COMMONWEALTH of VIRGINIA

Marine Resources Commission
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Matthew J. Strickler
Secretary of Natural Resources

Steven G. Bowman
Commissioner

December 1, 2019

MEMORANDUM

TO: The Honorable Ralph S. Northam
Governor of the Commonwealth of Virginia
And
Members of the Virginia General Assembly

THROUGH: The Honorable Matthew J. Strickler
Secretary of Natural Resources

FROM: Steven G. Bowman

SUBJECT: Blue Crab Fishery Management Plan

On behalf of the Virginia Marine Resources Commission, I am providing this report on the status and current implementation of the blue crab fishery management plan, in accordance with the provisions of § 28.2-203.1 of the Code of Virginia.

EXECUTIVE SUMMARY

The 30th Bay-wide Winter Dredge Survey was conducted from December 2018 to March 2019 by the Virginia Institute of Marine Science and Maryland Department of Natural Resources. Results indicate the blue crab stock is not depleted and overfishing is not occurring (Table 1). Table 2 presents data from the survey since the 2011 Benchmark Stock Assessment. The 2018-2019 Winter Dredge Survey estimate of abundance of all size classes of blue crabs is 594 million crabs, which is 60% higher than the 2017-18 total abundance estimate of 372 million crabs and 41% higher than the long-term survey average.

Juvenile crabs accounted for 54.4% of the 2018-19 total abundance, numbering 324 million crabs. This is nearly double the 2017-18 juvenile population of 167 million crabs and 44% higher than the long-term survey average of 224 million juvenile crabs. Juvenile crabs surveyed in wintertime are important to the current year's harvest, as they recruit to harvestable size in late summer and fall and contribute to the following year's late May and July-August spawning periods.

The survey estimated 191 million overwintering female crabs that could potentially spawn in 2019 (if not harvested prior to the spawning seasons), which is the fifth highest amount of spawning-age female crabs determined by this survey and 70% above the long term average. The 2019 abundance estimate of spawning-age female crabs is well above the threshold of 70 million crabs established by the 2011 Chesapeake Bay blue crab stock assessment but below the target of 215 million crabs. Since 2008, there has generally been a continuation of management measures by all Chesapeake Bay jurisdictions to conserve the spawning-age female crabs. The Virginia winter dredge fishery season has been closed since 2008. That conservation measure may partially account for above average spawning-age female abundance in eight of the eleven years since the winter dredge season was closed because it allows juvenile crabs from the previous year to be free of fishing pressure after they mature in fall. The importance of the mature female crabs is their contribution to the spawning events in late May and July – August of the same year the Bay-wide Winter Dredge Survey is completed. These crabs are also important to the spring and early summer harvest, as a high proportion of the Virginia commercial and recreational harvests consists of female crabs.

Year-to-year variation in abundance of blue crabs can be expected due to environmental influences, especially during the early life stages of crabs. Juvenile crab abundance can vary because of inter-annual differences in the entrainment of crab larvae from the ocean to Chesapeake Bay. This process is subject to natural fluctuations in the prevailing current and wind patterns. Environmental factors including weather conditions and predation can have an effect on all life stages of the crab population. Conservation of female spawning-age crabs as well as juvenile crabs is the primary management objective to attempt to lessen variability of the blue crab stock abundance. Overall overwintering mortality of 1.8% in 2019 was well below the survey average and was the second lowest mortality rate since 2014. The extensive management measures from 2008 that were implemented throughout the Chesapeake Bay jurisdictions have helped to mitigate year-to-year variability in the fisheries that previously resulted in overfishing during many prior years (see Attachment 1).

The Chesapeake Bay jurisdictions have also relied on a management framework enacted in 2014 in which the fishery is regulated from July 5 through July 4 of the next year. The benefit of this approach is that two Bay-wide Winter Dredge Surveys can be accomplished in that 12-month period, and conservation efforts can be applied after either survey is complete. Since 2014, the Virginia Marine Resources Commission (VMRC) and other Chesapeake jurisdictions have paid close attention the current year's juvenile abundance, as well as the mature female abundance, as the juveniles are the subsequent year's spawning stock. Six years ago (2013-14), the low abundance of spawning-age female crabs (68.5 million) indicated a depleted stock, as an abundance below the threshold of 70 million spawning-age female crabs is considered depleted. In 2019, the abundance of juvenile crabs at 324 million was 44% higher than the long-term survey average. The current July-to-July regulatory framework for blue crabs allows for the conservation of female crabs for spawning in both the current and following year. Predation and harvest in late summer and fall of 2019 will determine how many juveniles will mature as spawning-age female crabs in 2020 and join the mature female crabs that were not exploited by fisheries in 2019. For 2019 and 2020, the Commission reestablished the traditional crab pot season: a March 17 opening and a November 30 closure. Additional crab conservation measures maintained since 2014 include a shorter harvest season closure for all other crab gear that exploits juvenile (peeler-size) crabs.

The VMRC, PRFC (Potomac River Fisheries Commission), and MD DNR (Maryland Department of Natural Resources) agreed that any liberalization of current management measures concerning the blue crab fisheries must not interfere with the stability of the stock or annual Bay-wide abundances near the 215 million spawning-age female crab target. In response to the 2018-19 Winter Dredge Survey results, the jurisdictions agreed to maintain the current cautious, risk-averse approach in the 2019 season and to focus on the sustainability of the fishery. Each year the Commission uses the results of the Winter Dredge Survey to consider potential adjustments to blue crab management measures, such as changes in bushel and vessel limits. This year, the Commission decided against substantive increases in harvest, but increased November bushel limits at the request of the Crab Management Advisory Committee because the projected increase in annual harvest was only 0.5%. The Commission maintained the reduced bushel limits for March of 2020.

THE 2019 VIRGINIA BLUE CRAB FISHERY MANAGEMENT PLAN

Status of the Chesapeake Bay Blue Crab Stock

The 2011 benchmark stock assessment control rule established female-specific reference points based on the biological status of adult female crabs. Biological reference points are a primary output of stock assessments, and fishery regulations are implemented to conform to those biological standards. The 2011 blue crab stock assessment provided female-specific reference points for both the abundance of female crabs at least 2.4 inches in carapace width (spawning-age female crabs categorized as age 1+) and the annual removal rate based on the percentage of female crabs of all sizes harvested in a year.

The abundance and exploitation rate targets and thresholds (biological limits) used to monitor the health of the blue crab stock in Chesapeake Bay are provided in Table 1 below. The abundance estimate from the 2018-2019 Bay-wide Winter Dredge Survey of female spawning-age crabs (age 1+) was 191 million crabs. This abundance for 2019 is the fifth highest amount of female crabs capable of spawning since the Winter Dredge Survey was first implemented in 1990 and is more than double the threshold of 70 million spawning-age female crabs that signals a depleted stock condition. The most recent stock depletion occurred in 2014. The spawning-age crabs of at least 2.4 inches carapace width will spawn in late May or during the July—August peak spawning period. However, this spawning potential is challenged by continuous Bay-wide harvesting during nine months of the year.

Table 1. Abundance and exploitation rate targets and thresholds for the Chesapeake Bay blue crab stock. This is the control rule.

2011 Stock Assessment – Biological Reference Points		
Abundance	Overfished (Threshold)	70 million age 1+ female crabs
	Target	215 million age 1+ female crabs
Exploitation Rate	Overfishing (Threshold)	34% of all female crabs
	Target	25.5% of all female crabs

The 2018 female crab exploitation rate estimate was 23%, which is below the target exploitation rate of 25.5% removal of female crabs on an annual basis from fisheries alone. This estimate is below the overfishing threshold of 34%, so overfishing is not occurring on this stock. For the last eleven consecutive years the removal rate has been close to or less than the target. Some in the industry believe the fishery is under performing given it is uncommon to reach this target. However, there are some difficulties deriving these removal rates due to 1) lack of information on dead discards, 2) magnitude of the unreported recreational fishery, 3) potential commercial under-reporting, and 4) juvenile abundance estimates since 2011 that assume the dredge only captures 40% of these smaller crabs. The Chesapeake Bay jurisdictions believe it is prudent to remain slightly below the target by keeping present regulations in place rather than risk exceeding it.

The total abundance of 594 million crabs, determined by the Winter Dredge Survey, is similar to the survey average and is relatively balanced, in that approximately 32% of the total abundance is represented by spawning-age females and 45% is represented by juveniles. Just over one-half of those juveniles are female. It is equally important that both mature female crabs and juvenile crabs are conserved for spawning potential.

Overwintering mortality—the percent of dead crabs found in late winter dredge samples—for all blue crabs in the Chesapeake system was 1.80% in 2019. This mortality rate is the second-lowest in six years and is well below the 1996-2019 average of 4.71%. Mortality was highest for adult male crabs (7.83 %), followed by adult females (1.87 %), and lowest among juveniles (0.15 %).

In the 2019 Chesapeake Bay Blue Crab Advisory Report, the Chesapeake Bay Stock Assessment Committee (CBSAC) recognized several topics as critical data and analysis needs to aid in the understanding of the variability in the blue crab stock. CBSAC identified a list of fishery dependent and independent data needs that would provide better information on blue crab abundance and survival for management measures, such as in 2018, to include:

- Efficacy of the Winter Dredge Survey as an index of abundance;
- Increased accountability and harvest reporting for both commercial and recreational fisheries;
- Improving recruitment estimate through a shallow-water survey;
- Investigation of the influence of male abundance on population and fishery productivity;
- Quantifying environmental factors related to recruitment variability;
- Creation of a blue crab data hub focused on Chesapeake Bay blue crab data;
- Application of fishery independent survey data;
- Options for future fishery-dependent sampling programs;
- Analysis of the magnitude of other sources of incidental mortality;
- Biological parameters that are not fully characterized and remain as sources of uncertainty.

Table 2, below, provides a summary of the results from the Chesapeake Bay-wide Winter Dredge Survey since 2011, when the last Benchmark Stock Assessment was released. Results from the entire 30-year survey history can be found as a table in Attachment 1 of this report. The abundance of recruits (termed age-0 crabs) and the spawning-age crabs (termed age 1+) are differentiated according to size, with 2.4 inches in carapace width as the separator between the two size classes. Any abundance estimate represents the number of crabs that will be available to Chesapeake Bay fisheries following the end of the seasonal (December - March) Bay-wide Winter Dredge Survey (Figures 1A, 1B, & 1C).

Table 2. Bay-Wide Winter Dredge Survey results (winter of 2010-11 through winter of 2018-19). All surveys begin in December and end in March the next year. Commercial harvest and percentage of female crabs removed in 2019 are not yet available (TBD = to be determined).

Survey Year (year survey ended)	Total crab abundance (all ages in millions)	Juvenile abundance (both sexes in millions)	Spawning-age crab abundance (both sexes in millions)	Spawning-age females abundance (in millions)	Bay-wide Commercial harvest (in millions of pounds)	Percentage of female crabs harvested
2011	452	204	255	191	67	24%
2012	765	581	175	95	56	10%
2013	300	111	180	147	37	23%
2014	297	199	99	69	25	17%
2015	411	269	143	101	50	15%
2016	553	271	284	194	60	16%
2017	455	125	330	254	54	21%
2018	372	168	206	147	55	23%
2019	**594**	**324**	**271**	**191**	**TBD**	**TBD**

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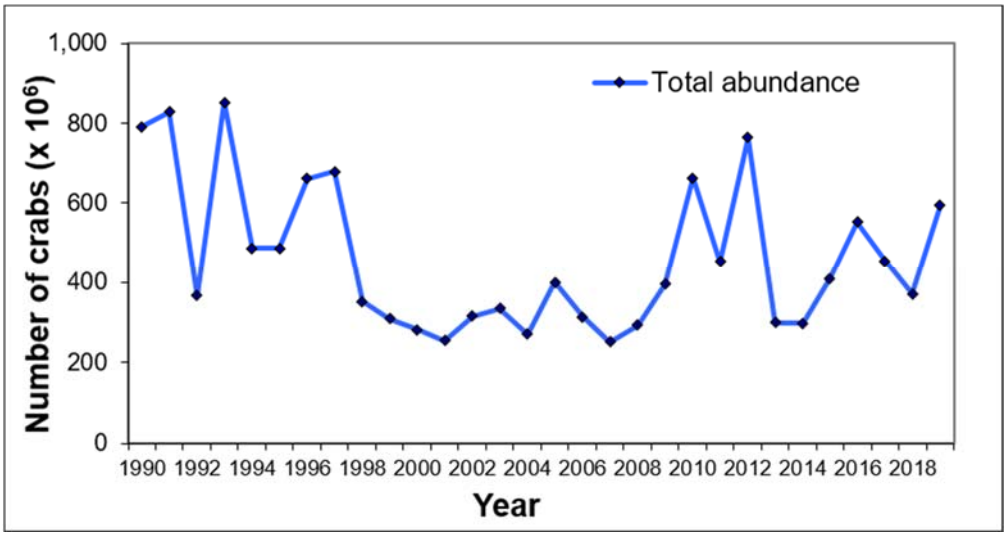

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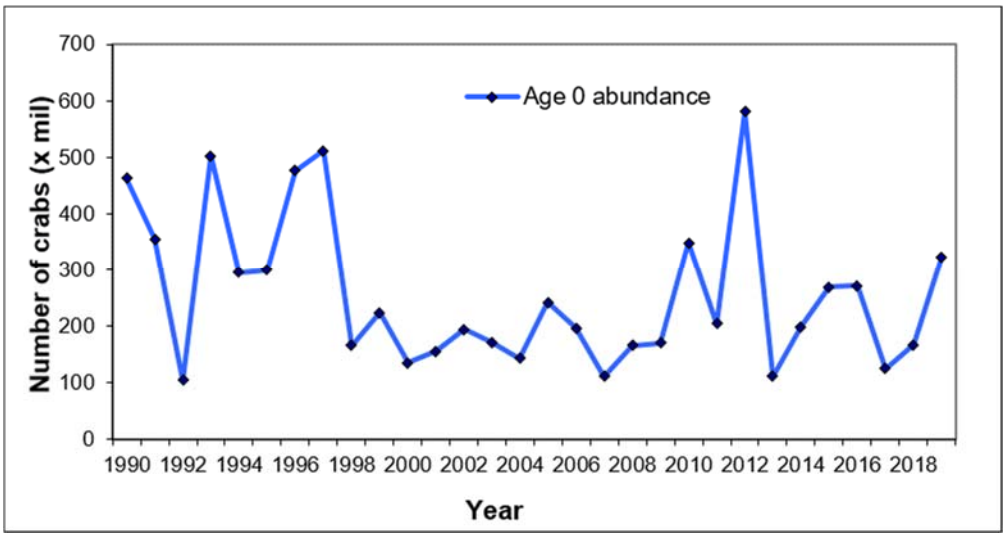

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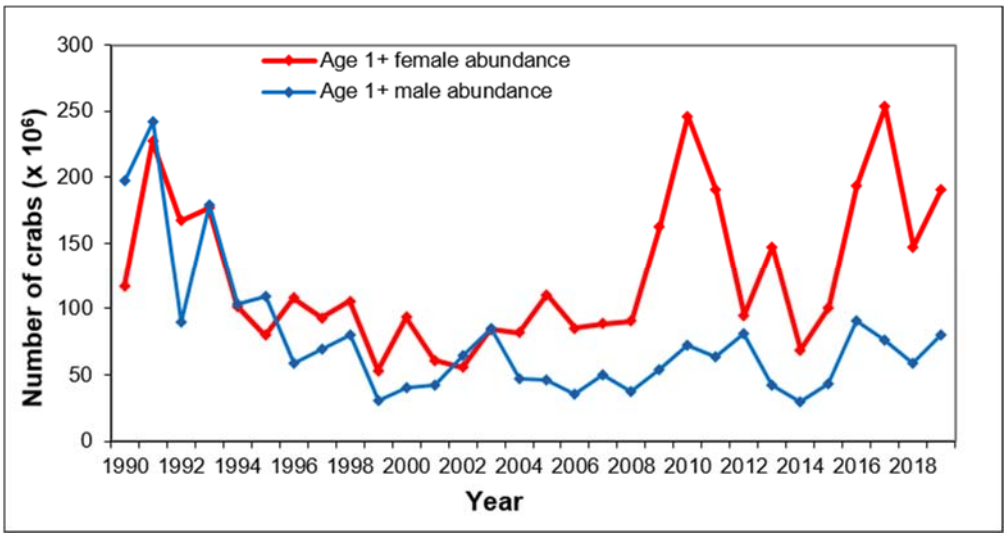


Figure 1A, 1B, & 1C. Abundance estimates (number of crabs in millions) from the 29-year Bay-Wide Winter Dredge Survey for (A) total crab abundance (males and females of all ages); (B) juvenile crab abundance (male and female new recruits); and (C) spawning-age (age 1+) female and male crab abundance, 1990 through 2019.

The total 2018 Bay-wide commercial harvest from the CBSAC report was approximately 55 million pounds, which remains below average but increased by 2% from the 2017 Bay-wide commercial harvest of approximately 54 million pounds (Table 2). The 2018 commercial harvest for both males and females from the Bay and its tributaries was estimated at 31.1 million pounds in Maryland, 21.2 million pounds in Virginia, and 3.0 million pounds in the Potomac River. This was a 9% increase for Maryland, 2% decrease for Virginia, and 0.5% increase for the Potomac River from 2017 commercial harvest levels (Figure 2). Note, Virginia provides harvest numbers to CBSAC before all 2018 reports are submitted (due to late reporting). As such, Virginia's 2018 harvest of 21.2 million pounds, reported by CBSAC, has been updated to 23.1 million pounds.

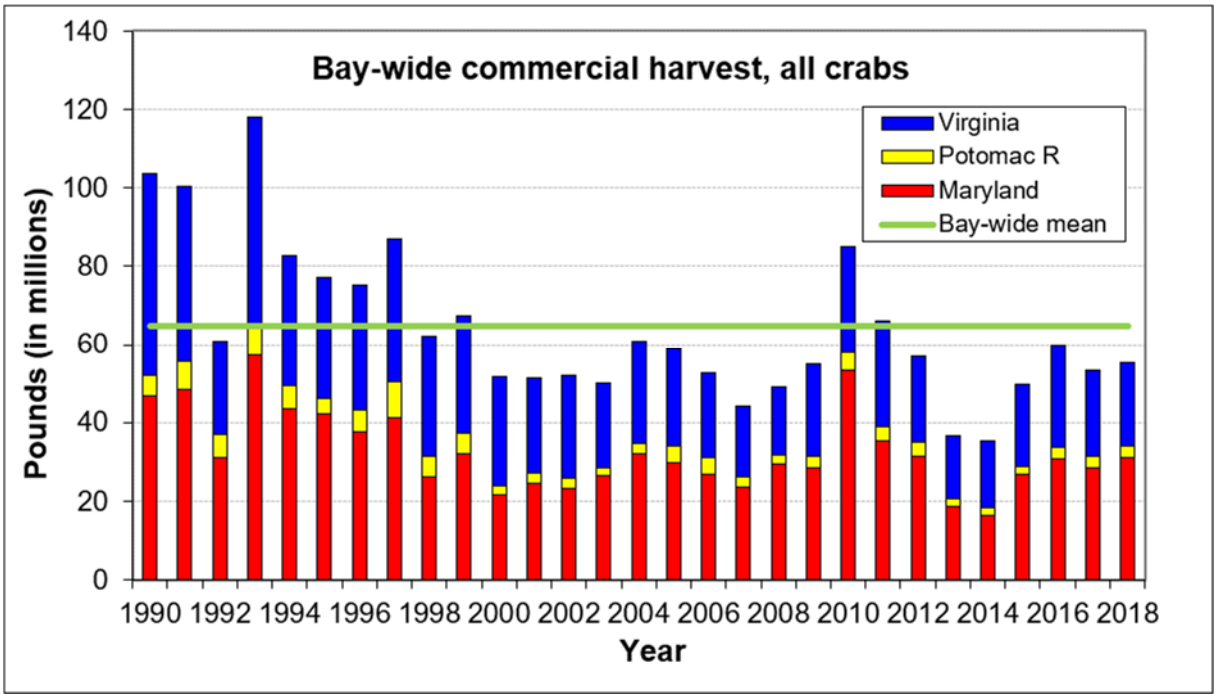


Figure 2. Chesapeake Bay-wide harvests (in pounds), by jurisdiction, 1990-2018.

Figure 3 displays the time series of the commercial crab harvest for all Virginia waters in pounds and estimated dockside value (first sale from harvester). The dockside value has been adjusted to 2018 dollars to account for inflation using the Consumer Price Index. Harvest statistics have been collected from Virginia fisheries since the late 1920s; however, 1994 is the first representative year of the mandatory commercial harvest reporting system. Fluctuations in dockside value track closely with those in harvest, although the overall magnitude depends on that year's market. The aggregate average reported price (in 2018 dollars) only recently (2013) exceeded one dollar per pound. Value of these harvests is not considered highly accurate, as VMRC depends on voluntary buyer reporting of dockside value while harvest and effort reporting are mandatory.

Table 3 provides a summary of harvest data by market category. Hard crabs dominate Virginia's harvest. Peeler and soft crabs (minimum size for soft crabs is 3 ½-inch; minimum size for peelers is 3 ¼-inch through July 15 and 3 ½-inch after July 15) contribute significantly less to the overall harvest in pounds—about 3-4%. However, because peeler and soft crabs are smaller than hard crabs, they may comprise up to 8 percent of the harvest in numbers. Harvest of peeler crabs peaked in 1998 at more than 2.5

million pounds, but has remained below one million pounds since 2006. In 2008 all Chesapeake Bay jurisdictions imposed a 34 percent reduction in the harvest of blue crab using varied conservation measures and

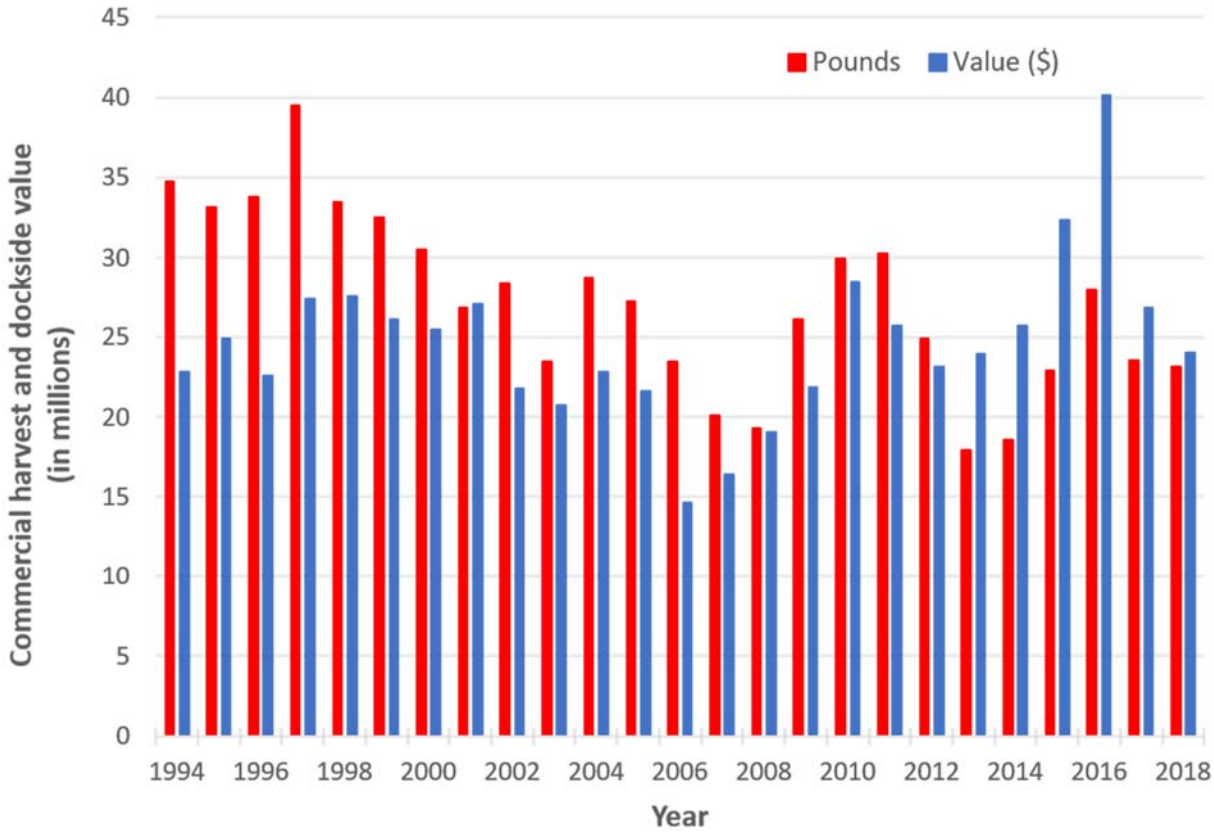


Figure 3. Annual harvest of all market categories of blue crab from Virginia tidal waters in pounds & corresponding dockside value in 2018 dollars, 1994 – 2018.

nearly all of those measures remain today. For example, there is a larger minimum size limit in place for peelers, and the number of peeler pots per license was reduced. In recent years peeler harvests have been somewhat in flux, ranging from less than 600,000 pounds to more than 900,000 pounds.

Table 4 provides harvest data by gear type, which indicates crab pots account for most of the harvest. Of the 20 different gear types that reported harvest during any year, from 2008 through 2018, the crab pot accounted for 95 percent of the total 2008-2018 harvest from Virginia waters, and the peeler pot fishery contributed four percent. The remaining one percent of annual harvest is comprised of crab trotlines, traps and pounds, scrapes, and dip nets.

Figures 4A and 4B provide a 12-year summary of participation in the crab pot and peeler pot fisheries. Each chart indicates the numbers of harvesters who were eligible for the fishery, purchased a license, or were active in a given year by harvesting at least one pound of blue crab. Since 2010, fishermen can maintain their eligibility without purchasing a license. Similarly, those fishermen who purchase a license may choose whether to be an active harvester. These charts show that in recent years the number of active crab pot fishermen has remained relatively stable between 65% and 73% of eligible fishermen. The number of eligible peeler pot fishermen who are active declined over the same

period, from 62% to 43%. These charts indicate that potential latent effort might exist in either fishery. However, there is no indication that eligible, but inactive, crab fishermen join either fishery because the blue crab abundance is particularly high in any given year. Since the license moratorium went into effect in 1999, many eligible crabbers are holding onto licenses for family members or for sale.

Table 3. Annual harvest of blue crab from Virginia waters by market category (hard crabs and peeler and soft crabs), in pounds, 2008 – 2018.

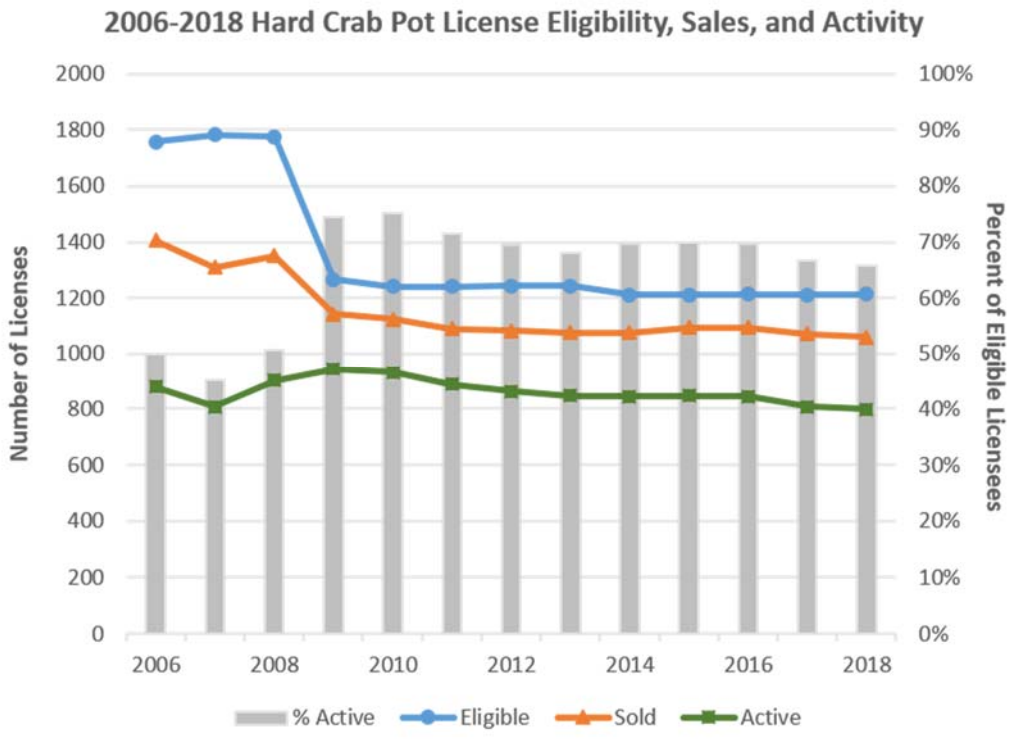
Year	Hard crabs	Percent of Total Harvest	Peeler & Soft Crabs	Percent of Total Harvest
2008	18,278,467	95%	995,014	5%
2009	25,112,135	96%	961,474	4%
2010	29,000,485	97%	969,942	3%
2011	29,534,671	97%	759,031	3%
2012	23,992,153	96%	879,751	4%
2013	17,352,456	97%	599,696	3%
2014	17,566,425	95%	985,254	5%
2015	22,101,632	97%	800,745	3%
2016	27,184,207	97%	735,197	3%
2017	22,899,140	97%	651,244	3%
2018	22,483,738	97%	641,742	3%

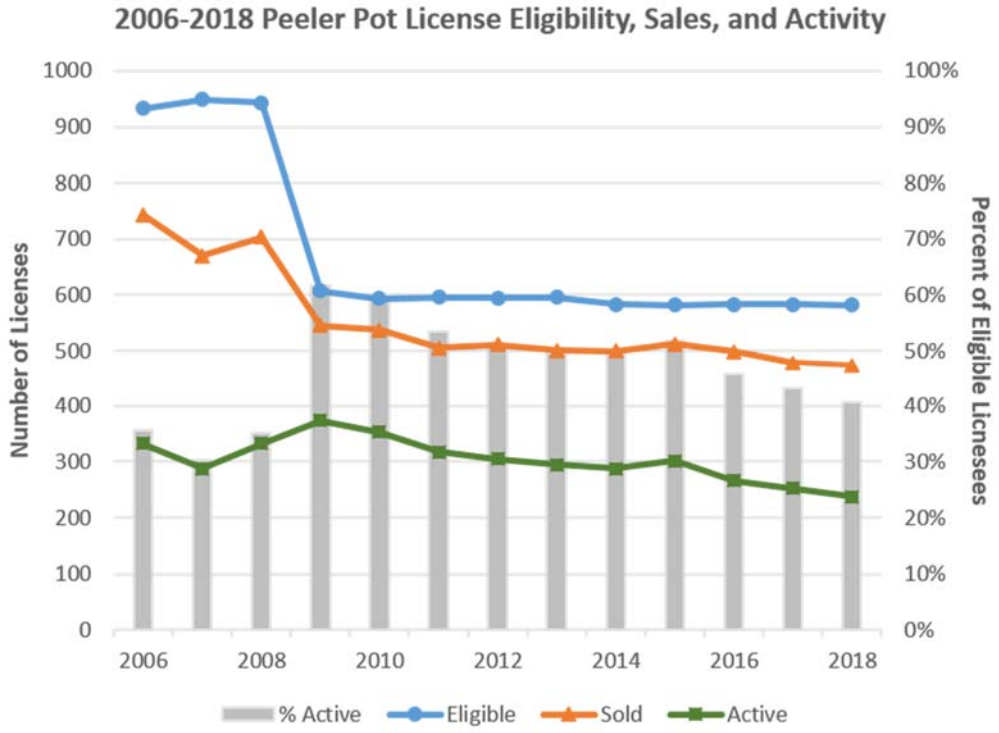
Table 4. Annual Virginia harvest in pounds of blue crabs by gear type (2008 – 2018).

Year	Gear						Total
	Hard Pot		Peeler Pot		Other Gears*		
2008	17,512,157	90%	963,324	5%	921,693	5%	19,397,173
2009	24,914,941	95%	981,319	4%	279,601	1%	26,175,861
2010	28,733,411	96%	1,057,239	4%	276,319	1%	30,066,969
2011	29,224,573	96%	900,169	3%	267,607	1%	30,392,349
2012	23,750,604	95%	917,917	4%	305,020	1%	24,973,540
2013	16,981,833	94%	646,156	4%	403,293	2%	18,031,282
2014	17,400,699	93%	1,040,753	6%	184,673	1%	18,626,125
2015	21,787,710	95%	1,006,207	4%	172,912	1%	22,966,828
2016	26,825,259	96%	982,348	4%	165,276	1%	27,972,883
2017	22,615,261	96%	858,690	4%	106,725	0.5%	23,580,675
2018	22,142,440	96%	868,597	4%	139,563	1%	23,105,280

* includes harvest by trot line, dip net, crab trap/pound, crab scrape, and crab dredge (2008 only)

A.





B.

Figures 4A & 4B. Eligible versus active fishermen in the crab pot and peeler pot fisheries, respectively (2006 – 2018).

Blue Crab Conservation Actions in 2019 and Previous Years

Commission actions since 1994 that have attempted to promote sustainability of the blue crab stock and fishery through conservation measures are included in Attachment 3. Many of these measures were designed to promote spawning potential of blue crabs and have helped in the recovery of the Chesapeake Bay stock. Total abundance increased following the blue crab fishery disaster in 2008, with the 2016-17 Bay-wide Winter Dredge Survey indicating the highest adult abundance in the survey's history. This is attributed partly to the conservation measures implemented since 2008. The 2018-19 survey results also showed strong improvement in juvenile production from the low juvenile abundance estimates of the previous few years, due in part to the high abundance of spawning-age female crabs in 2016-17. However, juvenile production is the most unpredictable variable life stage. Many measures taken by the Commission were employed before scientists developed status of the stock indicators, and these health-of-the stock indicators improved after each analytical stock assessment in 1997, 2005, and 2011. These improvements in science allowed the Commission to better target problem areas in the stock and its fisheries.

Previously enacted management measures were maintained this year at the recommendation of the Chesapeake Bay Stock Assessment Committee. Jurisdictional managers and scientists are in agreement that the stock appears stable. The Commission enacted conservation measures to afford additional conservation of the low juvenile crab abundance in 2017. In 2018, the Commission maintained its conservative management approach from the previous year and made no substantive regulatory changes to the management of the Chesapeake Bay blue crab stock.

Management measures that were enacted in 2017 and maintained for the 2018-19 season include the reduced crab pot bushel and possession limits for two additional weeks in March, as an effort to conserve juvenile crabs. This year, the Commission decided to increase November bushel limits to match those in all other months but March at the request of the Blue Crab Management Advisory Committee because the projected increase in harvest was a very modest 0.5%. Crab pot bushel limits and other regulations extend from July 5, 2019 through July 4, 2020 for all crab pot license categories.

The Commission continued the closure of the winter crab dredge fishery season for the eleventh consecutive season to allow for continued rebuilding of the spawning stock biomass. The main basis for this continued action is conservation of the juvenile abundance, which would mature this year and be exploited by a 2019-20 winter dredge season. In addition, the Commission maintained the season closure of November 30 in 2019, which was established last year for 2018 for the crab pot fishery, as compared to the 2017 closure of December 20. Similarly, the early March 1, 2017 opening of the crab pot season had been pushed back to March 17 in 2018; this change was also kept in place for 2019 and 2020.

Ecosystem Constraints on the Blue Crab Resource

§ 28.2.203.1 of the Code of Virginia provides that the blue crab fishery management plan shall be designed to reverse any fishing practices, environmental stressors, and habitat deterioration negatively impacting the short and long term viability and sustainability of the crab stock in Virginia waters. In recent years, the Commission has adopted effective conservation measures to reverse fishing practices that have negatively impacted the stock. The Commission relies on the efforts of its sister agencies to promote and sponsor improvements of Chesapeake Bay's water quality in order to meet the

requirements of §28.2.203.1 of the Code of Virginia dealing with environmental stress and habitat deterioration.

Algal blooms can result in hypoxic and anoxic conditions (low dissolved oxygen levels) in Chesapeake Bay that cause blue crabs to be displaced or result in mortality. The Commission is a member of the Virginia Department of Health's Harmful Algal Bloom Task Force (HAB TF). In 2018 HAB TF members combined efforts to implement an online reporting system for Virginia residents, conduct fly-overs to visually determine the extent of bloom conditions, take and analyze samples from areas with active HABs, and update the public about HABs. VMRC staff worked with HAB TF to provide links to VDH Harmful Algal Bloom notices on the VMRC website. VMRC staff participated in the HAB TF annual meeting held on February 19, 2019 via webinar. The impact of HABs on blue crab meat safety or health is unknown.

The Commission and the Virginia's crab industry recognize that improvements in blue crab habitat and water quality could increase the probability for improved recruitment to the stock and fisheries; however, many water quality and habitat impacts to the stock are not fully quantified or understood. The relationship between blue crabs and other components of the ecosystem is being explored by Chesapeake Bay scientists. Many natural and man-induced impediments continue to challenge the stability of the blue crab stock, including hypoxia, shoreline development, and pollution. The issue of climate change and sea level rise will continue to be important as well, as blue crab behavior is linked to water temperature and availability of sufficient habitat.

Water quality in Chesapeake Bay is improving due to the ongoing efforts of the Commonwealth and the signatories of the Chesapeake Bay Agreement. Additional work is being implemented to meet pollution reduction goals in Chesapeake Bay. Each of the bay jurisdictions has developed a Watershed Implementation Plan to guide restoration plans through 2025. The federal government developed Executive Order 13508, which guides the federal agencies plan to meet pollution reduction goals and establishes the Federal Leadership Committee that will publish an annual Chesapeake Bay Action Plan. A Chesapeake Bay Watershed Agreement was signed in June 2014 by governors from all seven watershed states, the Chesapeake Bay Commission, and the Environmental Protection Agency. The Watershed Agreement contains ten goals and 29 measureable, time-bound outcomes to improve the health of Chesapeake Bay, including sustaining blue crabs. The 2018 update to the 2016-2017 Milestone progress report, published by the Federal Government in July 2018, demonstrates advancement toward milestones and includes planned Bay restoration and protection for fiscal year 2019. The assessment found that there has been considerable progress made, including record acreage of underwater grasses and the highest estimate of water quality standards attained in more than 30 years.

Past reductions in submerged aquatic vegetation (SAV) beds have likely impacted the blue crab stock, especially juvenile crabs that use SAV beds as protection from predators. Seagrass beds provide nursery habitat for newly settled, young juvenile, and mating blue crabs. The dominant SAV in Virginia waters is eelgrass (a seagrass). The importance of eelgrass habitat functions in Chesapeake Bay was first demonstrated by VIMS in a 1961 report to the National Science Foundation. Subsequent studies by VIMS have led to a greater understanding of SAV Bay-wide distribution, abundance, and health. VIMS established the first broad-scale aerial monitoring of SAV in 1974, and expanded the survey in 1978 to cover all of Virginia's tidal waters. VIMS maintains a research and monitoring program that has significantly expanded our understanding of SAV, its role in the greater Bay ecosystem, and its linkages with the health of the blue crab stock. Ongoing SAV research and monitoring programs include:

- Annual Bay wide aerial survey;
- Eelgrass restoration in Virginia's seaside bays;

- The use of restored eelgrass beds by estuarine fauna;
- Targeted water quality monitoring and study of key SAV locations in Virginia waters for effects from water quality changes, global warming, and climate change;
- Assessment and monitoring of the effects of certain fishing techniques on eelgrass beds;
- Water quality assessments for evaluation of water quality standards attainment (SAV distribution is a criterion for water clarity);
- The role of abiotic factors influencing the flowering of eelgrass;
- The roles of dispersal and seed predation in determining eelgrass population dynamics;
- The influence of climate change factors on the use of eelgrass and widgeon grass beds;
- Habitat suitability of exotic algae versus native seagrass as an alternative nursery habitat for juvenile blue crabs;
- The distribution of overwintering age-0 blue crabs in shallow water habitats; and
- The functional relationships between seagrass characteristics and juvenile blue crabs under high recruitment.

Eelgrass is near its southern limits along the Atlantic coast in Virginia, so high summertime water temperatures can be especially harmful to eelgrass beds. Unusually high temperatures during periods in the summer of 2005 and 2010 resulted in severe diebacks in eelgrass beds, most dramatically in high-salinity areas (Orth *et al.* 2016). After each of these diebacks, some recovery was observed over the next few years; however, VIMS research (Jarvis and Moore 2010) has shown that since eelgrass seeds in the sediment are only viable for a year or less, consecutive years of diebacks would be especially deleterious. If water temperatures continue to increase as a result of climate change, losses of eelgrass beds in Virginia may accelerate. VIMS research has demonstrated that increased water clarity can help eelgrass beds persist under higher temperatures. Therefore, VIMS is working with Virginia regulatory agencies, MD DNR, and the Environmental Protection Agency to assess the current water clarity goals for Chesapeake Bay to determine if changes are appropriate and needed. Storms can also be stressful to SAV beds through direct physical disruption or by greatly increasing sediment and nutrient inputs into the Bay and its tributaries. Excess sediments and nutrients can promote increased turbidity, compounding the effects of high temperatures (Moore et al. 2012). Results of VIMS' studies indicate that Virginia's SAV beds do relatively well in withstanding the direct physical disruption by storms.

VIMS annual Bay-wide aerial survey serves as a significant indicator of Bay health and as a tool for determining compliance with Virginia water quality standards. Virginia tidal waters are home to 12 species of SAV, with eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*) having the most overlap with the distribution of juvenile blue crabs in Chesapeake Bay. Since historically low abundances in 1984, SAV restoration has varied between tidal waters with different salinities. Seagrass beds have continually increased in lower salinity tidal waters, increased initially in areas of medium-salinity followed by variable annual abundance levels, and increased initially in the high-salinity region followed by a general decline in abundance (Orth et al. 2010). These general trends remain accurate in the years since this study. The results of a VIMS study showed that juvenile blue crabs prefer denser SAV beds over thinner beds (Ralph et al. 2013), further demonstrating the positive influence that the quality of seagrass beds have on blue crab population dynamics. VIMS studies have also demonstrated the high value to juvenile blue crabs of unvegetated areas both adjacent to salt marshes in upriver areas of Bay tributaries and areas that contain an abundance of food such as clams and polychaetes (marine worms); and within areas of abundant macroalgae where native SAV nursery habitat has experienced reductions in aerial coverage (Seitz et al. 2003, Seitz et al. 2005, Johnston and Lipcius 2012).

Blue crabs have a diverse assemblage of parasites and pathogens, and the presence and occurrence of these pathogens has been a long-time research focus at VIMS. Many pathogens are present in the tidal waters of Virginia, but only a few have the potential to damage the blue crab stock or fisheries (Shields & Overstreet 2007, Shields 2012). Two agents, in particular, occur at high prevalence levels and show signs of high pathogencity. These are *Hematodinium perezi* and a recently identified reo-like virus. *Hematodinium perezi* is a parasitic dinoflagellate found primarily in the higher salinity waters of the Bay, particularly in the seaside bays of the Eastern Shore and along the eastern portions of lower Chesapeake Bay (Messick & Shields 2000). Prevalence levels of *Hematodinium* have a small peak in early summer and a large peak in autumn followed by a rapid decline with the onset of winter temperatures. Prevalence levels are associated with molting in juvenile blue crabs, which explains the bimodal peak occurrence of the parasite. Mortality levels of 87% have been observed in laboratory experiments (Shields and Squyars 2000). VIMS scientists discovered and described the life cycle of *Hematodinium perezi* in the blue crab (Li et al. 2011), and this will lead to a greater understanding of the risk of mortality and the environmental and biological factors that may influence the effects of this pathogen. The reo-like virus was initially described from juvenile crabs held in the laboratory (Johnson and Bodammer 1975). It has been implicated as a source of mortality in the production of soft-shell crabs based on infection trials and sampling of crabs from shedding facilities (Bowers et al. 2010). VIMS continues to be actively engaged in research on these pathogens.

Update of the blue crab stock assessment

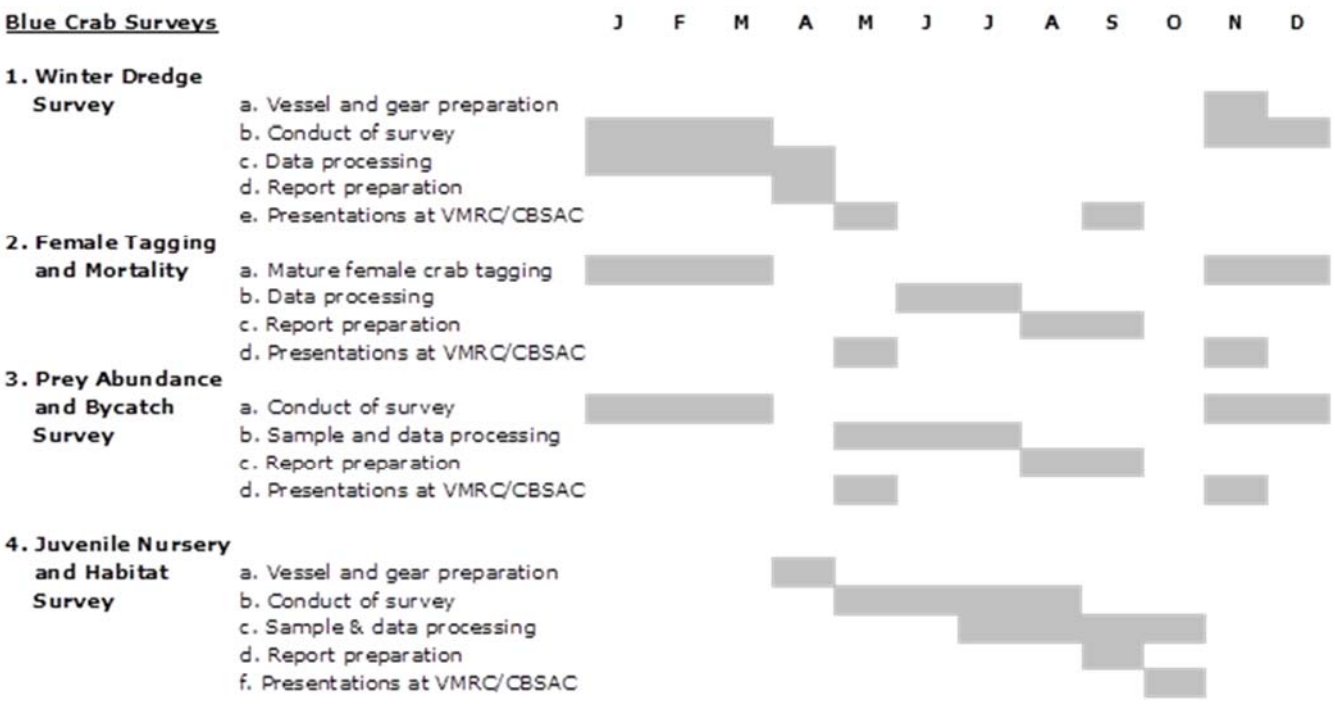
The 2019 CBSAC Annual Report is shown in Attachment 2. Findings of the stock assessment were endorsed by the Chesapeake Bay Program Sustainable Fisheries Goal Implementation Team's executive committee. The executive committee is represented by VMRC, MD DNR, the Potomac River Fisheries Commission, the National Oceanic and Atmospheric Administration's Chesapeake Bay Office, Maryland Sea Grant, the Atlantic States Marine Fisheries Commission, and the District of Columbia's Division of Fish and Wildlife.

Managers and scientists expect annual estimates of abundance and exploitation rate to vary. However, if at any time the Bay-wide Winter Dredge Survey results indicate the abundance of female spawning-age crabs has fallen below the overfished level of 70 million, then management measures would be implemented to protect the biological stability of the blue crab stock. Based on results from the 2018-19 Winter Dredge Survey, the female spawning-age biomass is not below the overfished threshold and has shown some recovery since management measures to reduce harvest on all crabs by 10% Bay-wide were implemented. Despite a history of variable abundance over the last several years, VMRC continues to promote conservation efforts that can afford benefits to all user groups.

In 2019, MD DNR released the results of a 2017 update to the blue crab stock assessment. This has been the first update since the 2011 benchmark stock assessment. With eight more years of data, the 2017 update determined that the stock status has not changed: the Chesapeake Bay blue crab population has not been overfished since 2003 and has not experienced overfishing since 1999. The CBSAC is recommending more frequent updates to be run by the jurisdictions until funding can be secured for a new benchmark assessment. The 2017 stock assessment update also resulted in slight changes to the biological reference points, decreasing the target abundance to 196 million blue crabs and increasing the target and threshold fishing mortality rates to 28% and 37%, respectively. The stock assessment update has been approved for use by the Sustainable Fisheries Goal Implementation Team, but the jurisdictions have not adopted the new reference points as of yet.

VIMS Blue Crab Surveys

VIMS conducts multiple blue crab surveys: the Winter Dredge Survey (WDS), the Main-stem Prey and Bycatch Survey (MPBS) associated with the WDS, the Female Tagging and Mortality (FTM) estimation associated with the WDS, the Juvenile Nursery Habitat Survey (JNS) associated with the WDS, and the Juvenile Fish and Blue Crab Trawl Survey. In addition, blue crab data is also gathered by the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP), a Bay-wide main-stem trawl survey of mostly adult fishes. Data from the VIMS Juvenile Fish and Blue Crab Trawl Survey is used to develop indices of abundance that are used to indicate the success or failure of annual recruitment and help predict the future of the stock. The JNS is complementary to the VIMS Juvenile Fish and Blue Crab Trawl Survey, in that it gathers data on juvenile blue crabs and habitat quality in shallow-waters where the other surveys are unable to sample. Samples and data from the WDS, MPBS, and FTM are processed during the course of the winter and spring as they are collected. Samples from the JNS require lengthy laboratory processing, so they are frozen and then processed later in the year from August through October. The activities of the WDS and their timing are listed below.



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Attachment 1

Bay-Wide Winter Dredge Survey results (winter of 1989-90 through winter of 2018-19). All surveys begin in December and end in March the next year. Commercial harvest and percentage of female crabs removed in 2019 are not yet available.

Survey Year (Year Survey Ended)	Total Number of Crabs in millions (All Ages)	Number of Juvenile Crabs in millions (both sexes)	Number of Spawning-Age Crabs in millions (both sexes)	Number of Spawning-age Female crabs in millions	Bay-wide Commercial Harvest in millions of Pounds	Percentage of Female Crabs Harvested
1990	791	463	276	117	104	43
1991	828	356	457	227	100	40
1992	367	105	251	167	61	63
1993	852	503	347	177	118	28
1994	487	295	190	102	84	36
1995	487	300	183	80	79	36
1996	661	476	146	108	78	25
1997	680	512	165	93	89	24
1998	353	166	187	106	66	43
1999	308	223	86	53	70	42
2000	281	135	146	93	54	49
2001	254	156	101	61	54	42
2002	315	194	121	55	54	37
2003	334	172	171	84	49.5	36
2004	270	143	122	82	60	46
2005	400	243	156	110	58.5	27
2006	313	197	120	85	52	31
2007	251	112	139	89	43	38
2008	293	166	128	91	49	21
2009	396	171	220	162	54	24
2010	663	340	310	246	85	16
2011	452	204	255	191	67	24
2012	765	581	175	95	56	10
2013	300	111	180	147	37	23
2014	297	198	99	68.5	35	17
2015	411	269	143	101	50	15
2016	553	271	284	194	60	16
2017	455	125	330	254	54	21
2018	371	168	206	147	55	23
2019	**594**	**323**	**271**	**191**	**TBD***	**TBD***

2019 Chesapeake Bay Blue Crab Advisory Report

CBSAC Meeting Date: May 30, 2019
Report Final: June 24, 2019

EXECUTIVE SUMMARY

The Chesapeake Bay Stock Assessment Committee (CBSAC) meets annually to review the results of the Chesapeake Bay blue crab surveys and harvest data, and to develop management advice. CBSAC adopted the Bay-wide Winter Dredge Survey (WDS) as the primary indicator of blue crab population health in 2006 because it is the most comprehensive and statistically robust of the blue crab surveys conducted in the Bay. Based on survey estimates, the total abundance of all crabs (males and females of all ages) was estimated at 594 million crabs in 2019. Recruitment, or the number of age 0 crabs (less than 60 mm or 2.4 inches carapace width), was estimated as 324 million crabs in 2019. Approximately 191 million age 1+ female crabs were estimated to be present in the Bay at the start of the 2019 crabbing season, which is well above the abundance threshold of 70 million crabs, and near the target of 215 million crabs. The 2011 benchmark assessment recommended a control rule based on biological reference points for the female component of the population. The percentage of female crabs (ages 0+) removed by fishing (exploitation fraction) in 2018 was approximately 23%. This exploitation fraction is below the target of 25.5% and the threshold of 34% for the 11th consecutive year since 2008. Therefore, overfishing is not occurring and the population is not depleted.

Based on analysis of the 2019 winter dredge survey results, CBSAC concludes that fishery restrictions by management are not warranted, but the jurisdictions should maintain a cautious, risk-averse approach in the 2019 season. CBSAC recommends that the jurisdictions implement procedures that provide accurate accountability of all commercial and recreational harvest moving forward, as this is an important component for accurately assessing stock health.

1. INTRODUCTION

1.1 Background: Management and Science

Management of the blue crab stock is coordinated among the jurisdictions by the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team (SFGIT). Organized by the Chesapeake Bay Program and chaired by NOAA Chesapeake Bay Office (NCBO), the SFGIT is led by an Executive Committee of senior fisheries managers from Maryland Department of Natural Resources (MDNR), Virginia Marine Resource Commission (VMRC), Potomac River Fisheries Commission (PRFC), the Atlantic States Marine Fisheries Commission (ASMFC), and the District Department of the Environment (DDOE).

The Chesapeake Bay Stock Assessment Committee (CBSAC) combines the expertise of state representatives and scientists from the Chesapeake Bay region, as well as federal fisheries scientists from the National Marine Fisheries Service's Northeast and Southeast Fisheries Science Centers. This committee has met each year since 1997 to review the results of annual Chesapeake Bay blue crab surveys and harvest data, and to develop management advice for Chesapeake Bay jurisdictions: the state of Maryland, the Commonwealth of Virginia, and the PRFC.

Three benchmark stock assessments of the Chesapeake Bay blue crab have been conducted since 1997. The most recent assessment was completed in 20111 with support from VMRC, MDNR, and PRFC. The 2011 assessment recommended revision of the former overfishing reference point, which had been based on conserving a fraction of the maximum spawning potential (MSP), to one based on achieving the maximum sustainable yield (MSY). The 2011 stock assessment recommended replacing the empirically-estimated overfished age 1+ (both sexes) abundance threshold and target with an MSY-based threshold and target based solely on the abundance of female age 1+ crabs. Female-specific reference points were formally adopted by all three management jurisdictions in December 2011.

An update to the 2011 assessment was completed with data through 2017. This update was submitted to CBSAC for peer review.

CBSAC adopted the Bay-wide Winter Dredge Survey (WDS) as the primary indicator of blue crab population health in 2006 because it is the most comprehensive and statistically robust of the blue crab surveys conducted in the Bay[2]. The WDS measures the density of crabs (number per 1,000 square meters) at approximately 1,500 sites throughout the Bay. The measured densities of crabs are adjusted to account for the efficiency of the sampling gear and are expanded based on the area of Chesapeake Bay, providing an annual estimate of the number of overwintering crabs by age and sex[2]. An estimate of the mortality during winter is also obtained from the survey results.

1.2 Stock Status and Current Management Framework

Under the current framework, annual estimates of exploitation fraction are calculated as the annual harvest of female crabs in a given year (not including discards, bycatch, or unreported losses) divided by the total number of female crabs (age 0+) estimated in the population at the start of the season. As part of this calculation, the juvenile component of the total estimated number of crabs is scaled up by a factor of 2.5 so that the empirical estimate of exploitation uses the same assumption about juvenile susceptibility to the survey as the stock assessment that generated the reference points. Thus, the empirical estimates of exploitation rate can be compared with the target and threshold reference points derived from the assessment model.

Crab abundance is estimated from the WDS each year. The current framework recommends monitoring the abundance of spawning-age female crabs (age 1+) in comparison to female-specific abundance reference points. Management seeks to control the fishery such that the number of crabs in the population remains above the minimum set by the overfished (depleted) threshold. Ideally, the fishery should operate to meet target values, never surpass the exploitation fraction threshold value, and never go below the abundance threshold value.

2. POPULATION SIZE (ABUNDANCE)

2.1 All Crabs (both sexes, all ages)

Based on survey estimates, the total abundance of all crabs (males and females of all ages) increased by almost 60% from 372 million crabs in 2018 to 594 million crabs in 2019 (Figure 1) and was above the long-term average (geometric mean[1]). Since 2008, the stock has demonstrated strong interannual variation, as expected for the species.

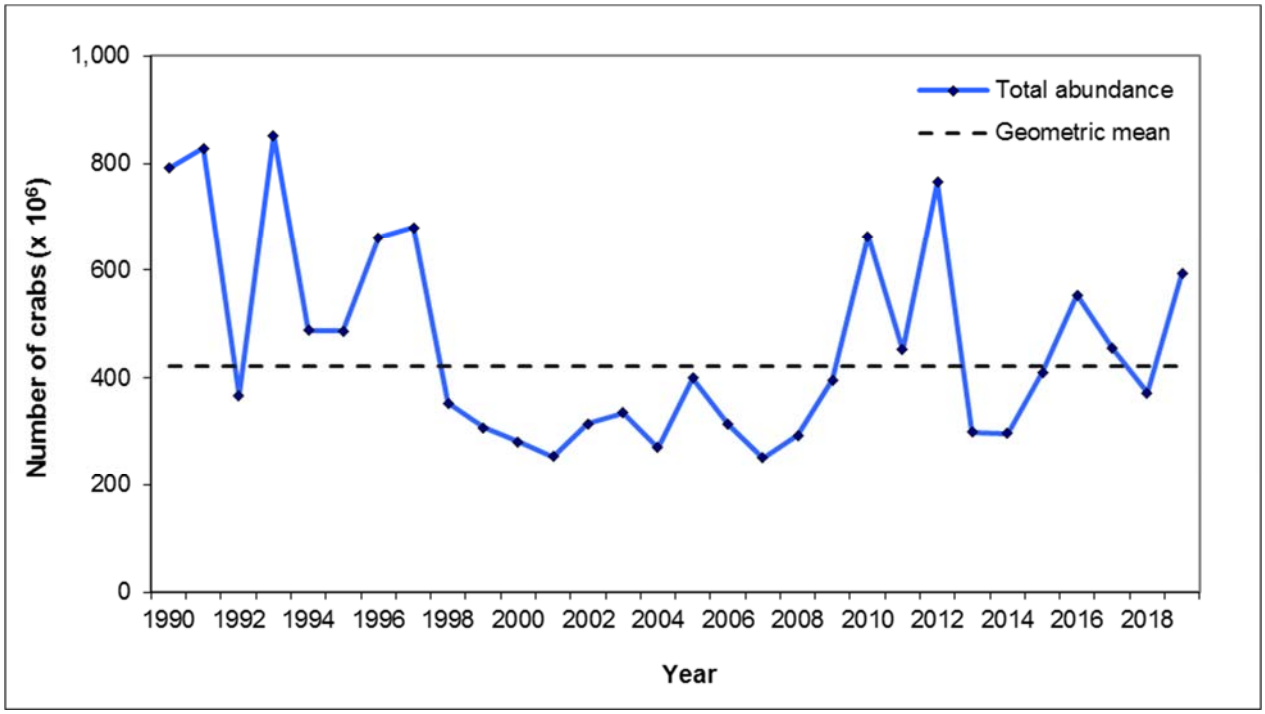

Figure 1. Winter dredge survey estimate of abundance of all crabs (both sexes, all ages) in Chesapeake Bay, 1990-2019.

2.2 Age 0 Crabs

Recruitment is estimated as the number of age 0 crabs (less than 60 mm or 2.4 inches carapace width) in the WDS. Based on survey estimates, the abundance of age 0 crabs was 323 million crabs in 2019, the 3rd highest estimate since female-specific management measures were put in place (Figure 2). This year's estimate was above the time series average of 224 million crabs (geometric mean) and in the top 27% of time series estimates.

[1] A geometric mean ($GM\bar{x} = \sqrt[n]{x_1, x_2, \ldots x_n}$) was used because it is not as sensitive to fluctuation from a single large value.

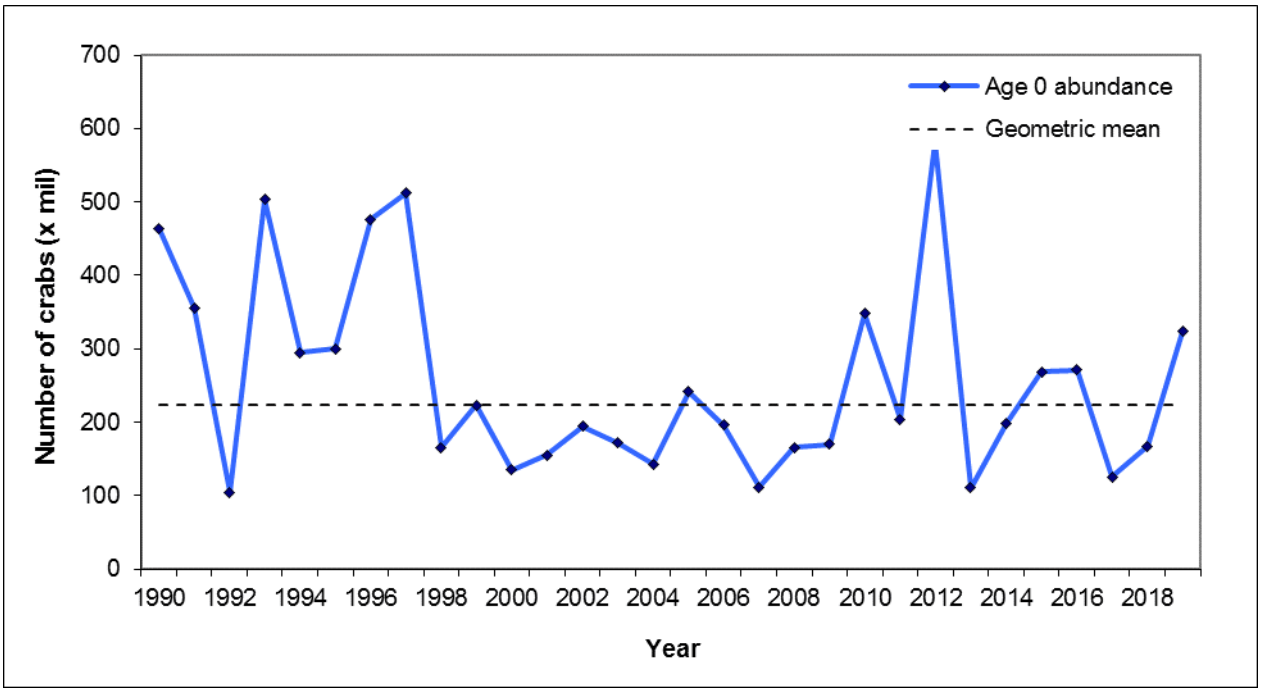

Figure 2. Winter dredge survey estimate of abundance of juvenile blue crabs (age 0), 1990-2019, calculated without the catchability adjustment for juveniles (section 1.2). These are male and female crabs measuring less than 60 mm across the carapace.

2.3 Overwintering Mortality

Overwintering mortality in 2019 was below average and among the lowest values observed in recent years (Table 1).

Table 1. Percent dead crabs found in late winter dredge samples each year from 2014-2019 and the average for 1996-2019.

Bay-wide Age/sex group	1996-2019 average	2014	2015	2016	2017	2018	2019
All crabs	4.71%	3.79%	15.68%	1.95%	1.15%	6.37%	1.80%
Juveniles	1.25%	0.89%	10.84%	0.50%	0.00%	0.87%	0.15%
Adult Females	8.40%	7.68%	19.25%	2.99%	1.37%	11.06%	1.87%
Adult males	9.66%	13.58%	28.11%	1.06%	2.29%	13.66%	7.83%

3. HARVEST

3.1 Commercial and Recreational Harvest

Annual blue crab commercial harvest increased slightly in 2018. The three management jurisdictions maintained harvest measures similar to those in 2017 (Appendix B). The 2018 commercial harvest for both males and females from the Bay and its tributaries was reported as 32.6 million pounds in Maryland, 22.9 million pounds in Virginia, and 3.2 million pounds in the Potomac River. Relative to 2017, annual female harvest decreased in Virginia and the Potomac River, but increased in Maryland. Annual male harvest was stable in Maryland and Potomac River, and increased in Virginia. The total 2018 Bay-wide commercial harvest of approximately 55 million pounds was below the 1990-2018 average and similar to the 2017 Bay-wide commercial harvest of approximately 54 million pounds (Figures 3-4).

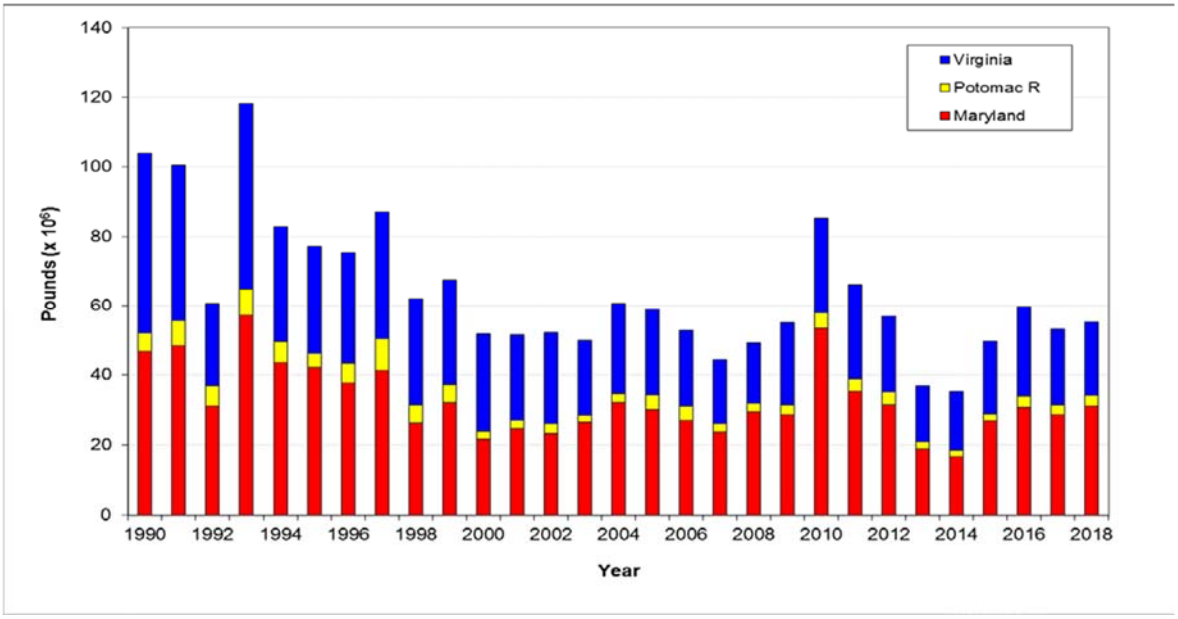

Figure 3. Total commercial blue crab landings (all market categories) in Chesapeake Bay, 1990-2018.

Prior to 2009, recreational harvest had been assumed to be approximately 8% of the total Bay-wide commercial harvest based on Ashford and Jones (2001, 2003, 2005, 2011).[5,6,7,8] Since recreational harvest of female blue crabs is no longer allowed in Maryland or in the Maryland tributaries of the Potomac River, recreational harvest is better described as 8% of commercial male harvest in those jurisdictions. 2018 Bay-wide recreational harvest was estimated as 3.4 million pounds, similar to the 2017 recreational harvest estimate of 3.6 million pounds. Combining the commercial and recreational harvest, approximately 59 million pounds of blue crabs were harvested from Chesapeake Bay and its tributaries during the 2018 crabbing season.

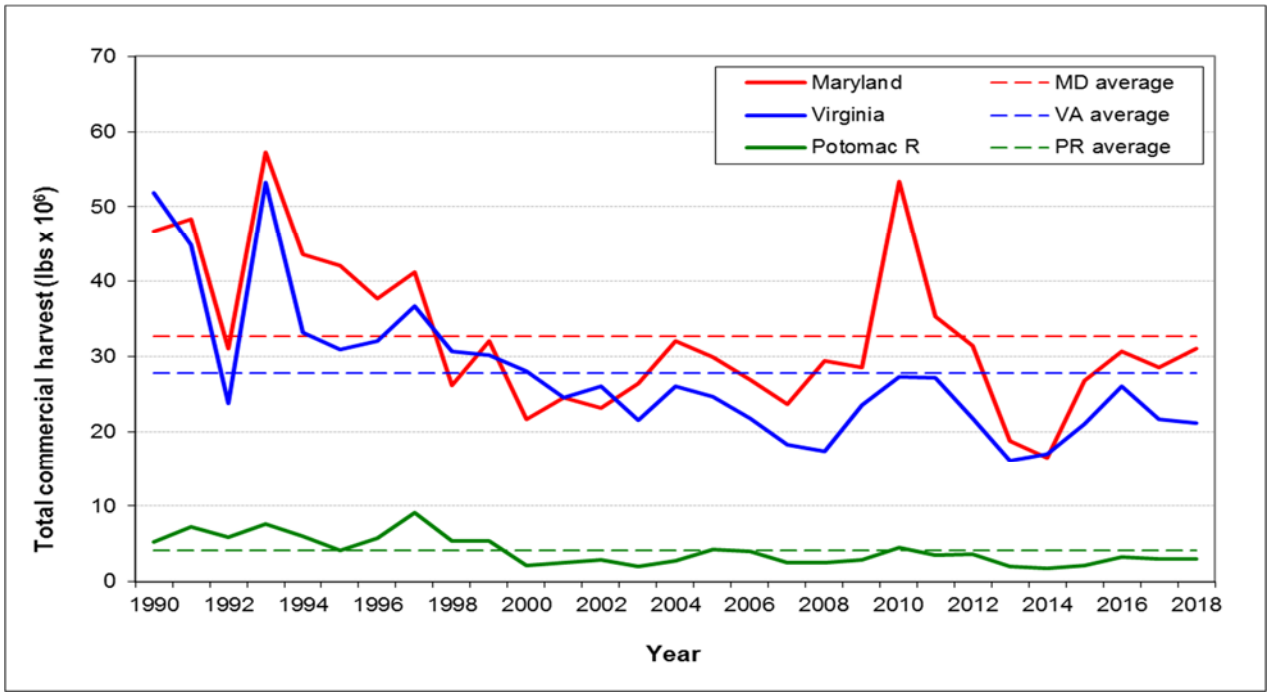

Figure 4. Maryland, Virginia, and Potomac River commercial blue crab harvest in millions of pounds from Chesapeake Bay, all market categories, 1990-2018. Corresponding average lines represent the arithmetic mean.

4. STOCK STATUS

4.1 Female Reference Points

The 2011 benchmark assessment recommended a control rule based on biological reference points for the female component of the population. The current female-specific targets and thresholds were developed using an MSY approach. U_{MSY} is defined as the level of fishing (expressed as the percentage of the population harvested) that achieves the largest average catch that can be sustained over time without risking stock collapse. Following precedent adopted by the New England and Mid-Atlantic Fishery Management Councils, the 2011 assessment recommended a target exploitation level that was associated with 75% of the value of U_{MSY} and a threshold exploitation level set equal to U_{MSY}. The female-specific age 1+ abundance target and threshold were set accordingly at abundance levels associated with $N_{0.75*UMSY}$ (target) and 50% N_{MSY} (threshold).

4.2 Exploitation Fraction

The percentage of all female crabs (ages 0+) removed by fishing (exploitation fraction) in 2018 was approximately 23%. This exploitation fraction is below the target of 25.5% and the threshold of 34% for the 11th consecutive year since 2008, when female-specific management measures were implemented (Figure 5).

4.3 Spawning Stock Abundance

The abundance reference point for the spawning stock was set at a threshold abundance of 70 million spawning-age (age 1+) female crabs and a target abundance of 215 million. Approximately 191 million age 1+ female crabs were estimated to be present in the Bay at the start of the 2019 crabbing season, a 30% increase from the 2018 estimate of 147 million (Figure 6). The 2019 abundance of spawning-age female crabs is well above the threshold (272% of threshold value) and close to the target (88% of the target).

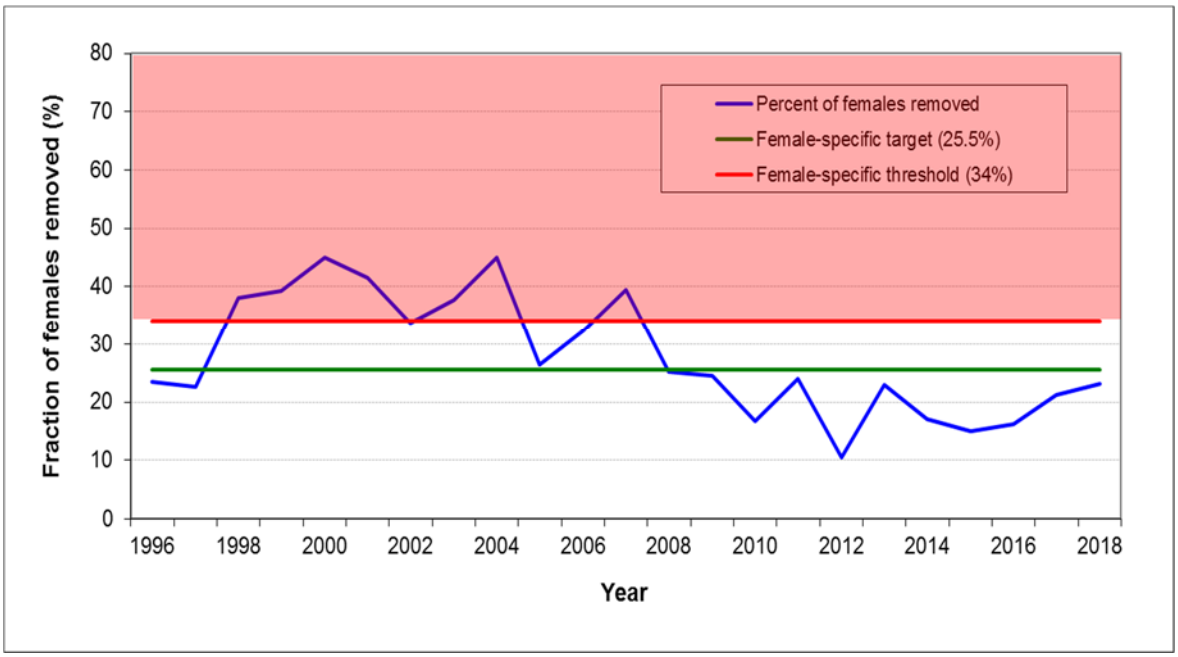

Figure 5. The percentage of all female blue crabs removed from the population each year by fishing relative to the female-specific target (25.5%) and threshold (34%) exploitation rates, 1990-2018.

Exploitation rate (proportion removed) is the number of female crabs harvested within a year divided by the female population (age 0+) estimated by the WDS at the beginning of the year.

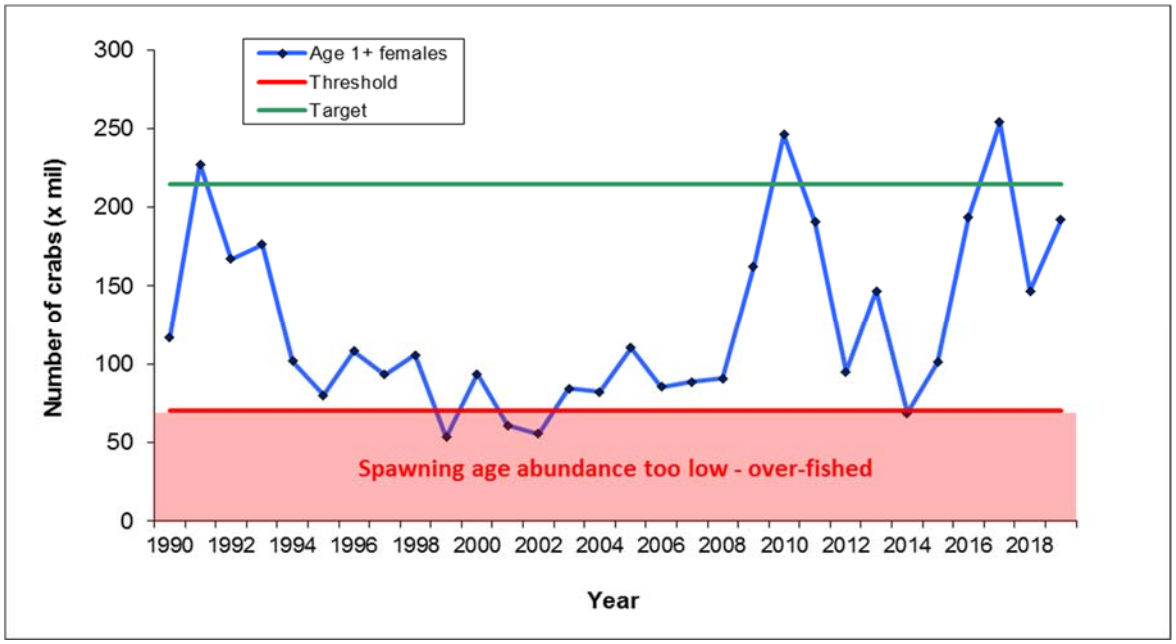

Figure 6. Winter dredge survey estimate of abundance of spawning-age female blue crabs (age 1+), 1990-2019, with female-specific reference points. These are female crabs measuring greater than 60 mm across the carapace and are considered the 'exploitable stock' that could spawn within this year.

4.4 Control Rules

Figure 7 shows the status of the blue crab stock for each year relative to both the female age 0+ exploitation (μ) reference points and the female age 1+ abundance (N) reference points (explained in sections 4.2 and 4.3). The red areas show where the thresholds for the female exploitation fraction and female abundance are exceeded. The intersection of the green lines shows where both the abundance and exploitation fraction targets would be reached. The figure includes data through 2018. 2019 data will be added at the completion of the 2019 fishery.

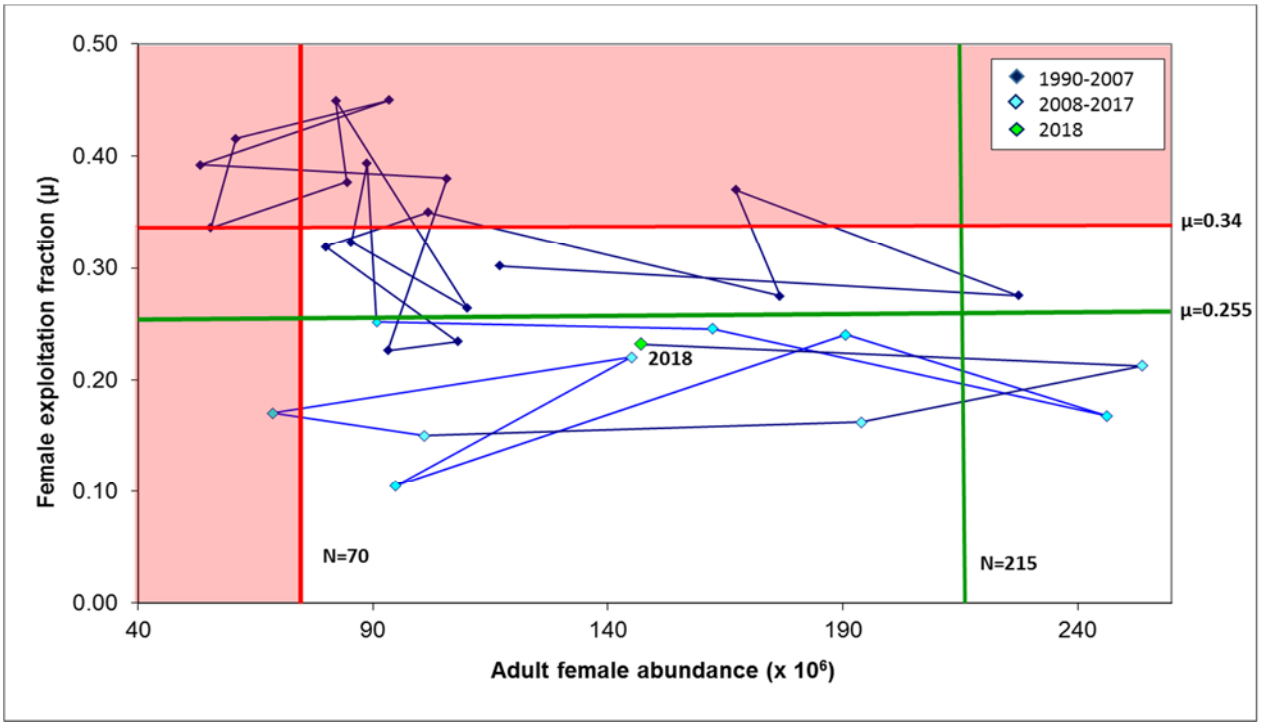

Figure 7. Status of the stock for the Chesapeake Bay blue crab fishery prior to and after implementation of initial female-specific management measures in 2008. The current female-specific management framework was formally adopted in 2011. In 2018, adult female abundance (N) was 147 million, which was above the 70 million threshold but below the 215 million target. The 2018 female exploitation fraction (U) was 23%, which was below the 25.5% target and 34% threshold.

Note: The 2013 point was moved slightly for display purposes, as it fell under the point for 2018.

The Chesapeake Bay blue crab stock is currently **not depleted and overfishing is not occurring** (Table 2). The 2019 estimated abundance of the spawning stock is above the threshold of 70 million age 1+ female crabs but below the target of 215 million age 1+ female crabs outlined in the current management framework. The 2018 exploitation fraction of 23% was below the target (25.5%) and threshold (34%). Abundance, harvest, and exploitation of all crabs are summarized in Appendix A and in the preceding sections.

Table 2. Stock status based on reference points for age 0+ (exploitation fraction) and age 1+ (abundance) female crabs. Recent stock status levels that did not exceed threshold values are shown in green, whereas exploitation values or abundance estimates exceeding thresholds are shown in red.

Control Rule	Reference Points			Stock Status						
	Period	Target	Threshold	2013	2014	2015	2016	2017	2018	2019
Exploitation Fraction (age 0+ female crabs)	Current, Female-specific	25.5%	34% (max)	23%	17%	15%	16%	21%	**23%**	TBD
Abundance (millions of age 1+ female crabs)	Current, Female-Specific	215	70 (min)	147	68.5	101	194	254	147	**191**

4.5 Male Conservation Trigger

In 2013, CBSAC recommended a conservation trigger for male crabs based on the history of male exploitation. Under this trigger, conservation measures should be considered for male blue crabs if male exploitation rate exceeds 34% (calculated with the juvenile scalar as described in section 1.2), which is the second highest exploitation fraction observed for male crabs since 1990. Choosing the second highest value in the time series ensures a buffer from the maximum observed value of exploitation. It should be noted that this value does not represent a fishing threshold or target. Rather, this trigger will ensure that the male component of the stock is not more heavily exploited than has occurred in 24 of the last 26 years. The 2018 male exploitation fraction was estimated at 33%, just below the male exploitation rate conservation trigger and lower than the 2017 estimate (Figure 8). Immediate management action is not necessary at present.

4.6 Age 1+ Males

The survey estimate of age 1+ male crabs (greater than 60 mm or 2.4 inches carapace width) in 2019 was 80 million crabs, a 37% increase from the 2018 estimate of 58 million adult male crabs (Figure 9). Age 1+ male abundance is above the time series mean of 66 million (geometric mean) but does not exhibit the same variable pattern of abundance compared to adult females.

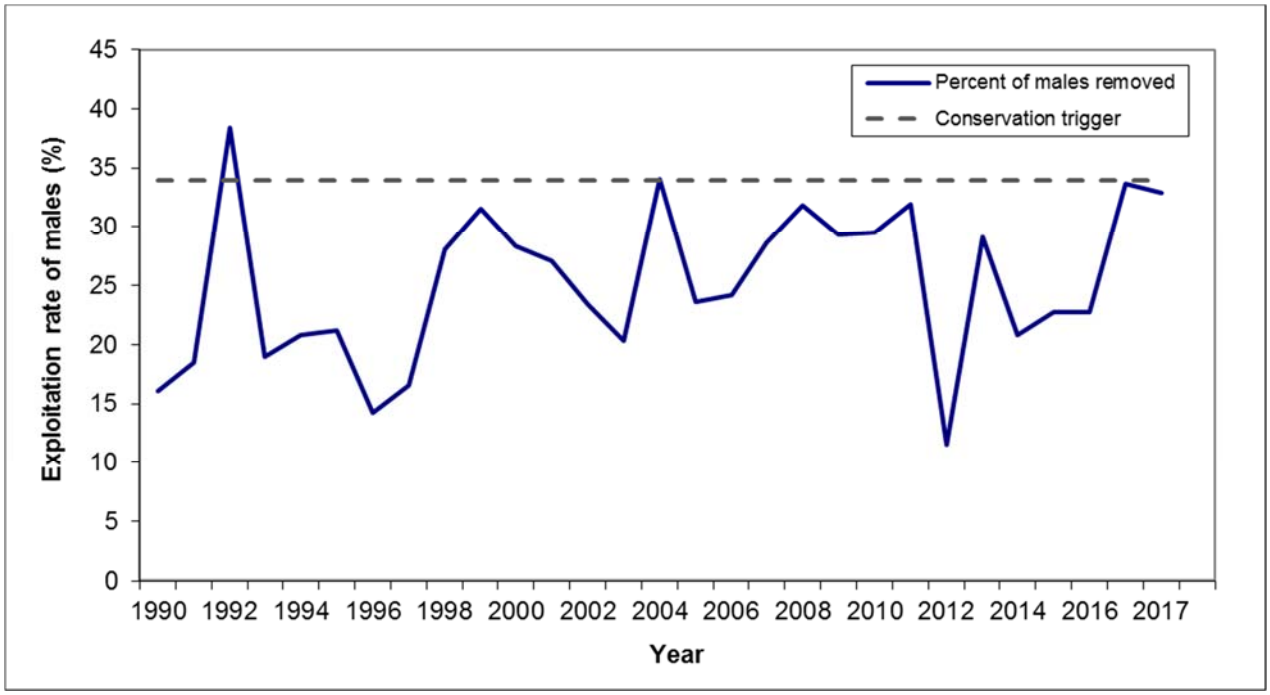

Figure 8. The percentage of male crabs removed from the population each year by fishing, 1990-2018. Exploitation rate (proportion removed) is the number of male crabs harvested within a year divided by the male population estimate (age 0+) at the beginning of the year, calculated with the juvenile scalar.

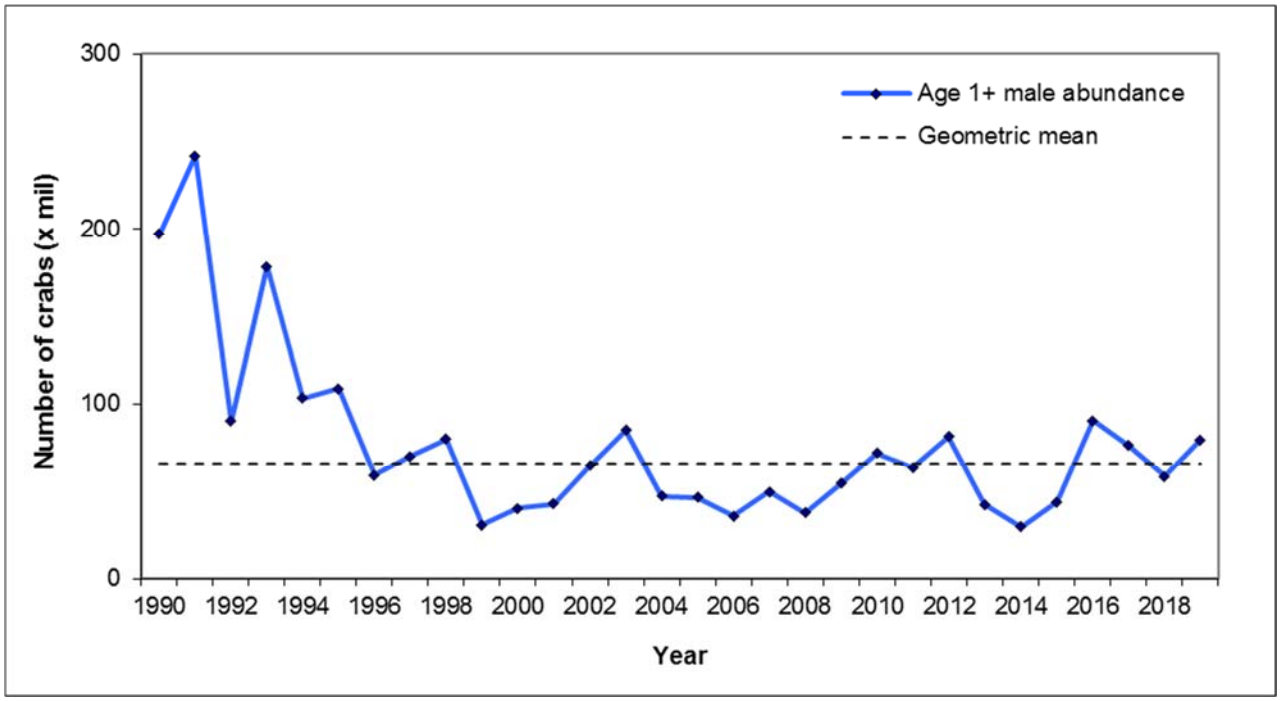

Figure 9. Winter dredge survey estimate of abundance of age 1+ male blue crabs, 1990-2019. These are male crabs measuring greater than 60 mm across the carapace and are considered the 'exploitable stock' capable of mating within this year.

4.7 Management Impact

Female exploitation fractions from 1990-2007 were much higher than the exploitation fractions from 2008-2018. These lower female exploitation fractions in recent years illustrate the influence of the female-specific management measures implemented by the jurisdictions starting in 2008. Male exploitation fractions have not shown the same pattern, which was expected because management action was targeted toward females (Figure 10). Additionally, the rapid increase in abundance from 2008-2010 and again from 2014-2016 indicate that the current management framework has allowed the stock to regain some of its expected resilience to environmental changes.

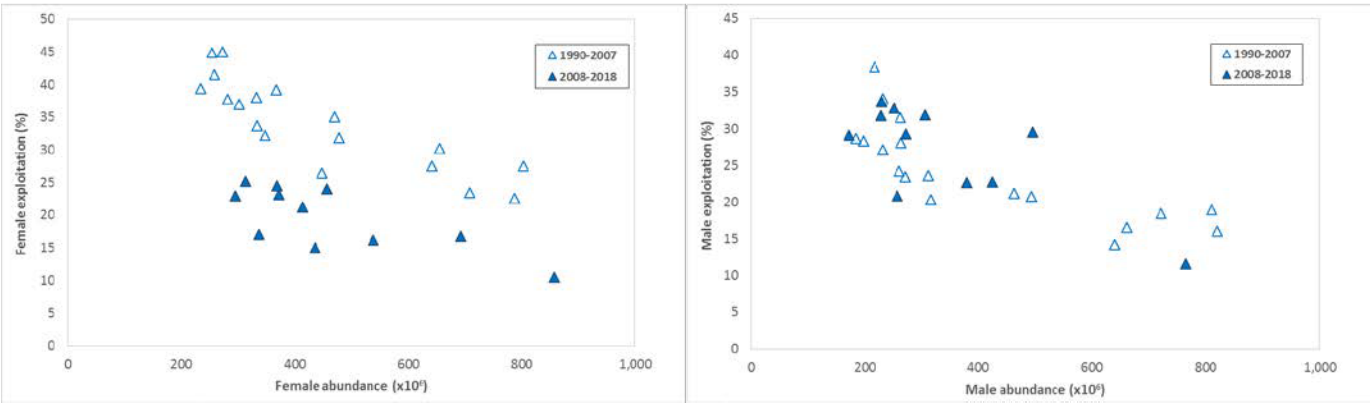

Figure 10. Female (left) and male (right) exploitation rate comparison of the time periods prior to and after the 2008 implementation of female-specific management measures.

5. MANAGEMENT ADVICE

5.1 Monitor Fishery and Stock Status Relative to Reference Points

The female exploitation fraction in 2018 was below the target of 25.5% for the 11th consecutive year. The abundance of adult female crabs increased and remained well above the threshold in 2019. The abundance of juveniles increased and was above the long-term average. Based on analysis of the 2019 winter dredge survey results, CBSAC concludes that fishery restrictions by management are not warranted, but the jurisdictions should maintain a cautious, risk-averse approach in the 2019 season. Past harvest regulations are summarized in Appendix B.

Large variations in recruitment (age 0 abundance) are a characteristic of blue crab biology and not unexpected. However, it should be the goal of management to maintain a robust spawning stock, thereby increasing the resiliency of the population to downturns in recruitment.

5.2 Catch Reports and Quantifying Effort

CBSAC again recommends that the jurisdictions implement procedures that provide accurate accountability of all commercial and recreational harvest. All three Chesapeake Bay management jurisdictions have programs in place to gather more accurate catch and effort information submitted by commercial and recreational harvesters. Most blue crab regulations focus on effort control in the form of limited entry, size limits, daily time limits, pot limits, spatial closures, spatial gear restrictions, and seasonal closures. To determine the efficacy of these management measures, detailed effort data that would reveal the spatial and temporal patterns of gear-specific effort should be a part of any system used to improve harvest data. Maryland, Virginia, and PRFC all require daily harvest reports to be submitted on a regular basis and are collaborating with industry groups to pursue new reporting technologies. Maryland has implemented an electronic reporting program that allows for daily harvest reporting in real time and harvest validation. Virginia continues to promote its online reporting system that began in 2009. PRFC is exploring the use of electronic reporting to potentially begin in the next few years.

While implementing systems for greater accuracy, efforts should also be made, where possible, to better determine the biological characteristics of the catch, both landed and discarded. Note that when changes in reporting requirements are implemented, it is vital to quantify the impact of these changes on the current estimates of harvest. Efforts should also be undertaken to assess the reliability of estimates of recreational harvest Bay-wide.

6. CRITICAL DATA AND ANALYSIS NEEDS

CBSAC has identified the following prioritized list of fishery-dependent and fishery-independent data needs as well as the benefits provided to management.

In addition to specific data needs, CBSAC recognizes the importance of future stock assessments in providing in-depth analyses of the Chesapeake Bay blue crab population and scientific guidance to managers. MDNR conducted a stock assessment update in 2017 using the 2011 stock assessment model, which CBSAC recommends be considered for adoption, providing a new framework for management. CBSAC also recommends annual runs of the stock assessment model be undertaken to aid in determining stock status. Given new information and issues with fishery performance, improvements to the current model should be pursued. A thorough evaluation concerning the need for a benchmark will be produced by the end of the year.

6.1 Efficacy of WDS as an Index of Abundance

The winter dredge survey is a key tool used by managers for determining the status of the stock and management decisions. It is also utilized by researchers in stock assessments for setting targets and thresholds. There are several aspects of survey design and interpretation that should be further explored and improved upon. At least three approaches using winter dredge data have been proposed to estimate relative abundance (Sharov et al 1993, Jensen and Miller 2005, Liang et al. 2018). The relative reliability of the means and variances of abundance estimated from these different approaches have never been evaluated. CBSAC recommends conducting a data workshop evaluating the performance of these and other analytical approaches. The workshop would provide guidance in evaluating the design of the survey to produce the most reliable estimates. Another outcome would be to recommend targeted studies to improve the survey.

6.2 Increased Accountability and Harvest Reporting for Commercial and Recreational Fisheries

CBSAC recommends jurisdictions continue to develop, explore, and evaluate implementation of real-time electronic reporting systems to increase the accuracy of commercial and recreational landings data. Improving commercial and recreational blue crab harvest accountability would provide managers with a more accurate exploitation fraction each year and better support midseason management changes.

The jurisdictions have been working to implement new harvest reporting technologies over the past few years. Since pilot efforts were introduced in 2012, MDNR has been using an electronic reporting system that allows commercial crabbers to enter each day's harvest from their vessel. The system includes random daily catch verification and a "hail-in, hail-out" protocol. Maryland is continuing to expand the use of this system for the commercial crabbing fleet.

Virginia implemented electronic reporting in 2009 as an alternative mandatory harvest reporting option, but growth has been slow. Through cooperative work among VMRC, Virginia Sea Grant, and various industry groups, promotional products were produced and participation of commercial crab harvesters has increased. PRFC will consider using an electronic reporting system in the next few years, given the interest among stakeholders.

CBSAC recommends a survey of recreational catch and effort be undertaken periodically to ensure the reliability of estimates of recreational removals, if at all possible. The last available estimate for Maryland waters was for 2011[5,6,7,8]. The last available estimate for Virginia was 2002[5]. Future surveys should ensure that recreational harvest from the Potomac River is also included. A license that would provide a valid sampling frame for recreational crabbing in all jurisdictions would greatly increase the accuracy of catch and effort estimates.

6.3 Improving Recruitment Estimate through a Shallow-Water Survey

Based on the 2011 stock assessment and field experiments by VIMS and the Smithsonian Environmental Research Center, a large fraction of juvenile blue crabs in shallow water is not sampled by the WDS[9]. VIMS pursued funding at the state level to conduct a shallow-water survey concurrent with the Virginia WDS to assess the potential for interannual bias in the fraction of juveniles not sampled by the WDS, but was not successful. CBSAC will discuss applying this effort Bay-wide based on funding and initial findings of a complementary shallow- water survey conducted by VIMS in spring.

6.4 Investigation of the Influence of Male Abundance on Population and Fishery Productivity

CBSAC recommends continued examination to quantify and better understand the influence of male crabs on reproductive success, the overall population, and fishery productivity. In lieu of biological metrics to determine the stock status of male blue crabs, CBSAC recommends evaluating replacement of the current male trigger with a more comprehensive set of criteria that would determine when management adjustments specific to male crabs would be warranted.

6.5 Quantifying Environmental Factors Related to Recruitment Variability

CBSAC recommends continued examination of the environmental factors that may contribute to interannual recruitment variability. In particular, emphasis should be placed on prediction of future recruitment success based on environmental conditions during the year.

6.6 Blue Crab Data Hub

To assist in stock assessments and analyses, CBSAC recommends exploring the creation of a data hub focused on Chesapeake Bay blue crab data. This would provide a consistent data

platform for all research and minimize the lengthy QA/QC process undertaken before any analyses can begin. Several steps would be necessary to implement such a data hub:

A) data policy workgroup to develop policies to ensure all interests are protected
B) determine best database design and structure
C) data QA/QC prior to loading into database

6.7 Application of Fishery-Independent Survey Data

CBSAC recommends continued review of existing fishery-independent survey data and potential application to provide additional information on the blue crab population, complementing the population estimates from the WDS. This would include incorporating data from new surveys, as well as performing additional analyses on existing data sets.
Characterizing the spring through fall distribution and sex-specific abundance of blue crabs remains important.

6.8 Fishery-Dependent Data

A verifiable electronic reporting system would collect much of the fishery-dependent data needed to improve management. In lieu of such a system, improvements in management could be made through a more detailed characterization of the catch. Mandatory harvest reporting is currently the only fishery-dependent data in Virginia and the Potomac River. Understanding catch composition, by size, sex, and growth phase, spatially and temporally, as well as effort characterization (mentioned in 6.2), would help improve the effectiveness of regulations and ensure compatibility at a Bay-wide level. VMRC conducted short-term fishery-dependent sampling in 2016-17 to provide some characterization of commercial harvest. CBSAC recommends that the jurisdictions consider options for future fishery-dependent sampling programs.

6.9 Other Sources of Mortality

CBSAC also recommends analyzing the magnitude of other sources of incidental mortality, specifically sponge crab discards, unreported losses after harvest from the peeler fishery, disease, and predation. An analysis of non-harvest mortality could improve reliability of exploitation fraction estimates and inform future assessments.

6.10 Biological Parameters

Longevity, age structure, and growth rates, particularly with respect to the timing of recruitment to the fishery within the season, are not fully characterized and remain as sources of uncertainty.

Attachment 2

CBSAC Members:

Glenn Davis (Chair)	Maryland Department of Natural Resources
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len Cosby	tomac River Fisheries Commission Mary-
Lynn Fegley	land Department of Natural Resources Vir-
Pat Geer Dan-	ginia Marine Resources Commission NMFS,
iel Hennen	Northeast Fisheries Science Center Virginia
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Attachment 2

Appendix A. Estimated abundance of blue crabs from the Chesapeake Bay-wide winter dredge survey, annual commercial harvest, and removal rate of female crabs.

Survey Year (Year Survey Ended)	Total Number of Crabs in Millions (All Ages)	Number of Juvenile Crabs in Millions (both sexes	Number of Spawning-Age Crabs in Millions (both sexes)	Number of spawning age Female crabs in Millions	Bay-wide Commercial Harvest (Millions of Pounds)	Percentage of Female Crabs Har-vested
1990	791	463	276	117	104	43
1991	828	356	457	227	100	40
1992	367	105	251	167	61	63
1993	852	503	347	177	118	28
1994	487	295	190	102	84	36
1995	487	300	183	80	79	36
1996	661	476	146	108	78	25
1997	680	512	165	93	89	24
1998	353	166	187	106	66	43
1999	308	223	86	53	70	42
2000	281	135	146	93	54	49
2001	254	156	101	61	54	42
2002	315	194	121	55	54	37
2003	334	172	171	84	49.5	36
2004	270	143	122	82	60	46
2005	400	243	156	110	58.5	27
2006	313	197	120	85	52	31
2007	251	112	139	89	43	38
2008	293	166	128	91	49	25
2009	396	171	220	162	54	24
2010	663	340	310	246	85	16
2011	452	204	255	191	67	24
2012	765	581	175	95	56	10
2013	300	111	180	147	37	23
2014	297	198	99	68.5	35	17
2015	411	269	143	101	50	15
2016	553	271	284	194	60	16
2017	455	125	330	254	53	21
2018	371	167	206	147	55	23
2019	**594**	**323**	**271**	**191**	**TBD***	**TBD***

* 2019 Bay-wide commercial harvest and exploitation rate are preliminary (TBD= to be determined) *Bay-wide harvest totals and female exploitation rates listed on this page for 2010 and prior were updated in 2016 to reflect final Bay-wide harvest totals. Previous reports listed preliminary harvest data on this page.*

Appendix B. Summary of Female Blue Crab Harvest Regulations in the Chesapeake Bay Jurisdictions 2008-2016

Starting in 2008, the jurisdictions (Maryland, Virginia, Potomac River Fisheries Commission) implemented female-specific management measures for the Chesapeake Bay blue crab fishery. The jurisdictions adopted the current female-specific reference points with targets and thresholds for spawning-age (age 1+) female abundance and female exploitation rate in December 2011. The chart below summarizes changes in spawning-age female management regulations each year from 2008-2016.

Year	All Crabs	Age 0 Juv Crabs	Age 1+ Female Crabs	%Female Crabs Harvested	Maryland Female Harvest Regulations	Virginia Female Harvest Regulations	Potomac River Fisheries Commission Female Harvest Regulations
2008	293	166	91	21%	34% reduction: restricted access to female fishery from Sept 1 to Oct 22 based on harvest history; created tiered bushel limits for females based on harvest history	34% reduction: closed winter dredge fishery; closed the fall season for females early on Oct 27 (five weeks early); eliminated the five-pot recreational crab license; required two additional/larger cull rings; reduced # pots per license by 15% as of May 1 and another 15% next year; reduced # peeler pots per license by 30% on May 1.	34% reduction: closed the mature female hard crab season early on Oct 22; established separate female daily bushel limits Sept 1 to Oct 22 for areas upstream of St. Clements Isl. And areas downstream of St. Clements Isl; reduced peeler & soft shell seasons; established that all hard males, hard females, peelers and soft shell crabs kept separate on catcher's boat.
2009	396	171	162	24%	Open access, with industry input created season-long bushel limits that vary by license type and through the season/ Created a 15-day June (1-15) closure and a 9 day fall (9/26 - 10/4) closure to female harvest	Closed crab sanctuary from May 1-Sept 15 (closed loopholes that prevented a uniform May 1 closure for entire sanctuary). Nov 21 harvest closure; waived proposed 15% reduction of pots per license class; reinstated 5-pot recreational license; continued closure of winter dredge fishery.	Maintained 2008 season dates. Did not continue female daily bushel limits from 2008.

Year	All Crabs	Age 0 Juv Crabs	Age 1+ Female Crabs	%Female Crabs Harvested	Maryland Female Harvest Regulations	Virginia Female Harvest Regulations	Potomac River Fisheries Commission Female Harvest Regulations
2010	663	340	246	16%	Same bushels limits as 2009, but eliminated the 9-day fall closure based on industry input	Continued moratorium on sale of new licenses; relaxed dark sponge crab regulation to allow possession as of July 1 (instead of July 16); continued closure of winter dredge fishery	Established three mature female hard crab closure periods: Sept 22-28 above 301 bridge; Sept 29-Oct 6 from 301 bridge to St. Clements Isl./Hollis Marsh; Oct 7-13 below St. Clements Isl./Hollis Marsh. Closed season Nov 30.
2011	452	204	191	24%	Increased bushel limits	Closed sanctuary May 16 instead of May 1; continued closure of winter dredge fishery.	Refined mature female closed seasons: Sept 20-30 above St. Clements Isl./Hollis Marsh; Oct 4-14 below St. Clements Isl./Hollis Marsh.
2012	765	581	95	10%	Decreased bushel limits to compensate for removal of June closure, which added 15 days (based on industry advice). 6-day emergency extension to offset days lost to Hurricane Sandy.	Extended fall season until Dec 15; 6-day emergency extension to offset days lost to Hurricane Sandy; continued closure of winter dredge fishery.	Maintained 2011 mature female closed seasons.
2013	300	111	147	23%	Decreased bushel limits.	Implemented daily bushel limits to offset 2012 fall extension; extended fall pot season to Dec 15; continue closure of winter dredge fishery.	Refined mature female closed seasons: Sept 18-Oct 2 above St. Clements Isl./Hollis Marsh; Oct 3-17 below St. Clements Isl./Hollis Marsh.

Year	All Crabs	Age 0 Juv Crabs	Age 1+ Female Crabs	%Female Crabs Harvested	Maryland Female Harvest Regulations	Virginia Female Harvest Regulations	Potomac River Fisheries Commission Female Harvest Regulations
2014	297	198	68.5	17%	Daily bushel limits the same as 2013; additional vessel bushel reduction of 12%.	10% reduction: reduced pot and vessel limits; continued closure of winter dredge fishery.	10% reduction: Closed mature female hard crab season Nov 20 and extended closure periods: 12-Oct 2 above St. Clements Isl./Hollis Marsh; Oct 3-23 below St. Clements Isl./Hollis Marsh.
2015	411	269	101	15%	Increase in min. peeler size April-July 14 due to low 2014 adult females. Daily bushel limited increased ~20% Sept-Nov 10 on adult female increased abundance in 2015.	Maintained 2014 daily bushel limits; continued closure of winter dredge fishery. Redefined the blue crab sanctuary into 5 areas with separate closure dates	Set female daily bushel limits from April-June.
2016	553	271	194	16%	Extended season to Nov 30, add-20 days. Increased bushel limits in Sept and Oct.	Extended season 3 weeks to Dec 20; maintained 2014 bushel limits; continued closure of winter fishery.	Extended fall season through Dec 10. Set female daily bushel limits starting in July for the whole season.
2017	455	125	254	21%	Shortened season to Nov 20. Reduced bushel limits.	Shortened season to Nov 30. Continued closure of dredge fishery. Reduced Nov bushel lim-	Shortened season to Nov 30. Reduced bushel limits.
2018	372	167	147	23%	Extended season to Nov 30. Reduced bushel limits.	Continued closure of dredge fishery and Nov bushel limits. Added hard crab allowance for scrapers.	Status quo

Maryland Department of Natural Resources: http://dnr.maryland.gov/fisheries/Pages/default.aspx Potomac River Fisheries Commission: http://prfc.us/ Virginia Marine Resources Commission: http://www.mrc.virginia.gov/

Attachment 3

VIRGINIA'S 21-POINT BLUE CRAB MANAGEMENT PLAN

October 1994, the Commission established the following 7-point blue crab management plan:

- Expanded the spawning sanctuary (146 sq. mi.) establish in 1942 by 75 sq. mi., with no crab harvest allowed from June 1 through September 15.
- Established a 14,500-acre winter-dredge sanctuary in Hampton Roads.
- Shortened the crab pot season to April 1 through November 30.
- Required two cull (escape) rings in each commercial and recreational crab pot.
- Required four cull rings in each peeler pound that allows escapement of small peeler crabs.
- Capped the number of peeler pots per license to prevent expansion of the fishery.
- Limited the crab dredge size to 8 feet to prevent increases in effort.

The Commission reinforced the 7-point management plan in January 1996.

- Prohibited the possession of dark-colored (brown through black) sponge crabs (adult female hard crab which had extruded her eggs on her abdomen), with a 10-sponge crab per bushel tolerance.
- Limited license sales of hard crab licenses, based on previous eligibility or exemption requirements.
- Established a 300-hard crab pot limit for all Virginia tributaries of the mainstem Chesapeake Bay. Other Virginia harvest areas were limited to a 500-hard crab pot limit.
- Established a 3 1/2-inch minimum possession size limit for all soft shell crabs.

Concerns over excess effort in the fisheries and a persistent trend of low spawning stock biomass during most of the 1990's led to additional crab conservation measures in 1999 and 2000.

- Lowered the maximum limit on peeler pots from 400 to 300 pots in 1999. Harvest by this gear type increased by 90%, from 1994 through 1998, while the overall harvest remained relatively static.
- Initiated a moratorium on additional commercial licenses for all commercial crabbing gear. This moratorium became effective May 26, 1999 and continued until May 26, 2004.
- Established (in 2000) a Virginia Bay-wide Blue Crab Spawning Sanctuary, in effect June 1 through September 15. This additional sanctuary (435 sq. mil) allows for increased spawning potential.

A cooperative Bay-wide agreement (October 2000) to reduce harvest 15% by 2003 led to new measures.

- Enacted an 8-hour workday for commercial crabbers (2002) that replaced Wednesday closures of 2001.
- Established a 3-inch minimum size limit for peeler crabs (2002).
- Reduced peeler pot limits from 400 to 300 pots (for 2001).
- Reduced the winter dredge fishery limit from 20 to 17 barrels (2001).
- Augmented (2002) the Virginia Blue Crab Sanctuary by 272 sq. mi. (total sanctuary area = 928 sq. mi.).
- Reduced unlicensed recreational harvester limits to 1 bushel of hard crabs, 2 dozen peelers (2002).
- Reduced licensed recreational harvester limits to 1 bushel of hard crabs, 2 dozen peelers, with vessel limit equal to number of crabbers on board multiplied by personal limits (2001).

Attachment 3

ACTIONS TO PROMOTE REBUILDING OF CHESAPEAKE BAY BLUE CRAB STOCK (2008 through 2018)

February 2008

- Larger cull ring (2-5/16") required to be open at all times in all tidal VA waters to promote additional increases in escapement.
- Peeler crab minimum size limit increased from 3" to 3 ¼" (through July 15) and to 3 ½" (as of July 16).
- Use of agents modified to prevent license "stacking" and to curtail use of agents.
- Winter dredge fishery capped at 53 licensees (from previous 225 licensees), all being active harvesters in previous two winter seasons.

March 2008

- Adopted an extended closure (May 1 - September 15) of blue crab spawning sanctuary, to protect spawning females, except for the historical sanctuary (146 square miles) managed by law.

April 2008

- Established a fall closure for female harvest (October 27 – November 30).
- Implemented a 15% reduction in pots per individual for 2008 crab pot fishery and a 30% reduction for 2009 crab pot and peeler pot fishery.
- Closed the 2008/09 winter dredge fishery season.
- Required use of two 3/8" cull rings for all areas (except Seaside of Eastern Shore) effective July 1.
- Eliminated 5-crab pot recreational license.
- Revamped revocation procedures, to allow a hearing after just two crab violations in a 12-month period.

November 2008

- In an attempt to address the latent effort, the Commission placed crab pot and peeler pot fishermen who had been inactive (no harvest) for a 4-year period (2004-07) on a waiting list until the abundance determined from the Bay-wide Winter Dredge Survey of age-1+ crabs exceeds the interim target of 200 million.

May 2009

- Shortened closed season for female crabs to November 21 - November 30.
- Closed the 2009/10 winter dredge fishery season.
- Lowered percentage reduction of crab pots from 30% (2008) to 15% (2009).
- Reestablished 5-pot recreational crab pot license but prohibited harvest on Sunday and from Sept 16 - May 31.
- Right to hold revocation hearing for crab licensee after two crab violations by authorized agent (agents cannot be licensed for any crab fishing gear).

May 2010

- Made it unlawful (from March 17 - June 30) to possess dark sponge crabs exceeding regulation tolerance of 10 per bushel (previously March 17 – July 15).
- Made it lawful (indefinitely) that commercial licenses (crab/peeler pot, scrape, trap, ordinary/patent trot line, dip net) shall be sold only to commercial fishermen eligible in 2010, except those placed on the waiting list established in November 2007.

- Closed the 2010/11 winter dredging fishery season.

April 2011

- Changed closed season on harvest from Virginia Blue Crab Sanctuaries from May 16 to May 1.
- Changed boundary line of Blue Crab Sanctuary in upper Bay near Smith Point Light.

September 2011

- Closed the 2011/12 winter dredging fishery season.
- Established 5-day maximum tending requirement for crab pots and peeler pots.

November 2012

- Closed the 2012/13 winter dredge fishery season.
- Funded the Winter Dredge Gear Study using Marine Fishing Improvement Funds.
- Extended the 2012 season until December 15, 2012 for both male and female crabs and applied conservation equivalent bushel limits to the 2013 crab pot season by gear license categories as follows:
    - For up to 85 crab pots a maximum limit of 27 bushels.
    - For up to 127 crab pots a maximum limit of 32 bushels.
    - For up to 170 crab pots a maximum limit of 38 bushels.
    - For up to 255 crab pots a maximum limit of 45 bushels.
    - For up to 425 crab pots a maximum limit of 55 bushels.
- Restricted crabbing in the Virginia portion of the Albemarle and Currituck watersheds to crab pots and peeler pots only.

February 2013

- Established a vessel harvest and possession limit equal to only one of the largest legal bushel limits on board any vessel.
- Limited the use of agents in the hard pot fishery to 168, with priority going to those licensees who received approval for agent use in 2012.

June 2013

- Established daily individual and vessel harvest and possession limits for the 2013 season.

October 2013

- Closed the 2013/14 winter dredge fishery season.
- Results of the Winter Dredge Mortality Project were presented.
- Extended the 2013 season until December 15, 2013 for both male and female crabs and applied conservation equivalent bushel limits to the 2013 season extension and the 2014 crab pot season by gear license categories as follows:
    - For up to 85 crab pots a maximum limit of 16 bushels.
    - For up to 127 crab pots a maximum limit of 21 bushels.
    - For up to 170 crab pots a maximum limit of 27 bushels.
    - For up to 255 crab pots a maximum limit of 43 bushels.
    - For up to 425 crab pots a maximum limit of 55 bushels.
- Established the 2014 crab pot season as March 17 through November 30, 2014 for both male and female blue crabs.
- Established a declaration date for agent use requirements in the crab pot fishery for the 2014 season.

Attachment 3

June 2014

- Closed the 2014/15 winter dredge fishery season.
- Enacted management reductions in response to the current scientific determination that the Chesapeake Bay blue crab abundance of spawning-age female crabs is depleted. The basis for this 10 percent reduction, which equals a potential savings of 1,316,726 pounds of female blue crab, is to augment spawning in summer 2014 and spring 2015 and help reverse the depleted stock condition of blue crab.
- From July 5, 2014 through November 15, 2014 and April 1, 2015 through July 4, 2015:
    - 10 bushels, or 3 barrels and 1 bushel, of crabs, if licensed for up to 85 crab pots.
    - 14 bushels, or 4 barrels and 2 bushels, of crabs, if licensed for up to 127 crab pots.
    - 18 bushels, or 6 barrels, of crabs, if licensed for up to 170 crab pots.
    - 29 bushels, or 9 barrels and 2 bushels, of crabs, if licensed for up to 255 crab pots.
    - 47 bushels, or 15 barrels and 2 bushels, of crabs, if licensed for up to 425 crab pots
- From November 16, 2014 through November 30, 2014 and March 17, 2015 through March 31, 2015:
    - 8 bushels, or 2 barrels and 2 bushels, of crabs, if licensed for up to 85 crab pots.
    - 10 bushels, or 3 barrels and 1 bushel, of crabs, if licensed for up to 127 crab pots.
    - 13 bushels, or 4 barrels and 1 bushel, of crabs, if licensed for up to 170 crab pots.
    - 21 bushels, or 7 barrels of crabs, if licensed for up to 255 crab pots.
    - 27 bushels, or 9 barrels of crabs, if licensed for up to 425 crab pots.
- The lawful season for the commercial harvest of blue crabs by all other commercial gears shall be March 17, 2014 through September 15, 2014 and May 1, 2015 through November 30, 2015. It shall be unlawful to place, set, fish or leave any lawful commercial gear used to harvest crabs, except crab pots, in any tidal waters of Virginia from September 16, 2014 through April 30, 2015.

May 2015

- Maintained and modified measures to conserve and allow rebuilding of the Blue Crab Resource:
    - Maintained previous crab management season and bushel limits.
    - Adjusted closure dates for non-crab pot gear season, closing September 26 and reopening April 21.
    - Amended Chapter 4 VAC 20-270-10 et seq., making it unlawful for any vessel to act as both a crab harvester and a crab buyer on the same trip.
    - Amended Chapter 4 VAC 20-370-10 et seq., making it unlawful for any person to possess dark sponge crabs from March 17 through June 15.
    - Amended Chapter 4 VAC 20-752-10 et seq., redefining Virginia Blue Crab Sanctuary Area 1 as Virginia Blue Crab Sanctuary Area 1A and Blue Crab Sanctuary Area 1B and implement separate closure dates for Blue Crab Sanctuary Areas 1A, 1B and Areas 2 through 4.
    - Amended Chapter 4 VAC 20-1140 et seq., to close the winter crab dredge fishery season from December 1, 2015 through March 31, 2016.

October 2015

- Closed the 2015/16 winter dredge fishery season to allow for continued rebuilding of the spawning-stock biomass.

Attachment 3

June 2016

- Closed the 2016/17 winter dredge fishery season to allow for continued rebuilding of the spawning stock biomass.

May 2016

- Closed the 2017/18 winter dredge fishery season to allow for continued rebuilding of the spawning stock biomass.
- Reestablished the traditional crab pot harvest season
- Added additional time for lower bushel limits

June 2017

- Closed the 2017/18 winter dredge fishery season to allow for continued rebuilding of the spawning-stock biomass and guard against over-depletion of an expected low 2018 spawning stock
- The Commission further reduced crab pot bushel and vessel possession limits for two additional weeks in November 2017 and March 2018, as an effort to conserve juvenile crabs from the winter of 2017 for the 2018 spawning potential
- The Commission adopted an earlier closure of November 30, for the crab pot fishery, as compared to the 2017 closure of December 20. Similarly, the early March 1, 2017 opening of the crab pot season was pushed back to March 17 in 2018, in order to conserve part of the 2018 spawning stock in late 2017 and early 2018.

June 2018

- Closed the 2018/19 winter dredge fishery season to allow for continued rebuilding of the spawning-stock biomass

June 2019

- Closed the 2019/20 winter dredge fishery season to allow for the continued rebuilding of the spawning stock biomass
- The Commission increased crab pot bushel limits for November 2019 to match bushel limits from April to October and kept the reduced bushel limits for March 2020.