

1. INTRODUCTION

1.1 Background

The Chesapeake Bay Stock Assessment Committee combines the expertise of scientists from the Chesapeake Bay region with that of Federal fisheries scientists from the National Marine Fisheries Service Northeast and Southeast Fisheries Science Centers. Since 1997, this group meets each year to review the results of annual Chesapeake Bay blue crab surveys, harvest data, and to develop management advice for Chesapeake Bay jurisdictions: Maryland, Virginia, and the Potomac River Fisheries Commission (PRFC).

Benchmark stock assessments of the Chesapeake Bay blue crab have been conducted every 3-7 years since 1992. The most recent assessment was completed in 2011¹ with support from the Virginia Marine Resources Commission (VMRC), Maryland Department of Natural Resources (MD DNR), and the NOAA Chesapeake Bay Office (NCBO). This assessment generated new reference points for the female component of the blue crab population. The maximum sustainable yield (MSY) based female reference points were recommended as replacements for the previous reference points which used combined data for both sexes. The new assessment recommended revision of the overfishing reference points which had been based on maximum spawning potential (MSP), with an exploitation fraction reference point based on MSY (Table 1). Similarly, the 2011 stock assessment recommended replacing the empirically-estimated overfished age 1+ (both sexes) abundance threshold and interim target with an MSY-based threshold and target based solely on the abundance of female age 1+ crabs.

Female-specific reference points were formally adopted by the Bay Program's Sustainable Fisheries Goal Implementation Team (SFGIT) in December of 2011 and are currently implemented in all management jurisdictions. Organized by the Chesapeake Bay Program and Chaired by the NOAA Chesapeake Bay Office, the SFGIT is led by an executive committee made up of senior fisheries managers from the MD DNR, VMRC, PRFC, the Atlantic States Marine Fisheries Commission (ASMFC), and the District Department of the Environment (DC DOE). The full team is made up of scientists, managers, stakeholders and non-profit organizations who share a common goal of advancing ecosystem-based fisheries management through science based management decisions that cross jurisdictional boundaries.

As the winter dredge survey (WDS) is the most comprehensive and statistically robust of the blue crab surveys conducted in the Bay², CBSAC has adopted the WDS as the primary indicator of blue crab population health. The WDS measures the density of crabs (number per 1,000 square meters) at approximately 1,500 sites around the Bay

(Figure 1). The measured densities of crabs are adjusted to account for the efficacy of the sampling gear and are then expanded to reflect the area of Chesapeake Bay, providing an annual estimate of the number of over-wintering crabs by age and sex².

1.2 Background: Previous and Current Management Framework

A comparison of the current female-specific and previous (both sexes combined) biological reference points for Chesapeake Bay blue crab fishery is presented in Table 1. The exploitation fraction is the percentage of all crabs removed from the population by commercial and recreational fisheries. Under the current framework, annual estimates of exploitation fraction are calculated as the annual harvest of female crabs divided by the total number of female crabs (age 0+) estimated in the population at the start of the season. Population estimates are derived from the winter dredge survey each year. The 2012 exploitation fraction cannot be calculated until the completion of the 2012 fishery and estimation of harvest and is therefore listed as *TBA*. Management seeks to control the fishery such that the overfishing threshold is not exceeded, resulting in a larger number of crabs than required by the overfished threshold. Ideally, the fishery should operate to meet target values to maintain sustainability. Stock status levels that do not exceed threshold values are shown in green.

		Target	Threshold	2010 Stock Status	2011 Stock Status	2012 Stock Status
Overfishing: Exploitation Fraction (% of market size crabs harvested)	Current, Female-specific	25.5%	34%	18%	25%	<i>TBA</i>
	Previous, Sexes Combined	46%	53%	39%	45%	<i>TBA</i>
Overfished: Abundance (millions of crabs)	Current, Female-Specific	215	70	251	190	97
	Previous, Sexes Combined	200	86	315	254	178

(Table 1)

2. CONTROL RULES

2.1 Control Rule from 2011 Benchmark Assessment

The 2011 Benchmark assessment recommended a new framework (control rule) based on biological reference points for the female component of the population (Figure 2). The application of a control rule framework to management of the blue crab fisheries was first adopted by the Bi-State Blue Crab Advisory Committee in 2001⁷. The current female-specific targets and thresholds were developed using the MSY concept. F_{MSY} or U_{MSY} is defined as the level of fishing that achieves the largest average catch that can be sustained over time without risking stock collapse. Following federal guidelines, the 2011 assessment recommended a target exploitation level that was associated with 75% of F_{MSY} and a threshold exploitation level set equal to F_{MSY} . The female-specific, age 1+ abundance target and threshold were set accordingly at abundance levels associated with fishing levels at 75% N_{MSY} (target) and 50% N_{MSY} (threshold). Annual exploitation was calculated as the number of female crabs removed by the fisheries divided by the total number of age-0+ female crabs estimated to be in the Bay at the beginning of the fishing season. Within this calculation, the juvenile component of the total estimated number of crabs was scaled up by a factor of 2.5 to achieve the best fits of the model to the observed data.

3. POPULATION SIZE (ABUNDANCE)

3.1 Spawning-age Female Crabs: Current Reference Points

The 2011 benchmark assessment recommended establishing a threshold number of 70 million female spawning-age crabs and replacing the interim target of 200 million male and female spawning-age crabs with a target of 215 million female spawning-age crabs. Approximately 97 million female age 1+ crabs were estimated to be present in the Bay at the start of the 2012 crabbing season. This number is below the recommended target but still above the new threshold (Figure 3). The 2012 estimate of female age 1+ crabs represented a significant drop from the over-wintering population of 190 million in 2011. However, the 2012 estimate is within the range of values observed for the 13 year period prior to implementation of the female-specific regulations being put in place. Although the 2012 estimate represents the median of the 22 year time series, the estimated 97 million female age 1+ crabs is below the 23 year average of 117 million age 1+ female crabs.

3.2 Age 1+ Male and Age 0 Crabs

In 2012, the number of age 1+ male crabs (greater than 60 mm or 2.4 inches carapace width) estimated to be present in the Bay was approximately 83 million crabs (Figure 4). This represents a 32% increase from male abundance in 2011 and is slightly below the survey average of 87 million crabs. Recruitment, as measured by the number of age 0

crabs (less than 60 mm or 2.4 inches carapace width), increased from 207 million in 2011 to 587 million in 2012 (Figure 5). This was the largest recruitment event recorded in the 22 years of the WDS.

4. HARVEST

4.1 2011 Commercial and Recreational Harvest

The 2011 Maryland commercial crab harvest from the Bay and its tributaries was estimated as 35.3 million pounds. The 2011 commercial harvest in Virginia was reported to be 28.4 million pounds, and 3.5 million pounds were reported to have been harvested from the jurisdictional waters of the Potomac River Fisheries Commission (Figure 6). Maryland's 2011 commercial harvest declined 34% from 2010. Commercial harvest in Virginia increased by 6% and declined by 22% in the Potomac River. Figure 7 shows levels of commercial harvest of male and female crabs by jurisdiction relative to male and female exploitable stock as estimated by the WDS (Table 2).

Prior to 2008, recreational harvest had been assumed to be 8% of the total Bay wide commercial harvest.^{3,4,5} Since recreational harvest of female blue crabs is no longer allowed in Maryland or in the Maryland tributaries of the Potomac River, recreational harvest is better described as 8% of male harvest in those jurisdictions. Therefore, 2011 Bay-wide recreational harvest was estimated to be 4.4 million pounds. Combining these categories, approximately 71.6 million pounds were harvested from Chesapeake Bay and its tributaries during the 2011 crabbing season. Despite decreasing by almost 20 million lbs, the 2011 Bay-wide harvest was the second highest since 1999.

Based on continued evidence of inflated harvest reports, Maryland's 2011 commercial harvest was estimated from fishery-independent data sources including the Maryland commercial reference fleet and an annual survey of crab pot effort in the Maryland portion of Chesapeake Bay⁶. Maryland's 2011 reported commercial harvest of 48.7 million pounds was 38% higher than the estimated harvest.

4.2 Exploitation Fraction: Recommended and Current Reference Points.

While the 2011 commercial female harvest remained nearly the same as the 2010 harvest, the over-wintering population of females dropped by 35%. Despite the decline in exploitable stock, the percentage of crabs removed by fishing (exploitation fraction) of female crabs in 2011 was approximately 25% compared to the recommended target of 25.5% and below the threshold of 34% (Figure 8).

When considering the previous reference points, the percentage of crabs removed by fishing (exploitation fraction) was approximately 45%, which was at the current target of 46% and below the previous threshold of 53% (Figure 9).

5. STOCK STATUS

The Chesapeake Bay blue crab stock is currently **not overfished** and **overfishing is not occurring**. These conclusions remain true even under the previous control rule framework using both sexes. Thus, the conclusion that the Chesapeake Bay blue crab fishery is operating sustainably is not only a reflection of the revised 2011 control rule, but is supported by both current and previous management frameworks. Abundance, harvest, and exploitation of all crabs are summarized in Table 3.

6. MANAGEMENT ADVICE-SHORT TERM

6.1) Monitor fishery performance and stock status relative to recommended reference points before adjusting regulations:

The female exploitation fraction in 2011 was below the recommended target of 25.5% for the 4th consecutive year. Management jurisdictions should carefully consider the performance of 2012 fisheries relative to the recommended female-specific reference points and the outcome of the 2011-2012 winter dredge survey before making regulatory decisions. The CBSAC notes that, despite record high recruitment in 2012, the abundance of adult female crabs has declined substantially over the past two years. As a result, the late-season 2012 and 2013 fisheries will depend heavily on the strong 2012 year class. Therefore, CBSAC recommends that jurisdictions exercise caution when considering management scenarios that may disproportionately impact the 2012 year class. If recruitment, as measured in the 2013 dredge survey, is low compared to the survey time series, the 2013 fishery will be primarily dependent on the 2013 year class and jurisdictions may need to adjust management to ensure that harvest is adequately constrained relative to abundance.

6.2) Catch Reports:

If management based on exploitation fraction continues, the CBSAC recommends that the jurisdictions implement procedures that allow accurate accountability of all commercial and recreational catches. If the jurisdictions continue with a sex-specific regulatory strategy, CBSAC recommends greater efforts to characterize the biological characteristics of all catch.

6.3) Recreational Catch and Effort:

Recreational catch and effort remains poorly quantified in Chesapeake Bay. The jurisdictions should continue to develop and evaluate methods for more precisely calculating recreational catch and effort, possibly through licensing systems. In March 2011, the benchmark stock assessment underwent rigorous peer review by international stock assessment scientists representing the Center for Independent Experts (CIE). All three reviewers identified improving estimates of recreational catch as

a priority. Thus CBSAC formally recommends that each jurisdiction renew efforts to quantify recreational catch and effort

7. MANAGEMENT ADVICE- LONG TERM

7.1) Catch Control:

A management strategy that sets annual catch levels based on estimates of abundance from the WDS and that potentially accounts for sex-specific seasonal distribution of crabs, could potentially balance annual harvests with highly variable recruitment. The CBSAC recommends that jurisdictions evaluate the benefits of quota-based management systems. Allocating annual quotas to each jurisdiction would improve performance of a Bay-wide quota and lead to jurisdictional accountability of harvest relative to the Bay-wide exploitation target.

7.2) Effort Control:

The blue crab fishery is currently managed under effort control with limited entry, size limits, catch limits and seasonal closures as the principal tools. However, the amount of effort expended in the fishery remains poorly quantified. CBSAC recommends an increased investment in bay wide effort monitoring that should include actions in all jurisdictions to implement a pot marking scheme and a bay wide survey of crab pot effort to estimate the total, spatial, and temporal patterns of the crab pot fishery.

7.3) Latent effort:

In both states, significant numbers of commercial crabbing licenses are unused. An increase in the blue crab population may increase the use of licenses that have, for some time, been inactive. During 2009 and 2010, both Maryland and Virginia have made headway addressing the amount of latent effort in the blue crab fishery with both states using Federal fishery disaster relief money to buy back commercial licenses. CBSAC recommends that continued efforts be made to estimate and monitor the level and possible re-entry of latent effort into the fishery. In addition to increases in latent effort, CBSAC also recognizes that temporal and seasonal shifts in estimated blue crab abundance may alter existing effort exerted by active licenses. The impact of inherent variability of blue crab abundance on both latent and active effort should be investigated and better understood as a part of this recommendation.

8. Critical Data and Analysis Needs

Blue crab management now employs sex-specific regulatory strategies. Given this, the lack of data describing sex ratio and size composition of the harvest will impede efforts to develop effective management strategies. CBSAC recommends that jurisdictions sample for biological characteristics in proportion to the magnitude of harvest from each harvest sector. A collaborative and coordinated Bay-wide, fishery-independent survey focused on the spring through fall distribution and abundance of blue crabs remains important, especially if agencies are considering regional or spatially-explicit management strategies. Finally, an assessment of the magnitude of incidental mortality due to various sources such as discarding female sponge crabs, the peeler fishery, predation and gear effects, would potentially improve reliability of exploitation estimates, and inform future assessments.

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Table 2. Comparison of how market category composition has changed in the commercial harvest since female-specific regulations took affect. The aggregated proportions are also compared to the most recent, 2011, harvest composition.

2008-09

	Male	Female	Peeler	Total
MD	0.31	0.20	0.05	0.55
VA	0.11	0.25	0.03	0.39
PR	0.03	0.02	0.00	0.05
Bay	0.45	0.47	0.08	1.00

2008-10

	Male	Female	Peeler	Total
MD	0.41	0.16	0.03	0.60
VA	0.12	0.22	0.01	0.35
PR	0.03	0.02	0.00	0.05
Bay	0.57	0.39	0.05	1.00

2008-11

	M	F	P	Total
MD	0.32	0.19	0.05	0.56
VA	0.11	0.26	0.02	0.39
PR	0.03	0.02	0.00	0.05
Bay	0.46	0.46	0.07	1.00

2011

	Male	Female	Peeler	Total
MD	0.35	0.15	0.03	0.53
VA	0.13	0.28	0.01	0.42
PR	0.04	0.01	0.00	0.05
Bay	0.52	0.44	0.04	1.00

Table 3. Estimated abundance of blue crabs from the Chesapeake Bay-wide winter dredge survey, annual commercial harvest, and removal rate of all crabs.

Survey Year (Year Survey Ended)	Total Number of Crabs (All Ages) ¹	Number of Age-0 Crabs ¹	Number of Spawning-Age Crabs ¹	Number of spawning-age FEMALE crabs ¹	Bay-wide Commercial Harvest (Pounds) ¹	Percentage of Crabs Removed
1990	791	463	276	117	96	42
1991	828	356	457	227	90	38
1992	367	105	251	167	53	54
1993	852	503	347	177	107	44
1994	487	295	190	102	77	57
1995	487	300	183	80	72	56
1996	661	476	146	81	69	41
1997	678	512	165	96	77	45
1998	353	166	187	108	56	64
1999	308	223	86	56	62	79
2000	281	135	146	107	49	69
2001	254	156	101	58	47	71
2002	315	194	121	56	50	59
2003	334	172	171	86	47	51
2004	268	146	124	84	47	72
2005	396	247	158	112	58	47
2006	311	199	121	87	54	54
2007	249	114	141	90	49	56
2008	291	169	131	92	43	48
2009	393	173	223	165	55	43
2010	658	345	315	250	91	43
2011	460	207	254	194		
2012	763	587	178	97		

¹ All values are in millions.