COMMONWEALTH of VIRGINIA

Marine Resources Commission
380 Fenwick Road
Building 96
Fort Monroe, VA 23651

Travis A. Voyles
Acting Secretary of Natural and Historic Resources

Jamie L. Green
Commissioner

December 1, 2022

MEMORANDUM

TO: The Honorable Glenn Youngkin
Governor of the Commonwealth of Virginia
And
Members of the Virginia General Assembly

THROUGH: The Honorable Travis A. Voyles
Secretary of Natural Resources

FROM: Jamie L. Green
Commissioner, Virginia Marine Resources Commission

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 33rd Bay-wide Winter Dredge Survey was conducted from December 2021 to March 2022 by the Virginia Institute of Marine Science (VIMS) and Maryland Department of Natural Resources (MD DNR). Results indicate the blue crab stock is not depleted and overfishing is not occurring relative to reference points established in the 2017 stock assessment. However the total abundance of crabs was the lowest in the survey history. The 2021-22 Winter Dredge Survey estimate of abundance of all size classes of blue crabs was 227 million crabs, which is 46% lower than the long-term survey average of 417 million crabs and 20% lower than the 2021 total abundance estimate of 282 million crabs.

Juvenile crabs accounted for 45% of the 2022 total abundance, or 101 million crabs. This is 18% higher than the 2021 juvenile population of 185 million crabs and 53% below the long-term survey average of 214 million juvenile crabs. It is the second lowest juvenile abundance recorded in the 33 years of the Winter Dredge Survey, just above the 2021 value. 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 spawning stock.

The survey estimated 97 million overwintering female crabs that could potentially spawn in 2022 (if not harvested prior to the spawning seasons), which is 34% below the average since female-conservative measures were put in place in 2008 and 16% below the long-term average. The 2022 abundance estimate of spawning-age female crabs is above the threshold of 70 million crabs established by the 2017 Chesapeake Bay Blue Crab Stock Assessment Update but below the target of 196 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 each year since 2008. That conservation measure may partially account for above average spawning-age female abundance in nine of the fourteen years since, because closing the winter dredge season allows juvenile crabs 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 in which 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 harvest consists of female crabs.

Conservative management can lessen the effects of environmentally-influenced annual variation in blue crab abundance. Abundance is especially variable during the early life stages of crabs when natural mortality is high. 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. 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). 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 influence all life stages of the crab population. Additionally, year to year variation of predators, such as red drum, blue catfish, striped bass, and adult blue crabs, can affect juvenile blue crab abundance.

In 2022, the total abundance of blue crabs in Chesapeake Bay was at a 33-year low, as was the abundance of adult male crabs. The juvenile abundance was the second-lowest, only higher than the 2021 abundance. This is a cause for concern for managers and scientists. In their 2022 Chesapeake Bay Blue Crab Advisory Report (Attachment 2), the Chesapeake Bay Stock Assessment Committee (CBSAC) recommended precautionary management measures to protect the juvenile and adult female cohorts in the bay. CBSAC also recommended a new benchmark stock assessment for blue crabs and hosted a data-gathering workshop in September 2022 to consider new data sources on drivers of blue crab abundance.

The VMRC, MD DNR, and the Potomac River Fisheries Commission (PRFC) agreed that precautionary management measures are appropriate, given the low total abundance and a trend of low juvenile recruitment. In response to the 2021-22 Winter Dredge Survey results, the jurisdictions agreed on managing for a 7-10% reduction in harvest. At a June 28, 2022 public hearing, the Commission reestablished the traditional crab pot season for 2021 and 2022: a March 17 opening and a November 30 closure. However, the Commission extended the fall and spring low bushel limits to begin October 1, 2022 and run through May 15, 2023. This will protect more females in the fall, when they migrate to their overwintering area of the lower bay, and in the spring, when the females are beginning to spawn. The Commission also curtailed the season for all other crab gears by two weeks on either end to close October 15, 2022 and reopen on April 15, 2023. While results of these management actions will not be evident until next year, it is notable that harvest in the spring of 2022 was 40% lower than the average across the preceding four years.

THE 2022 VIRGINIA BLUE CRAB FISHERY MANAGEMENT PLAN

Status of the Chesapeake Bay Blue Crab Stock

The annual Bay-wide Winter Dredge Survey has been conducted since 1990 and was adopted as the primary indicator of blue crab population health in 2006 by CBSAC because it is the most comprehensive and statistically robust of the blue crab surveys conducted in Chesapeake Bay. Each winter from December to March, MD DNR and VIMS dredge their respective portions of the bay, recording the density (number per 1,000 square meters), size, and sex of crabs 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 expanded based on the area of Chesapeake Bay, providing an annual estimate of the number of overwintering crabs by age and sex.

Managers and scientists expect annual estimates of abundance and exploitation rate to vary, so biological reference points are set to indicate stock status. Biological reference points, often including a target to manage around and a threshold to avoid, are a primary output of stock assessments, and fishery regulations are implemented to conform to those biological standards. The 2011 benchmark stock assessment established female-specific reference points based on the biological status and harvest of adult female crabs. The 2017 update to the blue crab stock assessment resulted in slight changes to the biological reference points, which the Executive Committee of the Sustainable Fisheries Goal Implementation Team approved for use in 2020.

Based on results from the 2021-22 Winter Dredge Survey and current biological reference points, the adult female biomass is not overfished, is not subject to overfishing, and has shown some recovery since management measures to reduce harvest on all crabs Bay-wide were implemented in 2008. While the adult female abundance was below average in 2022, it is still higher than most years pre-2008. If at any time the Bay-wide Winter Dredge Survey results indicate the abundance of adult female crabs has fallen below the overfished level, then management measures would be implemented to protect the biological stability of the blue crab stock.

The abundance and exploitation rate targets and thresholds (biological reference points) used to monitor the health of the blue crab stock in Chesapeake Bay are provided in Table 1. The abundance estimate from the 2021-22 Bay-wide Winter Dredge Survey of adult female crabs (age 1+) was 97 million crabs. The abundance for 2022 is 35% higher than the threshold that signals a depleted stock condition (72.5 million adult female crabs) . The most recent stock depletion occurred in 2014. The adult 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 limited by continuous bay-wide harvesting nine months out of the year.

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

2017 Stock Assessment Update– Biological Reference Points		
Abundance	Overfished Threshold	72.5 million age 1+ female crabs
	Target	196 million age 1+ female crabs
Exploitation Rate	Overfishing Threshold	37% of all female crabs
	Target	28% of all female crabs

The exploitation rate is defined as the percentage of the estimated crab abundance before the season opens that is harvested during the season by commercial and recreational fisheries. The 2021 female crab exploitation rate estimate was 29%, which is slightly above the target exploitation rate of 28%. However, this estimate is well below the overfishing threshold of 37%, so overfishing is not occurring. Since the 2008 management measures were put into place, 2021 is the first year where the bay jurisdictions have met or exceeded the target exploitation rate. Bay-wide harvest in 2021 was the third lowest value in the survey time series, so the higher exploitation rate is due mostly to the lower abundance of female crabs. Annual exploitation rates are likely underestimations due to 1) lack of information on dead discards, especially in the peeler fishery, 2) the magnitude of the unreported recreational fishery, and 3) potential commercial under-reporting. For these reasons, the Chesapeake Bay jurisdictions believe it is prudent to aim slightly below the target for annual harvest levels.

The total abundance of 227 million blue crabs estimated by the Winter Dredge Survey is the lowest since 1990. In 2022, 45% of the total population were juvenile crabs while adult female crabs made up 43%. The 2022 juveniles make up a larger percentage of the total abundance than they did in 2021 (30%). 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 3.57% in 2022. This mortality rate is higher than in the last three winters, but is well below the 1996-2020 average of 4.42%. Mortality was highest for adult female crabs (6.33%), followed by adult males (5.35%), and low among juveniles (0.39%).

Table 2 provides a summary of results from the last ten years of the Winter Dredge Survey. Results from the entire 33-year survey history can be found as a table in Attachment 1 and further results and analysis of the Winter Dredge Survey can be found in the 2022 CBSAC Annual Report in Attachment 2. The abundance of recruits (age-0 crabs) and adult crabs (age 1+ crabs) are differentiated according to size, with juveniles measuring under 2.4 inches (60 mm) in carapace width and adults measuring 2.4 inches or greater. Any abundance estimate represents the number of crabs that will be available to Chesapeake Bay fisheries following the end of the survey (Figures 1A, 1B, & 1C).

Low recruitment and total abundance despite an adult female population that is not depleted and is not being overfished has raised concerns with blue crab managers and scientists. CBSAC has recommended a new benchmark stock assessment to incorporate newly available data, evaluate previously made assumptions about stock structure, and revise the biological reference points. Benchmark stock assessments offer the opportunity to evaluate additional or alternative data sources and reconsider modeling decisions for use in describing a stock; the last benchmark for blue crabs was in 2011. To start the stock assessment process, CBSAC hosted a data workshop at the VMRC Main Office at Fort Monroe from September 20-21, 2022. Scientific experts and managers discussed blue crab population dynamics and the biotic (e.g. predation, disease, fecundity) and abiotic (e.g. water temperature, currents, habitat availability) factors that can affect the blue crab abundance. The scientists also identified what factors have data available for evaluation in a benchmark stock assessment. Managers are hoping a new benchmark stock assessment and these new data sources can identify ways to make the Chesapeake Bay blue crab population more stable and sustainable.

Table 2. Bay-Wide Winter Dredge Survey results (winter of 2012-13 through winter of 2021-22).

Survey Year (year survey ended)	Total crab abundance (all ages in millions)	Juvenile abundance (both sexes in millions)	Adult crab abundance (both sexes in millions)	Adult females abundance (in millions)	Bay-wide Commercial harvest (in millions of pounds)	Percentage of female crabs harvested
2013	300	111	180	147	37	23%
2014	297	199	99	69	35	17%
2015	411	269	143	101	50	15%
2016	553	271	284	194	60	16%
2017	455	125	330	254	53	21%
2018	372	168	206	147	57	27%
2019	594	324	271	191	62	14%
2020	405	185	220	141	50	19%
2021	282	86	196	158	**41**	**29%**
2022	**227**	**101**	**127**	**97**	**TBD**	**TBD**

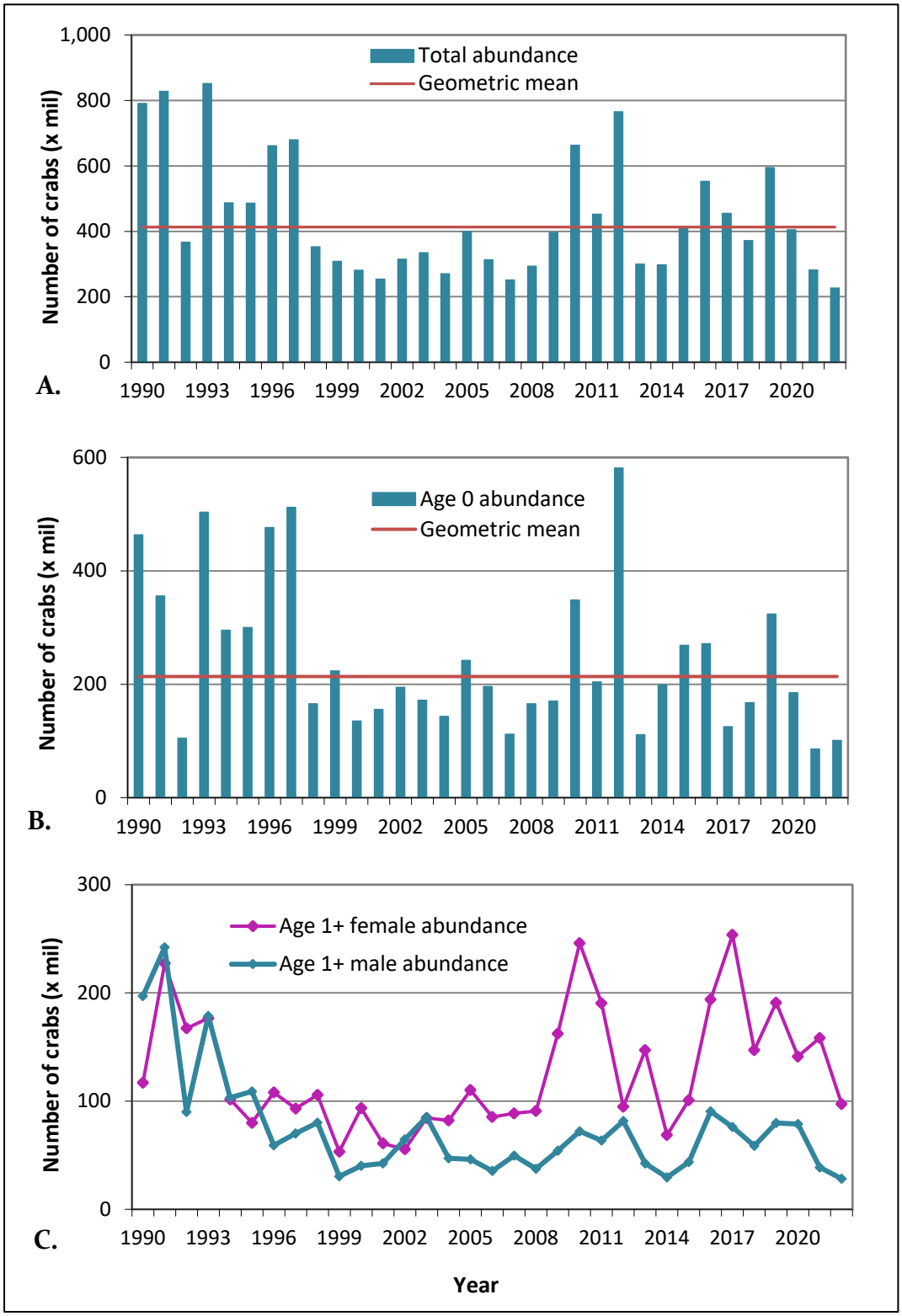

Figure 1A, 1B & 1C. Abundance estimates (number of crabs in millions) from the Bay-Wide Winter Dredge Survey for (A) total crab abundance (males and females of all ages); (B) juvenile (age 0) crab abundance (male and female); and (C) spawning-age (age 1+) female and male crab abundance, 1990 through 2022.

Commercial Harvest of Blue Crabs

The total bay-wide commercial harvest in 2021 was approximately 41 million pounds (Table 2), which is well below both the long-term geometric mean of 60 million pounds from 1990-2021 and the geometric mean of 49 million pounds since the 2008 conservation measures were put in place. Bay-wide commercial harvest was initially reported as 36 million pounds in the attached CBSAC report but was later revised once all harvest reports were processed. Harvest decreased 18% from 2020 and was the third lowest value over the last thirty years. The 2021 commercial harvest for both males and females from the bay and its tributaries (not including the seaside areas) was estimated at 22 million pounds in Maryland, 17 million pounds in Virginia, and 3 million pounds in the Potomac River. Harvest decreased from 2020 by 22% in Maryland, 14% in Virginia, and 13% in the Potomac River. Prices for blue crabs were high in 2021, which could incentivize harvest, however recreational and commercial crabbers alike reported low availability of crabs for harvest.

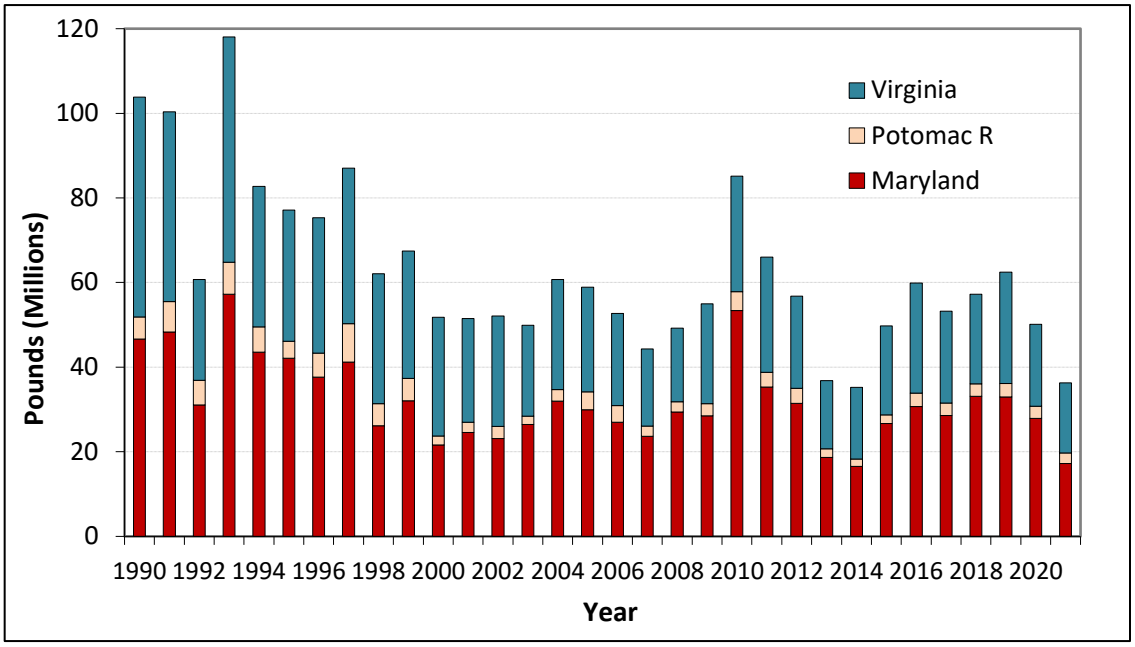

Figure 2. Chesapeake Bay-wide commercial harvest (in pounds), by jurisdiction, 1990-2021.

Harvest statistics have been collected from Virginia fisheries since the late 1920s; however, 1994 is the first representative year of Virginia's Mandatory Commercial Harvest Reporting Program. The National Marine Fisheries Services (NMFS) collected annual Virginia landings from 1929 to 1972. Between 1973 and 1992, monthly Virginia landings were collected by gear and Virginia implemented a voluntary monthly inshore dealer reporting system. In 1993, the Mandatory Commercial Harvest Reporting Program was implemented in which every harvester is required to report daily harvest for each month by the fifth of the following month. As of 2022, all blue crab harvest must be reported online through the VMRC Mandatory Harvest Reporting Program Web Application.

Figure 3 displays the commercial crab harvest for all Virginia waters in pounds and estimated dockside value (first sale from harvester) since 1994. The pre-2021 values have been adjusted to 2021

dollars using the Consumer Price Index to account for inflation. In 2021, Virginia's statewide commercial harvest of blue crabs was 18.3 million pounds and the dockside value of commercial harvest was estimated at $35.4 million. While harvest in pounds declined 14% since 2020, value of harvest increased by 15% due to high prices. Fluctuations in dockside value track closely with those in harvest, although the overall magnitude depends on that year's market. Value of harvest is not considered highly accurate, as VMRC depends on voluntary buyer reporting of dockside value while harvest and effort reporting are mandatory.

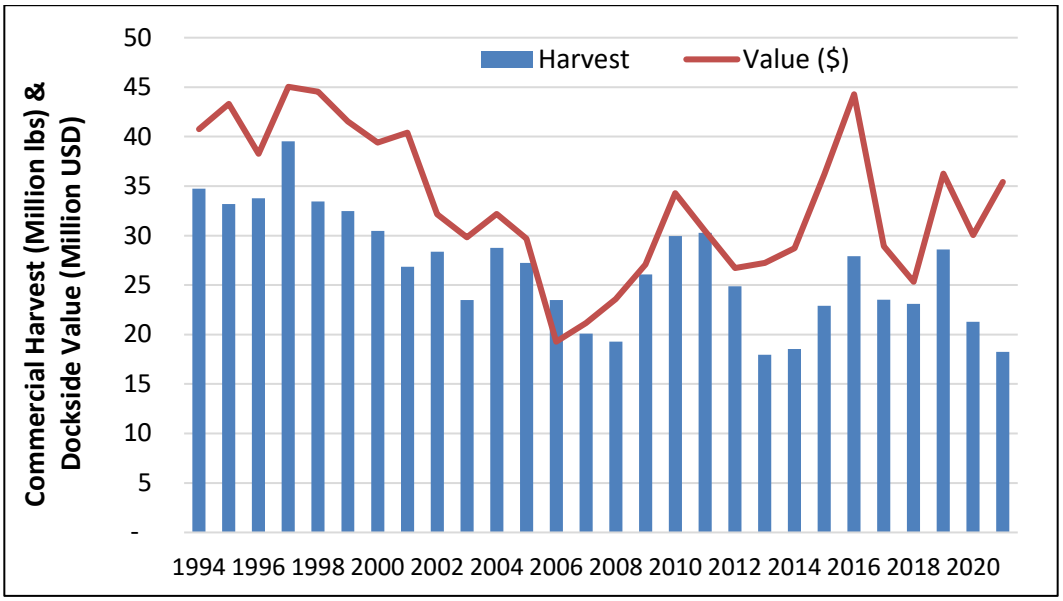

Figure 3. Annual harvest of all market categories of blue crab from Virginia tidal waters in pounds & corresponding dockside value in 2021 dollars, 1994 – 2021.

Table 3 provides a summary of harvest data by crab type. Hard crabs (minimum size for hard male and immature female crabs is five inches, no minimum size for hard mature female crabs) dominate Virginia's harvest, making up 98% of harvest in 2021. Peeler and soft crabs (minimum size for soft crabs is 3 ½ inches; minimum size for peelers is 3 ¼ inches through July 15 and 3 ½ inches after July 15) contribute significantly less to the overall harvest in pounds—about 2-4% of harvest in recent years. However, because peeler and soft crabs are smaller than hard crabs, they may comprise up to 8% of the harvest in numbers. The peeler harvest for 2021 continues a declining trend of peeler harvest since 2014. Peeler crabs in 2021 contributed to only 2% of harvest. Harvest of peeler crabs peaked in 1998 at more than 2.5 million pounds, but has remained below one million pounds since 2006. In the last five years, peeler harvest has stayed below 700,000 pounds.

Table 4 provides harvest data by gear type, which indicates that hard crab pots account for most of the harvest. From 2008 through 2021, the hard crab pot fishery accounted for more than 96% of the total harvest from Virginia waters, and the peeler pot fishery contributed around 4%. Up to 1% of annual harvest is attributed to other gear types such as crab trotlines, traps and pounds, crab scrapes, and dip nets.

Table 3. Annual harvest of blue crab from Virginia waters by market category (hard crabs and peeler or softshell crabs), in pounds (2008 – 2021).

Year	Hard Crabs	Percent of Total Harvest	Peeler & Soft Crabs	Percent of Total Harvest	Total Harvest
2008	18,278,467	95%	995,014	5%	19,273,481
2009	25,112,135	96%	961,474	4%	26,073,609
2010	29,000,485	97%	969,942	3%	29,970,427
2011	29,534,671	97%	759,031	3%	30,293,702
2012	23,992,153	96%	879,751	4%	24,871,904
2013	17,344,295	97%	599,696	3%	17,943,991
2014	17,561,666	95%	985,254	5%	18,546,920
2015	22,078,912	97%	800,745	3%	22,879,657
2016	27,184,207	97%	735,197	3%	27,919,404
2017	22,881,300	97%	651,244	3%	23,532,544
2018	22,458,417	97%	641,742	3%	23,100,160
2019	27,991,045	98%	635,198	2%	28,626,243
2020	20,894,331	98%	409,037	2%	21,303,368
2021	17,758,225	98%	405,327	2%	18,163,552

Table 4. Virginia harvest of blue crabs by gear type, in pounds (2008 – 2021).

Year	Gear						Total Harvest
	Hard Pot		Peeler Pot		Other Gears		
2008	17,512,157	91%	963,324	5%	798,000	4%	19,273,481
2009	24,914,941	96%	981,319	4%	177,349	0.7%	26,073,609
2010	28,733,411	96%	1,057,239	4%	179,777	0.6%	29,970,427
2011	29,224,573	96%	900,169	3%	168,960	0.6%	30,293,702
2012	23,750,604	95%	917,917	4%	203,384	0.8%	24,871,904
2013	16,981,833	95%	646,156	4%	324,162	2%	17,952,152
2014	17,400,699	94%	1,040,753	6%	110,228	0.6%	18,551,680
2015	21,787,650	95%	1,006,207	4%	108,521	0.5%	22,902,377
2016	26,825,259	96%	982,348	4%	111,796	0.4%	27,919,404
2017	22,597,369	96%	858,690	4%	76,485	0.5%	23,532,544
2018	22,137,274	96%	868,644	4%	94,243	0.4%	23,100,160
2019	27,561,353	96%	931,067	3%	159,744	0.6%	28,600,712
2020	20,743,277	97%	517,858	2%	42,235	0.2%	21,303,369
2021	17,729,110	97%	495,702	3%	38,739	0.2%	18,263,552

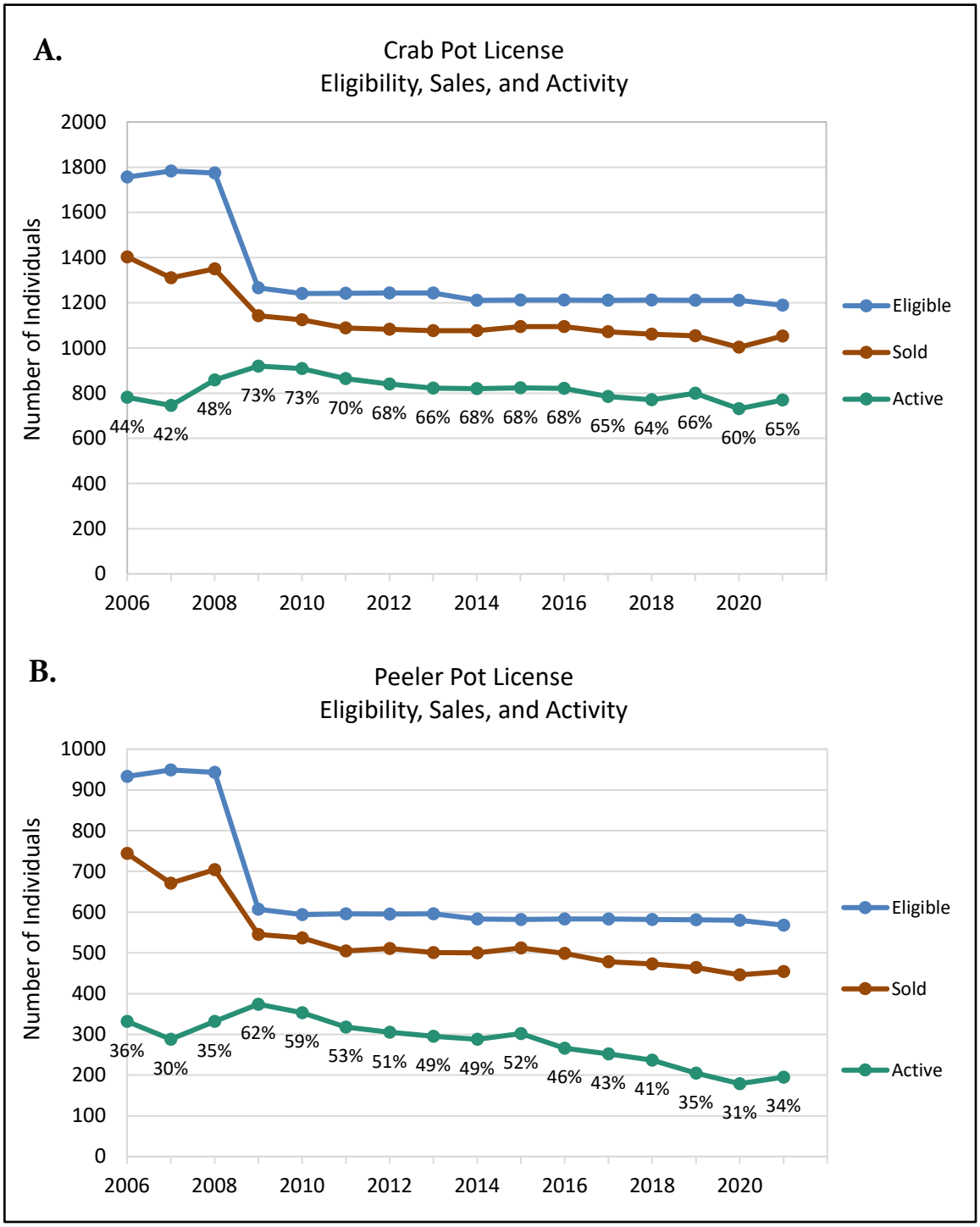

Figure 4A & 4B. Number of eligible crabbers, crabbers who purchased a license, and active crabbers in the crab pot (A) and peeler pot (B) fisheries (2006 – 2021), with percent of eligible licenses active during the year.

Figures 4A and 4B provide a summary of participation in the crab pot and peeler pot fisheries since 2006. Each chart indicates the numbers of harvesters who were eligible to purchase a license 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. Further, those fishermen who purchase a license may choose whether to be an active harvester. These charts show that

in recent years the percent of eligible crab pot fishermen actively harvesting has remained relatively stable between 65% and 70%. The number of eligible peeler pot fishermen who are active declined over the same period, from 62% to 34% in 2021. 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 when 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 future sale.

Blue Crab Conservation Actions Through 2022

Commission actions since 1994 that have attempted to promote sustainability of the blue crab stock and fishery through conservation measures are included in Attachments 3 and 4. Many of these measures were designed to promote spawning potential of blue crabs and have helped in the recovery of the Chesapeake Bay stock. Many measures taken by the Commission were employed before scientists developed stock status indicators, and these indicators demonstrated improved stock status 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.

The Chesapeake Bay jurisdictions have relied on a management framework enacted in 2014 in which the fishery is regulated annually from July 5 through July 4 of the next year. The benefit of this approach is that reactive management measures or conservation efforts can be applied after survey data becomes available. Since 2014, the VMRC and other Chesapeake Bay jurisdictions have paid close attention to the current year's juvenile abundance, as well as the mature female abundance, as the juveniles in one year are the subsequent year's spawning stock. 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.

Total abundance increased following the blue crab fishery disaster in 2008, with the 2016-17 Bay-wide Winter Dredge Survey estimating the highest adult abundance in the survey's history. This is attributed partly to the conservation measures implemented since 2008. Total crab abundance had a local peak in 2019 of 594 million blue crabs, but the 2022 total abundance of 227 million crabs was the lowest abundance in the survey history. This is likely attributed to the decline in juvenile production, though the adult male population was also the lowest in the survey history and adult female population also declined. There was a strong juvenile year class in 2019, but juvenile abundance decreased since then despite mild winters with low overwintering mortality and robust adult populations. However, juvenile recruitment is known to be highly unpredictable, due to high natural mortality and varying annual catchability.

Due to a trend of low recruitment in the last few years and the low total abundance, CBSAC recommended jurisdictions take proactive management measures. Jurisdictional managers and scientists agreed that while the adult female population appears stable, there may be dynamics at work restricting recruitment. VMRC, MD DNR, and PRFC agreed to make management restrictions to reduce harvest by approximately 7-10% to avoid overharvesting in this time of uncertainty. To achieve this reduction, the VMRC proposed to the Crab Management Advisory Committee (CMAC) several options

for management measures to achieve a harvest reduction. CMAC recommended re-establishing the fall low bushel limit to start on October 1, 2022- a month earlier than the November 1 start date in place prior to the removal of the fall low bushel limit due to high crab abundance in 2019. In addition, the spring low bushel limit (which has ended on March 31 since 2015) was extended through May 15, 2023. The season for all other crabbing gears, which do not operate under bushel limits, was reduced by one month to end on October 15, 2022 and re-open on April 15, 2023. The low bushel limits for crab pots and season restrictions for all other gears are aimed at protecting female crabs moving down the bay to their overwintering areas in the fall and preparing to spawn in the spring.

The Commission continued the closure of the winter crab dredge fishery season, which has been closed each year since 2008, 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 over this year and be exploited by a 2022-23 winter dredge season, and of the adult female abundance, which would spawn the next juvenile year-class in 2023.

Online commercial harvest reporting for blue crabs became mandatory starting in 2022. Blue crabs follow oysters in the transition from paper reports to mandatory online harvest reporting, which will increase accuracy, efficiency, and timeliness of harvest information for management decisions. While it took 67 days for a paper report to reach staff for management use, it only takes 22 days for online reports to be available. As of the fall of 2022, over 95% of mandatory harvest reports are now submitted online.

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 from habitats or, in the case of prolonged exposure, die. These mortality events are uncommon and generally limited to situations where crabs cannot move into more favorable conditions, such as when they are in crab pots in low dissolved oxygen zones. Although such mortality events are unlikely to affect the population significantly, the Commission is working to minimize these events as. a member of the Virginia Department of Health's Harmful Algal Bloom Task Force (HAB TF). Members of the HAB TF have combined efforts to implement an online reporting system for Virginia residents, conduct fly-overs to visually determine the extent of bloom conditions, collect and analyze samples from areas with active HABs, and update the public about HABs. VMRC staff collaborated with the HAB TF to provide links to VDH Harmful Algal Bloom notices on the VMRC website. The impact of HABs on blue crab meat safety or health is unknown.

The Commission and Virginia's crab industry recognize that improvements in blue crab habitat and water quality could increase the probability for stronger recruitment to the stock and fisheries; however, many water quality and habitat impacts to the stock are not fully quantified or understood. Chesapeake Bay scientists are exploring the relationships between blue crabs and other components of the ecosystem. Many natural and anthropogenic stressors continue to challenge the stability of the blue crab stock, including hypoxia, shoreline development, and pollution. The issue of climate change and associated 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 established 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 10 goals and 29 measurable, time-bound outcomes to improve the health of Chesapeake Bay, including sustaining blue crabs. A new 2-year workplan for the Blue Crab Abundance Outcome was finalized in 2020, prioritizing research needs identified by CBSAC and the jurisdictions.

Nursery habitats, those areas that improve survival and growth of juvenile blue crabs, are key to juvenile survival (Lipcius et al. 2007). Seagrass beds are a favorable nursery habitat for newly settled, young juvenile, and molting blue crabs. The historically dominant submerged aquatic vegetation (SAV) in Virginia waters is eelgrass (Orth et al. 2017). 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 research and monitoring programs of SAV and other critical habitats in Chesapeake Bay include:

- Annual bay-wide aerial survey;
- Targeted water quality monitoring and study of key SAV locations in Virginia waters for effects from water quality changes, global warming, and climate change;
- Water quality assessments (SAV distribution is a criterion for water clarity);
- 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;
- Importance of salt marshes as nursery habitats for the blue crab;

- The distribution of age-0 blue crabs in shallow water habitats including seagrass, algal patches, salt marshes, restoration oyster reefs, and shallow-water soft bottom (e.g., muddy coves) ; and
- The functional relationships between habitat characteristics and juvenile blue crabs.

Eelgrass is near its southern limits along the Atlantic coast in Virginia, so high summertime water temperatures can be especially harmful to eelgrass beds. 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.

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*), widgeon grass (*Ruppia maritima*), and exotic red macroalgae (as well as salt marshes) having the greatest 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 latest results of the aerial survey showed that SAV coverage bay-wide declined through 2019 and 2020 after a peak in 2018, but began recovering in 2021. In Virginia, coverage increased through 2020 and 2021 after the 2019 low.

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 has on blue crab population dynamics. Recent VIMS studies have also demonstrated the high value to juvenile blue crabs of salt marshes and shallow 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 and salt marshes where native SAV nursery habitat has experienced reductions in aerial coverage (Seitz et al. 2003, Seitz et al. 2005, Johnston and Lipcius 2012). The recent studies indicate that the blue crab stock will be resilient to loss of eelgrass due to its ability to use alternative nursery habitats opportunistically, such as widgeon grass, salt marshes, and exotic red macroalgae.

Climate change will have variable effects on blue crabs across life stages. Increasing temperatures are expected to increase the overwintering survival of adult and juvenile blue crabs (Glandon et al. 2019) and may also extend the spawning and growing season of blue crabs in Chesapeake Bay (Hines et al. 2011). These effects may increase productivity of the population. However, increased temperatures may also decrease the average size of blue crabs (Kuhn & Darnell 2019) and bring a suite of new predators that are expanding their range northward into Virginia waters, such as red drum. Warming waters may also limit eelgrass recovery and increase the severity and duration of hypoxic “dead zones”

in the bay. Other aspects of climate change, such as ocean acidification, changes in precipitation altering salinity regimes, increased tropical storms, sea level rise, and pathogen prevalence may also affect blue crabs (Etherington & Eggleston 2000, Rome et al. 2005, Bauer & Miller 2010, Tomasetti et al. 2018, Glaspie et al. 2017). Lastly, climate change may affect the predator and prey dynamics, food availability, and habitat partitioning of blue crabs. As wide scale change continues, it will be critical to monitor the potential positive and negative effects on blue crabs.

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 pathogenicity. These are *Hematodinium perezi* and a recently identified reo-like virus. *H. 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 *H. 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 based on infected 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). At present, these pathogens do not pose a significant risk to the Chesapeake Bay stock, but VIMS is now evaluating the potential role of climate change, specifically increasing water temperatures and salinities in the lower bay, on pathogen prevalence in the future.

VIMS Blue Crab Surveys

VIMS conducts multiple blue crab surveys: the Juvenile Fish and Blue Crab Trawl Survey, the Winter Dredge Survey (WDS), and two surveys associated with the WDS, the Main-stem Prey and Bycatch Survey (MPBS) and the Juvenile Nursery Habitat Survey (JNS). 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 and mature female crabs. Data from the VIMS Juvenile Fish and Blue Crab Trawl Survey are used to develop indices of abundance for annual recruitment to 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-water habitats where the other surveys are unable to sample. Samples and data from the WDS and MPBS 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.

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Attachment 1

Bay-Wide Winter Dredge Survey results (winter of 1989-90 through winter of 2021-22). Commercial harvest and percentage of female crabs removed in 2022 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 Mature Crabs in Millions (both sexes)	Number of Mature 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	50	36
2004	270	143	122	82	60	46
2005	400	243	156	110	60	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	53	21
2018	371	168	206	147	57	27
2019	594	323	271	191	62	14
2020	405	185	220	141	50	19
2021	282	86	196	158	41	29
2022	**227**	**101**	**125**	**97**	TBD*	TBD*

Attachment 2

2022 Chesapeake Bay Blue Crab Advisory Report

CBSAC Meeting Date: May 25, 2022
Final Report: July 6, 2022
Prepared by: Mandy Bromilow

EXECUTIVE SUMMARY

Each year, from November to March, the Maryland Department of Natural Resources (MDNR) and the Virginia Institute of Marine Science (VIMS) conduct the Blue Crab Winter Dredge Survey (WDS) to estimate the abundance of blue crabs in Chesapeake Bay. The estimated abundance of mature females from the WDS and female harvest estimates from each jurisdiction are used to assess blue crab stock status relative to female-specific management reference points. The Chesapeake Bay Stock Assessment Committee (CBSAC) meets each spring to review the results of the latest WDS and the previous season's harvest estimates to develop management recommendations for the jurisdictions.

In 2022, the WDS indicated that the total abundance of all crabs (males and females of all ages) was approximately 227 million individuals. Recruitment, or the number of age 0 crabs (less than 60 mm carapace width), was estimated at 101 million. Approximately 97 million age 1+ (mature) female crabs were estimated to be present in the Bay at the start of the 2022 crabbing season, which is above the abundance threshold of 72.5 million adult females, but below the target of 196 million. The percentage of female crabs (age 0+) removed by fishing (exploitation rate) in 2021 was estimated at 26%. This exploitation rate is below the target (28%) and the threshold (37%) for the 14th consecutive year since 2008.

Although these results suggest that the blue crab population is not depleted and overfishing is not occurring relative to the reference points, juvenile abundance has not responded to previous increases in female abundance as expected based on the current understanding of the population dynamics. Therefore, CBSAC recommends precautionary management measures in an effort to ensure that neither the female-specific management thresholds, nor the male conservation trigger, are exceeded to maintain a healthy spawning stock and to protect a sufficient fraction of this year's juvenile cohort to reach maturity and reproduce. CBSAC also recommends a new benchmark stock assessment be conducted to take into account newly available data, evaluate revisions to the current model structure, and revise the biological reference points used in management. Given concerns about the lower juvenile abundances in recent years, CBSAC has committed to conducting a blue crab workshop that will address science gaps related to juvenile recruitment success and population dynamics that will inform potential enhancements to the stock assessment. The workshop is planned for September 2022.

1. INTRODUCTION

1.1 Background

Management of the blue crab stock is coordinated among the jurisdictions by the Sustainable Fisheries Goal Implementation Team (SFGIT). The SFGIT, one of six goal implementation teams within the Chesapeake Bay Program structure, is led by an Executive Committee of senior fisheries managers from the Maryland Department of Natural Resources (MDNR), the Virginia Marine Resources Commission (VMRC), the Potomac River Fisheries Commission (PRFC), the Atlantic States Marine Fisheries Commission, and the DC Department of Energy and Environment.

The Chesapeake Bay Stock Assessment Committee (CBSAC) serves as a technical subcommittee of the SFGIT, and is coordinated by the NOAA Chesapeake Bay Office (NCBO). CBSAC combines the expertise of state resource managers and scientists from agencies and universities around 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 the Blue Crab Winter Dredge Survey (WDS) and the previous season's harvest data to develop management recommendations for the three Chesapeake Bay jurisdictions: the State of Maryland, the Commonwealth of Virginia, and PRFC.

1.2 Management Framework

Three benchmark stock assessments of the Chesapeake Bay blue crab have been conducted since 1997. The most recent benchmark assessment was completed by scientists at the University of Maryland Center for Environmental Science (UMCES), the Virginia Institute of Marine Science (VIMS), and MDNR in 2011 (Miller et al. 2011). The 2011 assessment recommended biomass and exploitation reference points based on maximum sustainable yield (MSY) for female blue crabs only. These female-specific reference points were formally adopted by all three management jurisdictions in December 2011. Management seeks to control the fishery such that the number of adult females in the population remains above the minimum abundance defined by the overfished (depleted) threshold. Ideally, the fishery should operate to meet target values and should never surpass the exploitation rate threshold and never fall below the abundance threshold.

1.3 Stock Assessment Updates

A stock assessment update was conducted in 2017 that utilized the model from the 2011 benchmark stock assessment and incorporated abundance data through 2017 and harvest data through 2016. The results of the update showed similar scale and trends in estimated abundance compared to the 2011 benchmark assessment, indicating appropriate model structure and stability, but the estimated reference points were slightly different (Table 1). In November 2020, the three jurisdictions formally adopted the new reference points from the 2017 stock

assessment update as these estimates constitute the best available science by which the stock should be assessed and managed.

Table 1. Biological reference points generated by the 2011 benchmark stock assessment and the 2017 stock assessment update. The jurisdictions formally adopted the 2017 reference points in November 2020.

Stock Assessment	Female Abundance (Age 1+) (millions)		Female Exploitation Rate (Age 0+) (per year)	
	Target	Threshold	Target	Threshold
2011	215	70	25.5%	34%
2017	196	72.5	28%	37%

In 2020, CBSAC recommended that annual model runs be conducted to monitor model performance and help guide the decision process for timing of the next benchmark stock assessment. These model runs use the same data sources and methodologies set forth by the 2011 benchmark assessment. The population and fishery parameters incorporated into the model – natural mortality, recruitment sex ratio, fraction of juveniles recruited to the fishery, recreational harvest fraction – are also the same. CBSAC is currently discussing a standard operating procedure (i.e., methods, timeline, etc.) for updating the reference points in the future. CBSAC aims to have these guidelines finalized and approved by the SFGIT by the end of 2022.

1.4 Data Sources

Blue crab abundance is estimated from the annual Bay-wide Winter Dredge Survey (WDS) conducted by MDNR and VIMS. CBSAC adopted the WDS as the primary indicator of blue crab stock status in 2006 because it is the most comprehensive and statistically robust of the blue crab surveys conducted in the Bay (Sharov et al. 2003). The WDS measures the density of crabs (number/1,000 m^2) at approximately 1,500 sites throughout the Bay each year. The measured densities of crabs are adjusted to account for the efficiency of the sampling gear and expanded to the area of Chesapeake Bay (9,812 km^2). This provides an annual estimate of the total number of crabs overwintering in the Bay by age and sex. The survey also provides an estimate of overwintering mortality based on the percentage of dead crabs found in the WDS each year. Blue crab data from trawl surveys conducted by MDNR and VIMS also inform the stock assessment model.

Commercial and recreational harvest information are collected annually by the three jurisdictions (MDNR, VMRC, PRFC) to determine Bay-wide exploitation rates. The female exploitation rate is calculated as the 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. For this calculation, the juvenile component of the total estimated abundance 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 WDS as the stock assessment that generated the reference points. Thus, empirical estimates of exploitation can be compared with the target and threshold reference points derived from the assessment model. Note that exploitation rate estimates in this report are preliminary and will be updated when the harvest data are finalized.

2. POPULATION SIZE (ABUNDANCE)

2.1 All Crabs

The WDS estimate of total abundance of all blue crabs (males and females of all ages) in Chesapeake Bay was 227 million in 2022 (Figure 1). This was a decrease from the 2021 estimate of 282 million, and is the lowest abundance observed over the history of the WDS.

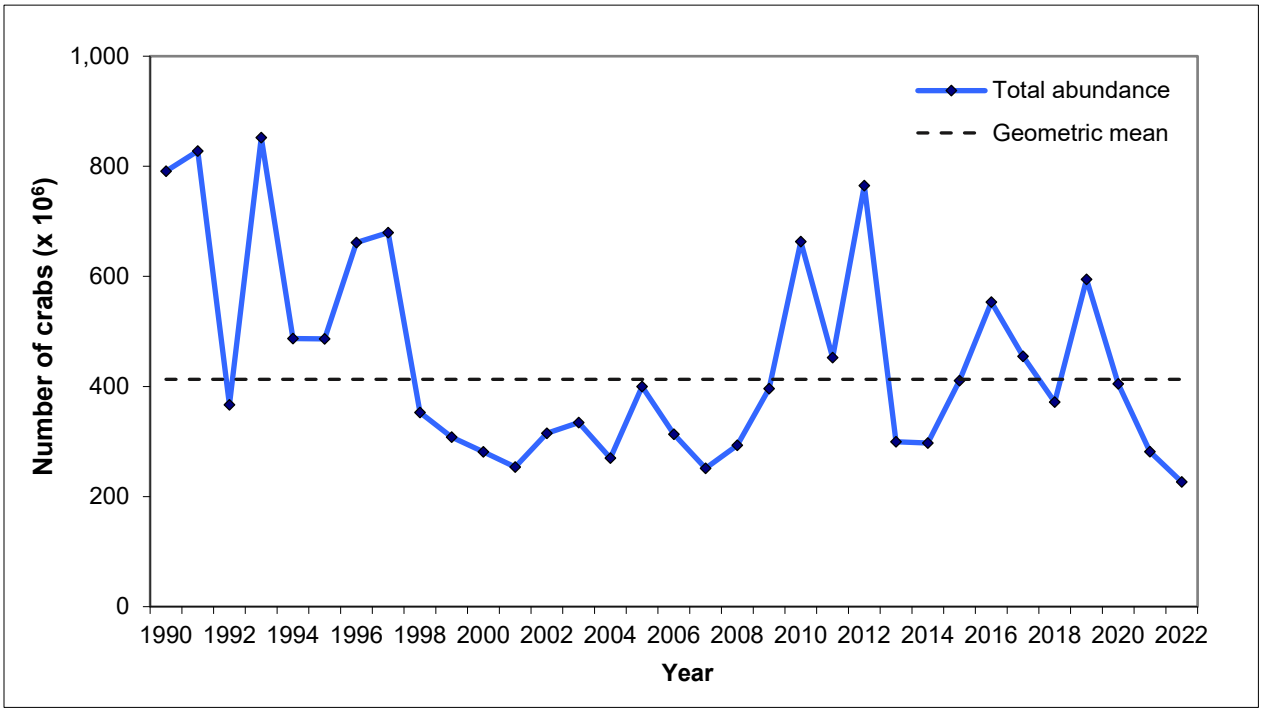

Figure 1. Winter Dredge Survey estimate of abundance of all crabs (both sexes, all ages) in Chesapeake Bay, 1990-2022.

2.2 Juvenile Crabs (Age 0)

Recruitment is estimated as the number of age 0 crabs (less than 60 mm carapace width) in the WDS. The abundance of juvenile crabs in 2022 was 101 million, an increase from the 2021 abundance of 86 million (Figure 2). However, this year's recruitment estimate was well below the average of 214 million juveniles (geometric mean). The 2021 estimate recruitment was the lowest observed in the history of the WDS, and the 2022 recruitment estimate is the second lowest in the time series.

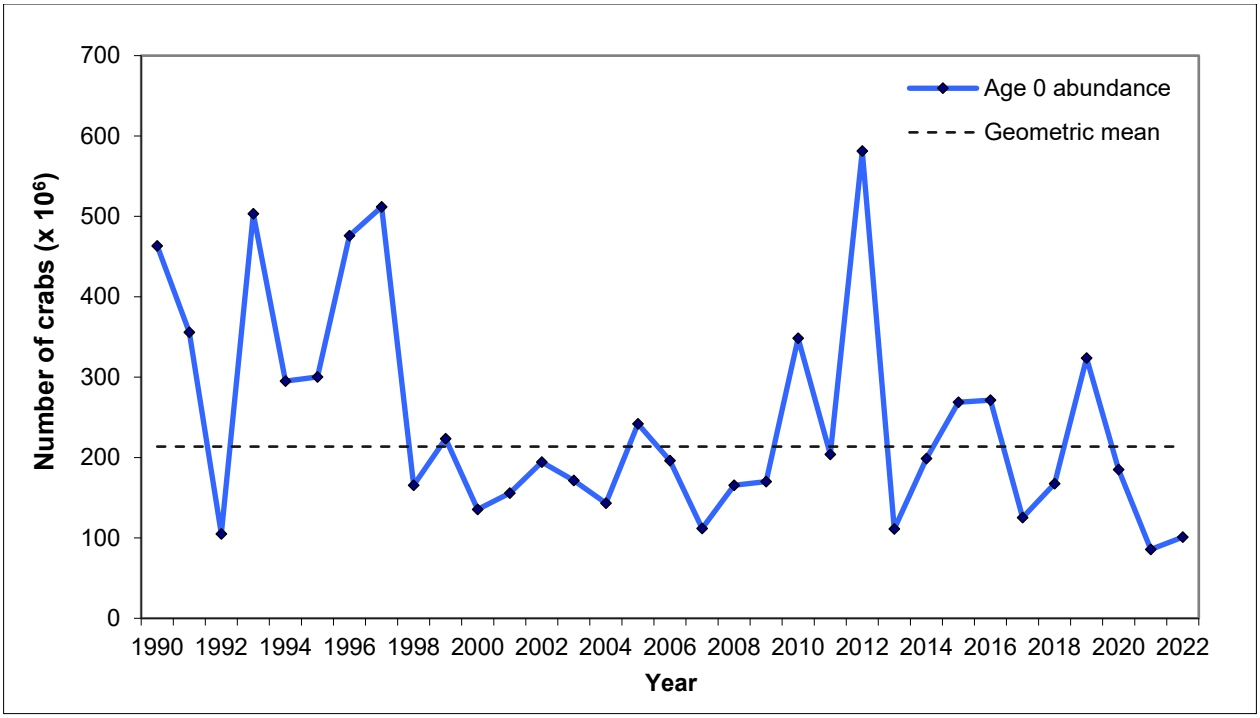

Figure 2. Winter Dredge Survey estimate of abundance of juvenile blue crabs (age 0), 1990-2022, calculated without the catchability adjustment for juveniles (section 1.4). These are male and female crabs measuring less than 60 mm (2.4 in) across the carapace.

2.3 Adult Males (Age 1+)

The WDS estimate of age 1+ male crabs (greater than 60 mm carapace width) in 2022 was 28 million, a decrease from the 2021 estimate of 36 million adult males (Figure 3). This was below the time series average of 62 million (geometric mean), and is the lowest in the time series (Figure 3).

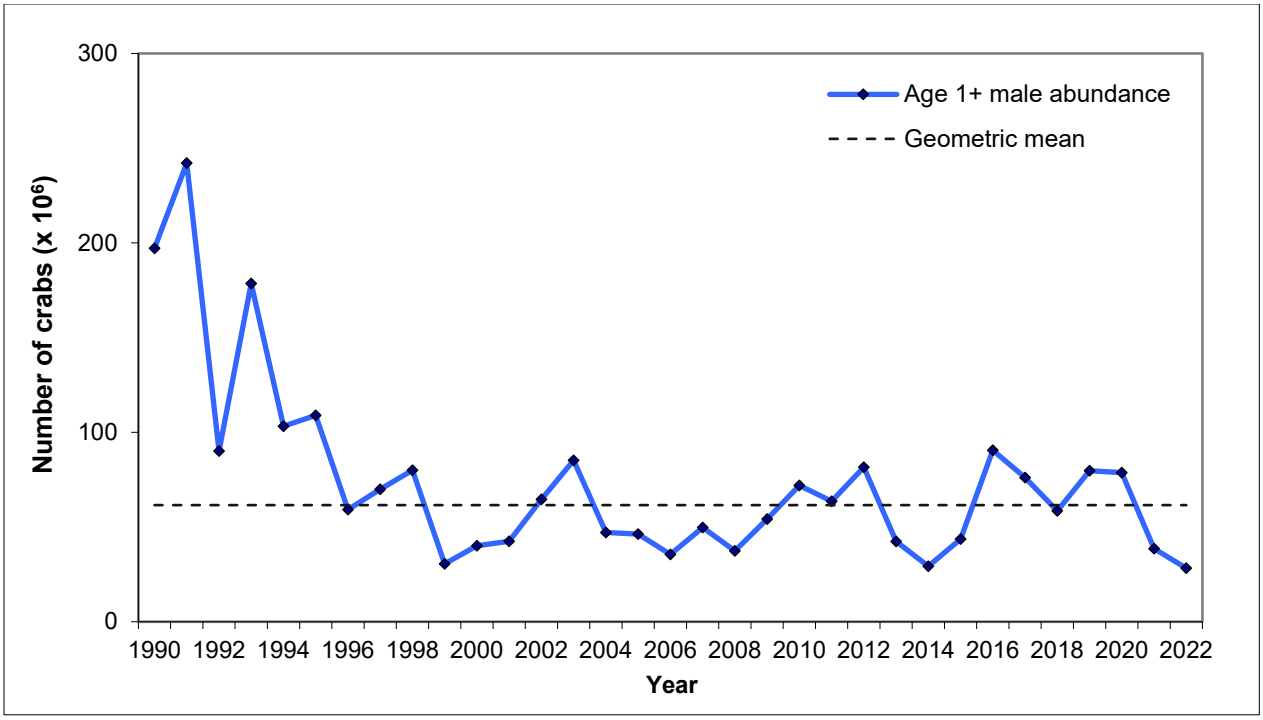

Figure 3. Winter Dredge Survey estimate of abundance of adult male blue crabs (age 1+), 1990-2022. These are male crabs measuring greater than 60 mm (2.4 in) across the carapace and are considered the "exploitable stock" capable of mating within the year.

2.4 Overwintering Mortality

Overwintering conditions affect the survival and year-class strength of marine and estuarine species such as the blue crab. For adult blue crabs, overwintering mortality is highly correlated to temperature and salinity, with mortality increasing at lower temperatures and salinities. Annual abundance estimates from the WDS are adjusted for loss due to overwintering mortality, which is estimated as the percentage of dead crabs found in the survey. In 2022, overwintering mortality estimates were slightly below the long-term average for all crabs in Chesapeake Bay (Table 2). However, juvenile and adult female mortality estimates were relatively high in 2022 compared to the last three years. The increase in overwintering mortality for mature females may have been due to the below-average water temperatures in January and February in the lower Bay where females reside, as indicated by NCBO's Winter 2021-2022 Seasonal Summary.

Table 2. Percentage of dead crabs found Bay-wide in WDS samples each year from 2018 to 2022 and the average for 1996-2022.

Age/Sex Grouping	1996-2022 Average	2018	2019	2020	2021	2022
All Crabs	4.42%	6.37%	1.80%	0.36%	2.80%	3.57%
Juveniles	1.11%	0.87%	0.15%	0.00%	0.11%	0.39%
Adult Females	7.77%	11.06%	1.87%	0.47%	2.12%	6.33%
Adult Males	9.10%	13.66%	7.83%	0.78%	8.39%	5.35%

3. HARVEST

3.1 Commercial Harvest

Preliminary reports indicated a decrease in Bay-wide commercial blue crab harvest in 2021, with an estimated total of 36.3 million pounds harvested, which is well below the long-term average of approximately 61 million pounds (Figure 4). Initial harvest estimates for each jurisdiction were as follows: 17.2 million pounds in Maryland, 16.6 million pounds in Virginia, and 2.5 million pounds in the Potomac River (Figure 4). The estimates for both Maryland and Virginia are the second lowest in their respective time series. Commercial blue crab harvest was likely impacted by the COVID-19 pandemic in 2021. The pandemic continued to limit restaurant patronage, and picking houses experienced labor shortages like many other sectors. Constituents also informed jurisdictions that there was a general decline in the availability of blue crabs to harvest in 2021.

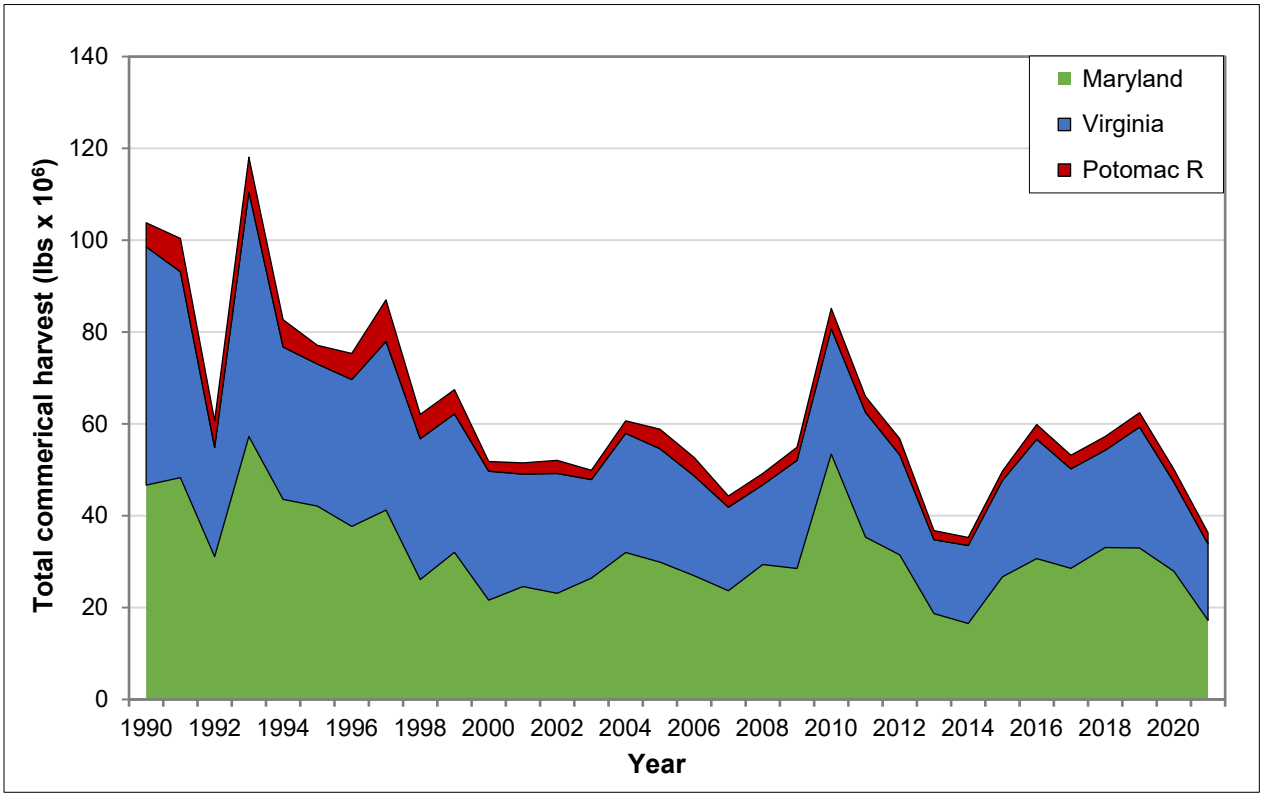

Figure 4. Commercial harvest of Chesapeake Bay blue crabs in millions of pounds (all market categories), 1990-2021.

3.2 Recreational Harvest

Recreational blue crab harvest in Chesapeake Bay is typically assumed to be approximately 8% of total commercial harvest (Ashford & Jones 2011). In 2009, however, MDNR prohibited the recreational harvest of females such that recreational harvest is better described as 8% of male commercial harvest in this jurisdiction. Preliminary estimates indicate a decrease in Bay-wide recreational harvest, from 3.1 million pounds in 2020 to 2.3 million pounds in 2021.

4. STOCK STATUS

4.1 Female-Specific Reference Points

The current blue crab management framework employs MSY-based female-specific targets and thresholds to assess the stock. U_{MSY} is the exploitation rate, or the level of fishing (expressed as the percentage of the population harvested each year), 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 blue crab stock assessment recommended a target exploitation rate that was associated with 75% of the value of U_{MSY} and a threshold exploitation rate equivalent to U_{MSY}. Overfishing occurs when the exploitation rate exceeds this threshold. The adult female (age 1+) abundance reference points were set at levels associated with $N_{0.75*UMSY}$ (target) and 50% N_{MSY} (threshold). The stock is considered overfished (or depleted) when the abundance of mature females falls below this threshold.

4.2 Exploitation Rate

The preliminary estimate of the female exploitation rate, or the percentage of all female crabs (age 0+) removed by fishing, was approximately 26% in 2021 (Figure 5). This exploitation rate is below the target of 28% and the threshold of 37%. However, as more harvest data are finalized, this estimate may increase and exceed the target.

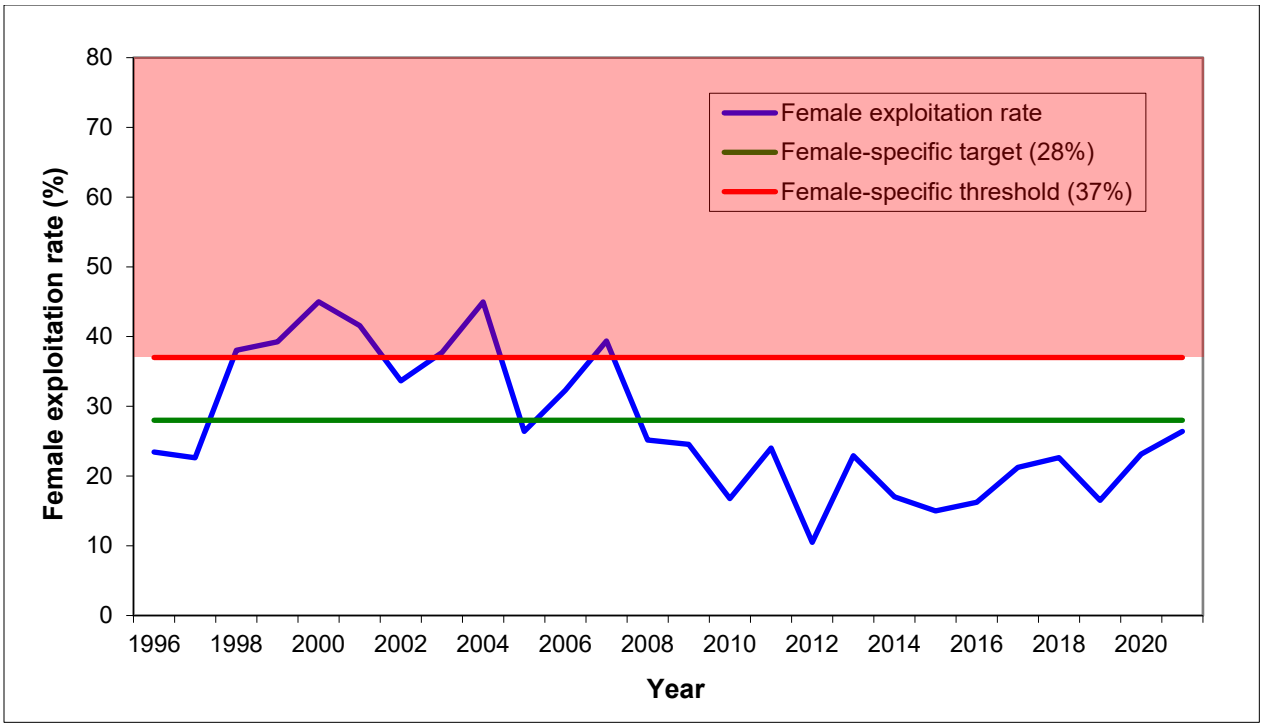

Figure 5. Estimated female exploitation rate relative to the female-specific target (28%) and threshold (37%), 1990-2021. The female exploitation rate is the number of female crabs harvested in a given year divided by the female abundance estimate (age 0+) at the beginning of the year.

4.3 Spawning Stock Abundance

Approximately 97 million age 1+ female crabs (i.e., the spawning stock) were estimated to be present in the Bay at the start of the 2022 crabbing season, which is above the threshold of 72.5 million, but below the target of 196 million (Figure 6). This abundance estimate is below the average abundance since 2008 (after female-specific management measures were enacted), and only slightly higher than the average abundance for the 14-year period preceding those measures.

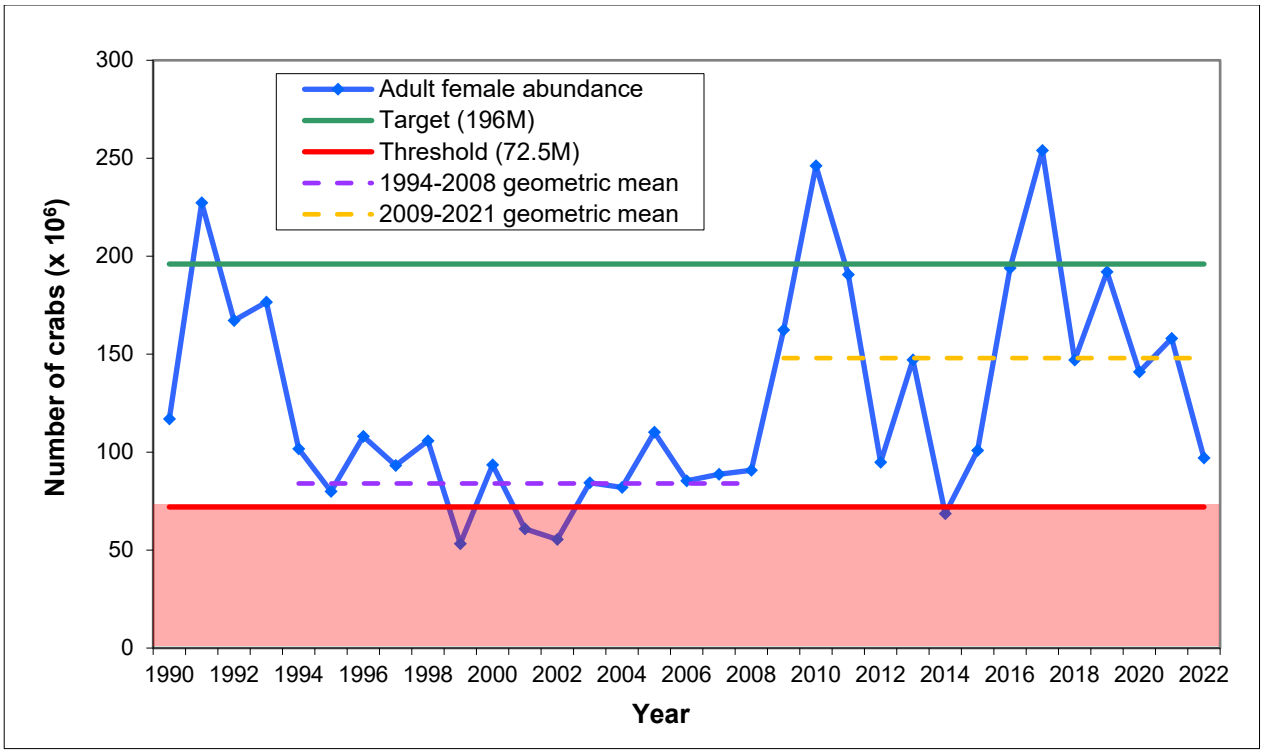

Figure 6. Winter Dredge Survey estimate of abundance of mature female blue crabs (age 1+), 1990-2022, relative to the female-specific reference points. These are female crabs measuring greater than 60 mm (2.4 in) across the carapace and are considered the "exploitable stock" capable of spawning within the year. The dashed lines represent the geometric mean of adult female abundance during two time periods: 2009-2022, after the current management framework was implemented (yellow dashes); and 1994-2008, the period of low abundance which prompted the management changes (purple dashes).

4.4 Control Rules

Each year, the status of the Chesapeake Bay blue crab stock is assessed relative to the control rules, i.e., the female exploitation rate (U) and adult female abundance (N) reference points. Figure 7 shows the status of the blue crab stock relative to these reference points each year since 1990. The 2022 estimate of spawning stock abundance is above the threshold of 72.5 million adult females, but below the target of 196 million. The preliminary estimate of the female exploitation rate in 2021 was 26%, which is below both the target (28%) and the threshold (37%). Therefore, the Chesapeake Bay blue crab stock is currently not considered overfished (depleted) nor is overfishing occurring (Figure 7; Table 3).

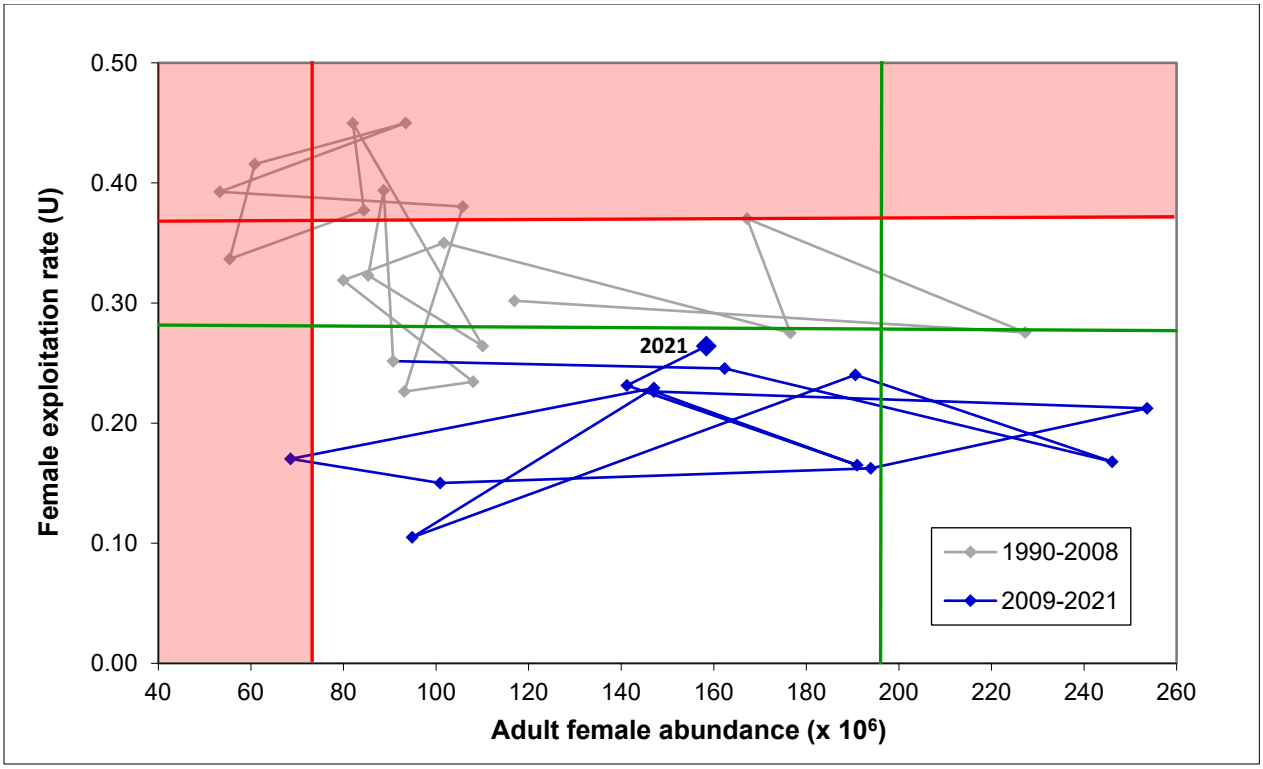

Figure 7. Stock status of the Chesapeake Bay blue crab prior to and after implementation of female-specific management measures in 2008. The female-specific management framework was formally adopted in December 2011, and revised biological reference points were adopted in November 2020. The shaded red areas show where the thresholds for the exploitation rate and/or abundance are exceeded. The intersection of the green lines shows both the abundance and exploitation targets. This figure includes data through 2021; the 2022 data point will be added at the completion of the 2022 fishery.

Table 3. Blue crab stock status over the last five years, based on the exploitation and abundance reference points for female crabs. Green shading indicates that the threshold was not exceeded.

Control Rule	Reference Points		Stock Status				
	Target	Threshold	2018	2019	2020	2021	2022
Exploitation Rate (percentage of age 0+ females removed)	28%	37% (max)	23%	17%	23%	**26%**	TBD
Abundance (millions of age 1+ females)	196	72.5 (min)	147	191	141	158	**97**

4.5 Male Conservation Trigger

Although the current blue crab management framework does not have reference points for males, CBSAC adopted a conservation trigger for male crabs in 2013. Under this trigger, conservation measures should be considered for male crabs if the male exploitation rate exceeds 34% (calculated with the juvenile scalar as described in section 1.4), which is the second-highest exploitation rate observed for male crabs since 1990. Choosing the second-highest value in the time series is a precautionary measure that provides a buffer from the maximum observed exploitation rate. This value does not represent a fishing threshold or target, but instead, will ensure that the male component of the stock is not more heavily exploited than has occurred in 30 of the last 32 years. Additional harvest data from recent years were incorporated into this year's analysis and revealed that the male exploitation rate exceeded the conservation trigger in 2017 and 2018. In 2021, the preliminary estimate of the male exploitation rate was 31%, approaching the conservation trigger (Figure 8). As more harvest data are finalized, the male exploitation rate may again exceed the conservation trigger.

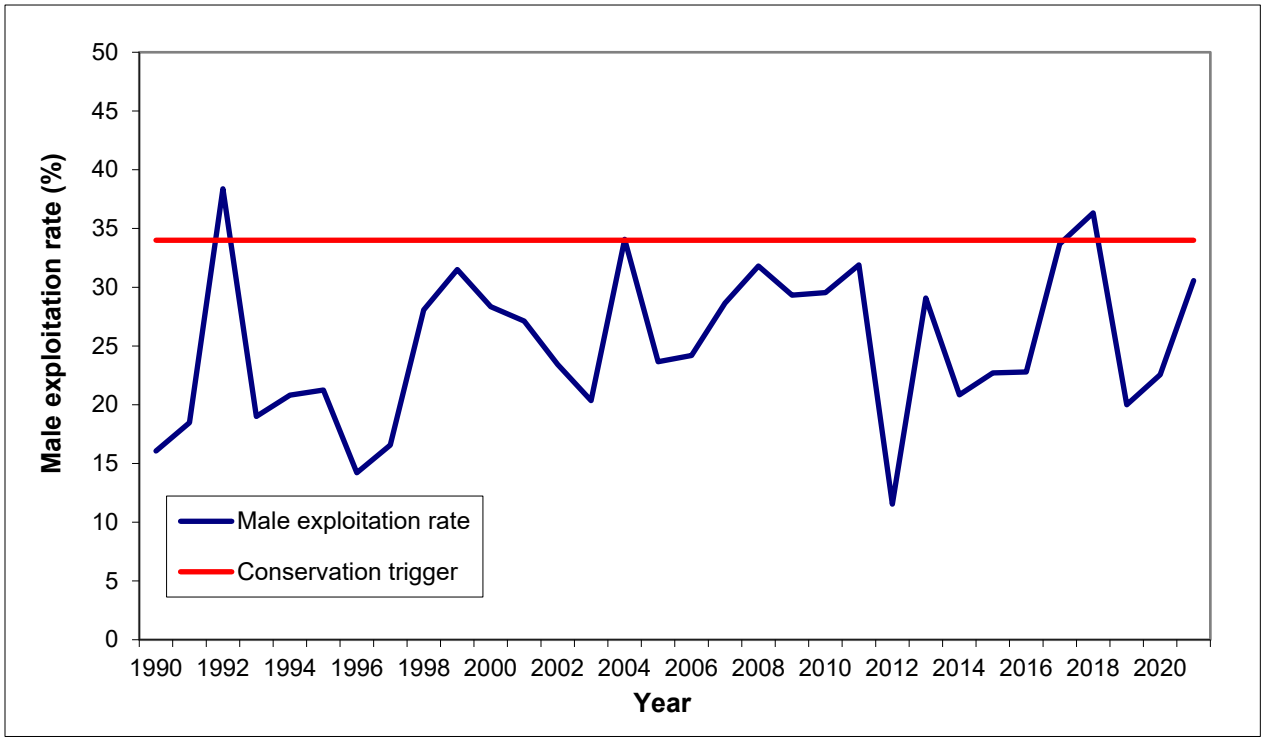

Figure 8. Estimated male exploitation rate relative to the male conservation trigger, 1990-2021. The male exploitation rate is the number of male crabs harvested in a given year divided by the male abundance estimate (age 0+) at the beginning of the year, calculated with the juvenile scalar (section 1.4).

4.6 Potential Management Impact

Female exploitation rates from 1990 to 2007 were much higher than the exploitation rates from 2008 to 2021 (Figure 9a). The lower female exploitation rates over the last two decades illustrate the influence of the female-specific management measures implemented by the jurisdictions in 2008. Additionally, the rapid increase in female abundance in 2009-2010, and again in 2014-2016, indicates that the female-specific management framework allowed the stock to regain some of its natural resilience to environmental changes. Male exploitation rates have not shown the same pattern (Figure 9b).

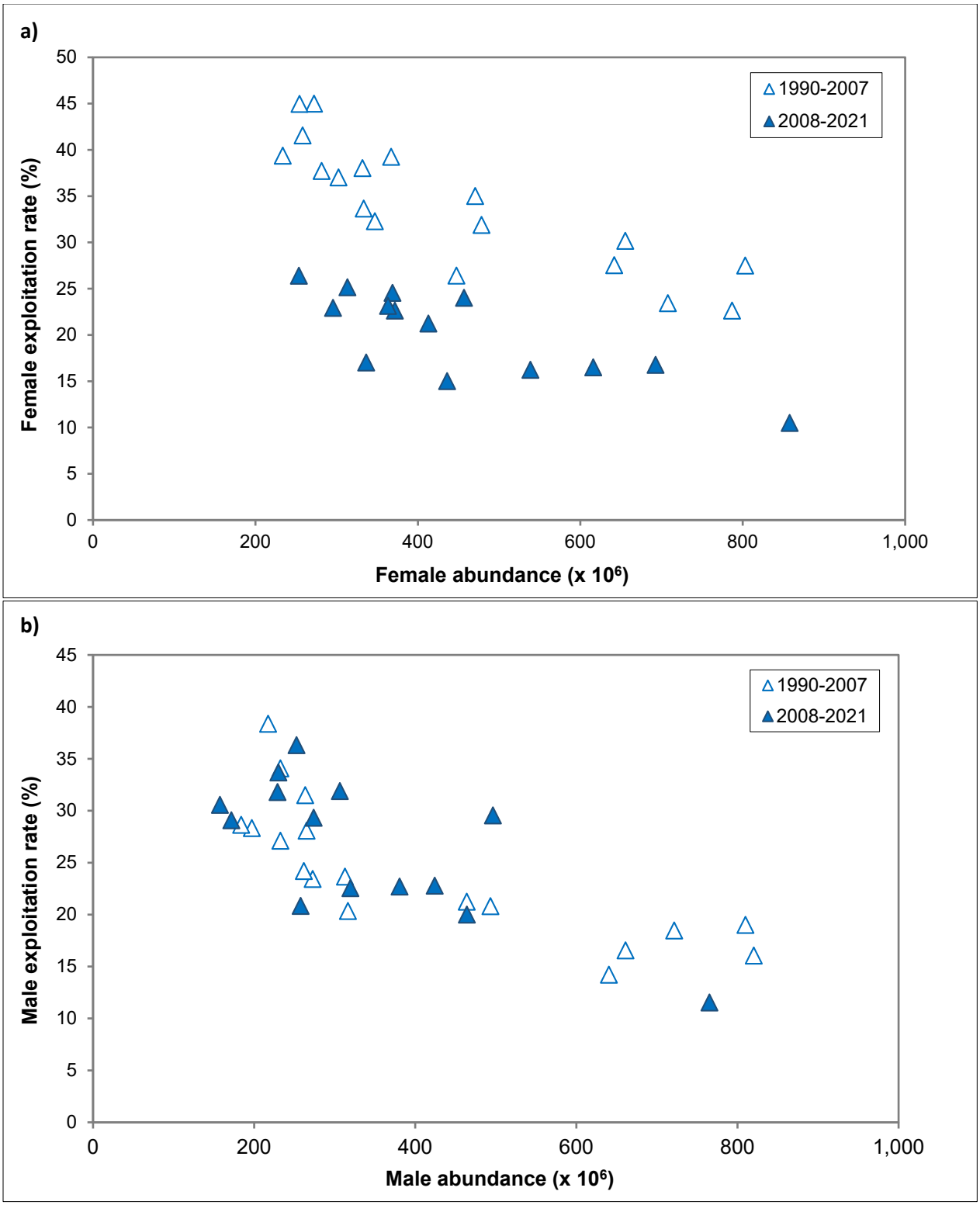

Figure 9. Comparison of female (a) and male (b) exploitation rates during the time periods prior to and after the 2008 implementation of female-specific management measures.

5. MANAGEMENT RECOMMENDATIONS

5.1 Implement Precautionary Management Measures

In 2022, abundance of both mature male and female blue crabs decreased, and juvenile abundance remained low. Harvest rates also increased for both males and females in the 2021 season. Although the 2022 results suggest that the blue crab stock is not overfished and overfishing is not occurring at this time, the reduced abundances, low recruitment, and higher male exploitation rates (near the conservation trigger) are of concern. Maintaining a robust spawning stock is necessary to replenish the population with new recruits each year. High fishing pressure can remove too many mature and soon-to-be-mature crabs from the population, negatively impacting recruitment success in the following years. To ensure a productive population and sustainable fishery, CBSAC recommends precautionary management measures be implemented to protect new recruits (age 0 crabs) that will enter the fishery in the second half of 2022 and represent the spawning stock for 2023. See Appendix B for more information about previous changes in harvest regulations by year.

5.2 Plan and Conduct a New Benchmark Stock Assessment

The current blue crab management framework is centered around reference points for adult female abundance and female exploitation rate, and stock status is assessed relative to these reference points. Fishery exploitation rates have been low, but both adult abundance and recruitment have not increased consistently as expected. This apparent disconnect between the spawning stock, recruitment, and fishery performance indicates a clear and pressing need to re-evaluate the stock assessment model. In many fisheries, benchmark stock assessments are conducted every five years; it has been a decade since the last benchmark for blue crabs in Chesapeake Bay. A new benchmark assessment could evaluate the effects of the substantial environmental and biological changes in the Chesapeake Bay ecosystem in the last decade on the blue crab population, and would also provide an opportunity to address many of CBSAC's priority science needs. For example, a new benchmark could explore various spatial and temporal scales in the model to fully take advantage of existing datasets, and could be paired with an existing effort to develop a blue crab population simulation model (section 6.2). CBSAC recommends a new benchmark stock assessment be conducted in the immediate future, as soon as funding allows.

6. SCIENCE AND DATA NEEDS

CBSAC has identified the following prioritized list of science and data needs that will improve management of the Chesapeake Bay blue crab population. To address some of these needs, CBSAC is pursuing funding opportunities through the Chesapeake Bay Program's Goal Implementation Team (GIT) Project Initiative, which provides funds to advance Bay Program goals and outcomes stipulated by the 2014 Chesapeake Bay Watershed Agreement, including the Blue Crab Abundance and Management Outcomes.

6.1 Quantifying Drivers of Blue Crab Population Dynamics

Given the recent declines in blue crab abundance, CBSAC has prioritized the need to better understand drivers of blue crab population dynamics, particularly recruitment success. Factors of interest include habitat availability (e.g., SAV, marsh), predation (e.g., red drum, blue catfish), food availability (e.g., clams), environmental conditions (e.g., water temperature, salinity, hypoxia), oceanic conditions (e.g., wind and tidal currents), and disease. By quantifying drivers of juvenile recruitment, CBSAC may be able to predict future recruitment success based on environmental and/or ecological conditions during the year. In addition to quantifying the impacts of these factors on recruitment success, CBSAC is also interested in re-examining the stock-recruitment relationship to better understand the connection between the spawning stock and juvenile recruitment. To address these science gaps, CBSAC is currently planning a workshop for September 2022 in which the workgroup will identify available data sources and evaluate hypotheses related to blue crab recruitment success and population dynamics.

Unknown and unquantified sources of mortality are also a major component of blue crab population dynamics that CBSAC needs to address. In addition to predation and disease impacts, CBSAC is particularly interested in quantifying sources of incidental mortality, such as sponge crab discards and unreported losses from the peeler fishery. An analysis of non-harvest mortality could improve reliability of exploitation rate estimates and inform future stock assessments.

6.2 Population Simulation Model for Management Strategy Evaluation

In 2021, CBSAC proposed a GIT-funded study to develop a spatially-explicit blue crab population simulation model that can be used to evaluate performance of the stock assessment model and fishery management under various hypotheses (e.g., differential natural mortality by sex, catchability of the WDS). This project would provide a better understanding of the current assessment model performance and a foundation for management strategy evaluation by which alternative management approaches for the blue crab population can be compared. The results of this modeling exercise could confirm the robustness of the current stock assessment and management framework. The simulation model could also test the response of recruitment indices to management, which is of particular interest given the continued low recruitment in

recent years. This project was accepted for funding by the Chesapeake Bay Trust and will begin in Summer 2022.

The new population simulation model will complement a current study conducted by VIMS researchers (and funded by the National Science Foundation) to develop a stage-structured population dynamics model, which is being calibrated with WDS and VIMS trawl survey data. The VIMS model is being used to examine the effects of depensatory exploitation, changes in reproductive output due to climate change, and habitat effects on the blue crab population and fishery. VIMS is also working to make this model spatially-explicit.

6.3 Harvest Reporting, Effort, and Catch Composition

Accurate harvest data for the commercial and recreational blue crab fisheries are necessary to obtain the most accurate exploitation rate each year and to better support mid-season management changes. To improve harvest reporting, the jurisdictions have been working to implement new 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. MDNR is continuing to expand the use of this system for the commercial crabbing fleet. VMRC implemented electronic reporting in 2009 as an alternative mandatory harvest reporting option, but growth was initially slow. Participation of commercial crab harvesters increased over time through cooperative work among VMRC, Virginia Sea Grant, and various industry groups. Beginning in 2022, VMRC is requiring all crab harvest to be reported through the online system to increase reporting efficiency. In 2021, PRFC received a grant from the Atlantic Coastal Cooperative Statistics Program to develop a pilot project for electronic harvest reporting, which began this spring. The details of each jurisdiction's harvest reporting efforts and challenges are outlined in CBSAC's Blue Crab Harvest Reporting Document.

In addition to commercial harvest reporting, a survey of recreational catch would be useful to ensure the reliability of recreational removal estimates. The most recent estimate of recreational harvest in Maryland was generated from a tagging study in Maryland waters in 2014-2015, which suggested that recreational harvest was approximately 6.5% of commercial harvest (Semmler et al. 2021). The last available estimates of recreational harvest for Virginia are from 2002. Future surveys should ensure that recreational harvest from the Potomac River is also included. A license or registration for all recreational crabbing in all jurisdictions would greatly increase the accuracy of catch and effort estimates.

Quantifying effort is another important component for understanding fishery dynamics. 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 reveal the spatial and

temporal patterns of gear-specific effort should be included in any harvest reporting system or recreational catch survey.

In addition to accurate harvest reporting and quantification of fishing effort, improvements in management could be made using more detailed characterization of catch. Understanding catch composition by size, sex, and growth phase, both spatially and temporally, would help improve the effectiveness of regulations and ensure they are compatible at a Bay-wide level. MDNR collects some size and sex composition data through their Cooperative Data Collection Program, which enlists watermen to voluntarily sample their catch and/or permit an onboard biologist to sample their catch. CBSAC has been working with the jurisdictions to assess the potential of implementing similar fishery-dependent sampling programs at VMRC and PRFC.

6.4 Efficacy of the WDS as an Index of Abundance

The WDS is the primary data source used by managers to assess the status of the blue crab stock and make management decisions. Although the WDS is considered one of the most comprehensive and statistically sound fisheries surveys on the east coast, there are several aspects of survey design and interpretation that should be further explored and improved upon. At least three approaches using WDS data have been proposed to estimate relative blue crab abundance in Chesapeake Bay (Sharov et al. 2003, Jensen & Miller 2005, Liang et al. 2017). However, the relative reliability of the means and variances of abundance estimated from these different approaches has never been evaluated. In partnership with CBSAC, researchers at UMCES are currently working with graduate students to conduct this analysis, and expect it to be completed by Fall 2022.

6.5 Influence of Males on Population and Fishery Productivity

A previous study at UMCES suggested that sperm limitation is not a concern for Chesapeake Bay blue crabs under the current management framework (Rains et al. 2018). However, 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 consideration of a set of indicators that would help determine when management adjustments specific to male crabs would be warranted.

6.6 Improving Recruitment Estimates Using a Shallow Water Survey

Based on the 2011 stock assessment and field experiments by VIMS and SERC, a large fraction of juvenile blue crabs in shallow water is not sampled by the WDS (Ralph & Lipcius 2014). Currently, VIMS is evaluating trawl survey and WDS data as a relative measure of age 0 abundance, and the Patuxent Environmental and Aquatic Research Laboratory (PEARL) is finalizing 50 years of recruitment indices from the George Abbe Blue Crat Pot Survey.

6.7 Blue Crab Data Hub

To assist in stock assessments and analyses, CBSAC has discussed 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. The following steps would be necessary to implement such a data hub:

1) Create a data policy workgroup to develop policies to ensure all interests are protected;
2) Determine the best database design and structure; and
3) QA/QC all data prior to uploading into the database

6.8 Application of Fishery-Independent Survey Data

CBSAC continues to review existing fishery-independent survey data to identify potential applications that will address questions about blue crab population dynamics and complement the population estimates from the WDS. Characterizing the seasonal distribution, spatial patterns in recruitment and production, and sex-specific abundance of blue crabs remains important. In preparation for the workshop in September 2022, CBSAC is compiling a list of data sources that could be incorporated into a new blue crab stock assessment and other relevant analyses. The George Abbe Blue Crab Pot Survey conducted by PEARL is one example of a data source that could be used to assess and study the Chesapeake Bay blue crab population.

6.9 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 are key sources of uncertainty**.** A new VIMS study examining blue crab age structure, reproduction, and sperm limitation may provide some insight into these critical biological parameters of the Chesapeake Bay population.

Additional Online Resources

Maryland Department of Natural Resources:
https://dnr.maryland.gov/fisheries/pages/blue-crab/index.aspx
Potomac River Fisheries Commission: http://prfc.us/
Virginia Marine Resources Commission: http://www.mrc.state.va.us/
Virginia Institute of Marine Science:
https://www.vims.edu/research/units/programs/bc_winter_dredge/index.php
Chesapeake Progress:
https://www.chesapeakeprogress.com/abundant-life/blue-crab-abundance
https://www.chesapeakeprogress.com/abundant-life/blue-crab-management

CBSAC Members

Pat Geer (Chair)	Virginia Marine Resources Commission
Mandy Bromilow (Coordinator)	ERT/NOAA Chesapeake Bay Office
Bruce Vogt	NOAA Chesapeake Bay Office
Ingrid Braun	Potomac River Fisheries Commission
Glenn Davis	Maryland Department of Natural Resources
Alexa Galvan	Virginia Marine Resources Commission
Daniel Hennen	NMFS, Northeast Fisheries Science Center
Tom Ihde	Morgan State University, PEARL
Eric Johnson	University of North Florida
Rom Lipcius	Virginia Institute of Marine Science
Genine McClair	Maryland Department of Natural Resources
Tom Miller	UMCES, Chesapeake Biological Laboratory
Amy Schueller	NMFS, Southeast Fisheries Science Center
Mike Seebo	Virginia Institute of Marine Science
Alexei Sharov	Maryland Department of Natural Resources
Mike Wilberg	UMCES, Chesapeake Biological Laboratory

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Appendix A. Estimated abundance of blue crabs from the Chesapeake Bay-wide Winter Dredge Survey, total commercial harvest, and female exploitation rate, 1990-2022*. Juvenile crabs are age 0 and adult crabs are age 1+.

WDS Year (Year Ended)	Total Crab Abundance (millions)	Juvenile Crab Abundance (millions)	Adult Crab Abundance (millions)	Adult Female Abundance (millions)	Total Commercial Harvest (millions of pounds)	Female Exploitation Rate (%)
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	50	36
2004	270	143	122	82	60	46
2005	400	243	156	110	59	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	69	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	324	271	191	61	17
2020	405	185	220	141	42	19
2021	282	86	197	158	**36**	**26**
2022	**227**	**101**	**125**	**97**	TBD	TBD

*2022 estimates of commercial harvest and female exploitation rate will be determined after the 2022 harvest season.

Appendix B. Summary of changes in female blue crab harvest regulations in the three Chesapeake Bay jurisdictions (MDNR, VMRC, PRFC) since implementation of the female-specific management framework in 2008. Abundance estimates for all crabs, juvenile crabs (age 0), and adult females (age 1+) and the female exploitation rate are also provided for each year.

Year	Total Abundance (millions)	Juvenile Abundance (millions)	Adult Female Abundance (millions)	Female Exploitation Rate	MDNR	VMRC	PRFC
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	Total Abundance (millions)	Juvenile Abundance (millions)	Adult Female Abundance (millions)	Female Exploitation Rate	MDNR	VMRC	PRFC
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	Total Abundance (millions)	Juvenile Abundance (millions)	Adult Female Abundance (millions)	Female Exploitation Rate	MDNR	VMRC	PRFC
2014	297	198	68.5	17%	Daily bushel limits the same as 2013; additional vessel bushel limit reduction of 12%.	10% reduction: reduced pot bushel and vessel limits. Continued closure of winter dredge fishery.	10% reduction: closed mature female hard crab season on Nov 20 and extended closure periods: Sept 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 based 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, adding 20 days. Increased bushel limits in Sept and Oct.	Extended season 3 weeks to Dec 20; maintained 2014 bushel limits. Continued closure of winter dredge 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 limits.	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.

Year	Total Abundance (millions)	Juvenile Abundance (millions)	Adult Female Abundance (millions)	Female Exploitation Rate	MDNR	VMRC	PRFC
2019	594	324	191	17%	Increased bushel limits for July - Nov. Season remained open through Nov 30.	Increased Nov bushel limits to the same limits as Apr-Oct. Continued closure of dredge fishery.	Status quo.
2020	405	185	141	19%	Increased bushel limits for one week in Nov in response to impacts related to COVID-19.	Extended hard crab pot season to Dec 19 in response to impacts related to COVID-19. Continued closure of dredge fishery.	Status quo.
2021	282	86	158	26%	Status quo.	Shortened hard crab pot season to November 30. Continued closure of dredge fishery.	Status quo.

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 4

ACTIONS TO PROMOTE REBUILDING OF CHESAPEAKE BAY BLUE CRAB STOCK (2008 through 2022)

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 (2004-2007) 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 4

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.
- Established the following bushel limits 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
- Established the following bushel limits 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.

May 2015

- Adjusted season dates for non-crab pot gear, closing September 26 and reopening April 21.
- Made it unlawful for any vessel to act as both a crab harvester and a crab buyer on the same trip.
- Made it unlawful for any person to possess dark sponge crabs from March 17 through June 15.
- Redefined the 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.

October 2015

- Closed the 2015/16 winter dredge fishery season.

June 2016

- Closed the 2016/17 winter dredge fishery season.
- Extended the crab pot season to close December 20, 2016 and open March 1, 2017.

June 2017

- Closed the 2017/18 winter dredge fishery season.
- Extended the fall bushel limit decrease to begin November 1, 2017, as an effort to conserve juvenile crabs from the winter of 2017 for the 2018 spawning potential
- Shortened the crab pot season to end November 30, 2017 and open March 17, 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.

June 2019

- Closed the 2019/20 winter dredge fishery season.
- Removed the fall bushel limit decrease.

June 2020

- Closed the 2020/21 winter dredge fishery season.

October 2020

- Extended the 2020 crab pot season through December 19, 2020 to offset economic effects of the COVID-19 pandemic.

June 2021

- Closed the 2021/22 winter dredge fishery season.
- Mandated online commercial blue crab harvest reporting starting January 1, 2022.

June 2022

- Closed the 2022/23 winter dredge fishery season.
- Re-established the fall bushel limit decrease to start October 1, 2022 and to extend the spring fall bushel limit decrease through May 15, 2023.
- Shortened the season for all other crab gear to end October 15, 2022 and open on April 16, 2023.