May 2016 Revision

to

Amendment 2

to the

North Carolina Blue Crab

Fishery Management Plan

Prepared by the

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Marine Fisheries
ENVIRONMENTAL QUALITY

Executive Summary

Blue crab (*Callinectes sapidus*) is the most economically important species for commercial fisheries in North Carolina. North Carolina typically ranks within the top three blue crab producing states on the east coast both in pounds harvested and in value. In an attempt to better assess and manage the blue crab fishery, in Amendment 2 to the N.C. Blue Crab Fishery Management Plan (FMP) an alternative method, the Traffic Light, was used to evaluate the blue crab stock condition. This method is capable of synthesizing a variety of information to provide a description of the stock condition. The Traffic Light for blue crab consists of three characteristics: adult abundance, recruit abundance, and production. The nature of the Traffic Light method does not allow for a quantitative assessment of sustainable harvest for the North Carolina blue crab stock since overfishing cannot be calculated.

Amendment 2 also established that the blue crab stock is considered overfished when the proportion of red in the production characteristic of the Traffic Light is greater than or equal to the third quartile (≥75% red) for three consecutive years. Based on this definition, the results of the current update indicate the N.C. blue crab stock is not overfished.

Due to the inability of the Traffic Light to estimate sustainable harvest levels, any level of reduction selected may be based on the degree of concern about the state of the blue crab stock as indicated by data trends. Further, the adaptive management framework in Amendment 2 does not identify specific reduction goals for either the moderate or elevated management levels. This is because without biological reference points it cannot be determined what reduction is needed to end overfishing if it is occurring. However, Amendment 2 does require some management action be taken to address the N.C. blue crab stock as indicated by the Traffic Light.

Though the overfished definition is based solely on the production characteristic, the adult abundance and recruit abundance characteristics are monitored for warning signs that the stock may be approaching an unfavorable state. If a series of negative trends is evident in the Traffic Light for the adult abundance or production characteristics for three consecutive years, management measures must be implemented through the adaptive management framework to improve the unfavorable condition of the stock. Only the adult abundance and production characteristics are utilized to trigger management action; the recruit abundance characteristic is used to augment management action, if deemed necessary. The recruit abundance characteristic is not used to trigger management action due to inadequate spatial and temporal survey coverage. A review by the Shellfish/Crustacean Advisory Committee is maintained to consider management options, evaluate their merits, and N.C. Marine Fisheries Commission (NCMFC) approval must be gained before the Director's proclamation authority (expanded under the adaptive management framework) is used to implement any changes to the fishery.

Impacts to the blue crab stock and the fishery were estimated for management options specified in the adaptive management framework. Generally, these options include: 1) increasing the minimum size limit, 2) restricting the harvest of immature female and sponge crabs, 3) modifications to the Crab Spawning Sanctuary system, 4) reducing the cull tolerance of undersize crabs, 5) gear modifications to increase escapement, and 6) closure of the fishery. Each of these options provides for increased escapement of either juvenile, immature female, or sponge stage blue crabs.

The revision, public comment, and advisory committee recommendations were presented to the NCMFC at its May 18-20, 2016 business meeting. At that time, the NCMFC selected their

preferred management options. Management measures approved by the NCMFC were implemented by Proclamation M-11-2016 effective June 6, 2016. This Information Paper serves as a Revision to Amendment 2 to the North Carolina Blue Crab FMP, and documents the management strategy changes and rationale for such as determined by majority vote of NCMFC. All other management strategies contained in Amendment 2 remain in force until another Revision, Supplement, or Amendment to the N.C. Blue Crab FMP occurs.

I. ISSUE

Implement adaptive management measures to remain in compliance with the North Carolina Marine Fisheries Commission's (NCFMC) Amendment 2 to the North Carolina Blue Crab Fishery Management Plan (FMP), based on results from the 2015 update to the blue crab Traffic Light.

II. ORIGINATION

North Carolina Division of Marine Fisheries (NCDMF), Fisheries Management staff.

III. BACKGROUND

Amendment 2 to the North Carolina Blue Crab Fishery Management Plan adopted by the Marine Fisheries Commission in November 2013 incorporated the use of the traffic light stock assessment method and adaptive management measures for management of the blue crab stock. Amendment 2 requires annual updates to the blue crab Traffic Light be presented to the Marine Fisheries Commission as part of the Division of Marine Fisheries' annual Stock Status Report. At the Marine Fisheries Commission's August 2015 meeting, the division stated it would update the blue crab Traffic Light early and present the results to the Marine Fisheries Commission in May 2016 due to the high probability management action would need to be taken after the 2015 update to the blue crab Traffic Light.

The Traffic Light method synthesizes a variety of information to provide a description of stock condition. The indicator (survey) value in each year for each data series was assigned a green, yellow, or red 'signal' based on the state of the indicator relative to the base years used in the Traffic Light. Typically, the color green is indicative of a positive stock condition, yellow of a neutral or transitioning stock condition, and red of a negative stock condition. Similar indicators were aggregated into three stock characteristics: adult abundance, recruit abundance, and production. The main assumptions of the Traffic Light method are: 1) the indicators reflect the characteristic to which they are assigned and 2) the characteristics adequately reflect the feature of the stock they represent. The base years used for the blue crab Traffic Light (1987-2009) will remain constant until the next amendment of the FMP unless a new approach to assess the stock is adopted.

The previous management strategy, established in the 2004 Blue Crab FMP Amendment 1, only used a single point estimate for stock status based on September data from the Pamlico Sound Survey (P195) (NCDMF 2004). In addition, compliance with the female seasonal maximum size limit was marginal and largely ineffective at protecting large mature females. Even when crabbers complied with the management measure by releasing large females, these females may have been captured multiple times and injured, or ultimately harvested by another

crabber during their migration to the lower estuaries and into the sounds. The Traffic Light method provides a more robust indicator of the overall blue crab stock condition because the data inputs are from multiple statewide surveys encompassing all aspects of the blue crab's life history and distribution rather than a single point index.

Adaptive Management Framework

An adaptive management framework adopted in Amendment 2 includes the blue crab Traffic Light. The blue crab Traffic Light is divided into three separate characteristics: 1) adult abundance, 2) recruit abundance, and 3) production. Each characteristic uses data from several division biological surveys and sampling programs to determine the relative abundance of adult and recruit blue crabs in the population and various production indictors for the stock each year. Under Amendment 2, management measures will be implemented in the blue crab fishery if certain biological triggers are met. Either the adult abundance or production characteristic of the blue crab Traffic Light must be at or above the 50% red threshold for three consecutive years to trigger moderate management action and must be at or above the 75% red threshold for two of three consecutive years to trigger elevated management action as established in Amendment 2. The recruit abundance indicator, while not used to trigger management action, may be used to augment any management action taken if a trigger is activated. The three-year time period was chosen to prevent taking management action as a result of annual variability in the blue crab stock and instead base any management response on the observation of a short but continued declining trend in the population.

Amendment 2 established the blue crab stock is considered overfished when the proportion of red in the production characteristic of the Traffic Light method is greater than or equal to 75% red for three consecutive years. Based on this definition, the results of the current update indicate the North Carolina blue crab stock is not overfished.

Once moderate or elevated management actions are implemented, they will remain in place for three years; then a three-year evaluation period will begin with the first year management actions were implemented. The decision-making flowchart for implementing management of the different scenarios and outcomes is presented in Figure 1. If management measures have been in place for the moderate threshold level for three consecutive years and the stock condition in that characteristic continues at the moderate threshold or rises to the elevated threshold, then management measures would increase to the elevated threshold level for another three-year period. If after that time the characteristic shows no further improvement, then it will automatically start the FMP supplement process. If management measures have been in place at the moderate threshold and the stock improved to a healthy condition for three consecutive years, then management measures could be relaxed.

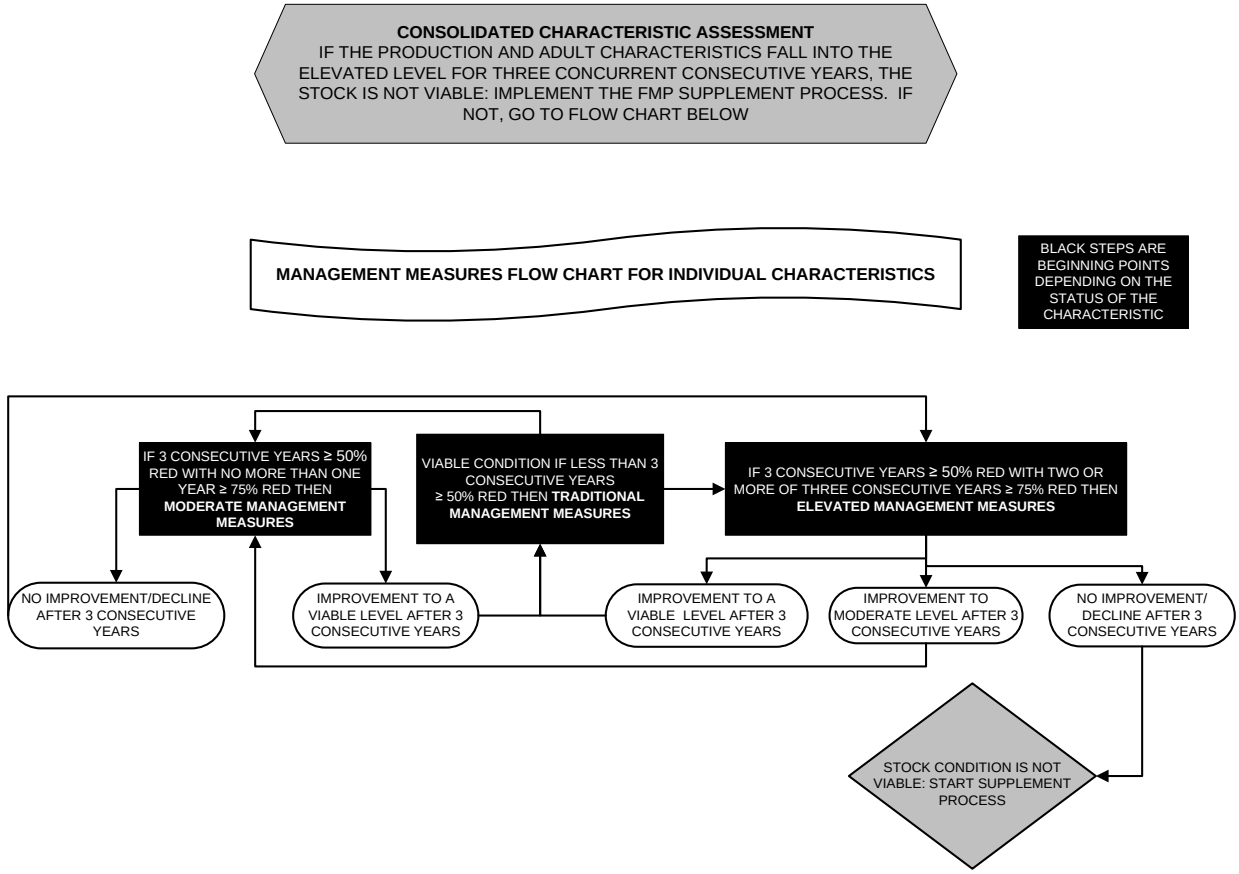

Figure 1. The blue crab adaptive management framework decision-making process for each management level.

Stock Concerns and Status of the Blue Crab Traffic Light

The blue crab Traffic Light has been updated with 2015 data for stock status determination (Figure 5). The production characteristic (2013=52%, 2014=71%, 2015=44% red) has not met the elevated threshold for three consecutive years; as such, the blue crab stock is not overfished (Figure 5). Figure 6 shows the status of the individual indicators used for the production characteristic. However, the adult abundance characteristic has met the moderate management threshold for three consecutive years (2013=72%, 2014=79%, 2015=50% red; Figure 5). As such, under the adaptive management framework adopted by the NCMFC as part of Amendment 2, management action is required to improve the condition of the N.C. blue crab stock using the moderate management measures specified for the adult abundance characteristic (Table 1). Figure 7 shows the status of the individual indicators used for the adult abundance characteristic. The recruit abundance characteristic has met the elevated management threshold (2013=92%, 2014=96%, 2015=75%; Figure 5) allowing both the moderate and elevated management measures specified for the recruit abundance characteristic to be considered. Figure 8 shows the status of the individual indicators used for the recruit abundance characteristic. Details about the sampling programs used to collect the data for the blue crab Traffic Light can be found in Appendix 1. Additional figures showing the survey data used for the blue crab Traffic Light can be found in Appendix 2. Additional information concerning commercial landings trends can be found in Appendix 3.

Table 1. Management measures under the adaptive management framework for the blue crab Traffic Light in the North Carolina Blue Crab Fishery Management Plan Amendment 2. **Measures shaded are those under consideration based on the adaptive management framework in Amendment 2 and the 2015 blue crab Traffic Light update results.**

Characteristic	Moderate management level	Elevated management level
Adult abundance	A1. Increase in minimum size limit for male and immature female crabs	A4. Closure of the fishery (season and/or gear)
	A2. Reduction in tolerance of sublegal size blue crabs (to a minimum of 5%) and/or implement gear modifications to reduce sublegal catch	A5. Reduction in tolerance of sublegal size blue crabs (to a minimum of 1%) and/or implement gear modifications to reduce sublegal catch
	A3. Eliminate harvest of v-apron immature hard crab females	A6. Time restrictions
Recruit abundance	R1. Establish a seasonal size limit on peeler crabs	R4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots in specific areas
	R2. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	R5. Expand existing and/or designate new crab spawning sanctuaries
	R3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	R6. Closure of the fishery (season and/or gear)
		R7. Gear modifications in the crab trawl fishery
Production	P1. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)	P4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots for specific areas
	P2. Minimum and/or maximum size limit for mature female crabs	P5. Reduce peeler harvest (no white line peelers and/or peeler size limit)
	P3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions	P6. Expand existing and/or designate new crab spawning sanctuaries
		P7. Closure of the fishery (season and/or gear)

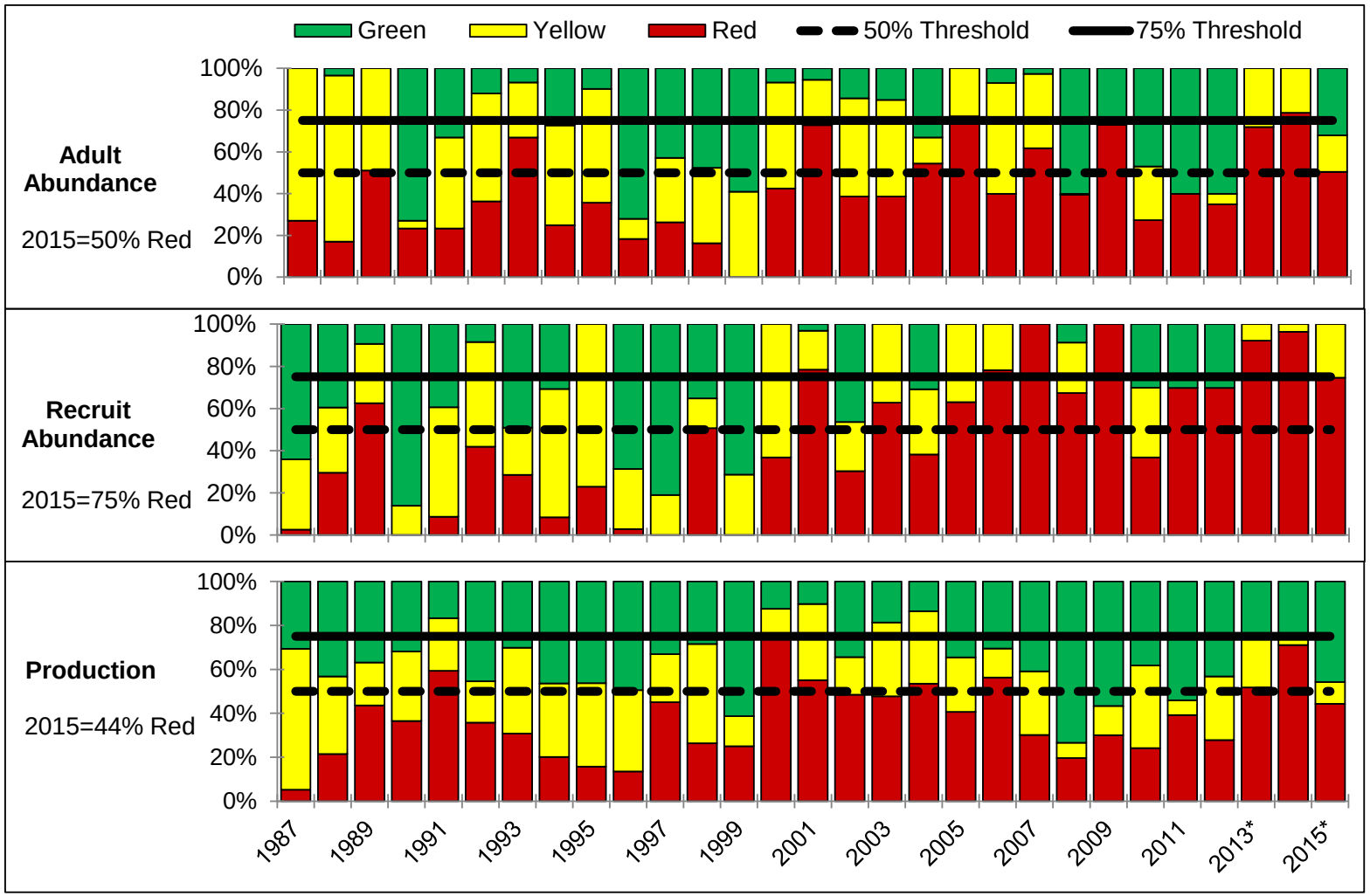

Figure 5. Traffic Light of adult abundance, recruit abundance, and production characteristic for the 2015 blue crab Traffic Light update, 1987 – 2015. *Note: 2013, 2014 and 2015 represent the three years that count toward the three consecutive years needed to activate moderate management for the adult abundance characteristic. The dashed (– –) and solid (—) lines represent the 50% and 75% quartiles for the proportion of red. = Good stock condition; = Neutral or transitioning stock condition; and = Bad stock condition.

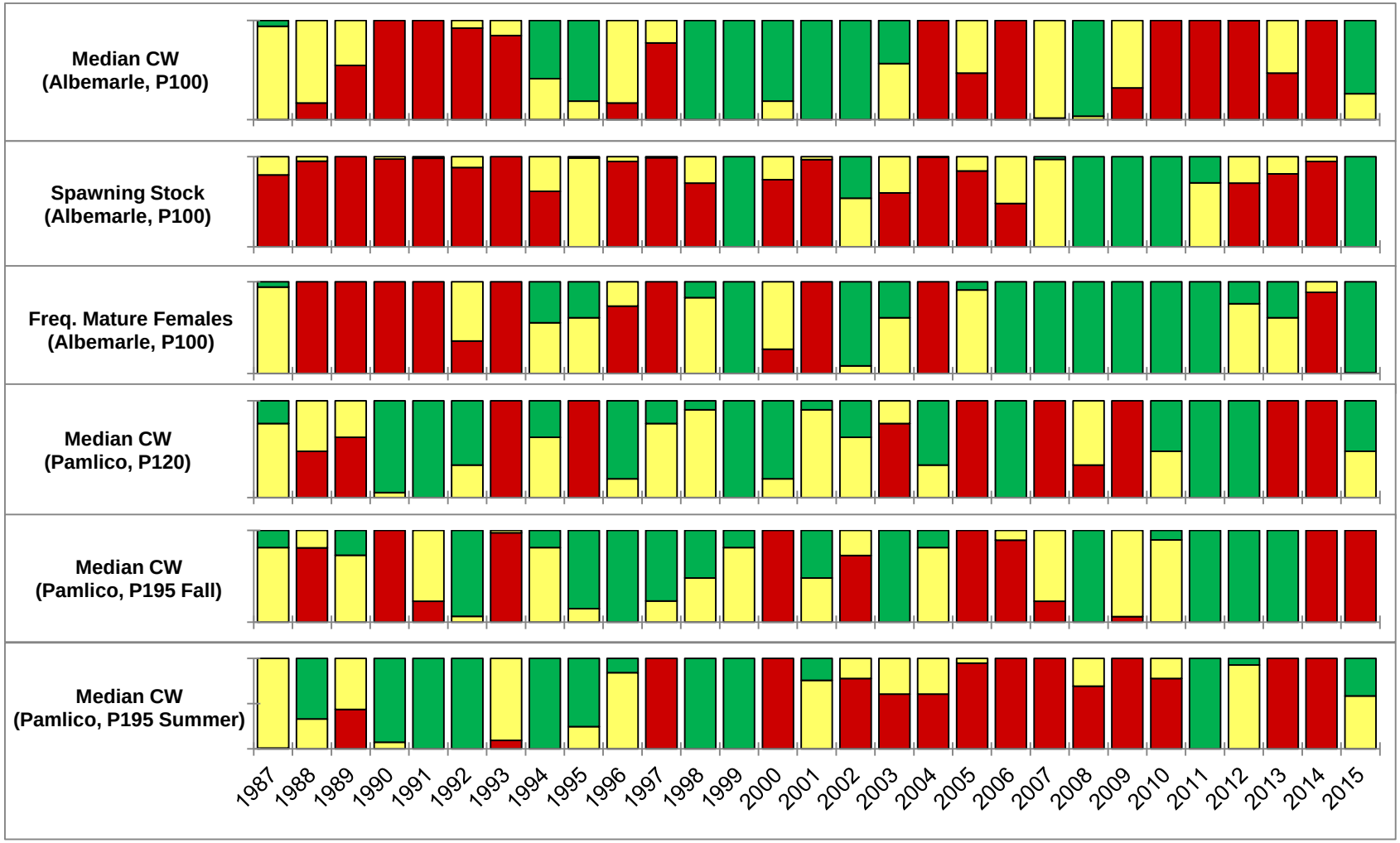

Figure 6. Traffic Light representations of individual production indicators and the integrated summary (bottom figure), 1987 – 2015.

Figure 6. cont. Traffic Light representations of individual production indicators and the integrated summary (bottom figure), 1987 – 2015.

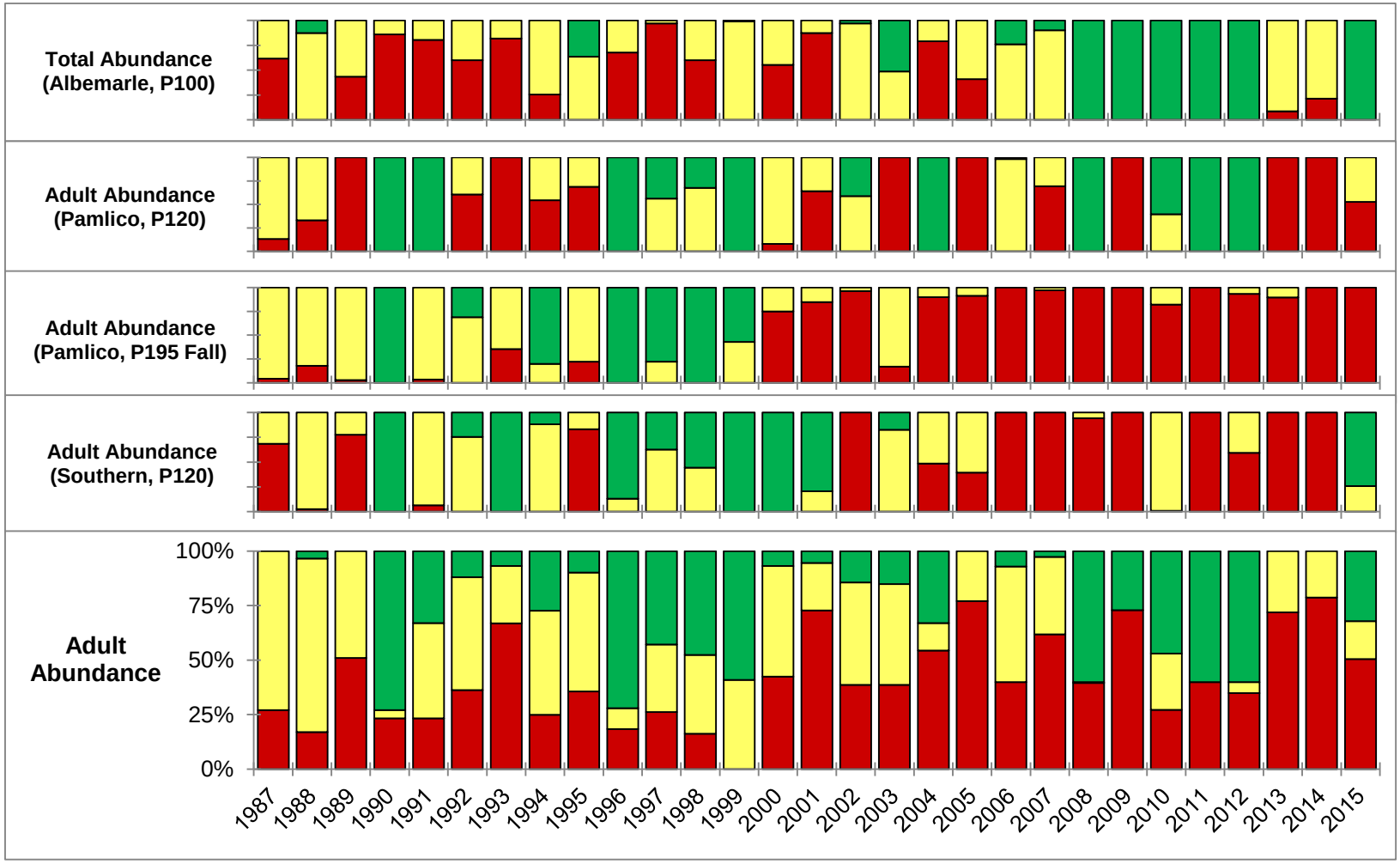

Figure 7. Traffic Light representations of individual adult abundance indicators and the integrated summary (bottom figure), 1987 – 2015.

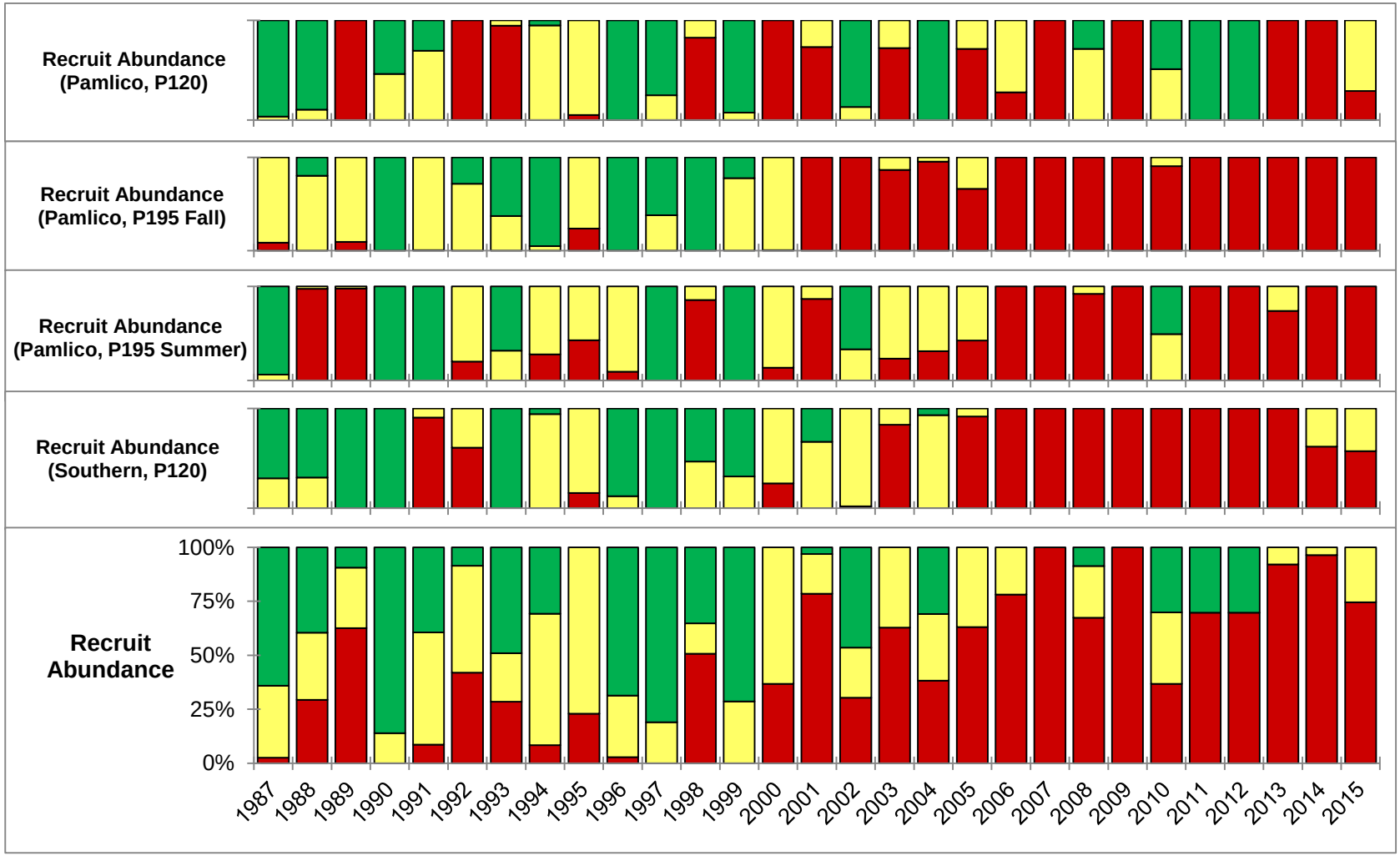

Figure 8. Traffic Light representations of individual recruit abundance indicators and the integrated summary (bottom figure), 1987 – 2015.

IV. AUTHORITY

North Carolina General Statutes

113-134 RULES
113-182 REGULATION OF FISHING AND FISHERIES
113-182.1 FISHERY MANAGEMENT PLANS
143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES

North Carolina Marine Fisheries Rules

15A NCAC 03J .0301 POTS
15A NCAC 03J .0302 RECREATIONAL USE OF POTS
15A NCAC 03L .0201 CRAB HARVEST RESTRICTIONS
15A NCAC 03L .0202 CRAB TRAWLING
15A NCAC 03L .0203 CRAB DREDGING
15A NCAC 03L .0204 CRAB POTS
15A NCAC 03L .0205 CRAB SPAWNING SANCTUARIES
15A NCAC 03R .0109 TAKING CRABS WITH DREDGES
15A NCAC 03R .0110 CRAB SPAWNING SANCTUARIES

V. DISCUSSION

The discussion below includes specific management measures discussed by the division's Blue Crab Plan Development Team and Management Review Team that fell within the broader management options listed in the adaptive management framework (Table 1). Since specific management options are listed in the adaptive management framework, this Revision is not intended to be a review of all measures that could be used to manage the blue crab fishery. Management measures not listed in the adaptive management framework may only be addressed through the supplement or amendment process.

Within each stock characteristic (adult abundance, recruit abundance and production), specific management measures were determined for each management level through the adaptive management framework. Many management tools are available; some are more restrictive to the fishery than others are and attempts were made to categorize them within the moderate and elevated management levels accordingly. The various management options under consideration are described below. Specific measures discussed for each management option are only examples and may not be all inclusive of what measures may be considered under the adaptive management framework.

Size Limits

Increasing the Minimum Size Limit for Male and Immature Female Crabs

Increasing the minimum size limit is a common management tool used to rebuild the spawning stock. Mature females and peeler/soft crabs are exempt from the 5-inch minimum size limit (NCMFC Rule 15A NCAC 03L .0201). The short-term effects of an increased minimum size limit would be reducing the pool of younger, smaller crabs immediately available for harvest, which in turn would produce a short-term decrease in the overall catch. Decreasing the harvest of smaller crabs may not have an immediate effect on reducing the fishing mortality on older,

larger crabs. The benefit to the fishery of an increased minimum size would not be realized until the smaller crabs that survive contribute more to the pool of older individuals. One of the major benefits to increasing the minimum size limit is it would allow a larger number of younger crabs the opportunity to mate and reproduce prior to harvest. Increasing the minimum size limit could have a negative impact on the crab market by creating uncertainty in product availability. From 2011-2015, approximately 14% of male and immature female hard crabs harvested were under the current 5-inch legal size limit (Figure 9).

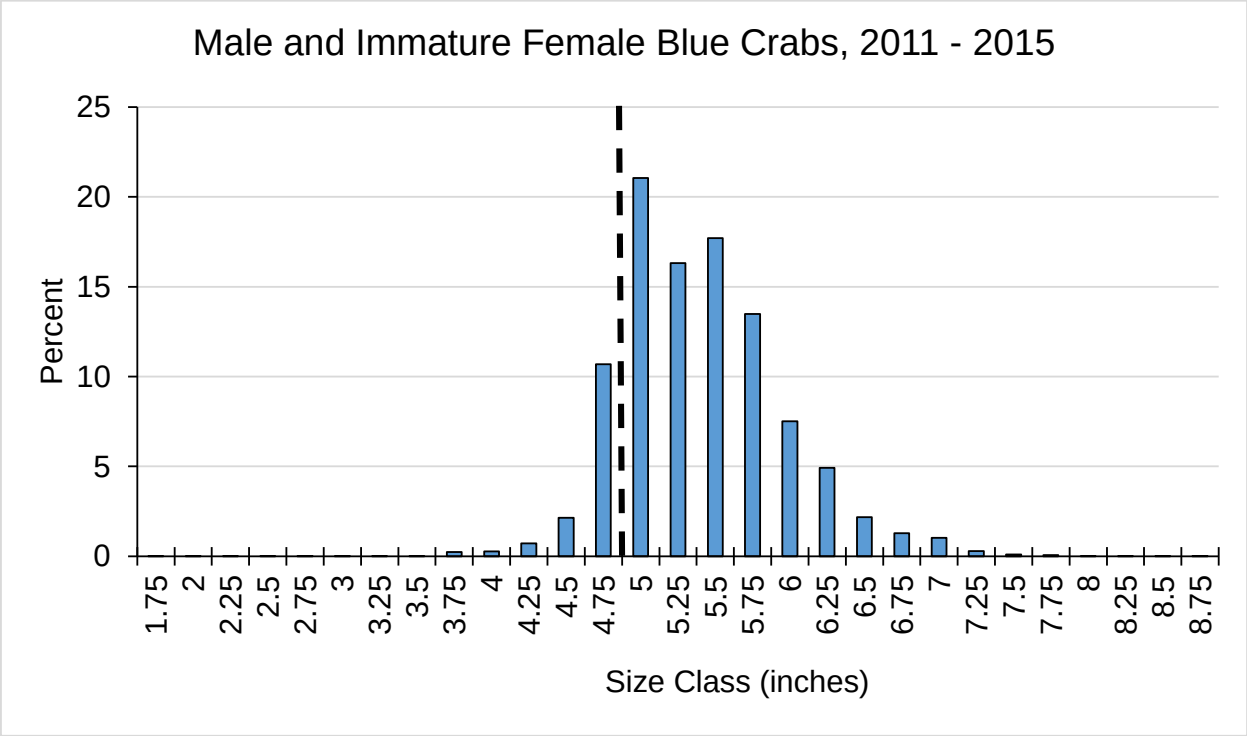

Figure 9. Size distribution of male and immature female hard crabs sampled from the commercial fishery, 2011 – 2015. Dashed line shows male and immature female blue crabs harvested above and below the current 5-inch minimum size limit.

Assuming no cull tolerance for sublegal crabs, several minimum size limit options were examined (Table 2). For example, if a 5 ¼-inch minimum size limit was imposed on male and immature female hard crabs, approximately 35% of male and immature female crab harvest fell into size classes below this minimum size limit. Some measure of recoupment would be likely for both male and immature females. Recoupment for male crabs would likely occur as they grow to the new legal minimum size where recoupment for immature females would likely occur after they undergo their terminal molt and become mature females, which are exempt from the minimum size limit.

Table 2. Estimated harvest reductions for various minimum size limits for male and immature female hard crabs.

Minimum Size Limit	Estimated Harvest Reduction
5 1/4-inch	35%
5 1/2-inch	52%
5 3/4-inch	69%
6-inch	82%

Establish a Seasonal Size Limit for Peeler Crabs

Increased effort and harvest in the peeler/soft blue crab fishery and reduced adult harvest has prompted concern about the impacts of peeler/soft crab harvest on the overall health of the fishery. Establishing a minimum size limit for peeler crabs would reduce fishing mortality on the smallest crabs currently allowed for harvest. Effects and benefits would be the same as those described above for minimum size limits. In addition, current peeler fishing practice is to employ live male crabs as an attractant or bait to target immature female peelers. Therefore, the vast majority of the peelers harvested are immature females that are approaching their terminal molt. Reducing fishing mortality on this segment of the population would contribute to efforts to protect the stock. Natural mortality of sublegal crabs (less than five inches) is in the range of 26% to 32% per year in Chesapeake Bay (Casey et al. 1992). Eggleston (1998) estimated an annual mortality rate of 50% for sub-adult and adult blue crabs in North Carolina. Several other states have minimum size limit restrictions for peeler and/or soft crab harvest. A Maryland report noted that raising the peeler size limit would potentially provide an increase in spawning stock biomass by allowing more females to enter the spawning population (Uphoff et al. 1993). Raising the size limit should also increase yield to the fishery. Peeler size limits could possibly improve recruit abundance by allowing some immature female crabs to mature and spawn prior to being subject to harvest.

As the time between sheds increases with increasing size, the probability of capture of larger crabs at the peeler stage decreases. The time interval between sheds of 3.0 or 3.5-inch crabs will generally be one to three months (Rothschild et al. 1992). The increased yield from a peeler size limit would not be totally lost to natural mortality. The overall value of the peeler/soft crab fishery might be enhanced by a minimum size limit as larger soft crabs generally bring a higher price. A potential adverse impact on the soft crab fishery would be a decrease in market flexibility, particularly during the early spring when product availability is low and small peeler/soft crabs are in demand, bringing very high prices to fishermen. A peeler size limit might increase handling mortality and waste in the fishery. A peeler/soft crab size limit could allow more effective and efficient enforcement of size limits, both in state and out of state as crabs are shipped to states with existing size limits. Therefore, adopting a peeler minimum size limit of 3 inches would address regulatory consistency among the Atlantic Coast states and potentially foster interstate trade.

Currently, there is no minimum size limit in place for peeler crabs. NCDMF collects size, sex and maturity (female) information on peeler crabs harvested for commercial shedding operations. Sample sizes decline considerably when summarized at a waterbody level and thus, only regional and statewide estimates are provided.

Assuming no cull tolerance for sublegal peeler crabs, several minimum size limit options were examined in ¼-inch increments of peeler crabs sampled from 2011 to 2015 (Table 3). For

example, if a 3 ¼-inch minimum size limit was imposed on peeler crab harvest, 4.8% of peeler crabs statewide fell into the size classes below this minimum size. The Pamlico region would be the most impacted by the minimum 3 ¼-inch size limit at 7.3%, followed by the Albemarle region at 3.2% and the Southern region at 2.1%.

Table 3. Estimated harvest reduction percentages (pounds) for various minimum size limits for peeler crabs.

	Peeler Size Limit Reduction Percent			
Minimum Size Limit	Albemarle	Pamlico	Southern	Statewide
3-inch	1.1%	2.8%	0%	1.8%
3 1/4-inch	3.2%	7.3%	2.1%	4.8%
3 1/2-inch	6.9%	15.3%	4.1%	10.2%
3 3/4-inch	13.4%	28.2%	10.3%	19.2%

Reducing the Cull Tolerance of Sublegal Crabs

Reducing the cull tolerance of sublegal male and immature female hard crabs would allow individuals a greater chance to mature and spawn prior to being harvested. Specific reductions from reducing the sublegal cull tolerance could not be calculated; instead, the number of sampled commercial trips is presented to get an idea of the impact to the fishery. For example, if the sublegal cull tolerance was reduced to 5%, approximately 26% of commercial trips sampled were above this limit. Some measure of recoupment would be likely for both male and immature females. Recoupment for male crabs would likely occur as they grow to the legal minimum size where recoupment for immature females would likely occur after they undergo their terminal molt and become mature females, which are exempt from the minimum size limit.

Table 4. Percent of sampled commercial crab pot trips at various cull tolerance levels for male and immature female hard crabs.

Cull Tolerance	Percent of Sampled Trips Above Cull Tolerance
10% (current cull tolerance)	12%
5%	26%
3%	37%
0%	63%

Gear Modifications to Reduce Sublegal Catch

Modifications to harvest gear can be used to reduce catch and mortality of the sublegal bycatch of target or non-target species. Increasing size limits often go in hand with gear modifications to eliminate sublegal bycatch. Cull (escape) rings are one such device used in crab pots to reduce bycatch. Current restrictions require two cull rings per pot of 2 5/16-inch minimum inside diameter.

Cull Ring Size

Several studies have examined the effects of increasing the cull ring size in crab pots. Rudershausen and Turano (2009) tested three different size cull rings: 2 5/16 inches, 2 3/8 inches, and 2 7/16 inches. They found the catch rates of sublegal males was reduced by increasing cull ring size. They also found the catch rates of legal males and mature females were generally maintained with larger cull rings and estimate the body length of minimally legal male crabs was not less than the current minimum cull ring diameter (2 5/16 inches). Rudershausen and Hightower (2016) tested three different size cull rings: 2 5/16 inches, 2 3/8 inches, and 2 7/16 inches. They found the mean number of legal male crabs was not significantly different among cull ring sizes but the mean number of sublegal male crabs was significantly less in pots using the two largest cull ring sizes.

Specific reductions from increasing the size of cull rings could not be calculated; instead, the number of sampled commercial trips is presented to get an idea of the impact to the fishery (Table 5). For example, if the minimum cull ring size was increased to 2 3/8 inches, approximately 33% of commercial trips sampled were at or above this limit. The cost and effort to change the cull ring size must also be considered.

Table 5. Percent of sampled commercial crab pot trips with various cull ring sizes.

Cull Ring Size	Percent of Sampled Trips By Cull Ring Size
2 5/16-inch (minimum legal size)	67%
2 3/8-inch	13%
2 7/16-inch	18%
2 1/2-inch	1%
>2 1/2-inch	1%

Number of Cull Rings

Some research has been done regarding the number of cull rings in crab pots and the associated reduction in sublegal crabs. Rudershausen and Turano (2009) determined that increasing the number of cull rings did not significantly reduce the catch of sublegal males.

Specific reductions from increasing the number of cull rings could not be calculated; instead, the number of sampled commercial trips is presented to get an idea of the impact to the fishery (Table 6). For example, if the number of required cull rings was increased to four, approximately 9% of commercial trips sampled were at or above this limit. The cost and effort to change the number of cull rings must also be considered.

Table 6. Percent of sampled commercial crab pot trips with varying sizes of cull rings.

Number of Cull Rings	Percent of Sampled Trips
2	80%
3	11%
4	5%
5	3%
>5	1%

Placement of Cull Rings

Some research has been done regarding the placement of cull rings in crab pots related to reductions in sublegal catch. Havens et al. (2009) tested pots with modified cull ring placement (Figure 10). Modified pots had cull rings placed in the corner of the pot and flush with the floor of the upper chamber. Approximately 60% of sublegal crabs escaped modified pots within one hour compared to 4% in unmodified pots. The odds of escapement of sublegal crabs in modified pots in a 24-hour period was eighteen times greater than in unmodified pots. Specific reductions from modifying the placement of cull rings in crab pots could not be calculated.

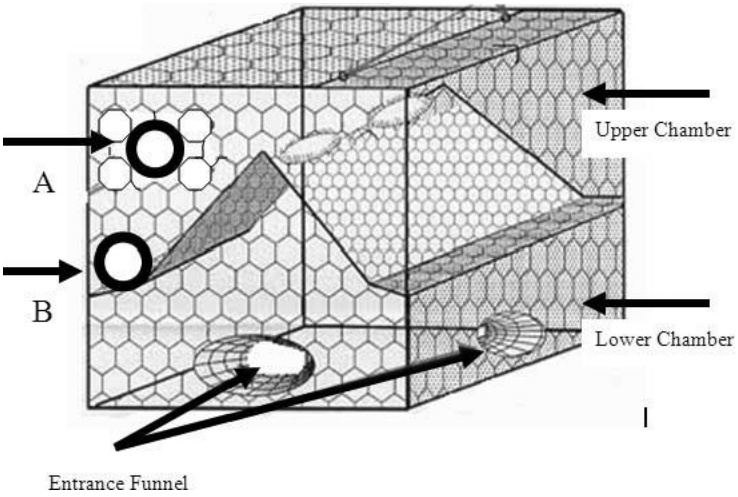

Figure 10. Placement of cull rings in crab pots: (A) unmodified pots had the cull ring placed on the outer wall of the upper chamber, 15 cm above the chamber floor; and (B) modified pots had the cull ring placed in the corner and flush with the upper chamber floor. Diagram is from Havens et al. 2009.

Removing Cull Ring Exemptions

Mature female crabs are exempt from the five-inch minimum size limit (NCMFC Rule 15A NCAC 03L .0201 (a)). Some females mature prior to reaching five inches in size and would be unavailable for harvest because once they mature they will not grow any larger. Particularly in high salinity areas, such as those with the current escape ring exemption, a significant portion of the available mature females may be of such a small size they may leave the pot through the 2 5/16-inch escape rings (minimum legal size). Therefore, during the development of Amendment 2, the long standing proclamation allowing pots to be set without escape rings or with closed escape rings to prevent the loss of small mature female blue crabs in Pamlico Sound and the Newport River were put into rule (Figure 11). However, the exemption area in Pamlico Sound was reduced by moving the boundary line from six miles from shore to the existing no trawl line behind the Outer Banks.

Based on NCDMF crab fishery sampling at the time, the escape ring exemption does not appear to be widely utilized by crabbers who fish the Outer Banks/Pamlico Sound area. Perhaps in the past when the southern Outer Banks fishery was robust with more crabs and crabbers, the practice of closing escape rings was more prevalent. NCDMF sampling, in recent years, has documented that some crabbers in this area do not close escape rings, while some

close one of the two required escape rings, and others close all the escape rings. During development of Amendment 2, NCDMF staff contacted and discussed the Outer Banks escape ring exemption and potential options to modify the boundary with area crabbers. Overall opinions were mixed; but several crabbers indicated they would like to maintain the flexibility to set pots with closed escape rings.

Assuming no cull tolerance for sublegal crabs and a 5-inch minimum size limit, the harvest reduction for eastern Pamlico Sound is approximately 13.1%. There was not enough commercial crab sampling data specific to the Newport River to estimate harvest reductions for this area. Some measure of recoupment would be likely for both male and immature females. Recoupment for male crabs would likely occur as they grow to the new legal minimum size where recoupment for immature females would likely occur after they undergo their terminal molt and become mature females, which are exempt from the minimum size limit. The recoupment of small mature female crabs would likely be low as some would be able to escape through the existing cull rings.

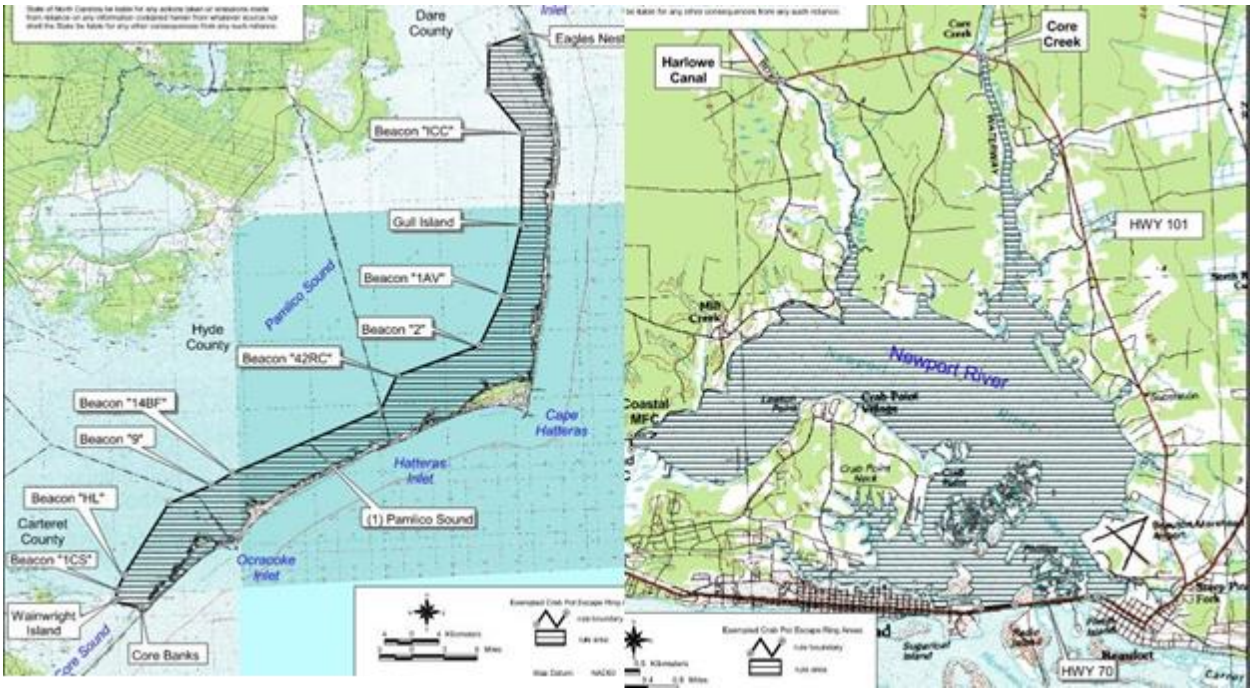

Figure 11. Escape ring exempted areas in Pamlico Sound, NC (left) and Newport River, NC (right).

<u>Eliminate Harvest of V-apron Immature Female Hard Crabs</u>

Immature (v-apron) females are encountered in the commercial crab sampling program across six market categories (Straight, Jimmies (No. 1), No. 2, No. 3, Culls, and Mixed). To provide an estimate of the impacts of prohibiting v-apron immature female hard crab harvest, the number of v-apron immature female hard crabs sampled was divided by the total number of crabs sampled by market category in the commercial crab sampling program to estimate the percentage by number. To apply the estimate to trip ticket information, the numbers were converted to weight in pounds using a conversion of three crabs per pound. Once the percentage by weight was calculated, weight estimates were applied to the trip ticket landings by market grade to

determine the statewide percent reduction for the elimination of v-apron immature female hard crabs in the harvest. The average annual reduction for immature females from 2001-2015 in the total harvest was estimated at 0.8% or 231,345 pounds (Table 7). Even with a culling tolerance, prohibiting the harvest of immature female hard crabs of 5 inches and larger would allow some to become spawning adults prior to being eligible for harvest.

Table 7. Estimated reductions (percent by weight) by region and statewide for eliminating v-apron immature female hard crab harvest, 2001 – 2015.

Year	Albemarle	Pamlico	Southern	Statewide	Statewide Pounds
2001	1.14	0.91	0.26	0.96	270,310
2002	1.02	0.86	0.12	0.91	316,871
2003	1.82	0.41	0.42	1.02	405,511
2004	1.03	0.76	0.58	0.85	266,358
2005	0.86	0.49	0.30	0.61	140,722
2006	0.91	0.33	0.12	0.63	150,232
2007	0.95	0.23	1.33	0.76	154,209
2008	0.41	0.43	0.03	0.40	121,737
2009	0.63	0.72	0.33	0.63	177,017
2010	0.84	1.10	0.27	0.91	266,793
2011	1.18	1.17	0.21	1.12	319,833
2012	0.79	0.59	0.31	0.70	179,100
2013	1.59	0.28	0.07	1.18	250,127
2014	1.03	0.65	0.36	0.91	227,940
2015	0.75	0.77	-	0.72	223,421
Average	1.00	0.65	0.32	0.82	231,345

Restricting or Prohibiting Sponge Crab Harvest

The underlying hypothesis of limiting sponge crab harvest is that by protecting the spawning stock (defined here as egg-bearing females), the fishery would benefit with more recruits to the fishery. Concerns with protecting egg-bearing female blue crabs (sponge crabs) are complex, consisting of economic factors (fewer pounds of meat can be picked from a given weight of sponge crabs than from the same weight of non-sponge crabs) and biological considerations (recruitment, overfishing). Currently, there are a number of states that prohibit the sale or possession of egg-bearing females (Table 8). Without exception, these states experience the same fluctuations in blue crab landings as seen in states that do not protect egg-bearing females. From the early 1920s until 1964, it was unlawful to harvest sponge crabs in North Carolina. In 1964 the sponge crab law was repealed and replaced with Crab Spawning Sanctuaries [NCMFC (2011) rules 15A NCAC 03L .0205 and 03R .0110]. During the period the North Carolina sponge crab law was in effect, reported hard crab landings showed the same fluctuations as were observed after its repeal. However, reducing or prohibiting sponge crab harvest would provide additional protection to crabs that will be spawning in a very short time (i.e., 14 days or less depending on sponge stage/color). Limiting harvest would protect sponge crabs where sanctuaries do not exist. Eggleston (2003) found no significant difference between mature female catches within the sanctuaries versus an area five kilometers outside of the

sanctuaries. Depending on the level of concern, catch limits on sponge crab harvest could be seasonal, regional, and/or by sponge stage/color. Limiting sponge crab harvest will have a greater economic impact in some areas during certain periods (e.g., Outer Banks during spring).

Some researchers have documented sponge mutilation (scrubbing) by pot-caught crabs (Rittschof 2004). Even when sponge crabs are returned to the water, egg mass destruction and reduced viability of the eggs may occur during the pot harvesting and handling process. Other research has indicated that sponge crab excluders can be effective in reducing the harvest of egg bearing crabs. Research comparing control crab pots and pots equipped with sponge crab excluders was conducted in the high salinity waters of Core Sound, NC near crab spawning sanctuaries (Rudershausen and Turano 2006). They concluded that in areas where mature females dominate the crab pot catch, the benefit of using excluders to reduce entry of sponge crabs might outweigh a potentially modest decrease in catch of non-sponged females.

Table 8. Summary of blue crab sponge and crab spawning sanctuary regulations (New Jersey to Texas).

State	Prohibit the sale or possession of sponge crabs	Have established crab spawning sanctuaries
New Jersey	Yes	No
Delaware	Yes	No
Maryland	Yes	No
Virginia	Yes [1]	Yes
North Carolina	No	Yes
South Carolina	Yes	No
Georgia	Yes	No
Florida	Yes	No
Alabama	No	No
Mississippi	Yes	No
Louisiana	Yes	No
Texas	Yes	No

[1] Prohibits brown and black sponge crab harvest from March 17 through June 15.

Sponge crab harvest could be restricted by quantity, sponge color, or establishing a cull tolerance. Establishing a cull tolerance similar to the one in place for sublegal crabs would reduce the amount of sponge crabs harvested without completely prohibiting their harvest.

Specific reductions from establishing a cull tolerance for sponge crabs could not be calculated, instead the number of sampled commercial trips is presented to get an idea of the impact to the

fishery (Table 9). For example, if the cull tolerance was set at 5%, approximately 13.2% of commercial trips sampled were at or above this limit.

Table 9. Percent of sampled commercial crab pot trips with varying cull tolerances for sponge crabs.

Cull Tolerance	Percent of Sampled Trips
10%	11.5%
5%	13.2%
3%	14.1%
1%	15.9%

Assuming no cull tolerance for sponge crabs, the average reduction statewide is approximately 3.8%. The Pamlico region will be impacted more than the Albemarle and Southern regions (Table 10), specifically the eastern side of Pamlico Sound (Table 11). Some measure of recoupment would be likely as sponge crabs could be harvested once they release their eggs. The Pamlico region and statewide commercial sampling has shown the catch of sponge crabs has declined in recent years, which may also be a result of fishing behavior shifting away from these less valuable sponge crabs. Therefore, eliminating sponge crab harvest may only have minimal impacts to the overall harvest.

Table 10. Total harvest, sponge crab harvest, and percent reduction if sponge crab harvest was prohibited by region, 2001 – 2015.

	Albemarle			Pamlico			Southern			Statewide		
Year	Total Pounds	Sponge Crab Pounds	Percent Reduction	Total Pounds	Sponge Crab Pounds	Percent Reduction	Total Pounds	Sponge Crab Pounds	Percent Reduction	Total Pounds	Sponge Crab Pounds	Percent Reduction
2001	11,820,264	-	-	14,359,628	1,373,754	9.57	1,993,997	11,473	0.58	28,173,889	1,385,228	4.92
2002	20,223,218	-	-	12,678,456	2,005,454	15.82	1,791,769	3,374	0.19	34,693,443	2,008,828	5.79
2003	17,257,582	-	-	20,289,934	2,850,359	14.05	2,087,805	7,654	0.37	39,635,322	2,858,013	7.21
2004	11,787,020	-	-	17,619,156	2,018,331	11.46	1,825,486	17,566	0.96	31,231,661	2,035,897	6.52
2005	8,713,645	1,017	0.01	12,273,290	2,147,818	17.50	1,940,115	8,473	0.44	22,927,050	2,157,308	9.41
2006	12,917,308	-	-	9,371,392	431,200	4.60	1,696,271	14,531	0.86	23,984,971	445,731	1.86
2007	12,881,819	349	0.00	5,972,830	1,623,618	27.18	1,408,726	68,447	4.86	20,263,375	1,692,414	8.35
2008	21,186,947	-	-	7,785,011	166,608	2.14	1,551,971	50,142	3.23	30,523,929	216,750	0.71
2009	19,674,596	-	-	6,689,881	498,300	7.45	1,563,678	33,904	2.17	27,928,155	532,204	1.91
2010	16,748,758	-	-	11,066,830	204,807	1.85	1,468,209	85,826	5.85	29,283,796	290,632	0.99
2011	15,150,132	-	-	11,807,797	779,301	6.60	1,623,932	8,223	0.51	28,581,861	787,524	2.76
2012	16,251,070	-	-	7,571,283	1,083,365	14.31	1,873,160	37,953	2.03	25,695,513	1,121,318	4.36
2013	14,867,463	-	-	4,705,404	313,317	6.66	1,575,686	47,937	3.04	21,148,554	361,254	1.71
2014	18,246,664	-	-	5,340,747	97,564	1.83	1,439,056	53,461	3.71	25,026,467	151,025	0.60
2015	19,466,259	-	-	9,992,495	1,516	0.02	1,510,795	-	-	30,969,550	1,516	0.005

Table 11. Pounds of sponge crabs sampled from commercial crab sampling program in eastern Pamlico Sound compared to the Pamlico region, 2001 – 2015.

	Year														
Sponge Crab Pounds Sampled	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Eastern Pamlico Sound	2,695	3,362	1,762	2,376	1,647	691	1,858	451	-	199	1,881	5,889	885	608	-
Total Pamlico Region	2,695	3,886	1,818	2,963	2,007	691	1,877	467	792	385	1,881	6,351	886	611	11
Percent Eastern Pamlico Sound	100	86.5	96.9	80.2	82.1	100	99.0	96.6	0	51.5	100	92.7	99.8	99.5	0

Spawning Sanctuaries

Close the Crab Spawning Sanctuaries from September 1 through February 28 and May Impose Further Restrictions

Currently 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 March 1 through August 31 in Crab Spawning Sanctuaries. This option would result in a year-round closure of the Crab Spawning Sanctuaries.

Expand Existing Spawning Sanctuaries

North Carolina has five locations designated as crab spawning sanctuaries north of Cape Lookout (Table 12, Figure 12). The spawning sanctuaries are already closed in Rule 03L .0205 from March 1 through August 31. Existing proclamation authority in Rule 03L .0205 also provides that these Crab Spawning Sanctuaries can be closed or restricted further outside of the closed period to protect spawning females.

The purpose of these sanctuaries is to protect mature females inhabiting these areas prior to and during the spawning season and sponge stage. Recent tagging data suggest this is not the case in all areas. In Core Sound, most tagged crabs migrate toward the inlets and many will release their first clutch of eggs prior to reaching the spawning grounds (Rittschof 2003). Some female crabs remain within the sounds and some go out the inlet and move with currents up and down the coast. In Pamlico Sound, sponge crabs are present on the spawning grounds from spring to fall, and mature females are present year round (Ballance and Ballance 2002; NCDMF 2008). Tag return data suggest females tagged on the sanctuaries in Pamlico Sound are consistently caught in areas up to four kilometers surrounding the sanctuaries (Ballance and Ballance 2002; NCDMF 2008).

Table 12. Location and approximate size (in acres) of the five current Crab Spawning Sanctuaries.

Location	Acreage
Oregon Inlet	5,787.5
Hatteras Inlet	4,444.0
Ocracoke Inlet	8,745.0
Drum Inlet	5,388.0
Bardens Inlet	4,610.0

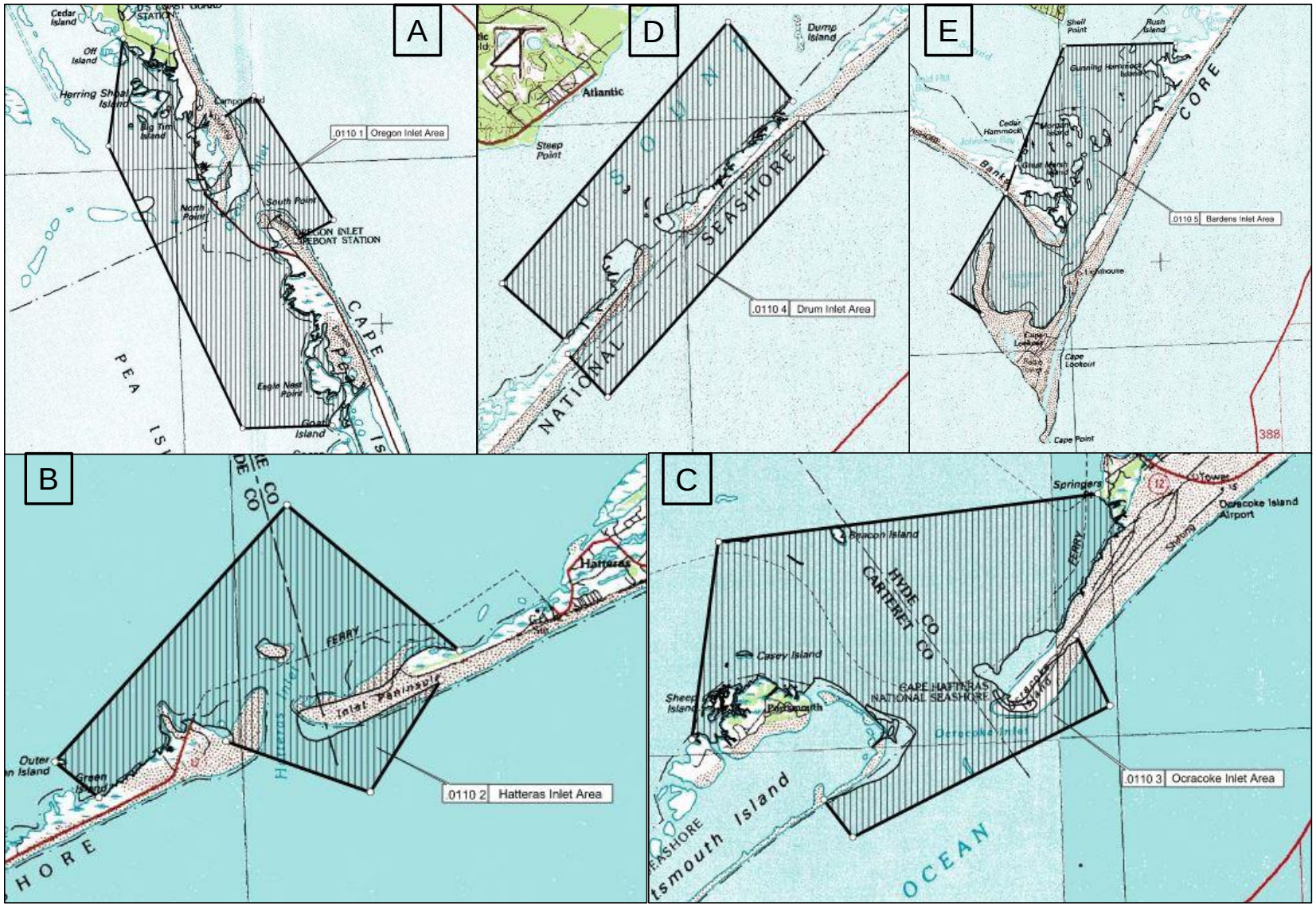

Figure 12. Boundaries of the five current Crab Spawning Sanctuaries. (A) Oregon Inlet, (B) Hatteras Inlet, (C) Ocracoke Inlet, (D) Drum Inlet, and (E) Bardens Inlet.

Designate New Crab Spawning Sanctuaries

Crab spawning sanctuaries have not been designated south of Cape Lookout, N.C. due to the small size of inlets and relatively small estuarine waters near most of the southern coastal inlets. Spawning sanctuaries around the southern inlets would prohibit commercial gears currently in use, forcing commercial harvesters into other areas and thereby increasing conflicts among other user groups. Local crabbers suggest the deep fast flowing waters of the lower Cape Fear River ship channel provide a natural barrier to some crab harvesting practices in that area. Thus, this area serves as an unofficial sanctuary for all blue crabs. Designating additional Crab Spawning Sanctuaries would further protect mature females as they migrate to the spawning grounds. Figures 13 – 15 show examples of potential Crab Spawning Sanctuaries in the southern portion of the state.

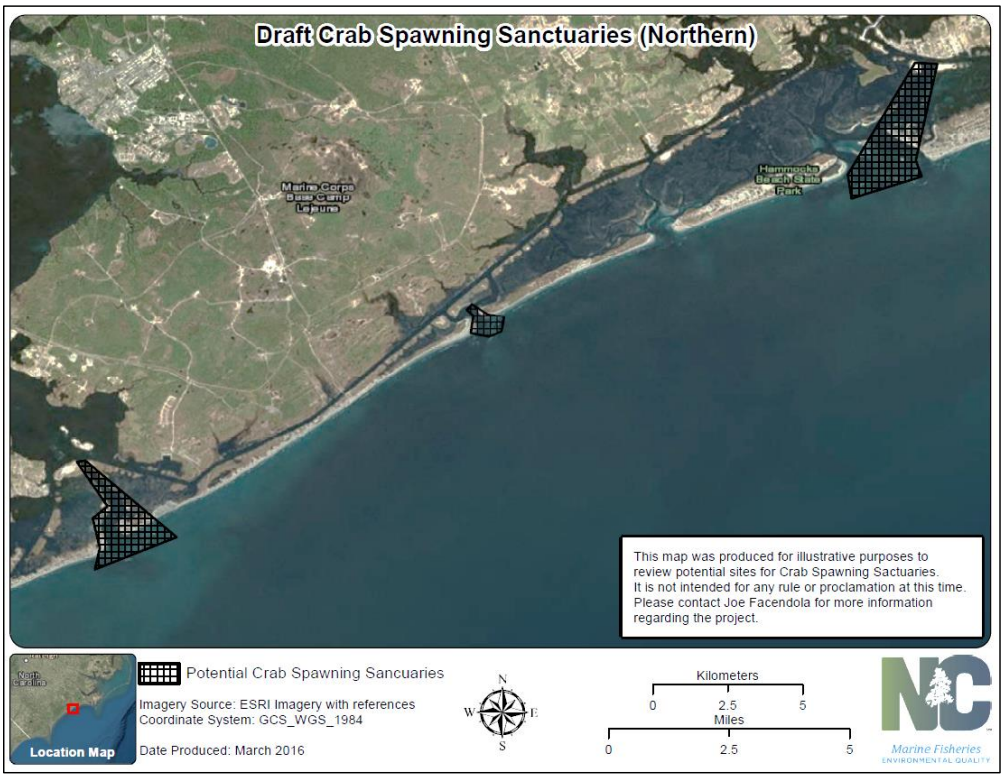

Figure 13. Potential Crab Spawning Sanctuaries for Bogue Inlet, Browns Inlet, and New River Inlet.

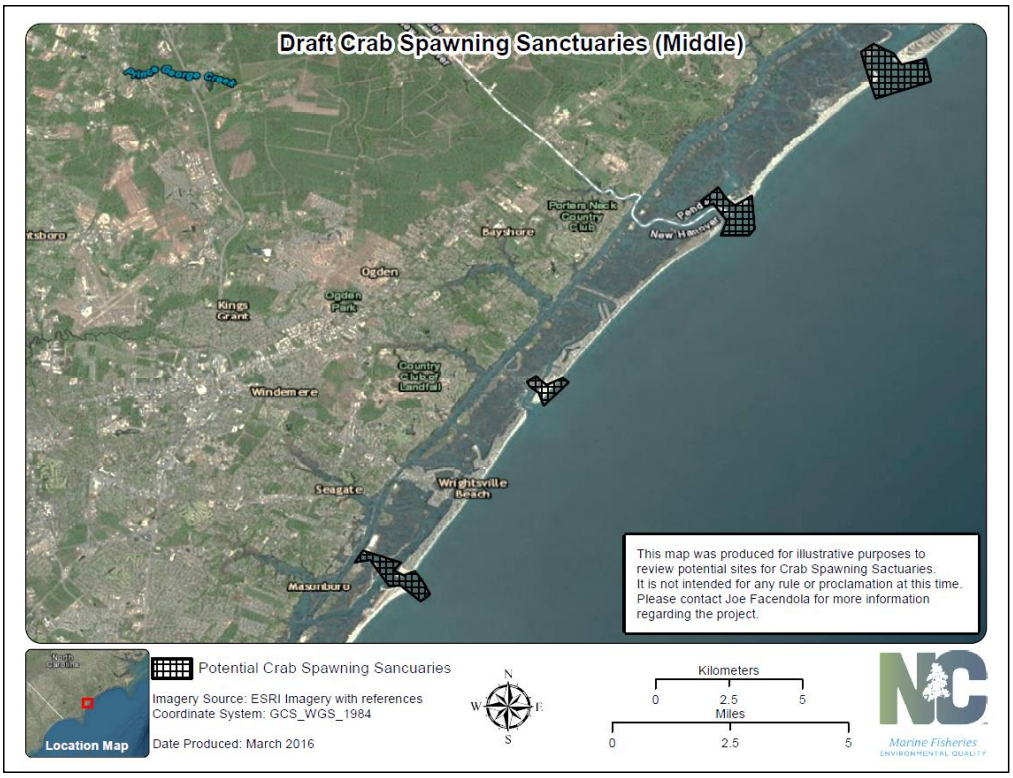

Figure 14. Potential Crab Spawning Sanctuaries for Old Topsail Inlet, Rich Inlet, Mason Inlet, and Masonboro Inlet.

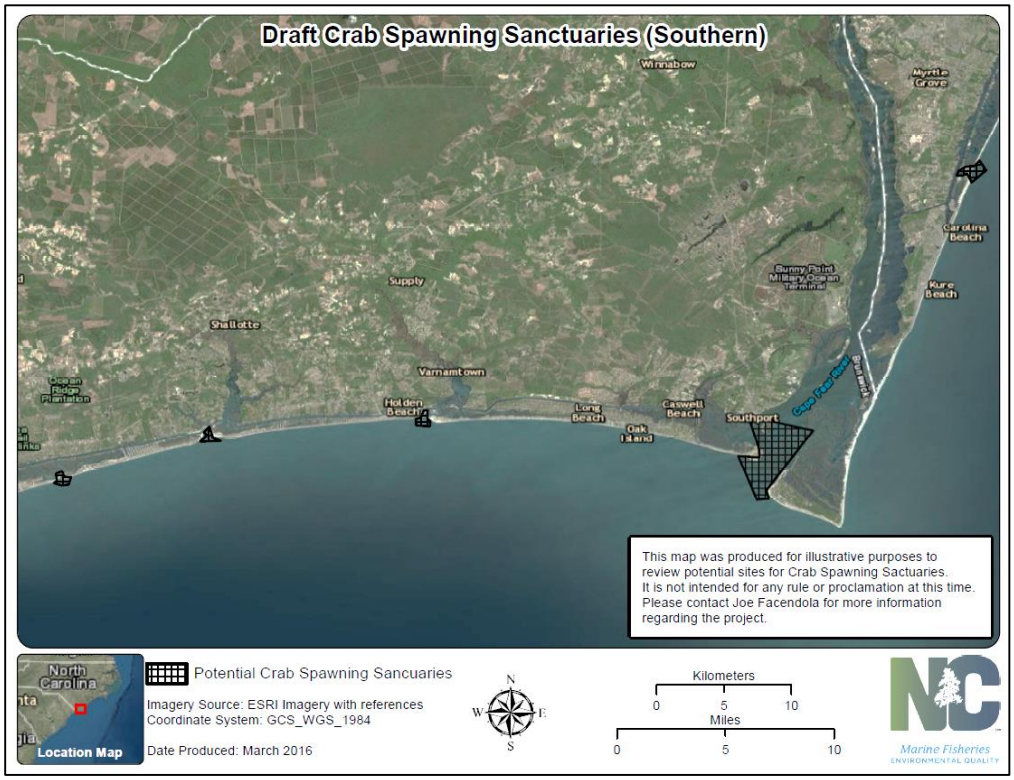

Figure 15. Potential Crab Spawning Sanctuaries for Carolina Inlet, Cape Fear River Inlet, Lockwoods Folly Inlet, Shallotte Inlet, and Tubbs Inlet.

Closure of the Fishery

Closures to the blue crab fishery could include season, area, gear, or life history stage. The premise behind this management tool is to restrict harvest, whether by time, location, fishery, or life history stage to provide protection to blue crabs that are vulnerable to harvest in a particular place and time or stage in their life history.

Seasonal Closures

A seasonal closure can be used to restrict harvest during certain times of the year and to reduce removals from the stock. Since effort can be increased during the open periods of the fishery to offset losses during the closed season, it is best to have seasonal closures that are a minimum of two weeks, but preferably longer. The timing of harvest from the different crab fisheries should also be considered.

Season closures during peak harvest periods tend to be more effective than season closures when harvest is minimal because closures at peak harvest leave less opportunity for recoupment by the fisheries. However, a possible result of overall season closures would be an increase in discards, particularly in fisheries that land, but do not target blue crabs.

An example of season closure would be to prohibit the harvest of sponge crabs during periods of peak abundance. Sponge crabs begin to appear in March, peaking in April and May, and persist in lower levels through the summer (Figure 16).

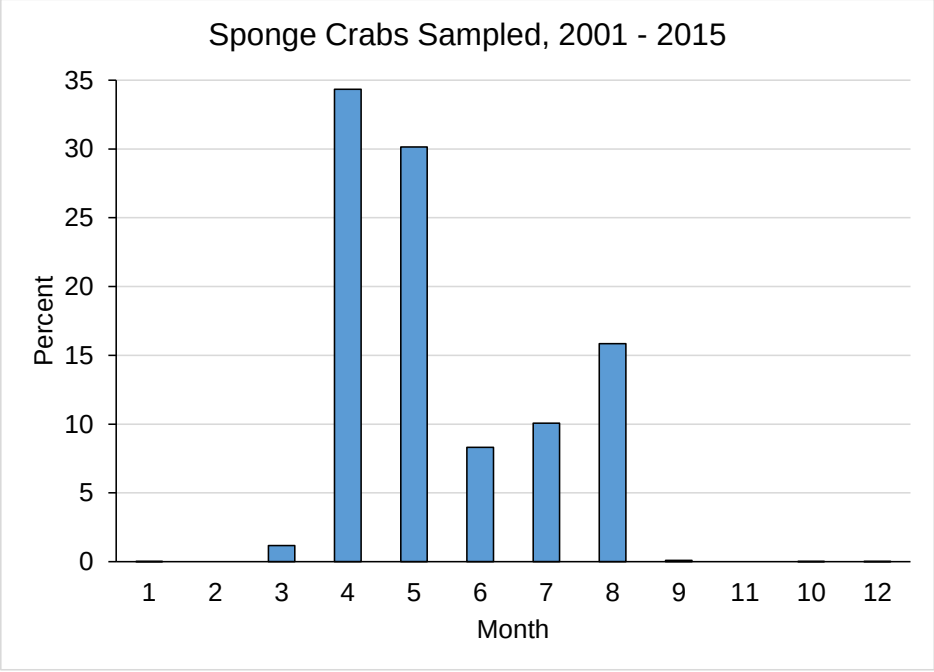

Figure 16. Average monthly sponge crab frequency in commercial crab sampling, 2001 – 2015.

Gear Closures

Dredges

One example of gear closure would be to close the targeted crab dredge fishery. This fishery has had minimal landings in recent years (Table 13) with most dredge landings coming from oyster dredges in January and February (Table 14), but when it was more active it primarily targeted overwintering mature female crabs. This fishery is currently only allowed in a small portion of the northern area of Pamlico Sound (Figure 17) during January and February.

Table 13. Annual crab landings (pounds) from crab and oyster dredges, 2011 – 2015.

Year	Crab Dredge	Oyster Dredge	Grand Total
2011	6,843	31,861	38,704
2012	4,051	2,756	6,807
2013	-	1,305	1,305
2014	-	7,372	7,372
2015	1,382	5,203	6,585

Table 14. Average monthly crab landings (pounds) from crab and oyster dredges, 2011 – 2015.

Month	Crab Dredge	Oyster Dredge	Grand Total
January	1,634	1,870	1,786
February	600	2,155	1,589
March	-	615	615
April	-	124	154
November	-	615	615
December	-	508	508

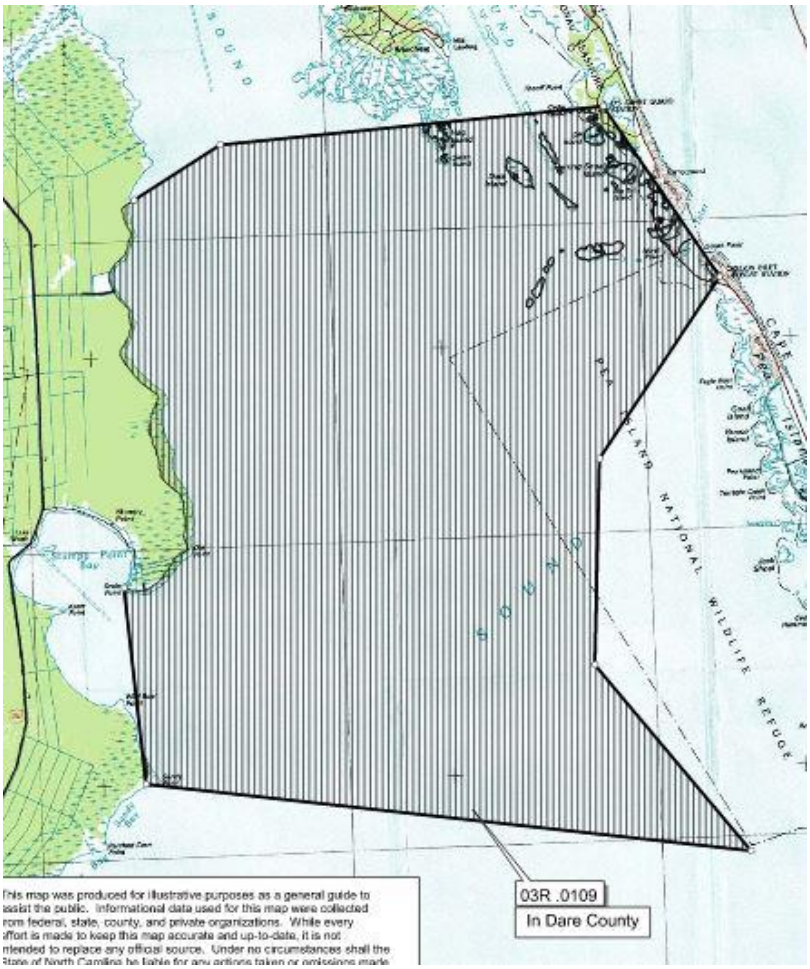

Figure 17. Designated crab dredge area in northern Pamlico Sound.

Crab Trawls

Another example of a potential gear closure would be to limit crab trawling in the Pamlico, Pungo, and Neuse rivers to the current shrimp trawl lines in each river. Currently there are minimal landings of crabs from crab and shrimp trawls in these systems (Table 15). Figures 18 and 19 show the current crab trawl boundary lines and the current shrimp trawl boundary lines for each system.

Table 15. Annual crab landings (pounds) from crab and shrimp trawls in the Pamlico, Pungo, and Neuse rivers, 2011 – 2015.

	Crab Trawl			Shrimp Trawl		
Year	Neuse River	Pamlico River	Pungo River	Neuse River	Pamlico River	Pungo River
2011	-	141	-	48	371	77
2012	450	-	-	-	12	-
2013	-	-	-	904	-	-
2014	220	-	-	2,561	-	-
2015	302	329	320	451	49	-

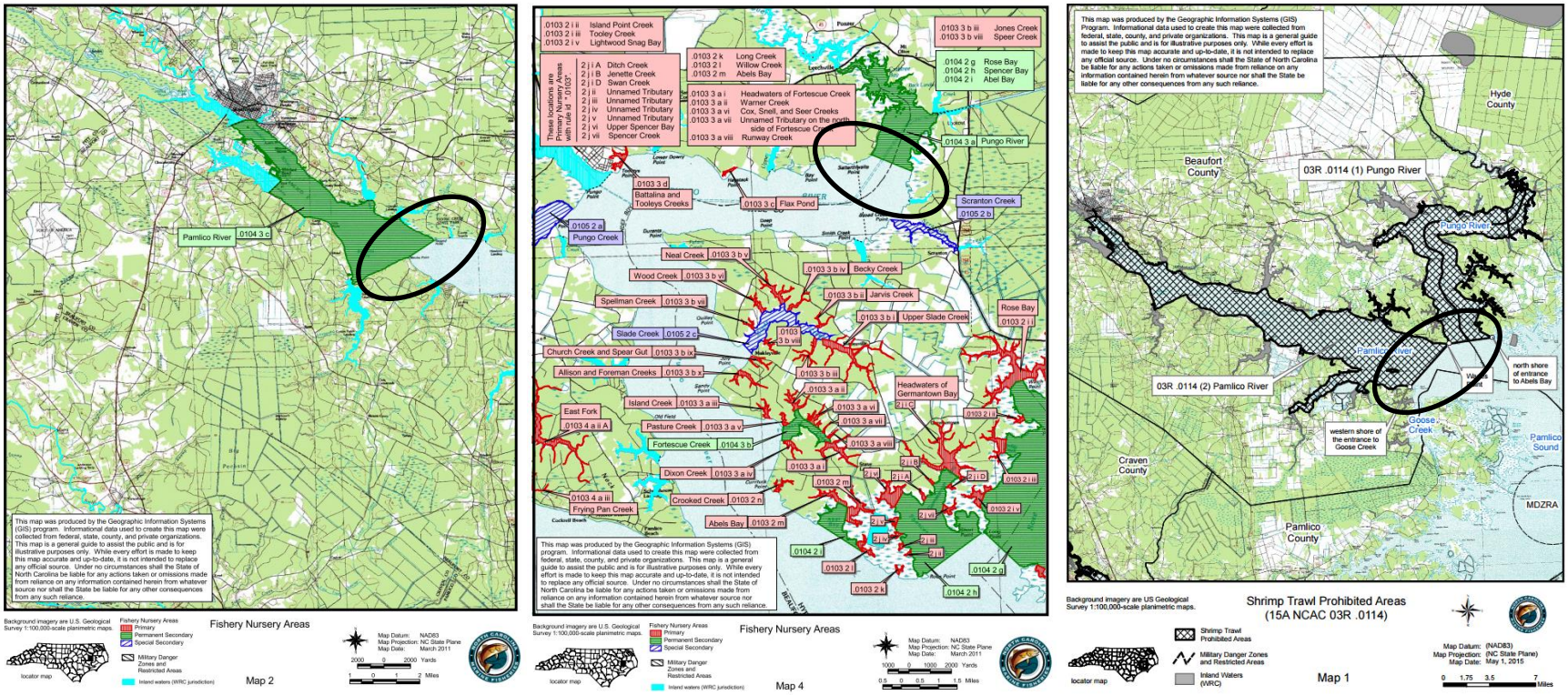

Figure 18. Current crab trawl boundary lines on the Pamlico (left) and Pungo (middle) rivers and the current shrimp trawl boundary lines for each river (right). Boundary lines are located within the circled areas.

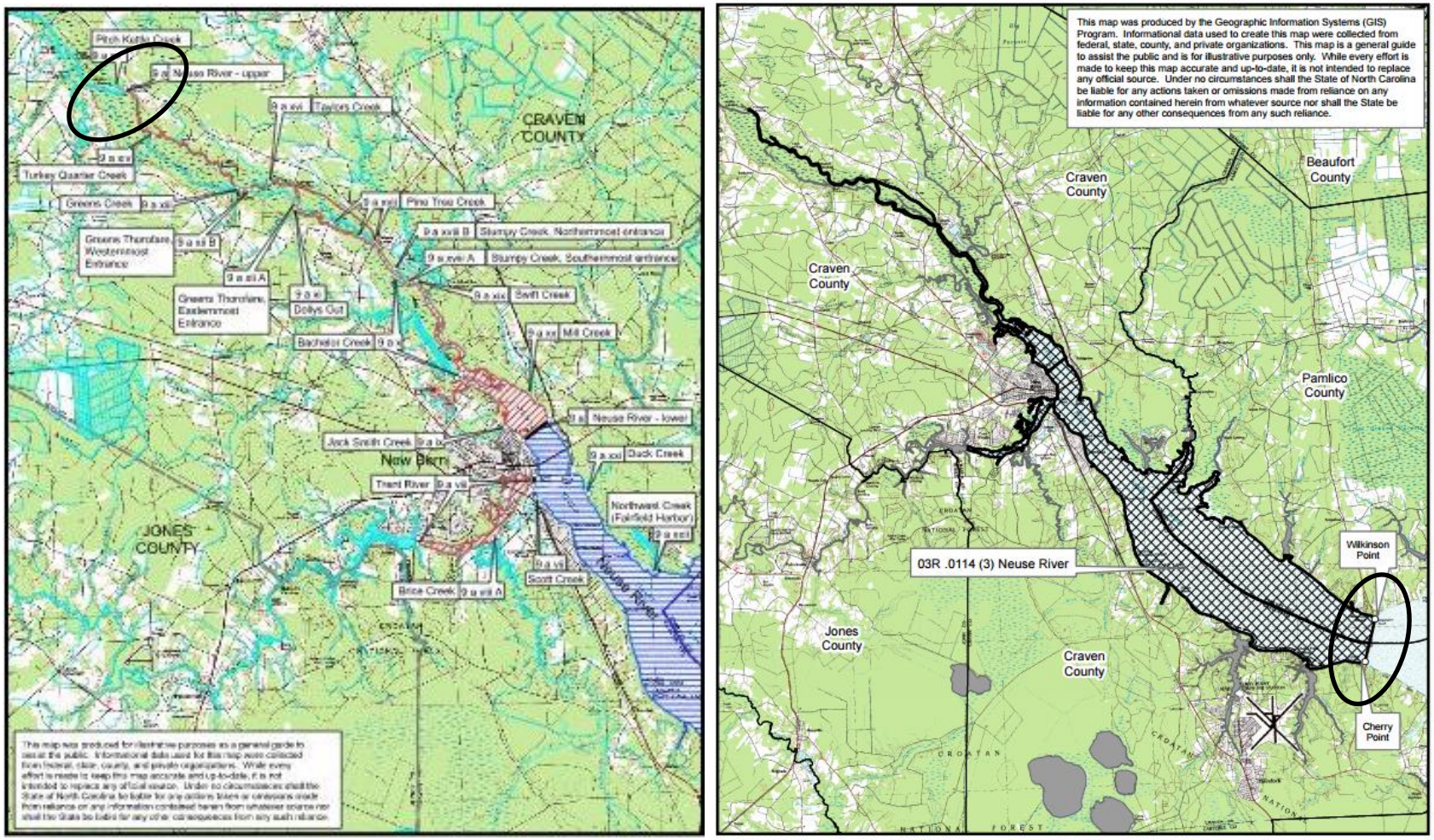

Figure 19. Current crab trawl boundary line on the Neuse River (left) and the current shrimp trawl boundary line on the Neuse River (right). Boundary lines are located within the circled areas.

Gear Modifications in the Crab Trawl Fishery

Existing NCMFC rule requires a minimum stretched mesh of 3 inches for crab trawls for taking hard crabs, except that the Director may, by proclamation, increase the minimum mesh length to no more than 4 inches [15A NCAC 03L .0202 (b)]. Increasing the minimum mesh length of crab trawls in areas not currently under proclamation authority would further reduce catch and mortality of sublegal crab bycatch. In 1992, the NCDMF conducted a study to examine the culling ability of larger tail bag sizes in crab trawls, the number of sublegal blue crabs was reduced by 13% in the 4-inch tail bag and the number of legal crabs was reduced by 7%, as compared to catches in a 3-inch tail bag (McKenna and Clark 1993). Overall survival rates were documented for trawl-caught crabs at 64%, while 93% of the crab pot caught crabs survived (McKenna and Camp 1992). During one trip a large number of paper shell and soft crabs were killed in the trawling process. Given the high percentage of sublegal blue crabs currently being captured by the crab trawl fishery, it was recommended that an increase in the minimum tail bag mesh size should be implemented to reduce fishing mortality on this species (McKenna and Clark 1993). A reduction of fishing mortality on sublegal crabs should allow more individuals to be available to spawn at a future date. Figure 20 shows the current boundary for 3-inch and 4-inch crab trawls. Selecting this option would extend the 4-inch minimum mesh size for crab trawls statewide.

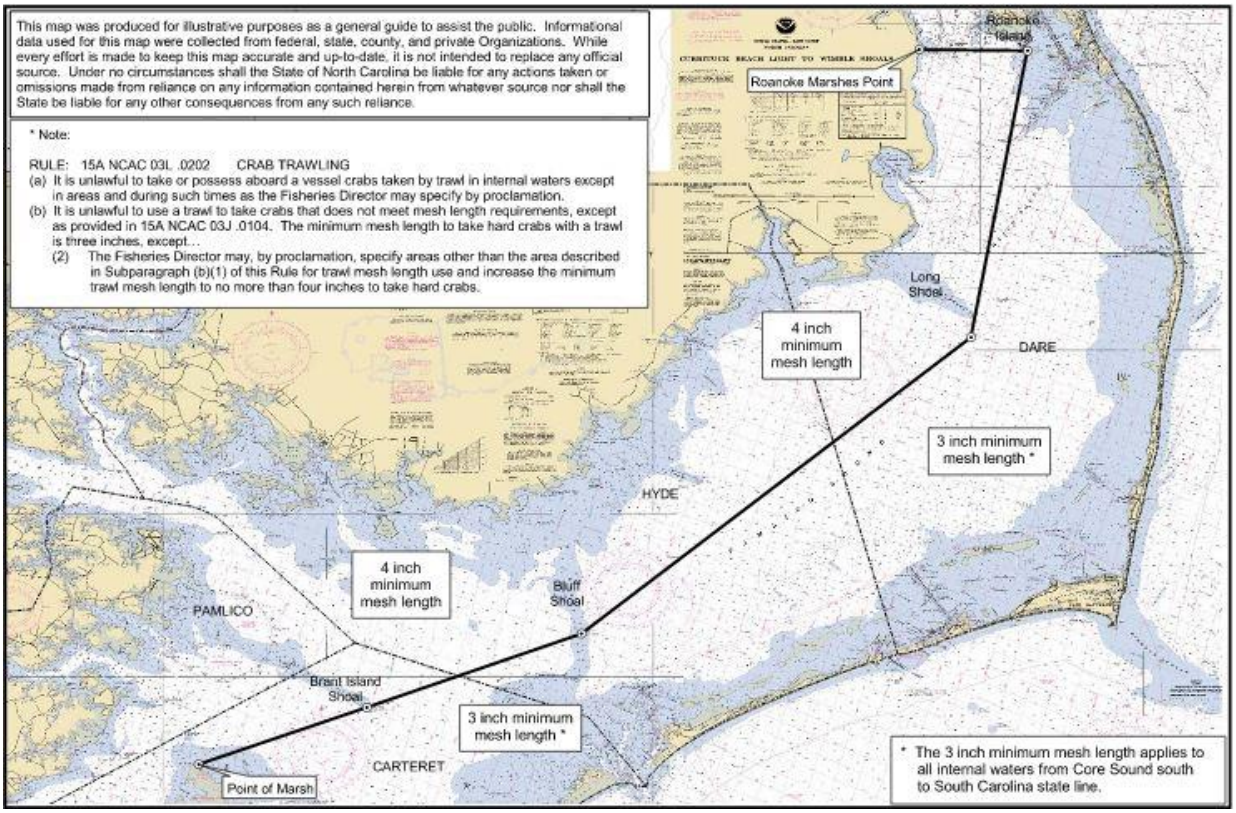

Figure 20. Current 3-4-inch crab trawl minimum mesh size boundary in Pamlico Sound.

The goal of the management options discussed in this revision is to increase the escapement of sublegal males and immature females, mature females, and sponge bearing mature females. Because the adaptive management framework does not identify specific reduction levels for

moderate and elevated management measures, the reduction chosen can only be based on the degree of concern with the blue crab stock as indicated by the data trends.

VI. MANAGEMENT REVISION OPTIONS

(+ Potential positive impact of action)
(- Potential negative impact of action)

1. Increase minimum size limit for male and immature female crabs
    - + May increase spawning stock biomass
    - + If cull ring size is also increased, discards will not increase
    - – Decreases harvest with economic loss to the fishery
    - – Some regions may be impacted more than others
    - – Predicted reduction may be less than actual due to recoupment once crabs reach legal size

2. Reduction in tolerance of sublegal blue crabs (to a minimum of 5%) and/or implement gear modifications to reduce sublegal catch
    - + Increases escapement of undersize crabs
    - – Decreases harvest with economic loss to the fishery
    - – Some regions may be impacted more than others
    - – Predicted reduction may be less than actual due to recoupment once crabs reach legal size
    - – Increased catch processing time for fishermen
    - – Additional cost to fishermen to make gear modifications

3. Eliminate harvest of V-apron immature hard crab females
    - + May increase spawning stock biomass
    - – Decreases harvest with economic loss to the fishery
    - – Some regions may be impacted more than others
    - – Predicted reduction may be less than actual due to recoupment once female crabs mature
    - – Increased catch processing time for fishermen

4. Establish a seasonal size limit on peeler crabs
    - + May increase spawning stock biomass
    - + If cull ring size is also increased, discards will not increase
    - – Decreases harvest with economic loss to the fishery
    - – Some regions may be impacted more than others
    - – Predicted reduction may be less than actual due to recoupment once crabs reach legal size
    - – Increased catch processing time for fishermen

5. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color)
    - + May increase spawning stock biomass
    - + May increase juvenile recruitment
    - – Decreases harvest with economic loss to the fishery
    - – Some regions may be impacted more than others

- Increased catch processing time for fishermen

6. Close the crab spawning sanctuaries from September 1 through February 28 and may impose further restrictions
    + May increase spawning stock biomass
    + Increases protection of mature female crabs
    + May increase juvenile recruitment
    - Decreases harvest with economic loss to the fishery
    - Some regions may be impacted more than others
    - May have impacts to other fisheries

7. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots in specific areas
    + May increase spawning stock biomass
    + Increases protection of mature female crabs
    + May increase juvenile recruitment
    - Decreases harvest with economic loss to the fishery
    - Some regions may be impacted more than others
    - Additional cost to fishermen to make gear modifications

8. Expand existing and/or designate new crab spawning sanctuaries
    + May increase spawning stock biomass
    + Increases protection of mature female crabs
    + May increase juvenile recruitment
    - Decreases harvest with economic loss to the fishery
    - Some regions may be impacted more than others
    - May have impacts to other fisheries

9. Closure of the fishery (season and/or gear)
    + May increase spawning stock biomass
    + Increases escapement of mature females
    + May increase juvenile recruitment
    - Decreases harvest with economic loss to the fishery
    - Some regions may be impacted more than others

10. Gear modifications in the crab trawl fishery
    + May increase spawning stock biomass
    + Increases escapement of mature females
    + May increase juvenile recruitment
    - Decreases harvest with economic loss to the fishery
    - Some regions may be impacted more than others
    - Additional cost to fishermen to make gear modifications

VII. RECOMMENDATIONS

NCDMF Recommendation

- Recommend adding two additional cull rings to crab pots, one of which 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 of the upper chamber of the pot.

- Recommend eliminating the harvest of v-apron immature female hard crabs (excluding peeler crabs) and that v-apron immature hard crab females be added to the current 10% culling tolerance (currently only includes sublegal male and immature female hard crabs).

- Recommend prohibiting sponge crab harvest (all stages) from April 1 – April 30.

- Recommend prohibiting crab harvest with dredges except incidental to lawful oyster dredging as outlined in N.C. Marine Fisheries Commission Rule 15A NCAC 03L .0203(a)(2).

Advisory Committee Recommendations

Northern Advisory Committee

- Recommended no possession of v-apron crabs (consistent with moderate management measure A3) and to keep a 10% cull tolerance across the board.

- Recommended the NCMFC investigate re-tooling the data collection system for the blue crab industry and work with the industry to identify a more appropriate sampling approach (e.g. winter dredge survey).

- Recommended adding two additional cull rings to crab pots. One cull ring must be within one full mesh of the bottom of the apron/stairs of the upper chamber of the pot, effective January 16, 2017.

Southern Advisory Committee

- Recommended to reduce the tolerance of sublegal size blue crabs to a minimum of 5% and directed the NCMFC to look at gear modifications to reduce sublegal catch and to eliminate harvest of v-apron immature hard crab females.

- Recommended no take of black sponge crabs with a cull tolerance of 5%.

Shellfish and Crustacean Advisory Committee

- Recommend to NCMFC to adopt the measures of no v-apron hard crabs and no black sponge crab harvest with a 5% tolerance for both (excludes v-apron peelers).

- Recommend to NCMFC to use two cull rings (no additional cull rings and current legal size) but to reposition one cull ring within one full mesh of the bottom of the apron/stairs of the upper chamber of the pot, effective January 16, 2017.

- Recommend to NCMFC to request the other commissions under the Coastal Habitat Protection Plan Steering Committee look at NCDMF blue crab recruit abundance data, ask what the Environmental Management Commission (EMC) and Coastal Resources Commission (CRC) have done to improve habitat and water quality conditions for blue crab, and determine if they can develop a suite of options that the EMC and CRC could implement to improve water quality and habitat conditions in those areas.

- Recommend to NCMFC to request NCDMF observers on commercial crab boats to collect data to assist with the blue crab Traffic Light assessment.

- Recommend to NCMFC to request NCDMF staff analyze the 21 years of commercial fishery data, refined by taking into account socio-economic information such as storms, prices, picking house availability, etc. that affects fishing effort, and align it with 21 years of NCDMF fishery-independent data and summarize in a report. In the future, refine the fishery-dependent data set so it can be incorporated.

- Recommend to NCMFC to request NCDMF staff look at the effect of predation by striped bass, red drum, cownose rays, and other species on blue crabs.

- Recommend to NCMFC to look at dealer requirements and how they are enforced and if changes are needed.

IX. MANAGEMENT REVISIONS TO AMENDMENT 2 TO THE N.C. BLUE CRAB FMP

Amendment 2 to the N.C. Blue Crab FMP provides the framework for the management changes proposed herein. This Information Paper serves as a Revision to Amendment 1 to the N.C. Blue Crab FMP and documents the rationale of the NCMFC for the following changes in blue crab management that were implemented June 6, 2016, unless otherwise specified. All management measures adopted by the NCMFC were implemented through Proclamation M-11-2016 (Appendix 4).

MFC Selected Management Revisions

- Add one additional cull ring to crab pots, which 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.

- Eliminate the harvest of v-apron immature female hard crabs (excluding peeler crabs) and that v-apron immature hard crab females be included in the culling tolerance (currently only includes sublegal male and immature female hard crabs).

- Prohibit harvest of dark sponge crabs (brown and black) from April 1-April 30. Include dark sponge crabs in the cull tolerance.

- Lower the cull tolerance to 5 percent for all crabs, except mature females.

- Prohibit crab harvest with dredges except incidental to lawful oyster dredging as outlined in North Carolina Marine Fisheries Commission Rule 15A NCAC 03L .0203(a)(2).

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APPENDIX 1

Traffic Light Data Sources

Data from three NCDMF fishery-independent and one fishery-dependent survey are used in the traffic light. Fishery-independent data are collected by scientists independent of commercial or recreational fishing operations and fishery-dependent data are collected directly from the commercial or recreational harvester. Fishery-independent data are collected through resource surveys (such as trawls surveys). These surveys are designed to sample in an objective and consistent manner using the same gear and techniques to provide unbiased and independent indices of abundance. Consequently, sampling is not necessarily done where crabs are most abundant. Instead, the objective is to collect information on the crab population throughout its entire geographic range. These surveys are conducted for many years to track the long-term trends in abundance of the population. Fishery-independent data are also not influenced by external factors (such as management measures or socioeconomics) and provide an unbiased picture of stock health.

Juvenile Anadromous Trawl Survey (Program 100)

The NCDMF Juvenile Anadromous Trawl Survey, also known as Program 100 (P100), was initiated in 1982 and targets juvenile alosines and striped bass in Albemarle Sound (Figure A1.1). Since its inception, the survey has sampled seven stations (Hassler stations) in western Albemarle Sound. In July 1984, twelve sampling stations were added in the central Albemarle Sound area (Central stations) to monitor juvenile striped bass abundance and to determine if a shift in the striped bass nursery area had occurred.

Sampling for the survey is conducted bi-weekly from mid-July through October. The survey uses an 18-foot semi-balloon trawl with a body bar mesh size of ¾- inch and a ¼-inch bar mesh tail bag. Eleven links of 3/16-inch chain are attached over nine inches on the footrope. Tow duration is 15 minutes at the Hassler stations and ten minutes at the Central stations. Temperature, pH, conductivity, salinity, and dissolved oxygen are recorded at each station.

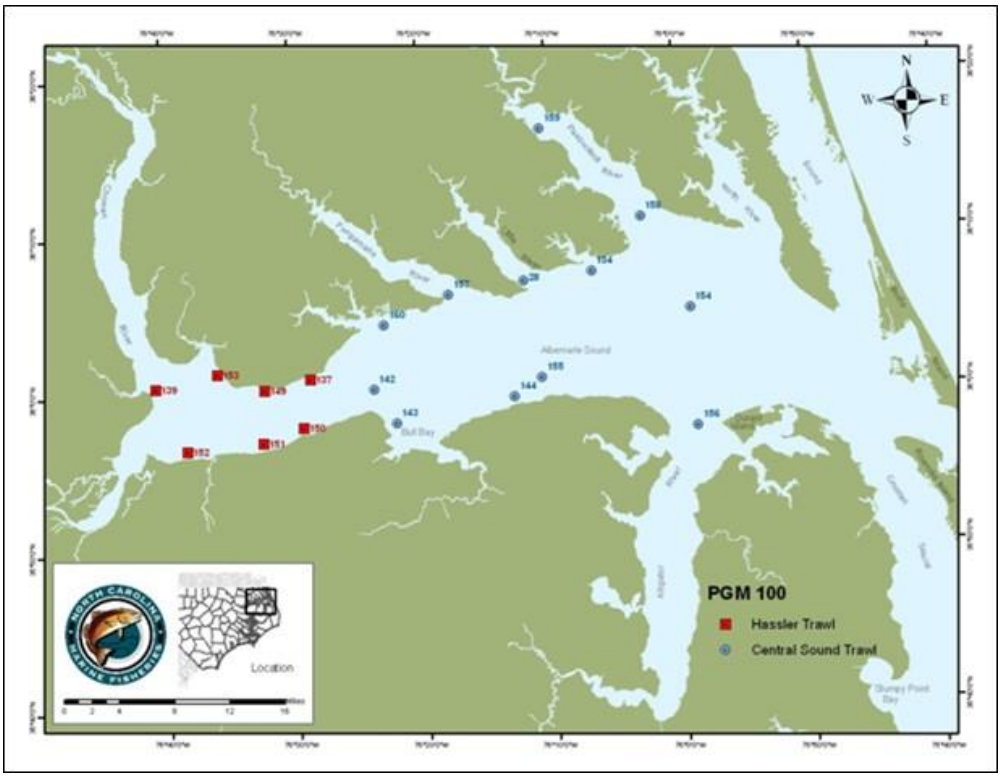

Figure A1.1. Location of sites in Albemarle Sound sampled by the NCDMF Juvenile Anadromous Trawl Survey (Program 100).

Estuarine Trawl Survey (Program 120)

In 1971, the NCDMF initiated a statewide Estuarine Trawl Survey, also known as Program 120 (P120). The initial objectives of the survey were to identify the primary nursery areas and produce annual recruitment indices for economically important species. Other objectives included monitoring species distribution by season and by area and providing data for evaluation of environmental impact projects.

The survey samples shallow-water areas south of the Albemarle Sound system (Figure A1.2). Major gear changes and standardization in sampling occurred in 1978 and 1989. n 1978, tow times were set at one minute during the daylight hours. In 1989, an analysis was conducted to determine a more efficient sampling time frame for developing juvenile abundance indices with acceptable precision levels for the target species. A fixed set of 105 core stations was identified and sampling was to be conducted in May and June only, except for July sampling for weakfish (dropped in 1998, Program 195 deemed adequate), and only the 10.5-ft headrope, ¼-inch bar mesh trawl would be used.

The current gear is a 3.2-m (10.5 ft.) otter trawl with 6.4-mm (1/4-inch) bar mesh body netting of 210/6 size twine and a tail bag mesh of 3.2-mm (1/8-inch) Delta-style knotless nylon with a 150-mesh circumference and 450-mesh length. Three loops of 3/16-inch diameter chain are attached to each wing. Each loop is comprised of thirteen links hung over a distance of ten links. Two loops are at the corners, where bars and points meet, and one loop is in the center. The trawl is towed for one minute during daylight hours and similar tidal stages covering a distance of 75 yards.

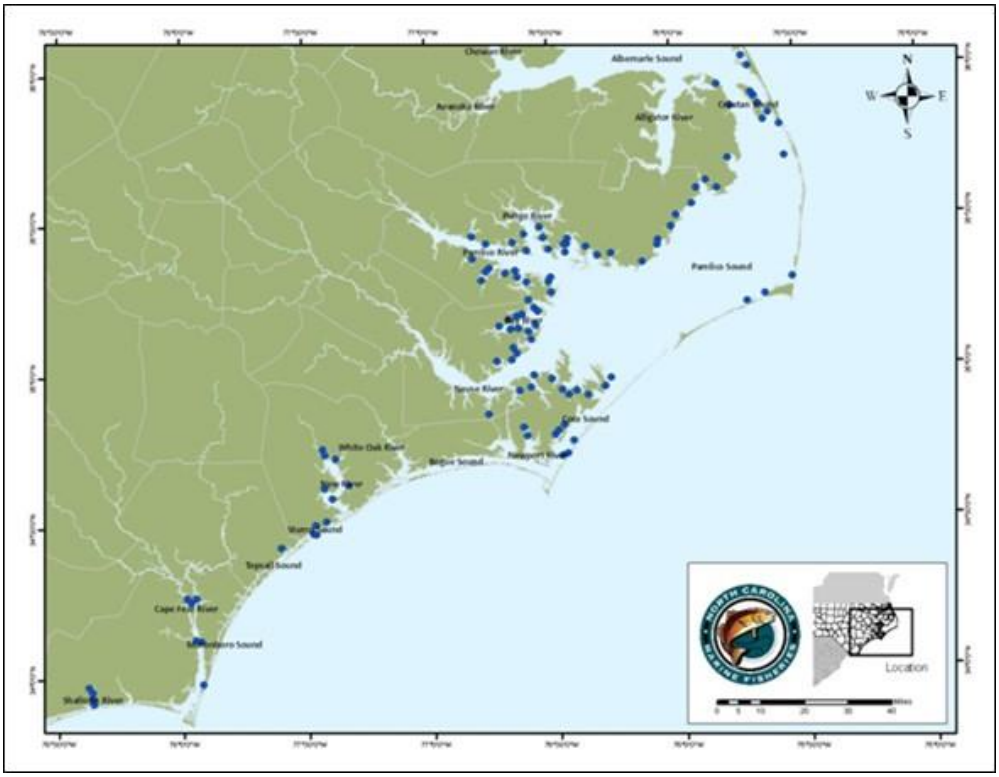

Figure A1.2. Locations of core stations sampled by the NCDMF Estuarine Trawl Survey (Program 120).

Pamlico Sound Survey (Program 195)

The Pamlico Sound Survey, also known as Program 195 (P195), was instituted in March 1987 to provide a long-term, fishery-independent database for the waters of the Pamlico Sound, eastern Albemarle Sound, and the lower Neuse and Pamlico rivers. Data collected from the survey have been used to calculate juvenile abundance indices and estimate population parameters for interstate and statewide stock assessments of recreationally and commercially important fish stocks.

The survey samples 54 randomly selected stations based on a grid system (one-minute by one-minute grid system equivalent to one square nautical mile). Sampling is stratified by depth and geographic area. Shallow water is considered water between 6 to 12 feet in depth and deep water is considered water greater than 12 feet in depth. The seven designated strata are: Neuse River; Pamlico River; Pungo River; Pamlico Sound east of Bluff Shoal, shallow and deep; and Pamlico Sound west of Bluff Shoal, shallow and deep. A minimum of three stations (replicates) are maintained in each stratum. A total of 108 stations are sampled each year to ensure maximum areal coverage. Sampling now occurs only in the Pamlico Sound and associated rivers and bays (Figure A1.3).

Sampling is conducted aboard the RV *Carolina Coast*, equipped with double-rigged demersal mongoose trawls. The RV *Carolina Coast* is a 44-ft fiberglass hulled double-rigged trawler. The trawl consists of a body made of #9 twine with 47.6-mm (1 7/8-inch) stretch mesh, a cod end of #30 twine with 38.1-mm (1 ½-inch) stretch mesh, and a 3.05-m (10 ft.) tail bag. A 36.6-m (120 ft.) three-lead bridle is attached to each of a pair of wood doors that measure 1.22 m (4 ft.) by

0.610 m (2 ft.) and a tongue centered on the 9.1-m (30 ft.) headrope. A 4.76-mm thick, 9.26-m tickler chain is connected to the door next to the 10.4-m (34 ft.) footrope. Tow duration is 20 minutes at 2.5 knots.

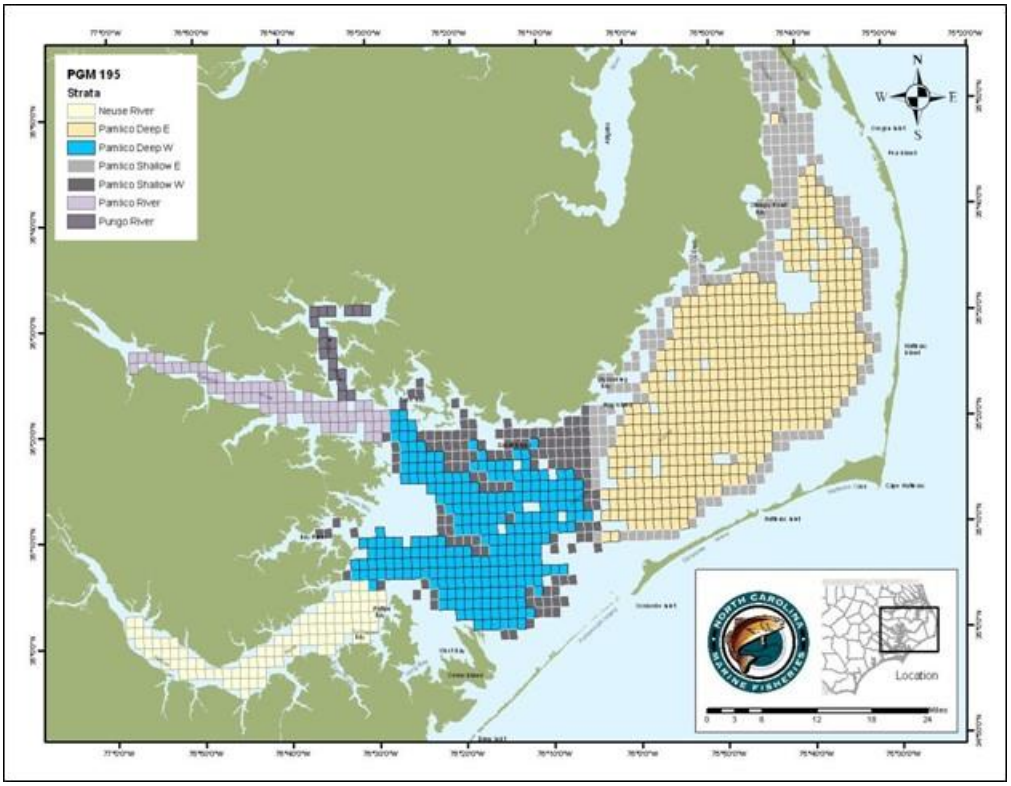

Figure A1.3. Location of sampling grids in Pamlico Sound sampled by the NCDMF Pamlico Sound Survey (Program 195).

Commercial Crab Sampling (Program 436)

Commercial Crab Sampling, also known as Program 436 (P436), was initiated in April 1995 to collect fisheries-dependent data at fish houses from North Carolina's commercial blue crab fishery. Initially, sampling was limited to the northeast and Pamlico Sound regions of North Carolina. Statewide sampling was initiated in 1998. Subsamples of sorted (by market category) and unsorted catches are taken and biological information is recorded. All blue crabs in a subsample are measured and sexed, and maturity of females is recorded. Program 436 only samples voluntarily cooperative fish houses, and sampling distribution may not reflect landing patterns.

APPENDIX 2

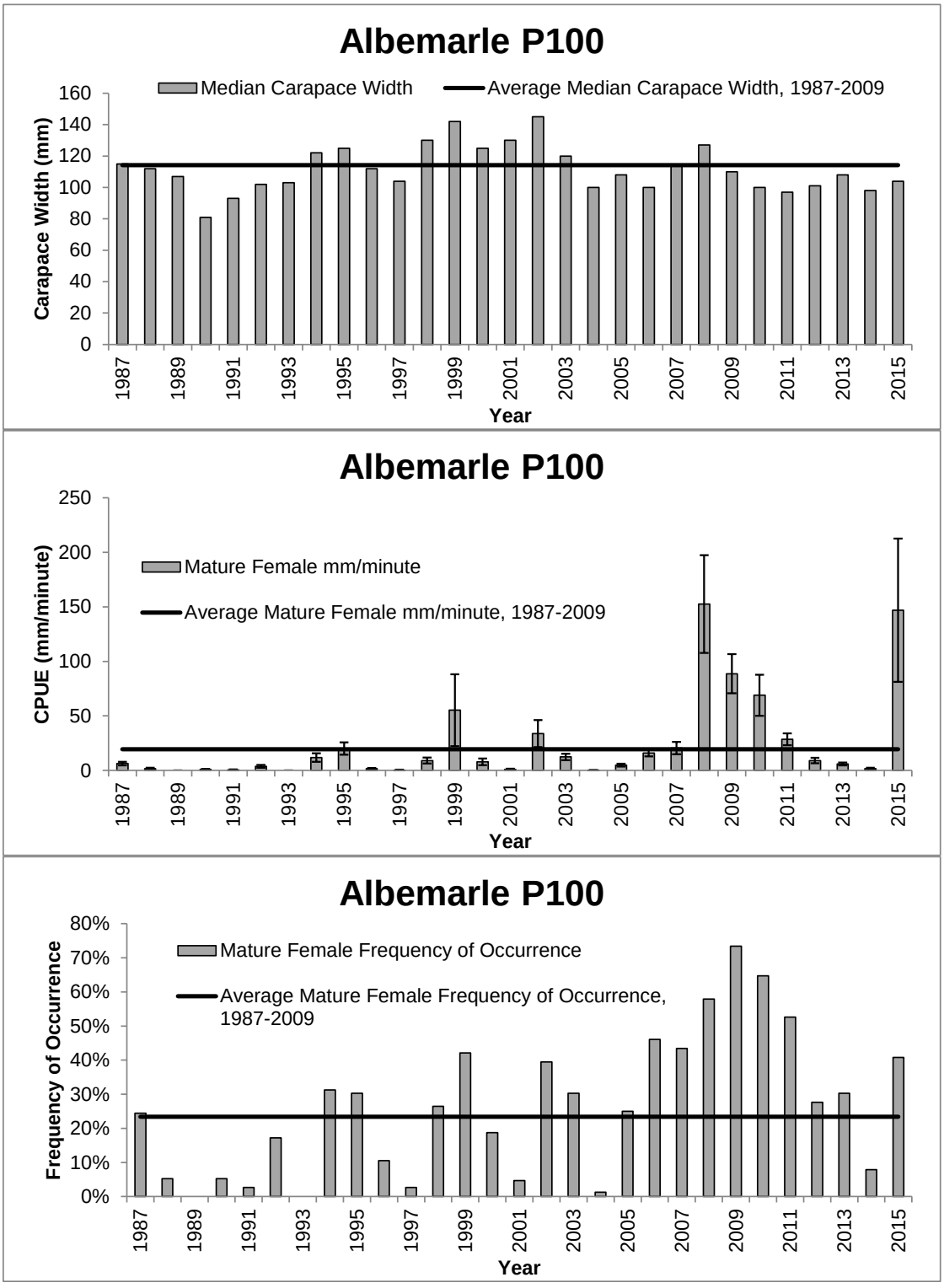

Figure A2.1. Indices from the NCDMF Juvenile Anadromous Trawl Survey (P100) used for the production characteristic of the blue crab Traffic Light, 1987-2015. Error bars represent one standard error of the mean.

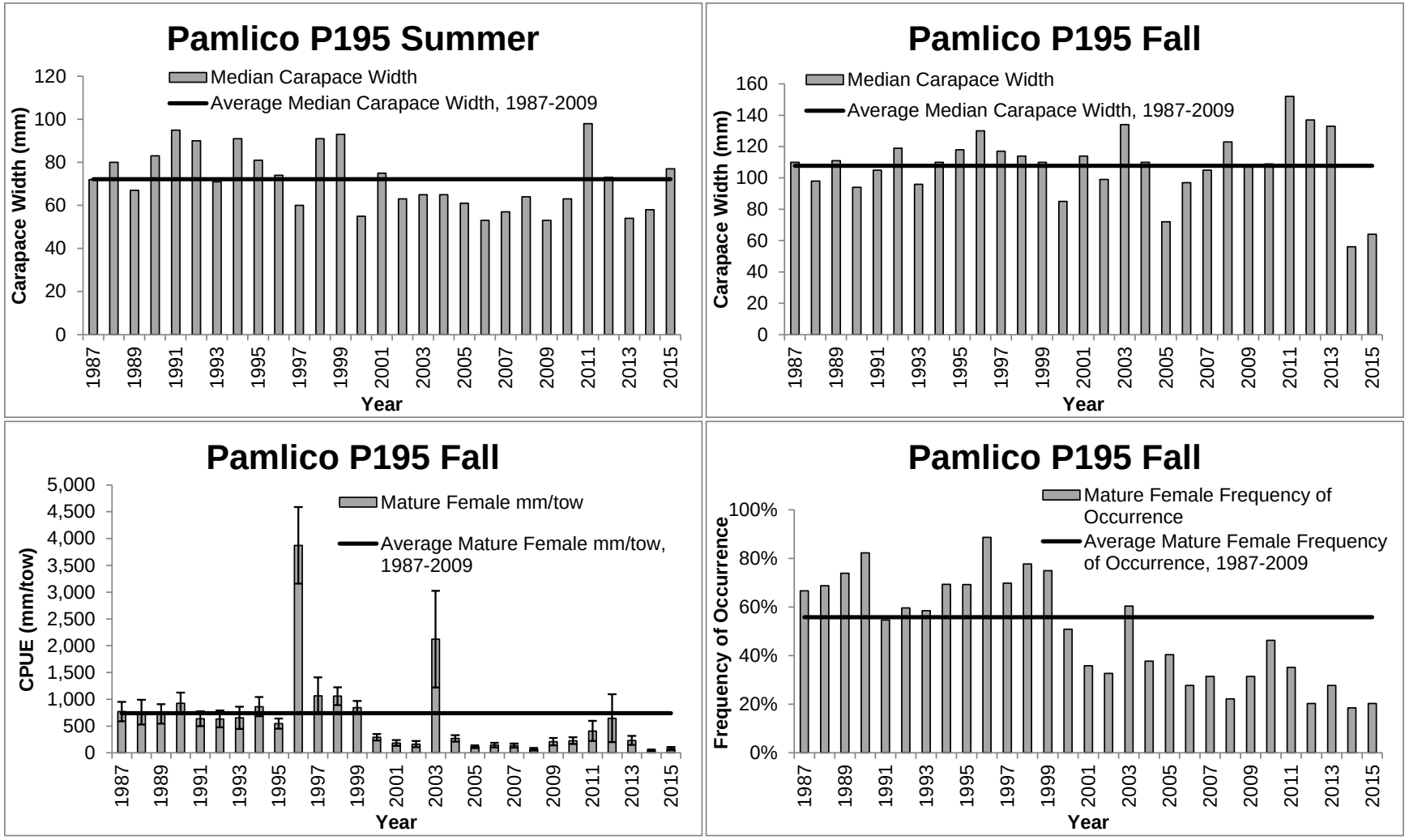

Figure A2.2. Indices from the NCDMF Pamlico Sound Survey (P195) used for the production characteristic of the blue crab Traffic Light, 1987-2015. Error bars represent one standard error of the mean.

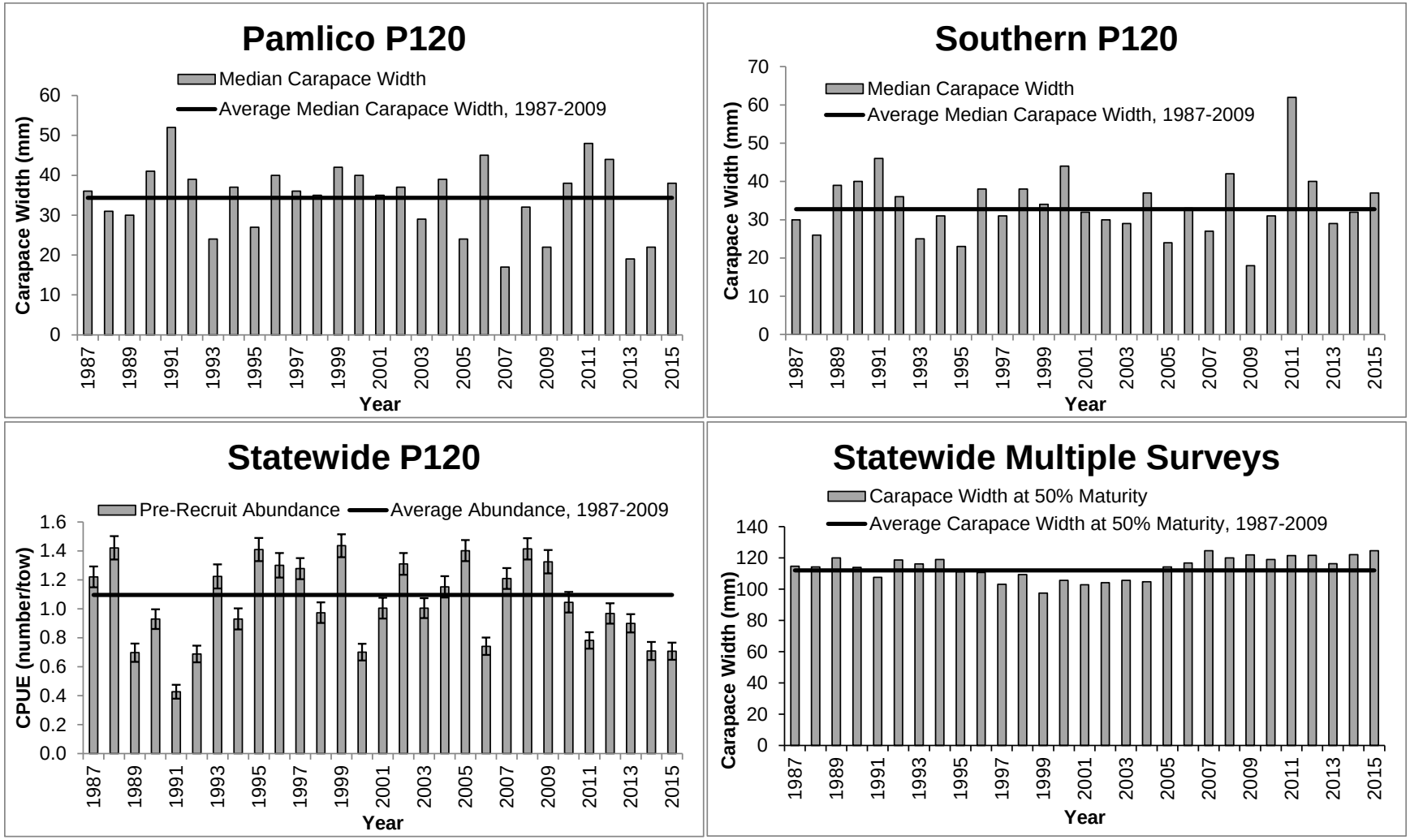

Figure A2.3. Indices from the NCDMF Estuarine Trawl Survey (P120) and the statewide carapace width at 50% maturity for female blue crabs used in the production characteristic of the blue crab Traffic Light, 1987-2015. Data from all fishery-dependent and independent surveys were included in the maturity analysis. Error bars represent one standard error of the mean.

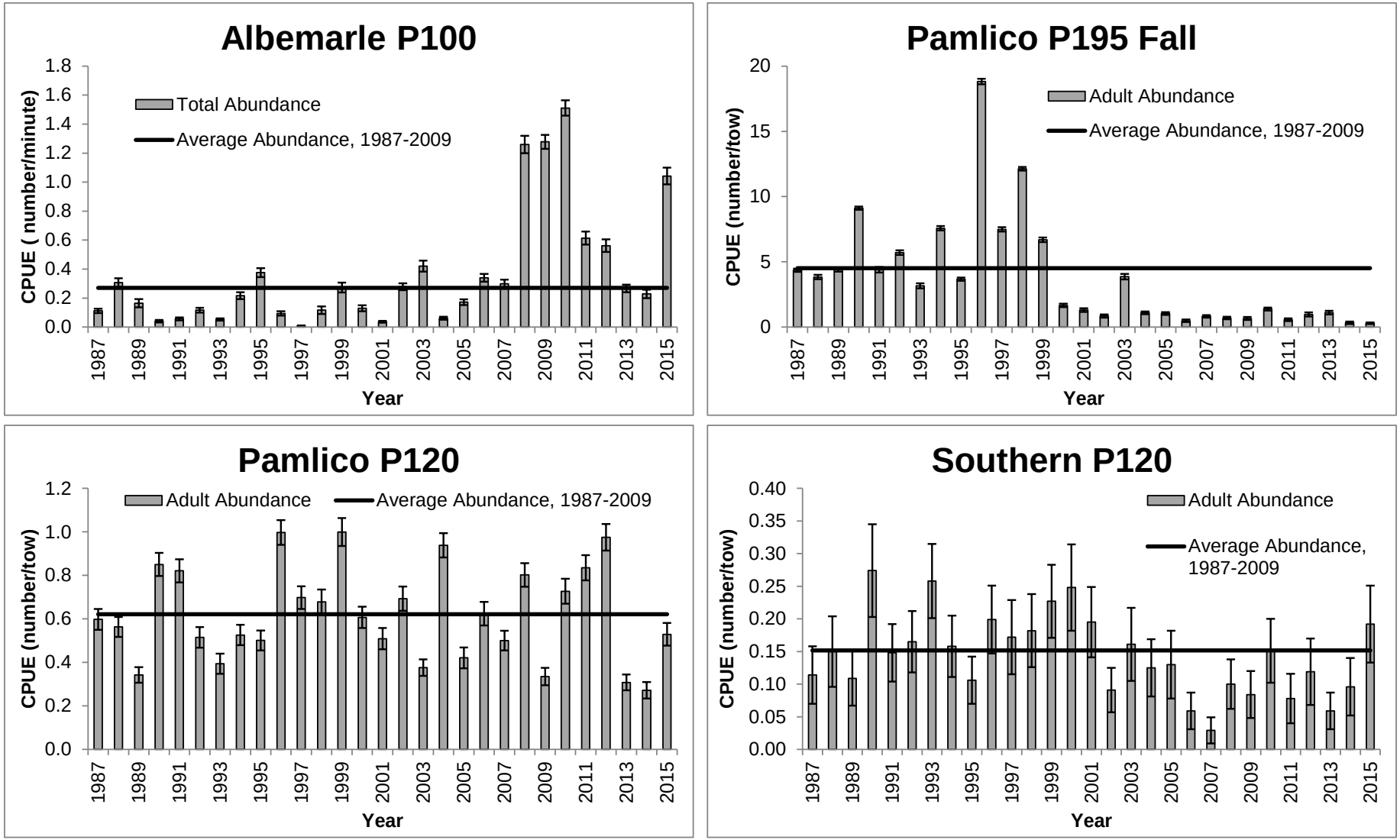

Figure A2.4. Indices from the NCDMF Juvenile Anadromous Trawl Survey (P100), Estuarine Trawl Survey (P120), and Pamlico Sound Survey (P195) used for the adult abundance characteristic of the blue crab Traffic Light, 1987-2015. Error bars represent one standard error of the mean.

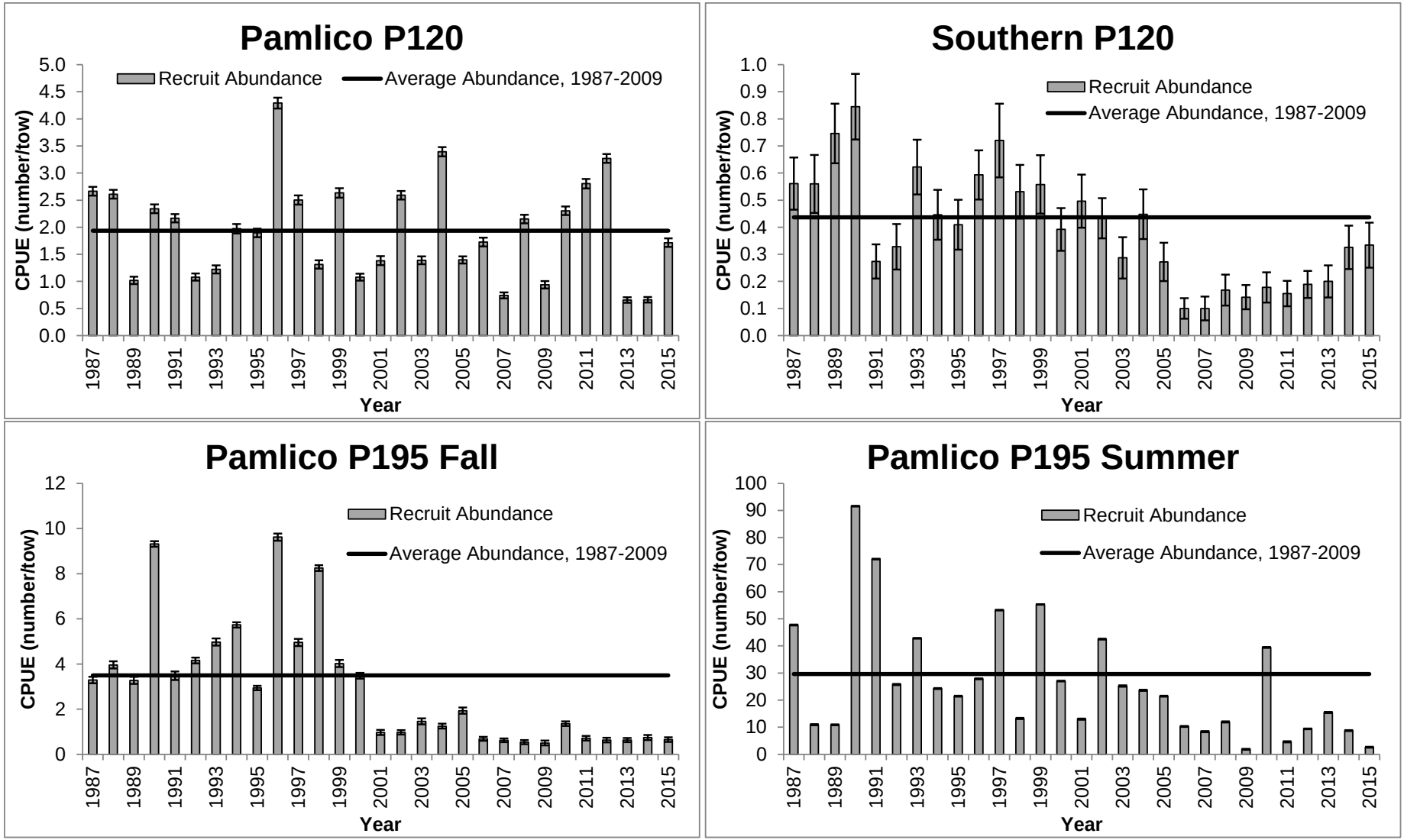

Figure A2.5. Indices from the NCDMF Estuarine Trawl Survey (P120) and Pamlico Sound Survey (P195) used for the recruit abundance characteristic of the blue crab Traffic Light, 1987-2015. Error bars represent one standard error of the mean.

APPENDIX 3

The following analyses were originally included as part of Issue Paper 11.1 Adaptive Management Framework for the North Carolina Blue Crab Stock in Amendment 2. They were updated here to see how commercial catch-per-unit-effort (CPUE) and the commercial landings comparison to the blue crab Traffic Light have changed since the FMP was adopted.

It should be noted that for both analyses there was no correction for variation in landings that come from differing effort, fishing efficiency, crabber choice, differences in landings data collection methods over the years, or any commonly used standardization techniques for comparison of these data. Also, note that the collection of commercial landings data changed considerably in 1994. Prior to 1994, commercial landings data were provided on a voluntary basis. As of January 1994, dealers have been required to report trip-level commercial fisheries landings using trip tickets. This change in reporting should be considered when comparing commercial landings before and after 1994.

Commercial CPUE Analysis

Commercial CPUE data was calculated for 1994-2015. This updated analysis followed the same procedures for selecting crabbers as before, those fishing more than 10 and less than 1200 pots per year, and trips landing between zero and fifteen pounds per pot from 1997-2015. Generally, the number of pots fished has decreased but has remained relatively stable since 2010 (Figure A3.1). The number of trips has also decreased during this period. The total pounds harvested have generally decreased in the Pamlico and Southern regions, where harvest in the Albemarle region has fluctuated with no trend. The CPUE (pounds per pot) across all regions has remained relatively steady despite the decreased number of trips and pots being fished.

Comparing Commercial Landings to the Traffic Light

While fisheries landings data are not a direct measure of abundance, landings may fluctuate in response to changes in abundance (and numerous other factors). Here, commercial hard crab landings are shown in comparison to the adult abundance characteristic. For this analysis, the percentage of green and yellow were added together and plotted with the percentage of red. This analysis shows that commercial hard crab landings does track fairly well with the adult abundance characteristic (Figure A3.2). In the mid- to late 1990s, when the percentage of green and yellow in the adult abundance characteristic was at its peak, commercial hard crab landings were also at their peak. When the amount of green and yellow in the adult abundance characteristic declined in the early 2000s, landings also declined sharply; neither commercial landings or the amount of green and yellow in the adult abundance characteristic have rebounded to previous levels.

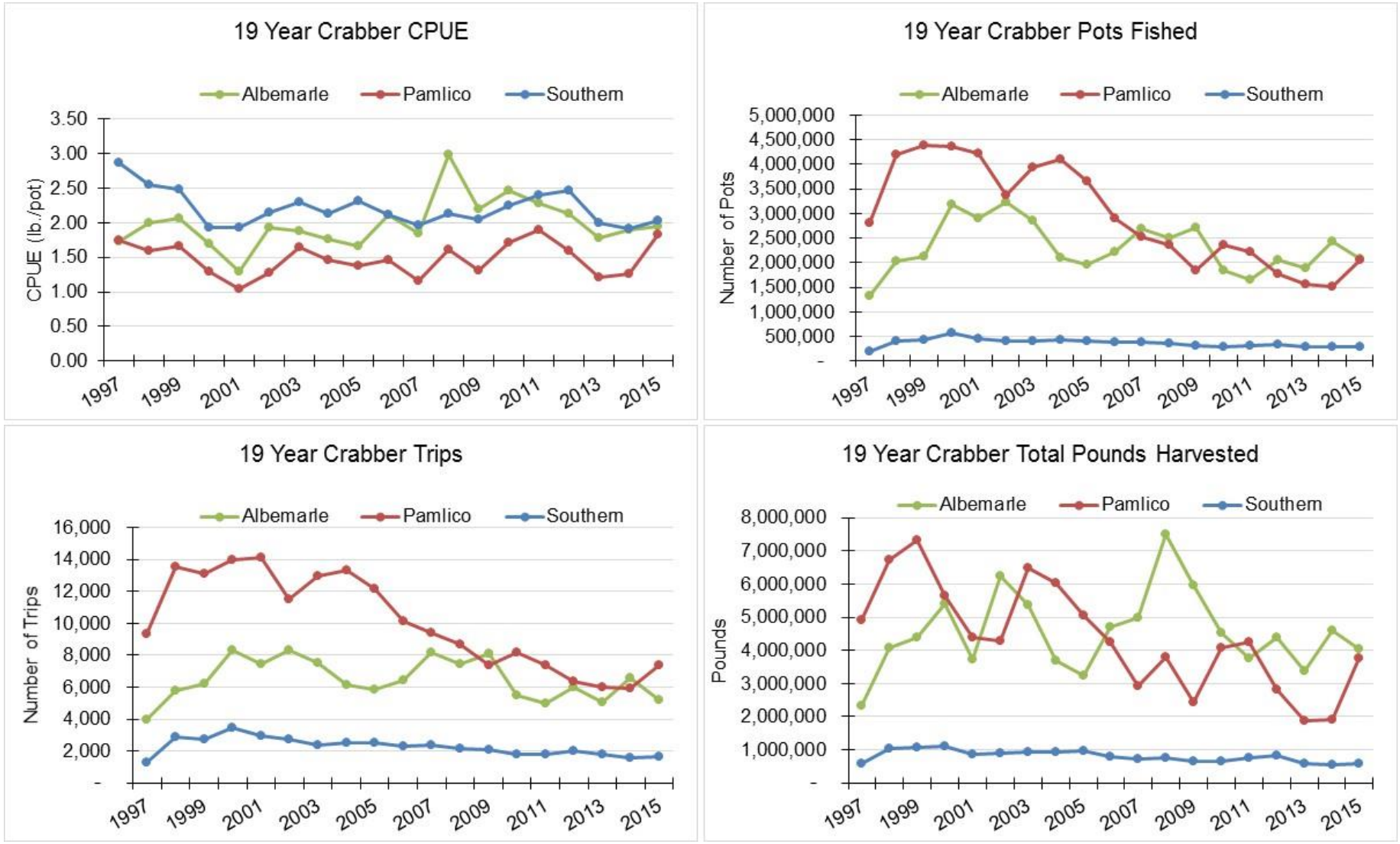

Figure A3.1. Commercial CPUE, trips, pots fished, and total pounds harvested summarized by removing trips by crabbers with less than 19 years' experience and reported landings of either zero or greater than fifteen pounds per pot and fishing no more than 1,200 or less than 10 pots per day.

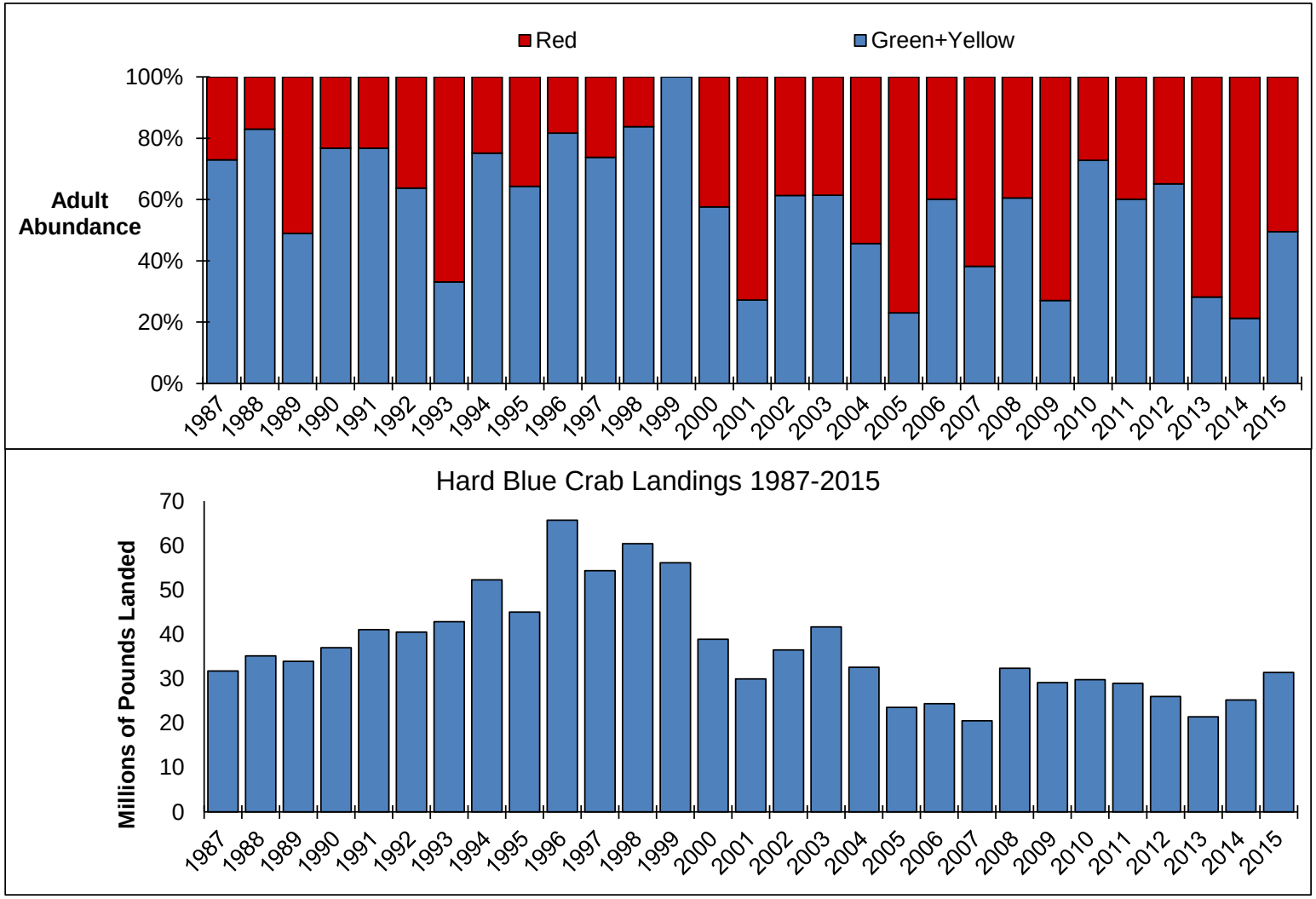

Figure A3.2. A comparison of the inverted adult abundance characteristic results and commercial hard crab landings (millions of pounds), 1987 - 2015. The blue bars for adult abundance are the combined percentages of green and yellow in the Traffic Light.

Appendix 4

M-11-2016

PROCLAMATION

RE: RULE SUSPENSION - BLUE CRAB ADAPTIVE MANAGEMENT MEASURES

Braxton C. Davis, Director, Division of Marine Fisheries, hereby announces that effective on the dates below the following shall apply to the harvest of blue crabs:

I. SUSPENSION OF PORTIONS OF N.C. MARINE FISHERIES COMMISSION RULES 15A NCAC, 03L .0201, 03L .0203, AND 03J .0301

The following portion of North Carolina Marine Fisheries Commission Rule 15A NCAC 03L .0201 is suspended effective at 12:01 A.M., Monday, June 6, 2016:

Sections (a) and (b), which read:

(a) It is unlawful to possess more than 10 percent by number in any container, male and immature female hard blue crabs less than five inches from tip of spike to tip of spike and to fail to return hard blue crabs not meeting this restriction to the waters from which taken, except the Fisheries Director may, by proclamation authority established in Paragraph (f) of this Rule, further restrict the harvest of blue crabs. All blue crabs not sorted into containers as specified in Paragraph (b) of this Rule shall be deemed hard blue crabs for the purpose of establishing the 10 percent culling tolerance.

(b) It is unlawful to possess blue crabs less than five inches from tip of spike to tip of spike unless individual crabs are sorted to and placed in separate containers for each of the following categories:

(1) soft crabs;
(2) pink and red-line peeler crabs;
(3) white-line peeler crabs; and
(4) from March 1 through October 31, male crabs to be used as peeler crab bait.

The following portion of North Carolina Marine Fisheries Commission Rule 15A NCAC 03L .0203 is suspended effective at 12:01 A.M., Monday, June 6, 2016:

Section (a), which reads:

(a) It is unlawful to take crabs with dredges except:

(1) from January 1 through March 1 in the area of Pamlico Sound described in 15A NCAC 03R .0109; and
(2) incidental to lawful oyster dredging operations in areas not subject to the exception in Subparagraph (a)(1) of this Rule provided the weight of the crabs shall not exceed:
(A) 50 percent of the total weight of the combined oyster and crab catch; or
(B) 500 pounds, whichever is less.

The following portion of North Carolina Marine Fisheries Commission Rule 15A NCAC 03J .0301 is suspended effective at 12:01 A.M., Sunday, January 15, 2017:

Sections (g), which reads:

(g) 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 two and five-sixteenths inches inside diameter and located in the opposite outside panels of the upper chamber of the pot, except the following are exempt from the escape ring requirements:

(1) unbaited pots;
(2) pots baited with a male crab; and
(3) pots set in areas and during time periods described in 15A NCAC 03R .0118.

II. BLUE CRAB HARVEST RESTRICTIONS

Effective at 12:01 A.M., Monday, June 6, 2016:

A. It is unlawful to possess more than **five percent** by number the following hard blue crabs in any combination in any container:
    1. Male hard blue crabs less than five inches from tip of spike to tip of spike;
    2. Immature female hard blue crabs; and
    3. Mature female hard blue crabs with a dark (brown and black) sponge from April 1 through April 30. A mature female hard blue crab with a dark sponge is defined as a mature female hard crab which has extruded her eggs on the abdomen or abdominal flap and the eggs have developed a coloration ranging from any shade of brown through black.

B. It is unlawful to fail to immediately return hard blue crabs not meeting the restriction described in Section II. A. to the waters from which they were taken.

C. It is unlawful to possess blue crabs described in Section II. A. (1) and (2) unless individual crabs are sorted and placed into separate containers for each of the following categories:
    1. Soft crabs;
    2. Pink and red-line peeler crabs;
    3. White line peeler crabs; and
    4. From March 1 through October 31, male crabs to be used as peeler crab bait.

D. All blue crabs not sorted into containers as specified in Section II. C. shall be deemed hard blue crabs for the purpose of establishing the five percent culling tolerance described in Section II. A.

E. It is unlawful to take blue crabs with dredges except incidental to lawful oyster dredging operations provided the weight of the crabs shall not exceed:
    1. 50 percent of the total weight of the combined oyster and crab catch; or
    2. 500 pounds, whichever is less.

III. CRAB POT ESCAPE RING REQUIREMENTS

Effective at 12:01 A.M., Sunday, January 15, 2017, it is unlawful to use crab pots in Coastal Fishing Waters unless:

A. Each pot contains no less than **three** unobstructed escape rings that are at least two and five-sixteenths inches inside diameter and:
    1. For pots with a divider:
        a. Two escape rings are located on opposite outside panels of the upper chamber of the pot; and
        b. At least one escape ring is located within one full mesh of the corner and one full mesh of the bottom of the divider in the upper chamber of the pot.
        c. A divider is defined as a panel that separates the crab pot into upper and lower sections.
    2. For pots without a divider:
        a. Two escape rings are located on opposite outside panels of the pot; and
        b. At least one escape ring is located within one full mesh of the corner and one full mesh of the bottom of the pot.

B. The following crab pots are exempt from the escape ring requirements in Section III. A.:
    1. Unbaited pots;
    2. Pots baited with a male crab; and
    3. Pots set in areas and during time periods described in North Carolina Marine Fisheries Commission Rule 15A NCAC 03R .0118.

IV. GENERAL INFORMATION

A. This proclamation is issued under the authority of North Carolina General Statutes 113-134; 113-182; 113-182.1; 113-170.4; 113-170.5; 113-221.1; 143B-289.52 and North Carolina Marine Fisheries Commission Rules 15A NCAC 03H .0103, 03J .0301, 03L .0201, and 03L .0203.

B. It is unlawful to violate the provisions of any proclamation issued by the Fisheries Director under his delegated authority pursuant to North Carolina Marine Fisheries Commission Rule 15A NCAC 03H .0103.

C. The intent of this proclamation is to manage the blue crab fishery under the adaptive management framework adopted as part of the North Carolina Blue Crab Fishery Management Plan Amendment 2.

D. The harvest of mature female blue crabs is allowed except as described in Section II. A. of this proclamation.

E. In accordance with North Carolina General Statute 113-221.1(c) All persons who may be affected by proclamations issued by the Fisheries Director are under a duty to keep themselves informed of current proclamations.

F. Contact the North Carolina Division of Marine Fisheries, P.O. Box 769, Morehead City, NC 28557 252-726-7021 or 800-682-2632 for more information or visit the division website at http://ncmarinefisheries.net

G. This proclamation supersedes Proclamation M-9-2015, dated June 3, 2015. This proclamation implements blue crab harvest restrictions adopted by the N.C. Marine Fisheries Commission at their May 19, 2016 business meeting and incorporated in the June 2016 Revision to the North Carolina Blue Crab Fishery Management Plan Amendment 2. It prohibits the harvest of immature female hard blue crabs. It also prohibits the possession of mature female hard blue crabs with dark sponges from April 1 through April 30. It reduces the culling tolerance for prohibited blue crabs to 5 percent by number. It prohibits targeted crab dredging while still allowing minimal crab harvest from oyster dredge operations. It requires crab pots to have a third escape ring with a minimum inside diameter of two and five-sixteenths inches. It also specifies the installation location for the third escape ring. The escape ring requirement is not effective until January 15, 2017 to allow time for fishermen to make the necessary modifications to their pots.

Braxton C. Davis, Director
DIVISION OF MARINE FISHERIES

June 3, 2016
1:30 A.M.
M-11-2016
/sab

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