 2020

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption:	December 1998
Amendments:	Amendment 1 – December 2004 Amendment 2 – November 2013 Amendment 3 – February 2020
Revisions:	May 2016 May 2020 Masonboro Sound Lower Cape Fear River DTMAs
Supplements:	None
Information Updates:	None
Schedule Changes:	August 2016
Next Benchmark Review:	2025

The original North Carolina Blue Crab Fishery Management Plan (FMP) was adopted in December 1998 (NCDMF 1998). The plan adopted several management changes including: 1) requiring sinking lines to be used on all crab pot buoys, 2) prohibited commercial gears (except attended gill nets) in crab spawning sanctuaries from March 1 through August 31, 3) prohibited baiting peeler pots except with live legal-size male blue crabs, 4) repealed the exemption for culling peelers before reaching shore in the hard crab fishery, 5) prohibiting the possession of white line peelers from June 1 through September 30, 6) changed the unattended pot rule from 10 days to seven days, 7) prohibiting setting pots in any navigation channel marked by State or Federal agencies, 8) modified crab pot area regulations to use depth instead of distance from shore, 9) implemented marking requirements for recreational pots, 10) defined collapsible traps as non-commercial gear, and 11) established a permit for shedding operations.

Amendment 1 was adopted in December 2004 (NCDMF 2004). The amendment implemented several management changes including: 1) establishing a 6.75-inch maximum size limit for mature females from September 1 through April 30 if the spawner index fell below the threshold for two consecutive years, 2) establishing a 5.25-inch maximum size limit for female peeler crabs from September 1 through April 30 if the spawner index fell below the threshold for two consecutive years, 3) prohibiting the sale of white-line peelers but allow possession by licensed peeler operations and requiring white-line peelers to be kept separate from pink and red-line

peelers, 4) extending the pot cleanup period by nine days, 5) change the unattended pot rule from seven days to five days, 6) requiring a four-inch stretch mesh tail bag for crab trawls in western Pamlico Sound (including the Pamlico, Pungo, Bay, and Neuse rivers), 7) separate hard and peeler crab trawl landings on trip ticket, 8) modifying channel net rule to incorporate limited blue crab bycatch provisions identical to those for shrimp trawls, 9) modifying user conflict rule to resolve user conflicts on a regional basis, 10) rule change to allow crab pots in all designated long haul areas in the Hyde, Beaufort, and Pamlico counties, 11) modifying the dates for designated crab pot areas from May 1 through October 31 to June 1 through November 30, 12) change designated pot area boundary description to a standardized six foot depth contour in many areas, and 13) prohibit the use of trawls in designated pot areas.

Amendment 2 was adopted in November 2013 (NCDMF 2013). The amendment implemented several management changes including: 1) repealing the spawner index trigger (and associated maximum size limits for mature female and peeler blue crabs) and replacing it with adaptive management framework based on the results of the annual Traffic Light Stock Assessment update, 2) open long haul areas in the Pungo River to pots, 3) add Lower Broad Creek to non-pot areas in rule, 4) modify crab dredging rule to conform to current harvest management, 5) incorporate Pamlico Sound four-inch crab trawl line into rule, 6) redefine criteria for exempting escape rings in crab pots from the 1.5-inch pot mesh size to unbaited pots and pots baited with a male crab, 7) repeal proclamation authority that allowed for the exemption of escape ring requirement to allow harvest of peeler crabs, 8) adopt no trawl line in Pamlico Sound and Newport River boundary in rule as new boundary for areas where closure of escape rings to take small mature female crabs is allowed, 9) modify trawl nets rule to identify Pamlico, Back, and Core sounds as areas that can open to peeler trawling by proclamation, 10) modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for various crab categories, and 11) establish proclamation authority to require terrapin excluders in crab pots and establish a framework for developing criteria and terrapin excluder specifications.

The NCMFC adaptive management strategy for blue crabs under Amendment 2 relied on the Traffic Light Stock Assessment as the tool to provide information on the relative condition of the stock. The base years (1987 to 2009) for assigning the signals in the Traffic Light Stock Assessment remained constant and was updated annually by July of each year.

Based on the results of the annual Traffic Light update, with 2015 data, management action was required by the North Carolina Marine Fisheries Commission (NCMFC). At their May 19, 2016 business meeting, the NCMFC was presented with several management options identified in the adaptive management framework in Amendment 2 to the N.C. Blue Crab FMP (NCDMF 2016). To improve the condition of the blue crab stock the NCMFC adopted the following management measures: 1) require one additional escape ring in crab pots and one of the three escape rings must be located within one full mesh of the corner of the pot and within one full mesh of the bottom of the apron/stairs (divider) of the upper chamber of the pot; 2) eliminate the harvest of v-apron immature female hard crabs (excluding peeler crabs); and include v-apron immature female hard crabs in the culling tolerance; 3) prohibit the harvest of dark sponge crabs (brown and black) from April 1-April 30 each year; and include dark sponge crabs in the culling tolerance; 4) lower the culling tolerance from 10 percent to five percent for all crabs, except

mature females; and 5) prohibit the harvest of crabs with dredges except incidental to lawful oyster dredging as outlined in NCMFC Rule 15A NCAC 03L .0203(a)(2).

All adaptive management measures became effective June 6, 2016 except for the additional escape ring requirement which was postponed until January 15, 2017 (NCDMF 2016). This delay coincided with the annual pot closure period to allow fishermen time to modify pots. The above actions taken by the NCMFC are documented in the May 2016 Revision to Amendment 2 to the N.C. Blue Crab FMP (NCDMF 2016).

The Benchmark Review of the Blue Crab FMP was originally scheduled to begin in July 2018 but at their August 2016 business meeting the NCMFC voted to move the review up on the FMP schedule to begin immediately. Consequently, the review of the Blue Crab FMP for development of Amendment 3 began in August 2016. The stock assessment has been completed and accepted for management use and Amendment 3 was adopted by the NCMFC at their February 19, 2020 business meeting (NCDMF 2020). The amendment retained measures implemented with the May 2016 revision to the Blue Crab FMP and implemented several management changes including: 1) crab harvest closure periods (January 1-31 north of the Highway 58 bridge to Emerald Isle and March 1-15 south of the Highway 58 bridge, 2) a 5-inch minimum size limit for mature female crabs statewide, 3) replacing the annual Traffic Light Stock Assessment update with an adaptive management framework based on an interim update of the 2018 benchmark assessment, 4) removal of all cull ring exempted areas, 5) new crab spawning sanctuaries established in Beaufort, Bogue, Bear, Browns, New River, Topsail, Rich, Mason, Masonboro, Carolina Beach, Cape Fear River, Shallotte, Lockwoods Folly, and Tubbs inlet with March 1-October 31 closure, 6) crab trawling prohibition in areas of the Pamlico, Pungo, and Neuse rivers where trawling for shrimp was prohibited, 7) adopted a process to designate Diamondback Terrapin Management Areas, and 8) addressed water quality issues requiring partnering with other commissions and state agencies (Table 1).

The Diamondback Terrapin Management Area (DTMA) framework in Amendment 3 contains the criteria required to identify areas of the state where terrapin excluder devices are required. Two DTMAs were established May 2020 in Masonboro Sound and the lower Cape Fear River. These areas have documented terrapin populations and significant waterbody area in which diamondback terrapins are susceptible to incidental capture. In 2021, all pots in these areas will be required to be modified with a NCDMF approved excluder device in each funnel from March 1 – October 31.

Management Unit

The management unit includes the blue crab (*Callinectes sapidus*) and its fisheries in North Carolina coastal waters.

Goal and Objectives

The goal of Amendment 3 to the North Carolina Blue Crab FMP is to manage the blue crab fishery to achieve a self-sustaining population that provides sustainable harvest using science-based decision making processes. The following objectives will be used to achieve this goal:

1. Implement management strategies that maintain/restore the blue crab spawning stock with multiple cohorts and adequate abundance to prevent recruitment overfishing.

2. Restore, enhance, and protect habitat and environmental quality necessary to maintain or increase growth, survival, and reproduction of the blue crab population.

3. Use biological, environmental, habitat, fishery, social, and economic data needed to effectively monitor and manage the blue crab fishery and its ecosystem impacts.

4. Promote stewardship of the resource through increased public awareness regarding the status and management of the blue crab fishery, including practices that minimize bycatch and discard mortality.

STATUS OF THE STOCK

Life History

The blue crab is common to all North Carolina coastal waters, but most reside in the Albemarle and Pamlico sounds and their tributaries. Blue crabs mature at approximately 12 to 18 months of age and have an average lifespan of three years with some living as long as eight years (Fischler 1965; Johnson 2004; Rugolo et al. 1997). Mating occurs in brackish areas of the estuary and lower portions of the rivers from late spring to early fall, and spawning occurs in high-salinity waters near the ocean inlets from early summer to fall (Forward et al. 2003; Whitaker 2006). The first larval stage is carried offshore by ocean currents where they undergo several stages of development (Van Engel 1958; Epifanio 1995). Settlement of larval blue crabs occurs in the estuaries after winds and tides transport them through the inlets from the ocean. Once within the estuary, larval blue crabs settle in beds of submerged aquatic vegetation and other complex habitats, like salt marsh and oyster shell, where they become juvenile blue crabs. Juvenile blue crabs gradually migrate to lower salinity waters in the upper estuaries and rivers to grow (molt) and mature (Etherington and Eggleston 2000). Molting is a process of growth in blue crabs that requires shedding the hard exoskeleton. Following each molt, the shell is soft for several hours until it hardens, during this time the crab is more vulnerable to predators. Juvenile and adult blue crabs typically eat what is available to them such as dead and live fish, crabs, shrimp, and shellfish (Laughlin 1982; Williams 1984; Hines et al. 1990; Cordero and Seitz 2014) and serve as food for predator species such as striped bass and red drum (Binion-Rock 2018).

Male and female blue crabs are easily identified by the shape of the apron on their abdomen. A mature male crab is called a "jimmy" and is easily recognized by the blue shading on his shell and claws and T-shaped apron on its underside. Female crabs are either called "sooks" as adults or "she-crabs" when immature. The immature female apron is triangular-shaped and held tightly against the abdomen. The mature female’s apron becomes rounded and can be easily pulled away from the body after the final molt. The "sponge crab" is a female that has an egg mass on her abdomen.

Stock Status

Results of the 2018 benchmark blue crab stock assessment indicate the stock is overfished and overfishing is occurring (NCDMF 2018). The spawner abundance threshold was estimated to be 64 million mature females on average, and the spawner abundance target was estimated to be 73 million mature females on average (Figure 1). The average spawner abundance for 2016 was estimated to be 50 million mature females (< the threshold) with a 95% CI of 37-68 million, which determines the population in 2016 is overfished with a probability of 0.98. The fishing mortality threshold and target were estimated to be 1.46 and 1.22 on average, respectively. The average fishing mortality for 2016 was 1.48 (> the *F* threshold) with a 95% CI of 0.86-2.42, which indicates overfishing is occurring in 2016 with a probability of 0.52.

Stock Assessment

The 2018 benchmark blue crab stock assessment used a sex-specific two-stage model applied to available data to assess the status of North Carolina's blue crab stock for 1995–2016 (NCDMF 2018). Data were available from commercial fishery monitoring programs and several fishery-independent surveys. Only hard crab landings were incorporated in the model and neither recreational or soft/peeler landings were included primarily due to their minimal contribution to the overall harvest. The two-stage model was developed based on the catch-survey analysis designed for species lacking information on the age structure of the population. The model synthesized information from multiple sources, tracked population dynamics of male and female recruits and fully recruited animals, estimated critical demographic and fishery parameters such as natural and fishing mortality, and thus, provided a comprehensive assessment of blue crab status in North Carolina. The hierarchical Bayesian approach was used to estimate model parameters, which can incorporate uncertainty associated with the data and model assumptions.

The model estimated an overall declining trend in catch, relative abundance indices, population size of both male and female recruits and fully recruited crabs, with a rebound starting in 2007. Females had higher natural mortality estimates than males. The estimated fishing mortality remained high before 2007, and decreased by approximately 50% afterwards.

The status of the blue crab stock was evaluated using biological reference points based on maximum sustainable yield (MSY). The MSY-based biological reference points (BRPs) have been widely used in fishery stock assessments including blue crabs, e.g., Chesapeake Bay 2001 (Miller et al. 2011), Florida 2007 (Murphy et al. 2007) and Gulf of Mexico 2013 assessments (VanderKooy 2013).

The fishing mortality that maximizes the total yield (F_{MSY}) was set to be the threshold for overfishing, and $0.75F_{MSY}$ was set to be the target fishing mortality. The spawner abundance at F_{MSY} (SP_{MSY}) and 0.75 F_{MSY} was set to be the threshold and target for overfished population, respectively. In the current stock assessment, the populaion is determined to be overfished if the average spawner abundance in 2016 falls below SP_{MSY}, and is determined to be undergoing overfishing if the average *F* in 2016 is above F_{MSY}.

STATUS OF THE FISHERY

Current Regulations

General Statutes

All management authority for North Carolina's blue crab fishery is vested in the State of North Carolina. Statutes that have been applied to the blue crab fishery include:

- Definitions relating to resources. G.S. 113-129.
- Definitions relating to activities of public. G.S. 113-130.
- Jurisdiction of fisheries agencies. G.S. 113-132.
- It is unlawful for any person without the authority of the owner of the equipment to take fish from said equipment. G.S. 113-268(a).
- It is unlawful for any vessel in the navigable waters of the State to willfully, wantonly, and unnecessarily do injury to any seine, net, or pot. G.S. 113-268(b).
- It is unlawful for any person to willfully destroy or injure any buoys, markers, stakes, nets, pots, or other devices or property lawfully set out in the open waters of the state in connection with any fishing or fishery. G.S. 113-268(c).

Marine Fisheries Commission Rules

The NCMFC has established several rules that directly govern the harvest of blue crabs. Below are rules and excerpts from rules that directly affect the blue crab fishery. The rules below do not cover all gear, area, or other rules which may impact the blue crab fishery. As regulations may change, please contact the North Carolina Division of Marine Fisheries (NCDMF) for the most current regulations.

Definitions

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. 15A NCAC 03I .0101(2)(c).

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. 15A NCAC 03I .0101(2)(f).

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 which 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. 15A NCAC 03I .0101(3)(c).

Mesh Length: The diagonal distance from the inside of one knot to the outside of the other knot, when the net is stretched hand-tight. 15A NCAC 03I .0101(3)(k).

Crab Harvest Restrictions
Hard crab minimum size limit of five inches measured from tip of spike to tip of spike for male and immature female hard blue crabs. Soft crabs shall be separated where taken and placed in a separate container. Peeler crabs shall be separated where taken and placed in a separate container. White-line peeler crabs shall be separated from pink and red-line peeler crabs where taken and placed in a separate container. Male crabs to be used as peeler bait are exempt from the five-inch size limit from March 1 through October 31 and shall be placed in a separate container. A culling tolerance of not more than five percent by number shall be allowed for white-line peelers in the pink and red-line peeler container [suspended by Proclamation M-11-2016]. It is unlawful to: sell white-line peelers, possess white-line peelers unless they are to be used by the harvester in the harvester's permitted blue crab shedding operation, possess male white line peelers from June 1 through September 1. It is unlawful to possess more than 50 crabs per person per day not to exceed 100 blue crabs per vessel per day for recreational purposes. To comply with management measures in the N.C. Blue Crab Fishery Management Plan, the Director of the NCDMF, may by proclamation, close the harvest of blue crabs and may impose any or all of the following restrictions on the commercial and recreational harvest of blue crab: specify, areas, season; time periods, means and methods, culling tolerance, and limit harvest based on size, quantity, sex, reproductive stage, or peeler stage. 15A NCAC 03L .0201.

Spawning Sanctuaries
It is unlawful to set or use trawls, pots, and mechanical methods for oysters or clams or take crabs with the use of commercial fishing equipment from crab spawning sanctuaries [15A NCAC 03R .0110] from March 1 through August 31. During the remainder of the year the Director may, by proclamation, close these areas and may impose any or all of the following restrictions: areas, time periods, means and methods, and limit harvest based on size, quantity, sex, reproductive stage, or peeler stage. 15A NCAC 03L .0205.

Peeler and Soft Crabs
It is unlawful to possess more than 50 blue crabs in a shedding operation without first obtaining a Blue Crab Shedding Permit from the NCDMF. 15A NCAC 03O .0503(c).

Recreational Harvest
- Blue crabs may be taken without a commercial license if the following gears are used; cast nets, collapsible crab traps with the largest open dimension no larger than 18 inches, a dip net 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; single bait-and-line equipment, or seines less than 30 feet. 15A NCAC 03I .0101(3)(c)(i), (ii), (iii), (vi), and (ix).

- Recreational crab pot buoys must be any shade of hot pink in color, and be no less than five inches in diameter and length and be engraved with the owner's last name and initials. If a vessel is used the buoy must also be engraved with the gear owner's current motorboat registration number or owner's U.S. vessel documentation name. 15A NCAC 03J .0302(a)(1) and (2).
- It is unlawful for a person to use more than one crab pot attached to the shore along privately owned land or to a privately-owned pier without possessing a valid Recreational Commercial Gear License. 15A NCAC 03J .0302(b).
- Up to five crab pots may be used by holders of the Recreational Commercial Gear License. 15A NCAC 03O .0302(a)(3).
- Peeler pots are not permitted to be used by holders of the Recreational Commercial Gear License. 15A NCAC 03O .0302(a)(3).
- One multiple hook or multiple bait trotline up to 100 feet in length may be used to harvest blue crabs. 15A NCAC 03O .0302(a)(4).
- Trotlines must be marked at both ends with any shade of hot pink in color, and be no less than five inches in diameter and length and be engraved with the owner's last name and initials. If a vessel is used the buoy must also be engraved with the gear owner's current motorboat registration number or owner's U.S. vessel documentation name. 15A NCAC 03J .0302.

Trawls

- It is unlawful to use trawl nets in designated pot areas opened to the use of pots and within an area bound by the shoreline to the depth of six feet. 15A NCAC 03J .0104(b)(6).
- It is unlawful to use shrimp trawls for the taking of blue crabs in internal waters, except that it shall be permissible to take or possess blue crabs incidental to commercial shrimp trawling provided that the weight of the crabs shall not exceed; 50 percent of the total weight of the combined crab and shrimp catch; or 300 pounds, whichever is greater. For individuals using shrimp trawls authorized by a Recreational Commercial Gear License, 50 blue crabs, not to exceed 100 blue crabs if two or more Recreational Commercial Gear License holders are on board. The Fisheries Director may, by proclamation, close any area to trawling for specific time periods in order to secure compliance with this rule. 15A NCAC 03J .0104(f)(1), (f)(2)(A) and (B), and (g).
- From December 1 through March 31 it is unlawful to possess finfish caught incidental to shrimp and crab trawling in the Atlantic Ocean unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish; except that trawlers working south of Bogue Inlet may keep up to 300 pounds of kingfish, regardless of their shrimp or crab catch weight. 15A NCAC 03J .0202(5).
- It is unlawful to take or possess crabs aboard a vessel in internal waters except in areas and during such times as the Fisheries Director may specify by proclamation. 15A NCAC 03L .0202(a).
- It is unlawful to take crabs with crab trawls with a mesh less than three inches, except in areas of western Pamlico Sound the minimum mesh length is four inches; the Director may, by proclamation, specify other areas for trawl mesh length and increase the minimum mesh length to no more than four inches. 15A NCAC 3L .0202(b)(1) and (2).

- It is unlawful to use trawls with a mesh length less than two inches or with a combined total headrope length exceeding 25 feet for taking soft or peeler crabs. 15A NCAC 03L .0202(c).
- It is unlawful to use trawl nets for any purpose in any of the special secondary nursery areas, except that the Fisheries Director, may, by proclamation, open any or all of the special secondary nursery areas, or any portion thereof to crab trawling from August 16 through May 14. 15A NCAC 03N .0105(b), 03R .0105, 03L .0100 and .0200.
- It is unlawful to use trawl nets in areas listed in 15A NCAC 03R .0106, except that certain areas may be opened to peeler trawling for single-rigged peeler trawls or double-rigged boats whose combined total headrope length does not exceed 25 feet. 15A NCAC 03J .0104(b)(4) and 03R .0106(1).

Crab Pots

- It is unlawful to leave pots in any coastal fishing waters for more than five consecutive days, when such pots are not being employed in fishing operations, except upon a timely and sufficient showing of hardship. 15A NCAC 03I .0105(b)(1), (b)(2)(A) and (B), (b)(3), and (c).
- All pots shall be removed from internal waters from January 15 through February 7. Areas may be reopened, by proclamation, to the use of pots after January 19 if it is determined that such areas are free of pots. 15A NCAC 03J .0301(a)(1).
- From June 1 through November 30 the use of crab pots is restricted in certain areas north and east of the Highway 58 Bridge at Emerald Isle. These areas are described in 15A NCAC 03R .0107(a). To allow for the variable spatial distribution of crustacea and finfish, the Fisheries Director may, by proclamation, specify time periods for or designate the areas described in 15A NCAC 03R .0107(b); or any part thereof, for the use of pots. From May 1 through November 30 in the Atlantic Ocean and west and south of the Highway 58 Bridge at Emerald Isle in areas and during time periods designated by the Fisheries Director by proclamation.15A NCAC 03J .0301(a)(2)(A) and (B), (a)(3), and 03R .0107(a) and (b).
- It is unlawful to use pots in any navigation channel maintained and marked by State or Federal agencies. 15A NCAC 03J .0301(b)(1).
- It is unlawful to use pots in any turning basin maintained and marked by the North Carolina Ferry Division. 15A NCAC 03J .0301(b)(2).
- It is unlawful to use pots in a commercial fishing operation unless each pot is marked by attaching a floating buoy which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length. Buoys may be any color except yellow or hot pink or any combination of colors that include yellow or hot pink. The pot owner's N.C. motorboat registration number, or U.S. vessel documentation name, or last name and initials shall be engraved in the buoy, or on a metal or plastic tag attached to the buoy. 15A NCAC 03J .0301(c)(1), (2), and (3).
- It is unlawful to use crab pots in coastal fishing waters unless each pot contains no less than two unobstructed escape rings that are at least 2 and 5/16 inches inside diameter and located in the opposite outside panels of the upper chamber of the pot except: unbaited pots, pots baited with a male crab, and pots set in areas described in 15A NCAC 03R .0118. 15A NCAC 03J .0301(g) [suspended by Proclamation M-11-2016, effective January 15, 2017].
- The Fisheries Director may, by proclamation, exempt the escape ring requirement describe in paragraph (g) in order to allow the harvest of mature female crabs and may impose any or

all of the following restrictions: specify time, areas, means and methods, seasons, and quantity. 15A NCAC 03J .0301(h).

- It is unlawful to use more than 150 pots per vessel in the Newport River. 15A NCAC 03J .0301(i).
- It is unlawful to remove crab pots from the water or remove crabs from pots between one hour after sunset and one hour before sunrise. 15A NCAC 03J .0301(j).
- It is unlawful to use pots to take crabs unless the line connecting the pot to the buoy is non-floating. 15A NCAC 03J .0301(k).

Crab Dredging

- It is unlawful to use any dredge weighing more than 100 pounds except in the Atlantic Ocean. 15A NCAC 03J .0303(a).
- It is unlawful to use more than one dredge per vessel to take crabs or to use any dredges between sunset and sunrise. 15A NCAC 03J .0303(b).
- It is unlawful to take crabs with dredges except from January 1 through March 1 in portions of Pamlico Sound. 15A NCAC 03L .0203(a)(1) [suspended by Proclamation M-11-2016, effective June 6, 2016] and 15A NCAC 03R .0109.
- Crabs may be taken incidental to lawful oyster dredging provided the weight of the crabs shall not exceed 50 percent of the total weight of the combined oyster and crab catch; or 500 pounds, whichever is less. 15A NCAC 03L .0203(a)(2)(A) and (B) [suspended by Proclamation M-11-2016, effective June 6, 2016].
- It is unlawful to take crabs with dredges between sunset and sunrise and between sunset on any Saturday and sunrise on the following Monday, except in the Atlantic Ocean. 15A NCAC 03L .0203(b).

Miscellaneous

- It is unlawful to possess, sell, or purchase fish under four inches in length except for use as bait in the crab pot fishery in North Carolina with the following provision: such crab pot bait shall not be transported west of U.S. Interstate 95 and when transported, shall be accompanied by documentation showing the name and address of the shipper, the name and address of the consignee, and the total weight of the shipment. 15A NCAC 03M .0103(1).

<u>Wildlife Resources Commission Rules</u>

Manner of Taking Nongame Fish Purchase and Sale

- Blue crabs shall have a minimum carapace width of five inches (point to point) and it is unlawful to possess more than 50 crabs per person per day or to exceed 100 crabs per vessel per day. 15A NCAC 10C .0401(a)(1).
- Blue crab taken by hook and line, grabbling or by licensed special devices may not be sold. 15A NCAC 10C .0401(c).

Taking Nongame Fish, Crustaceans, and Mollusks for Bait or Personal Consumption

- A single, multiple bait line for taking crabs not to exceed 100 feet in length that is under the immediate control and attendance of the user and is limited to one line per person and no more than one line per vessel. The line is required to be marked on each end with a solid

float no less than five inches in diameter and bearing legible and indelible identification of the user's name and address. 15A NCAC 10C .0402(a)(6).

- A collapsible crab trap with the largest opening not greater than 18 inches and which, by design, collapses at all times when in the water, except when being retrieved or lowered to the bottom. 15A NCAC 10C .0402(a)(7).
- Nongame fishes, crustaceans (crayfish and blue crabs), and mollusks taken for bait or personal consumption may not be sold. 15A NCAC 10C .0402(b).
- No more than 50 crabs per person, per day or 100 per vessel, per day with a minimum carapace width of five inches (point to point) from inland fishing waters or in designated waterfowl impoundments located on game lands. 15A NCAC 10C .0402(d)(3).

Special Device Fishing

- It is unlawful to use crab pots in inland fishing waters, except by persons owning property adjacent to the inland fishing waters of coastal rivers and their tributaries who are permitted to set two crab pots to be attached to their property and not subject to special device license requirements. 15A NCAC 10C .0404(e).

Commercial Landings

Commercial blue crab landings (hard, soft, and peeler crabs) averaged 36.6 million pounds from 1995 – 2016 (stock assessment years; Table 2). Generally, commercial blue crab landings have been lower recently and ranged from a high of 67.1 million pounds in 1996 to a low of 17.0 million pounds in 2018. The majority of blue crab landings are hard blue crabs. Landings for 2019 (22.9 million pounds) were 26 percent higher than 2018 and have been below the stock assessment years' average since 2003 (Figure 2). The majority of blue crab landings come from crab pots (97.5 percent in 2019) followed by peeler pots (2.1% in 2019), crab trawls (0.3% in 2019) and other gears (0.1% in 2019; Figure 3). Most crabs landed in 2019 were hard crabs (97.2 percent), followed by peeler (2.0 percent) and soft (0.8 percent) crabs (Figure 4).

Recreational Landings

A survey of Recreational Commercial Gear License (RCGL) holders conducted from 2002 – 2008 by the NCDMF indicated blue crabs were the most abundant species landed (by weight) by RCGL participants. During this time, on average, blue crabs accounted for 20 percent (116,797 pounds) of the total poundage (587,172 pounds) landed by RCGL holders. This survey was discontinued in 2009 so more recent estimates of RCGL harvest are unavailable. The harvest of RCGL exempted shore and pier-based pots, as well as other non-commercial gear, is unknown.

The Marine Recreational Information Program is primarily designed to sample anglers who use rod and reel as the mode of capture. Since blue crab are also harvested recreationally throughout coastal North Carolina, primarily by pots, this program does not provide precise estimates of recreational harvest. To address this, the division began a mail survey of Coastal Recreational Fishing License (CRFL) holders in the fall of 2010 to attempt to generate recreational harvest estimates for blue crab. One weakness of the survey is a CRFL is not required to harvest blue crab so the harvest from the recreational sector is likely underestimated. Full year results from this survey are available for 2011-2018 (Figure 5; Table 2). Generally, estimates of recreational

blue crab harvest were low, ranging from 47,766 blue crabs (approximately 15,922 pounds, using an average of three crabs per pound) in 2018 to 120,979 blue crabs (approximately 40,326 pounds) in 2012. For 2011 – 2019, the average annual recreational harvest of blue crab was 87,652 blue crabs (approximately 29,217 pounds).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

The number of blue crab lengths obtained from the fishery dependent sources from 1995 through 2019 ranged from 7,698 in 2018 to 33,007 in 1995 (Table 3). Mean carapace width (CW) varied little ranging from 5.5 inches to 6.0 inches. Minimum CW ranged from 1.2 inches to 3.8 inches. Maximum CW ranged from 7.8 inches to 9.1 inches. In general, the commercial fishery harvests a narrow size range of blue crab, with most crabs running from 5 to 6.25 inches CW. The length composition and modal length of blue crab caught in the commercial fishery has varied little over time (Figure 6).

The annual length of 50 percent maturity is compared across the stock assessment years of 1995 – 2016 (113.4 mm CW [4.5 inches]). In 2019, the length of 50 percent maturity was 115.2 mm CW (4.5 inches) and was above the mean for the stock assessment years (113.4 mm CW [4.4 inches]). The length of 50 percent maturity has been above the base years mean since 2005 (Figure 7).

Fishery-Independent Monitoring

The blue crab stock assessment uses several fishery-independent indices for the recruit and fully recruited indices. The base years used for the blue crab stock assessment were 1995 – 2016.

Recruit Abundance

The recruit indices use data from the Estuarine Trawl Survey (Program 120) and the Pamlico Sound Survey (Program 195) to monitor blue crab recruit abundance. Each index consists of blue crabs less than 127 mm CW (5.0 inches). Two indices are derived from Program 120, a male recruit index and a female recruit index (Figure 8). Four recruit indices are derived from Program 195, June indices by sex and September indices by sex (Figure 9).

Recruit relative abundance in Program 120 for male blue crabs has been below the stock assessment years' mean (4.5 crabs/tow) since 2010 (4.8 crabs/tow). Female recruit relative abundance has also been below the stock assessment years' mean (2.7 crabs/tow) since 2010 (2.8 crabs/tow). In 2019, recruit abundance was 1.9 crabs/tow for male blue crabs and 1.2 crabs/tow for female blue crabs. Recruit abundance for Program 195 varies greatly from year to year. In 2019, the June male recruit abundance was greater than the stock assessment years' mean (24.7 crabs/tow) at 33.2 crabs/tow. The June female recruit abundance was also greater than the stock assessment years' mean (26.6 crabs/tow) at 37.7 crabs/tow. September male recruit abundance was 2.2 crabs/tow and female recruit abundance was 2.1 crabs/tow, below the base years' means (3.1 crabs/tow; 3.2 crabs/tow, respectively).

Fully Recruited Abundance

The adult indices include data from the Juvenile Anadromous Trawl Survey (Program 100) and the Pamlico Sound Survey (Program 195). Indices consist of blue crabs greater than or equal to 127 mm CW (5.0 inches). Four indices are derived from Program 100, a male fully recruited index and a female recruit index by season (Figure 10). Program 195 also has four indices derived, June indices by sex and September indices by sex (Figure 11).

Fully recruited summer abundances in Program 100 for male and female blue crabs have been above the stock assessment years' mean (1.34 crabs/tow; 0.53 crabs/tow, respectively) since 2018 (6.64 crabs/tow; 2.74 crabs/tow, respectively). Fall male and female blue crabs fully recruited abundances have been above the stock assessment years' mean (2.26 crabs/tow; 2.25 crabs/tow, respectively) since 2017 (2.84 crabs/tow; 2.54 crabs/tow, respectively). In 2019, fully recruited abundance of male blue crabs in summer was 2.75 crabs/tow and 4.04 crabs/tow in fall. Female blue crabs fully recruited abundance in in 2019 was 1.06 crabs/tow in summer and 2.90 crabs/tow in winter. Program 195 fully recruited abundance does not vary in the same way as the recruit abundance. In 2019, the June male fully recruited abundance was greater than the stock assessment years' mean (1.78 crabs/tow) at 1.96 crabs/tow. The June female recruit abundance was markedly greater than the stock assessment years' mean (3.00 crabs/tow) at 13.16 crabs/tow. September male fully recruited abundance has been below the average stock assessment years' mean (1.62 crabs/tow) since 1999 (3.37 crabs/tow). This is mostly due to large catches from 1996-1999. In 2019, September male fully recruited abundance was 0.30 crabs/tow. Female fully recruited abundance for September also had a few outlier years early in the time series, however, not to the same degree as the male abundance. In 2019, September fully recruited female blue crab abundance was below the stock assessment years' mean (3.71 crabs/tow) at 1.04 crabs/tow.

MANAGEMENT STRATEGY

Amendment 3 adopted an adaptive management framework, replacing the traffic light, based on the peer-reviewed and approved stock assessment model. Division staff will update the stock assessment at least once between full reviews of the FMP. If the stock is overfished and/or overfishing is occurring or it is not projected to meet the sustainability requirements, management measures shall be adjusted using the director's proclamation authority. If the stock is not overfished and overfishing is not occurring, management measures may be relaxed provided it will not jeopardize the sustainability of the blue crab stock. Any quantifiable management measure with the ability to achieve sustainable harvest (as defined in the stock assessment), either on its own or in combinations, may be considered. The director's proclamation authority for adaptive management is contingent on consultation with the Northern, Southern, and Shellfish/Crustacean advisory committees as well as approval by the NCMFC.

Principal Issues

Several management issues were explored in Amendment 3; Table 1 outlines the specific issues explored and the implementation status of each management strategy.

RESEARCH NEEDS

Several research needs were identified in N.C. Blue Crab Fishery Management Plan Amendment 3; the bulleted list below outlines the specific needs and highlights the priority of each management and research need.

Biological/Stock Assessment/Fishery

- Implement long-term monitoring of blue crab discards in other fisheries (e.g., gill net, trawl). [High]
- Develop statewide fishery-independent survey(s) to monitor the abundance of all blue crab life stages. [High]
- Expand time and area coverage of existing fishery-independent surveys. [High]
- Better characterize the magnitude of recreational harvest. [High]
- Develop better estimates of life-history parameters, especially growth and natural mortality. [High]
- Explore alternative biological reference points. [High]
- Research interaction rates of non-target species in the blue crab fishery and identify factors that may lead to interactions (e.g., migration patterns, habitat utilization). [High]
- Characterize the harvest and discard of blue crabs from crab shedding operations. [Medium]
- Explore alternative model types. [Medium]
- Investigate and support research on promising methods to age blue crabs. [Low]
- Evaluate the genetic stock structure of blue crabs within North Carolina and the magnitude of mixing between populations. [Low]
- Identify programs outside the NCDMF that collect data of potential use to the stock assessment of North Carolina's blue crabs. [Low]

Ecosystem

- Identify biological characteristics of submerged aquatic vegetation beds of ecological value to blue crab and implement restoration and conservation measures. [High]
- Research mature female migration routes and seasonal habitat use (e.g., inlets, staging areas). [High]
- Research gear modifications to minimize interactions with non-target species (e.g., diamondback terrapin) in the blue crab fishery. [High]
- Research the impacts of land use activities and shoreline clearing on water quality and the blue crab stock. [High]
- Research the impact of endocrine disrupting chemicals on the various life stages of blue crabs and ways to reduce their introduction into estuarine waters, including discharge from wastewater treatment plants. [High]
- Research the impact of increased predator abundance on the blue crab stock. [Medium]
- Identify key environmental factors that significantly impact North Carolina's blue crab stock and investigate assessment methods that can account for these environmental factors. [Medium]
- Identify, map, and protect habitat of ecological value to blue crab (in particular juvenile habitat) and implement restoration and conservation measures. [Medium]

- Assess the impact of inlet dredging activities on mature female blue crabs. [Medium]
- Implement monitoring of hazardous events (e.g., hurricane, extreme hot or cold weather) affecting blue crab population dynamics and harvest. [Medium]
- Research the extent, causes, and impacts of hypoxia and anoxia on blue crab behavior and population abundance in estuarine waters. [Medium]
- Research the impact of invasive species (e.g., blue catfish) on the blue crab stock. [Medium]

Socio/Economic

- Research and identify key market forces and their effects on the blue crab industry. [Low]

FISHERY MANAGEMENT PLAN RECOMMENDATION

The division is continuing to implement Amendment 3, which was adopted by the NCMFC in February 2020. An update to the 2018 benchmark stock assessment will begin no sooner than 2023 and will include data through the previous year. The next scheduled review of this plan will begin in July 2025.

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TABLES

Table 1. Summary of management strategies and outcomes from N.C. Blue Crab Fishery Management Plan Amendment 3.

Management Strategy	Implementation Status
A closed season in which the region will remain closed for the entirety [replaced the variable pot closure period(s) prior to Amendment 3] • Jan. 1 - 31 north of the Highway 58 bridge to Emerald Isle • March 1 - 15 south of the Highway 58 bridge	Proclamation M-8-2020
A 5-inch minimum size limit for mature female crabs statewide	Proclamation M-8-2020
Retain the prohibition on harvest of immature female hard crabs statewide, established in the 2016 Revision	Proclamation M-8-2020
Retain the current 5% cull tolerance, established in the 2016 Revision	Proclamation M-8-2020
Adopt an adaptive management framework based on the stock assessment: • Update the stock assessment at least once between full reviews of the FMP, timing at the discretion of the division • If the stock is overfished and/or overfishing is occurring or the blue crab stock is not projected to meet the sustainability requirement, management measures shall be adjusted using the director's proclamation authority • If the stock is not overfished and/or overfishing is not occurring management measures may be relaxed provided it will not jeopardize the sustainability of the blue crab stock • Any quantifiable management measure, including those not explored in this paper, with the ability to achieve sustainable harvest (as defined in the stock assessment), either on its own or in combination, may be considered	Proclamation M-8-2020
Maintain number of cull rings in pots to 3, established in the 2016 Revision	Proclamation M-8-2020
Maintain one cull ring placed within one full mesh of the corner and the apron in the upper chamber of the pot, established in 2016 Revision	Proclamation M-8-2020
Remove cull ring exemptions for Newport River and eastern Pamlico Sound and prohibit designation of exempt areas in future	Proclamation M-8-2020
Maintain prohibited harvest of dark sponge crabs from April 1 through April 30, established in 2016 Revision	Proclamation M-8-2020

Management Strategy	Implementation Status
Work with other commissions and state agencies to address water quality issues affecting blue crab. Strategies selected are: • Highlight problem areas and advise other regulatory agencies • Create a joint interagency work group • Support the Clean Water Act • Task the CHPP steering committee to prioritize blue crab water quality impacts [NCMFC identified as the highest priority, Option 4] • Send letters to other state agencies sharing concerns about water quality and Best Management Practices • Invite other agencies to future NCMFC meetings to present their efforts to address water quality • Initiate public outreach on how to report crab and fish kills	Under consideration by CHPP steering committee
Division habitat staff shall regularly report back to the Habitat and Water Quality and Shellfish/Crustacean ACs with progress on each selected management water quality issue	Under consideration by CHPP steering committee
Maintain existing boundaries for the Oregon, Hatteras, and Ocracoke inlets crab spawning sanctuaries; expand the existing crab spawning sanctuary in Barden Inlet and move the boundary of the Drum Inlet sanctuary to encompass Ophelia Inlet	Proclamation M-7-2020
Maintain existing mechanical gear restrictions and prohibition of crab harvest from March 1 -August 31	Proclamation M-7-2020
Establish new crab spawning sanctuaries in Beaufort, Bogue, Bear, Browns, New River, Topsail, Rich, Mason, Masonboro, Carolina Beach, Cape Fear River, Shallotte, Lockwoods Folly and Tubbs inlets	Proclamation M-7-2020
NCDMF recommended boundary approved for Cape Fear River Inlet sanctuary	Proclamation M-7-2020
Closure period of March 1 through October 31 for new sanctuaries with the same gear and harvest restrictions as existing sanctuaries	Proclamation M-7-2020

Management Strategy	Implementation Status
Adopted the framework and criteria for identifying diamondback terrapin management areas, adding a step to bring proposed management areas back to the NCMFC following committee meetings at the next regularly scheduled meeting for approval. The framework is this document in total and consists of the following criteria: • Step 1 Determine NCDMF approved terrapin excluder device types and sizes to be required • Step 2 Determine dates when terrapin excluder devices will be required • Step 3 Identify the zone of potential diamondback terrapin interaction with crab pots • Step 4 Validate diamondback terrapin presence and overlap with zone of potential crab pot interaction • Step 5 Determine appropriate Diamondback Terrapin Management Area (DTMA) boundaries • Step 6 Develop initial issue paper detailing the proposed DTMA, presented issue to the appropriate regional committee, and receive public comment • Step 7 NCMFC review documents and take action to adopt, adopt with modification, or deny proposed DTMA • Step 8 Implement adopted DTMA by proclamation and incorporate the finalized issue paper as a revision to the FMP	Completes process established in NCMFC Rule 15A NCAC 03L .0204(b), April 1, 2014
Retain prohibiting taking of crabs with crab dredges, established in the 2016 Revision	Proclamation M-8-2020
Reduce the bycatch limit of crabs from oyster dredges to 10% of the total weight of the combined oyster and crab catch or 100 pounds, whichever is less	Proclamation M-8-2020
Prohibit the taking of crab by trawls in areas where the taking of shrimp with trawls are already prohibited in the Pamlico, Pungo, and Neuse rivers	Proclamation SH-1-2020

Table 2. Blue crab recreational harvest (number and weight) and releases (number) and commercial harvest, 1987 – 2019. Recreational harvest weight is calculated using a standard conversion of 3 crabs per pound.

	Recreational*			Commercial	Total
	Numbers		Weight (lb)	Weight (lb)	Weight (lb)
Year	Landed	Released	Landed	Landed	Landed
1987	-	-	-	32,423,604	32,423,604
1988	-	-	-	35,604,423	35,604,423
1989	-	-	-	34,724,673	34,724,673
1990	-	-	-	38,070,328	38,070,328
1991	-	-	-	41,829,676	41,829,676
1992	-	-	-	41,068,374	41,068,374
1993	-	-	-	43,672,732	43,672,732
1994	-	-	-	53,513,124	53,513,124
1995	-	-	-	46,443,541	46,443,541
1996	-	-	-	67,080,200	67,080,200
1997	-	-	-	56,090,109	56,090,109
1998	-	-	-	62,076,171	62,076,171
1999	-	-	-	57,546,676	57,546,676
2000	-	-	-	40,638,384	40,638,384
2001	-	-	-	32,180,390	32,180,390
2002	-	-	-	37,736,319	37,736,319
2003	-	-	-	42,769,797	42,769,797
2004	-	-	-	34,130,608	34,130,608
2005	-	-	-	25,430,119	25,430,119
2006	-	-	-	25,343,158	25,343,158
2007	-	-	-	21,424,960	21,424,960
2008	-	-	-	32,916,691	32,916,691
2009	-	-	-	29,707,232	29,707,232
2010	-	-	-	30,683,011	30,683,011
2011	114,426	81,763	38,142	30,035,392	30,073,534
2012	120,979	79,072	40,326	26,785,669	26,825,995
2013	94,174	61,452	31,391	22,202,623	22,234,014
2014	100,597	67,413	33,532	26,231,112	26,264,644
2015	71,587	60,135	23,862	32,127,043	32,150,905
2016	84,879	82,781	28,293	25,462,740	25,491,033
2017	72,645	67,667	24,215	19,273,156	19,297,371
2018	47,766	57,024	15,922	17,013,514	17,028,276
2019	81,815	78,784	27,272	22,987,370	23,014,642
Average	87,652	70,677	29,217	35,915,811	35,923,779

*Recreational data collection began in October 2010 and the first full year estimates were available in 2011.

Table 3. Blue crab length (carapace width [CW], inches) data from commercial fish house samples, 1995-2019.

Year	Mean CW	Minimum CW	Maximum CW	Total Number Measured
1995	5.6	2.0	8.3	33,007
1996	5.7	2.7	8.3	23,333
1997	5.6	2.7	8.1	22,001
1998	5.7	3.4	7.9	15,246
1999	5.5	1.2	7.8	13,456
2000	5.7	3.4	8.0	15,560
2001	5.7	2.9	9.1	18,316
2002	5.5	3.5	8.3	11,417
2003	5.7	3.3	7.8	11,802
2004	5.7	3.2	8.6	17,386
2005	5.6	3.2	8.3	10,474
2006	5.7	3.3	8.1	10,867
2007	5.7	3.4	8.0	14,898
2008	5.9	3.0	8.7	20,420
2009	6.0	3.7	8.7	17,910
2010	5.7	2.7	8.4	16,123
2011	5.8	2.9	8.3	16,461
2012	5.8	3.8	8.6	12,918
2013	5.8	1.9	8.5	17,616
2014	5.9	2.3	8.5	11,304
2015	5.8	2.2	9.0	14,681
2016	5.7	3.5	9.0	13,531
2017	5.8	3.6	8.1	9,978
2018	5.8	3.7	8.1	7,698
2019	5.7	3.8	8.4	11,779

FIGURES

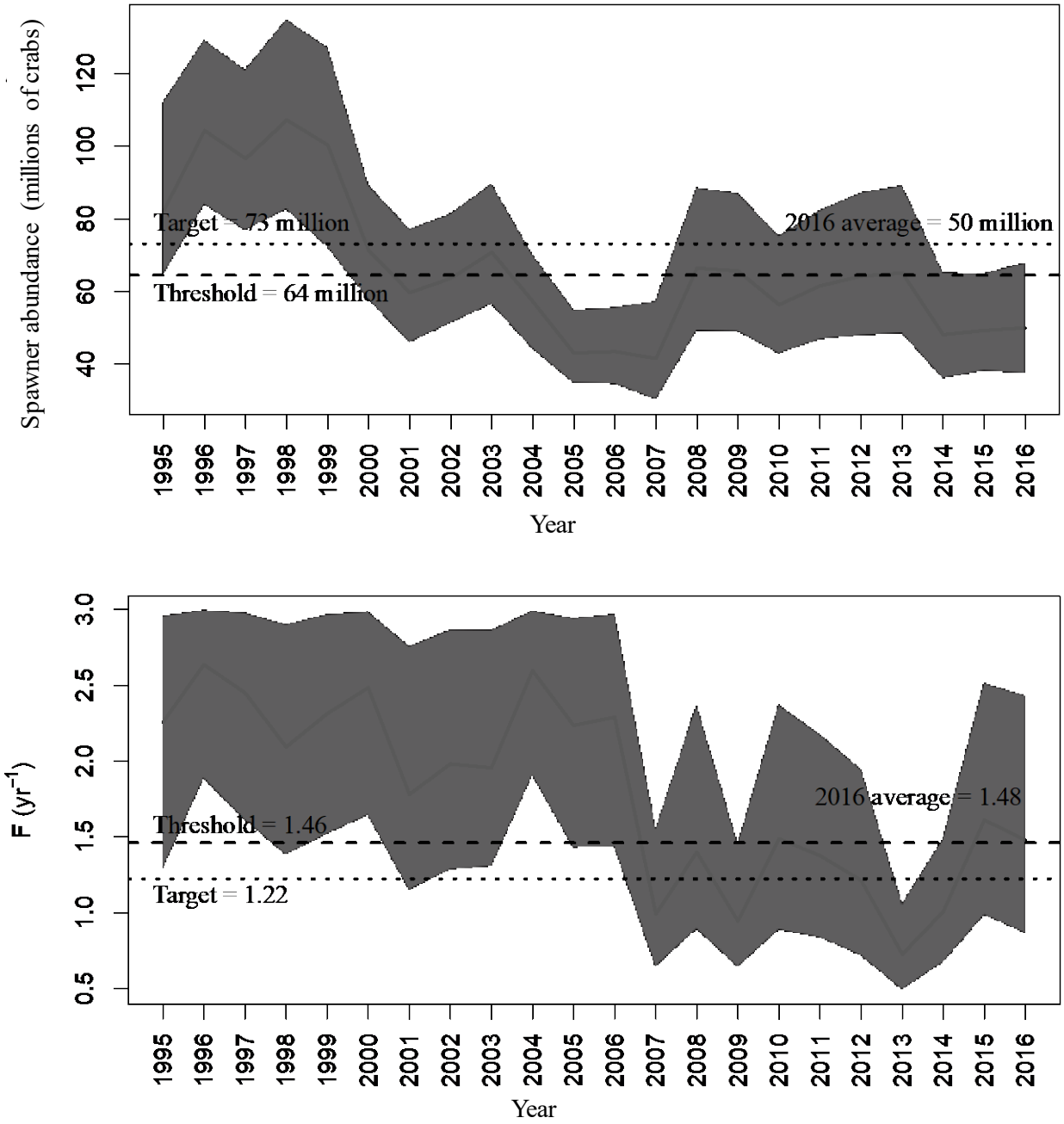


Figure 1. Estimated spawner abundance (mature female blue crabs) and fishing mortality (F) from the 2018 blue crab stock assessment (NCDMF 2018). The solid lines represent the posterior mean and the shaded area represents the 95% credible interval. The threshold and target values are the posterior means (dashed lines).

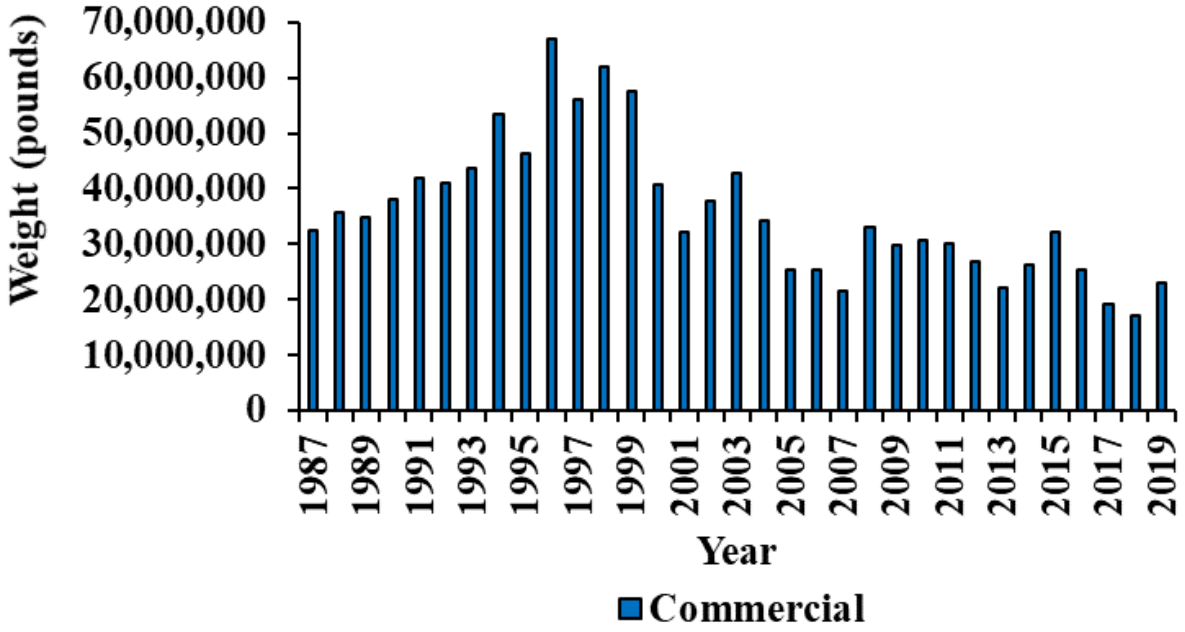


Figure 2. Annual blue crab commercial landings, 1987-2019. Landings include hard, soft, and peeler crabs.

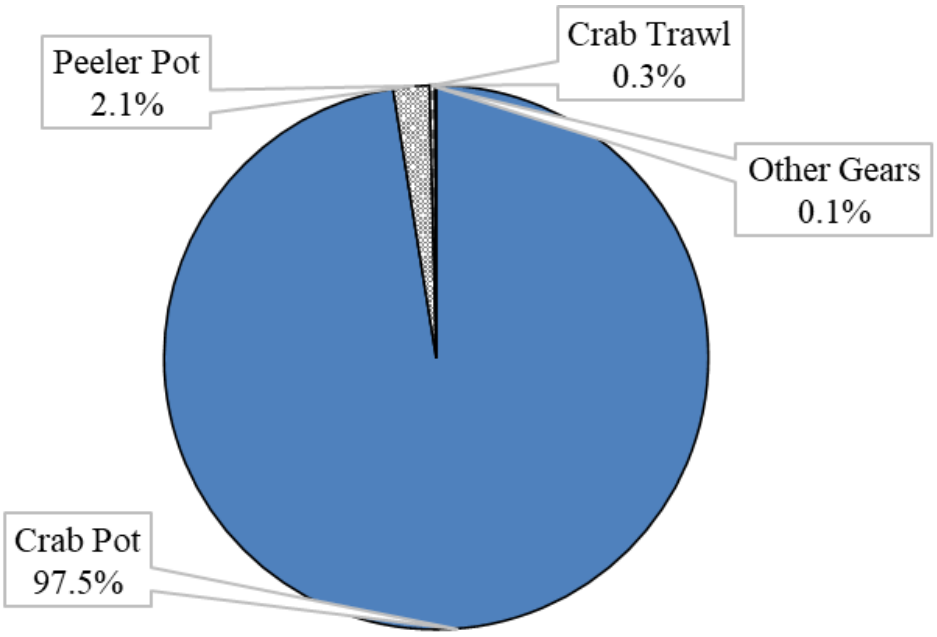


Figure 3. Commercial harvest (pounds) of blue crab by gear, 2019.

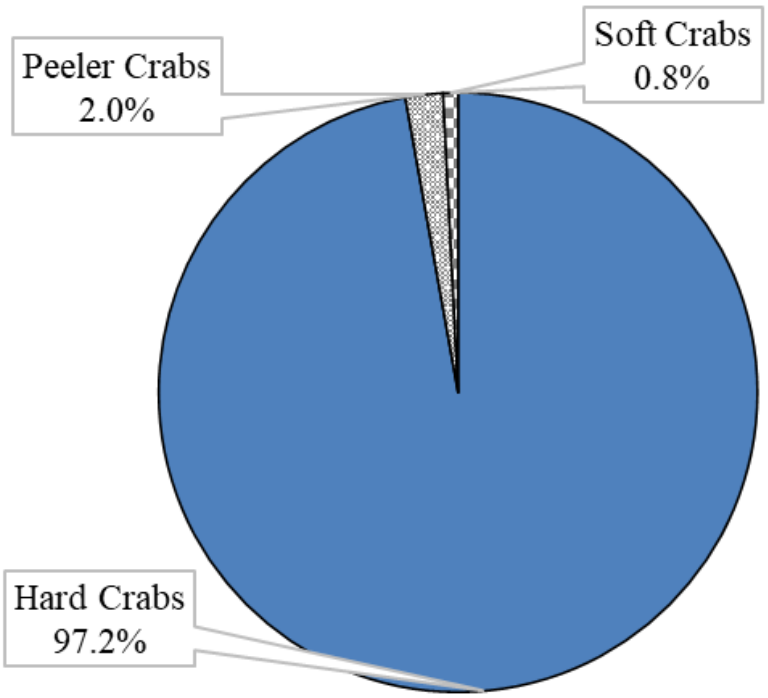


Figure 4. Commercial harvest (pounds) of blue crab by crab type, 2019.

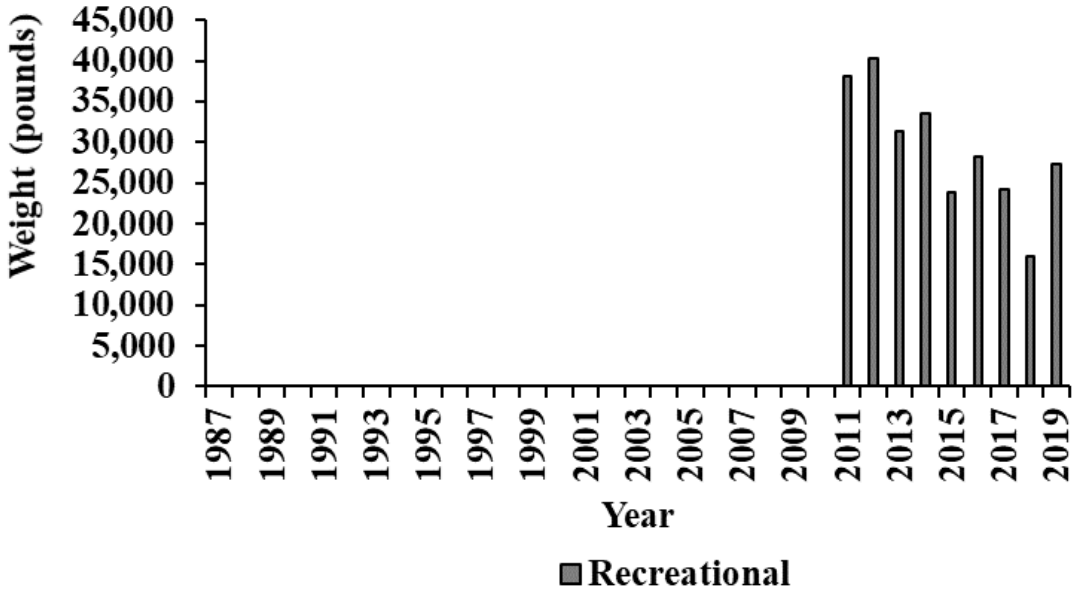


Figure 5. Annual blue crab recreational harvest, 1987-2019. Recreational mail survey began in October 2010 with the first full year of data available for 2011.

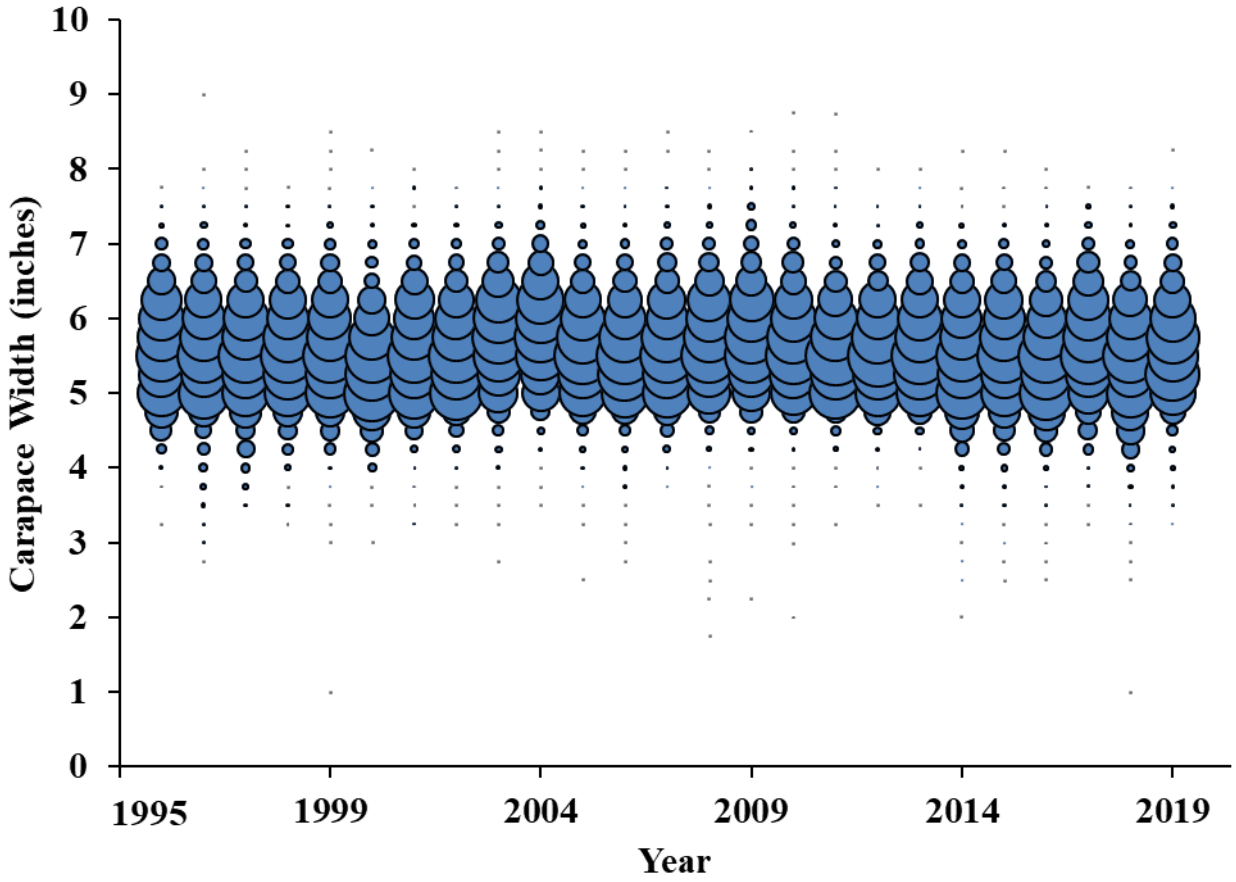


Figure 6. Commercial length frequency (carapace width, inches) of hard blue crab harvested, 1995-2019. Bubble represents the proportion of crabs at length.

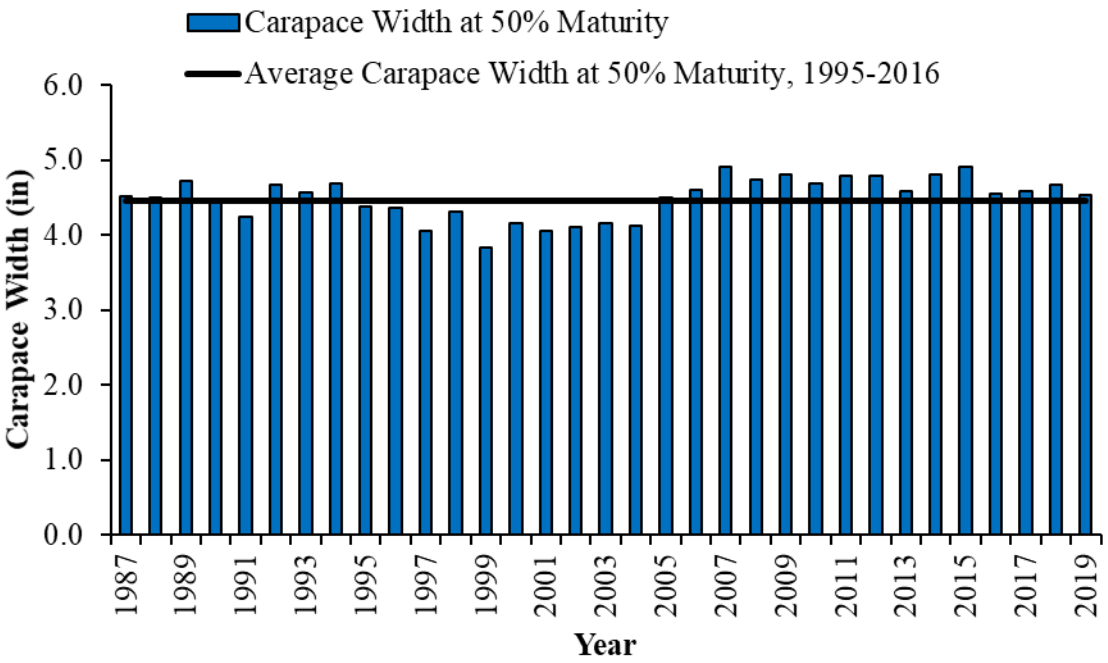
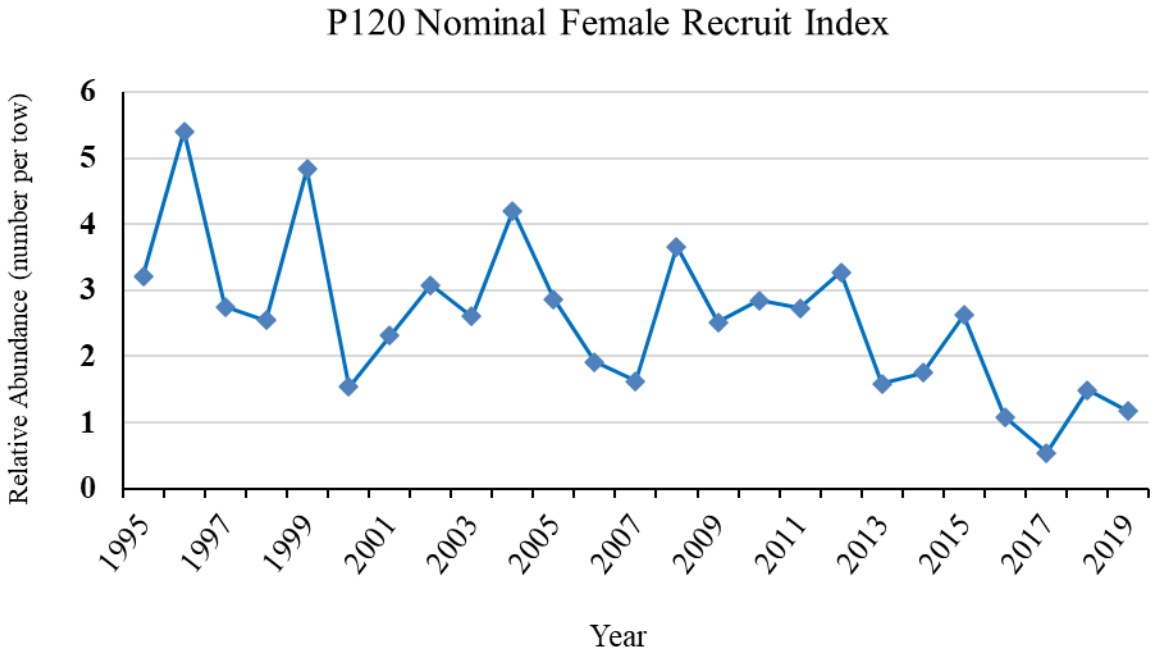


Figure 7. Length at 50% maturity for female blue crabs compared to stock assessment years, 1995-2016. Fishery-dependent and independent data were included in the analysis.



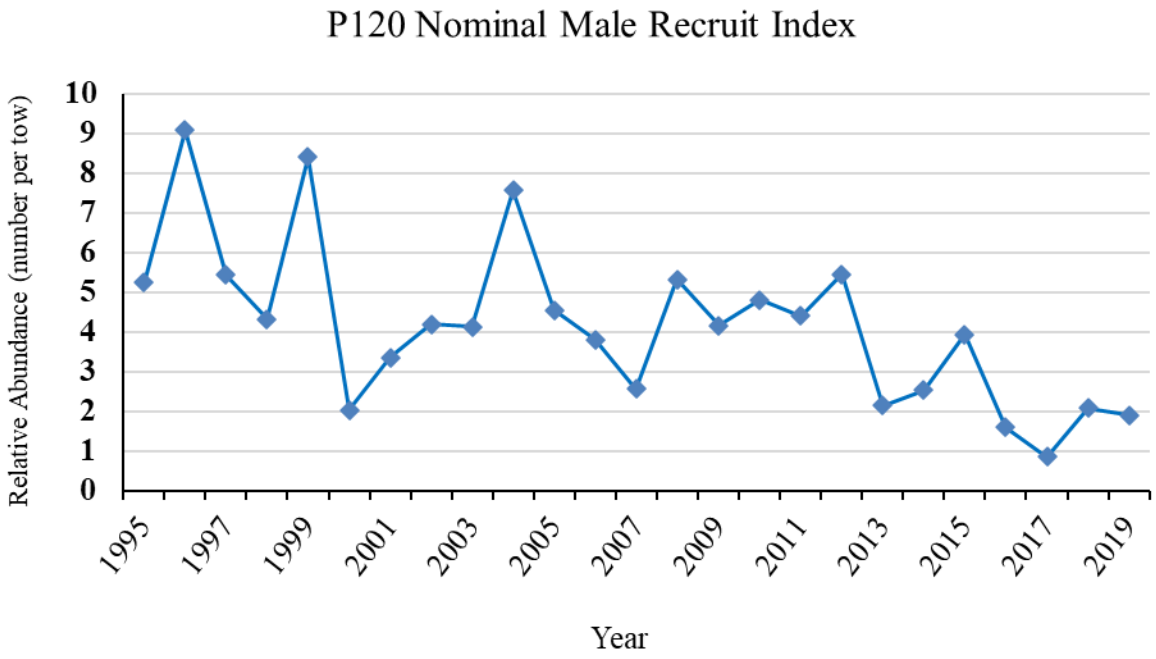
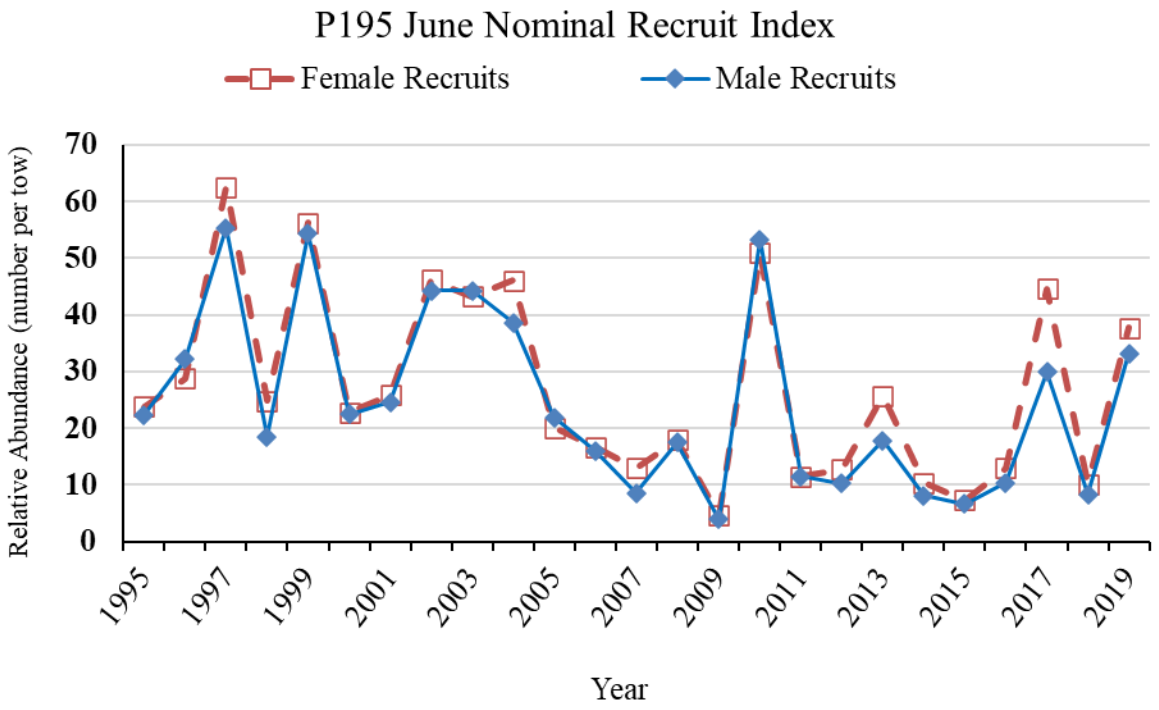


Figure 8. Nominal index (number of crabs per tow) of recruit crabs (<127 mm CW) captured in Program 120 in May and June by sex, 1995-2019.



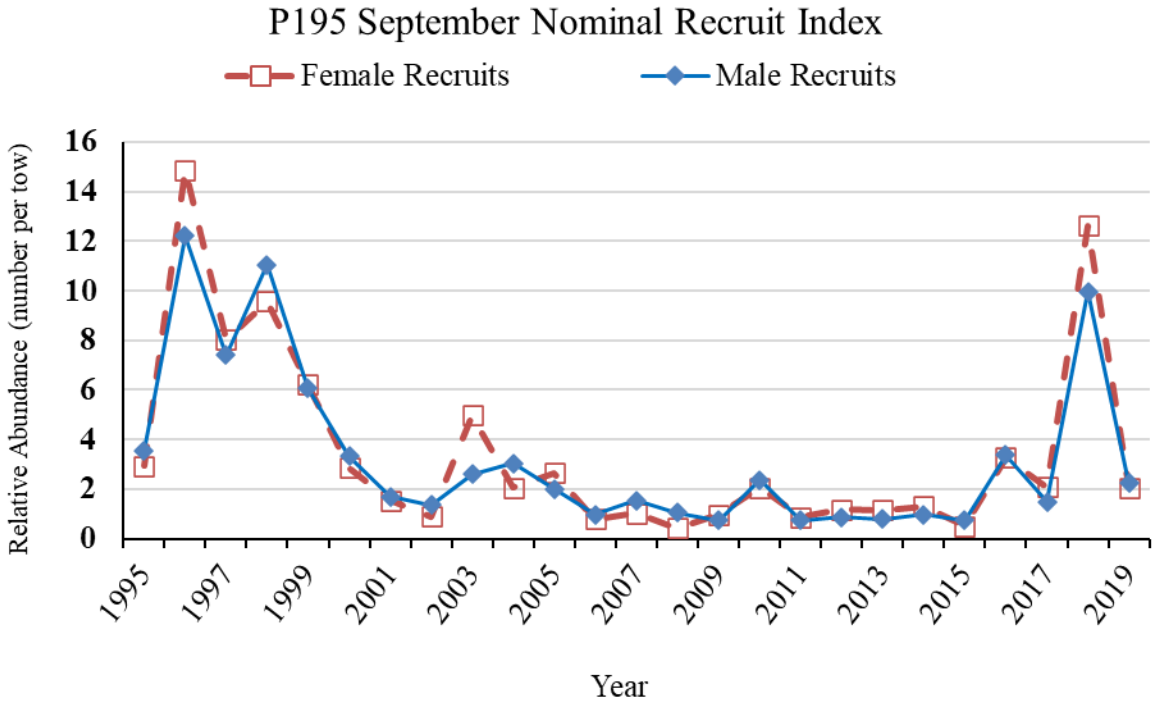
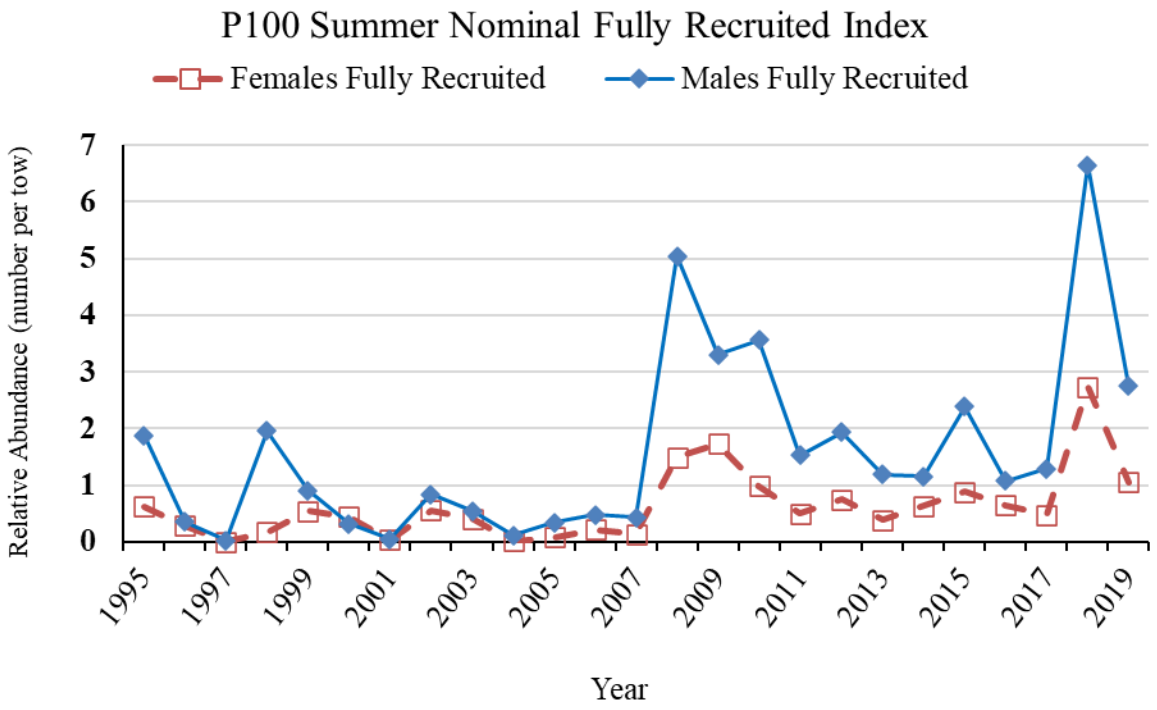


Figure 9. Nominal index (number of crabs per tow) of recruit crabs (<127 mm CW) captured in Program 195 by month and sex, 1995-2019 for all strata combined. [Note: 2018 sampling was conducted in October]



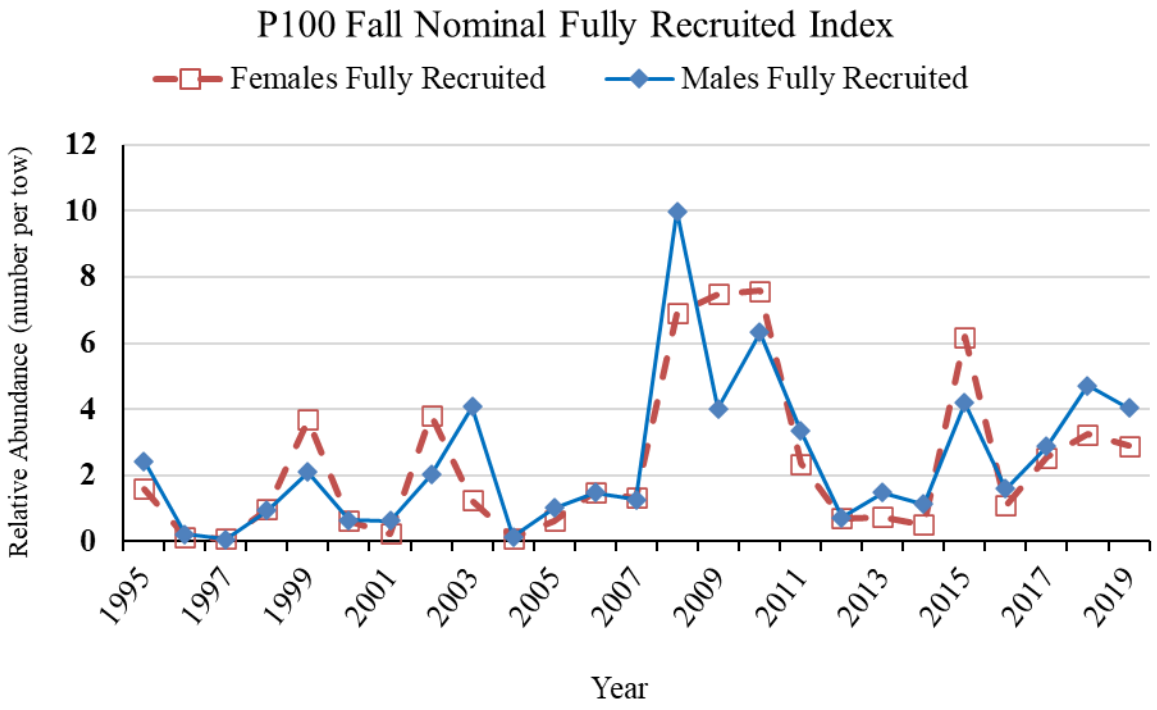
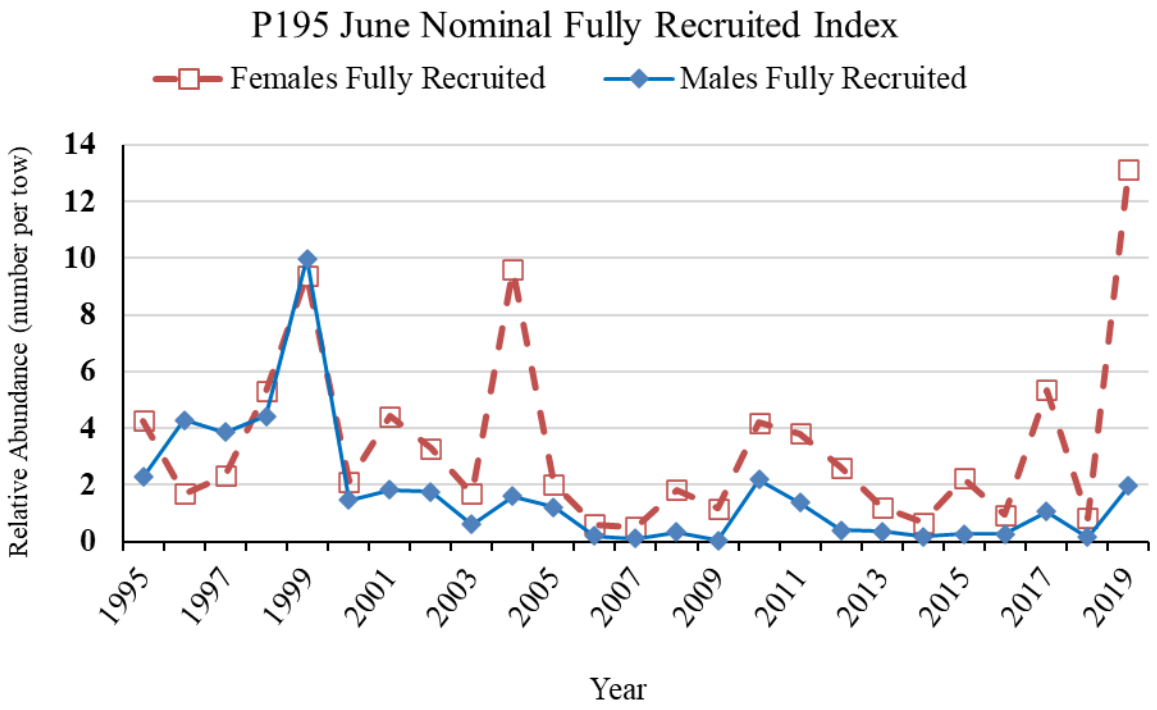


Figure 10. Nominal index (number of crabs per tow) of fully recruited crabs (≥127 mm CW) captured in Program 100 by season and sex, 1995-2019.



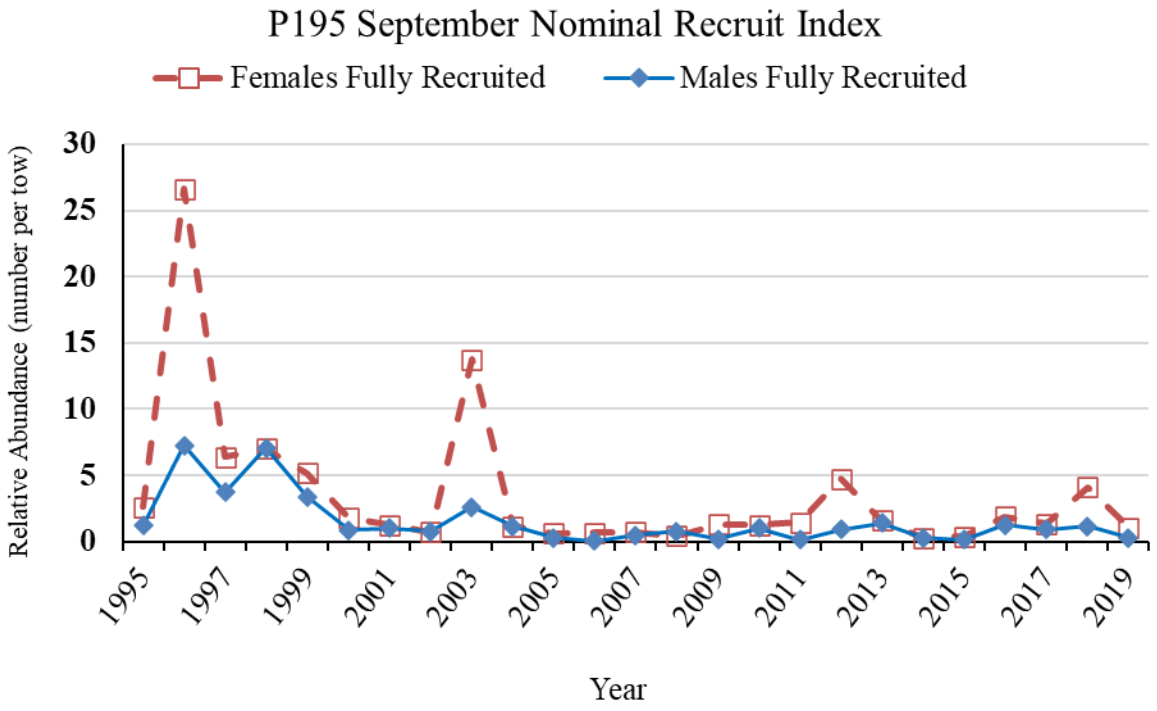


Figure 11. Nominal index (number of crabs per tow) of fully recruited crabs (≥127 mm CW) captured in Program 195 by month and sex, 1995-2019 for all strata combined. [Note: 2018 sampling was conducted in October]