COMMONWEALTH of VIRGINIA

Marine Resources Commission
2600 Washington Avenue
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Newport News, Virginia 23607

Douglas W. Domenech
Secretary of Natural Resources

Steven G. Bowman
Commissioner

December 1, 2011

MEMORANDUM

TO: The Honorable Robert F. McDonnell
Governor of the Commonwealth of Virginia
And,
Members of the Virginia General Assembly

THROUGH: The Honorable Douglas W. Domenech
Secretary of Natural Resources

FROM: Steven G. Bowman

SUBJECT: Blue Crab Fishery Management Plan

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

EXECUTIVE SUMMARY

Despite lower numbers of blue crab in 2011 as compared to 2010, the overall abundance of recruits and spawning-age crabs was 460 million and was the second highest since 1998. Most importantly, the blue crab stock was not overfished and overfishing of this stock was not occurring, following the close of the 2010 Chesapeake Bay blue crab fisheries.

Results from the December 2010–March 2011 Bay-wide Winter Dredge Survey conducted by the Virginia Institute of Marine Science and the Maryland Department of Natural Resources indicated the abundance of all (male and female) spawning-age crabs (age-1+, also crabs greater than 2.4 inches in carapace width) was 254 million. This abundance or number of crabs available to the Chesapeake Bay fisheries, starting in spring 2011, was 19 percent less than in the

previous winter when the number of spawning-age crabs was 315 million spawning-age crabs. This marks the third consecutive winter that the abundance of this size category of crabs exceeded an interim target, established in 2008, of 200 million spawning-age crabs. Abundance of recruits (age-0 crabs) was 207 million, as compared to 345 million determined from the 2009-2010 Winter Dredge Survey, but the 207 million recruits was close to the median abundance for this 22-year fishery independent survey that samples approximately 1500 sites throughout the Chesapeake Bay.

In 2011, an analytical stock assessment of the blue crab was completed. The previous complete stock assessment was available to Chesapeake Bay jurisdictions in 2005. The 2011 stock assessment provides biological reference points or limits for overfishing and an overfished stock that are solely based on female crab abundance and exploitation rates. These female-specific biological limits are more conservative than the combined male and female overfishing and overfished limits that have guided management of this important resource since 2001. The recently peer-reviewed stock assessment also recommends an optimal abundance target and removal rate that are more conservative than Chesapeake Bay resource managers have been utilizing during this stock rebuilding effort that started in 2008. Final endorsement of the provisions of the new stock assessment, by the Chesapeake Bay Program Sustainable Fisheries Goal Implementation Team's executive committee, is expected later this year. This executive committee is represented by the Marine Resources Commission, the Maryland Department of Natural Resources, the Potomac River Fisheries Commission, the National Oceanic and Atmospheric Administration's Chesapeake Bay Office Maryland Sea Grant, Atlantic States Marine Fisheries Commission, and District of Columbia Division of Fish and Wildlife.

From its annual review of blue crab survey and harvest data, the Chesapeake Bay Stock Assessment Committee (CBSAC) identified three main research priorities, as follows: 1) to implement monitoring to characterize the sex, size, and life stage composition of commercial crab harvest; 2) to implement a survey to estimate recreational crab fishery effort; and 3) to continue the winter dredge survey and refine gear efficiency and over-winter mortality calculations. The CBSAC also reviewed the recent stock assessment and agreed emphasis should be placed on the determination of overfished and overfishing limits for male crabs. As another important marker of stock health, the CBSAC will develop a standard based on the ratio of spawning age males (age-1+) to pre-pubertal females (age-1). This standard will allow the jurisdictions to adjust management measures, should that ratio indicate reproductive capacity is impeded from harvesting activities. The Chesapeake Bay Stock Assessment Committee combines the expertise of scientists from the Chesapeake Bay region, with that of federal fisheries scientists from the Northeast and Southeast Fisheries Science Centers of the National Marine Fisheries Service, and has provided management advice to the jurisdictions of the Chesapeake Bay since 1997, following a review of blue crab survey and harvest data.

In September 2011, the Commission voted to close the winter dredge fishery season for the fourth consecutive season and to not allow any wait-listed individuals (former licensees who were inactive from 2004 through 2007) to return to the crab pot or peeler pot fisheries at this time, as described in detail below. For the fourth consecutive crab pot and peeler pot season (March 17 through November 30), the Commission maintained crab fishery management measures in 2011 that conserved female crabs, in an attempt to promote increases in spawning

activities. In 2008, the Commission had enacted a management plan designed to reduce the harvest of female crabs by 34%. This reduction in female harvest was also implemented by Maryland and the Potomac River Fisheries Commission. The major conservation measures of the 2008 blue crab management plan that remained in effect through the 2009 - 2011 crab fishing seasons included a closure of the winter dredge season, an earlier closure of the spawning sanctuaries than the traditional June 1-September 15 closure (the current closure begins May 16), an increased minimum size limit for harvested peeler crabs (from 3 inches to 3 ¼ inches then 3 ½ inches), and a requirement for larger escape rings (2 3/8 inches) in crab pots.

Overcapacity still exists in the fishery and remains a challenge for the successful management of this stock. In the 2010 crab pot fishery, only 1,084 of 1,234 eligible licensees were active harvesters, and that amount of active harvesters was solely attributable to the increased abundance of crabs in 2010. In the peeler pot fishery, only 408 licensees of 589 eligible licensees were active. In many previous years, either the number of active harvesters was less than in 2010 or more harvester than could be supported by the existing abundance. Since the fishery remains at overcapacity with effort and because there is a substantial amount of potential or latent effort that could become active, the Commission has chosen to continue with conservation measures implemented in 2008 through 2011.

For the third year, the Commission administered the expenditures from the funds provided in 2008 and 2009 by the Department of Commerce for the declared Fishery Disaster in the Chesapeake Bay blue crab fisheries. This Disaster Relief Fund has provided various crab industry members (harvesters, buyers, and processors) who experienced financial setbacks from the very low abundance of the blue crab resource, in past years, an opportunity to work in resource or habitat enhancement projects. These projects have provided innovative work opportunities to approximately 288 participants who are associated with the crab fishery or its industry. The total amount of funding from the Disaster Relief Fund is $14,995,000, and of the six project areas, two projects continue in 2011: the derelict crab pot and marine debris collection program, and the oyster aquaculture projects.

The total Virginia 2010 harvest was 29.6 million pounds which represents a 14% increase from the 2009 statewide harvest and a 54% increase over the 2008 harvest. The average per capita dockside earnings by crab pot fishermen increased from $18,595 (2008) to $19,242 in 2009 and $28,092 in 2010. The number of active harvesters was 885 (2008), 1010 (2009) and 934 in 2010. The average per capita dockside earnings by peeler pot fishermen decreased from $4,665 in 2008 to $4,361 in 2009, but increased to $4,503 in 2010. The number of active peeler pot harvesters has fluctuated from 342 (2008) to 438 (2009) and 361 in 2010.

On a Bay-wide basis, the commercial harvest increased nearly 51% in 2010, as compared to the 2009 harvest. Recreational harvest for the three Chesapeake jurisdictions is assumed as 8% of the total commercial harvest, based on several studies of this fishery in the last ten years. However, most Bay-wide managers consider this an underestimate.

Abundance and Fishery Removal Rates

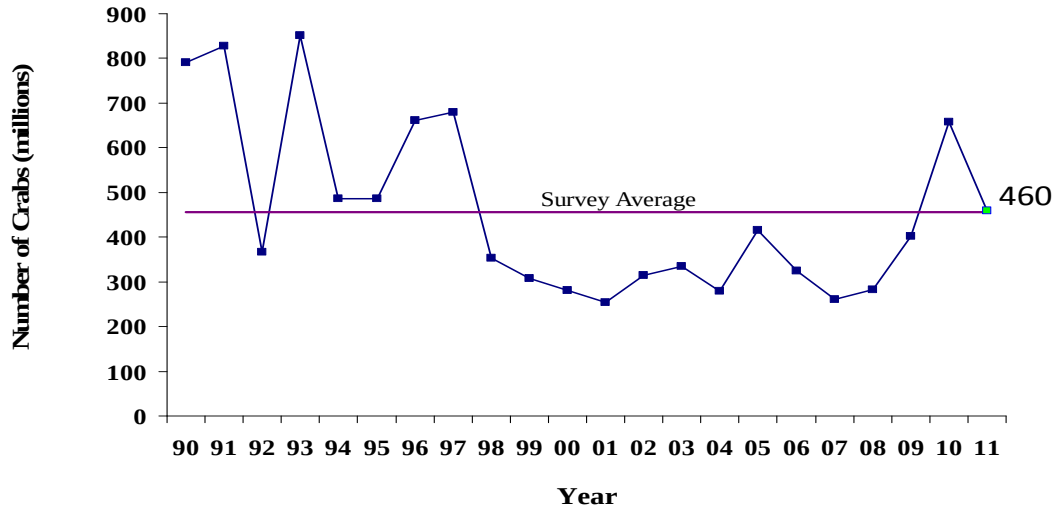
Despite a 30% decline in overall abundance (number of crabs of all sizes) determined from the Bay-wide Winter Dredge Survey of December 2010 to March 2011, as compared to the 2009-2010 Bay-wide Winter Dredge Survey results, the overall abundance of recruits and spawning-age crabs was 460 million and was the second highest since 1998. Most importantly, the blue crab stock was not overfished and overfishing of this stock was not occurring, following the close of the 2010 Chesapeake Bay blue crab fisheries.

Results from the December 2010–March 2011 Bay-wide Winter Dredge Survey conducted by the Virginia Institute of Marine Science and the Maryland Department of Natural Resources indicated the abundance of spawning-age crabs (age-1+) was 254 million (both sexes included). This abundance that was available to the Chesapeake Bay fisheries, starting in spring 2011, was lower than the previous winter abundance of 315 million crabs. This marks the third consecutive winter that the abundance of this size category of crabs (> 2.4 inches, in carapace width) exceeded an interim target of 200 million spawning-age crabs. Abundance of recruits (age-0 crabs) was 207 million, as compared to 345 million determined from the 2009-2010 Winter Dredge Survey, but the 207 million recruits was close to the median abundance for this 22-year fishery-independent survey. The following figures provide the results of the 22-year Bay-wide Winter Dredge Survey and summarize the estimates of the various groupings of blue crab.

2010-2011 Bay wide Winter Blue Crab Dredge Survey

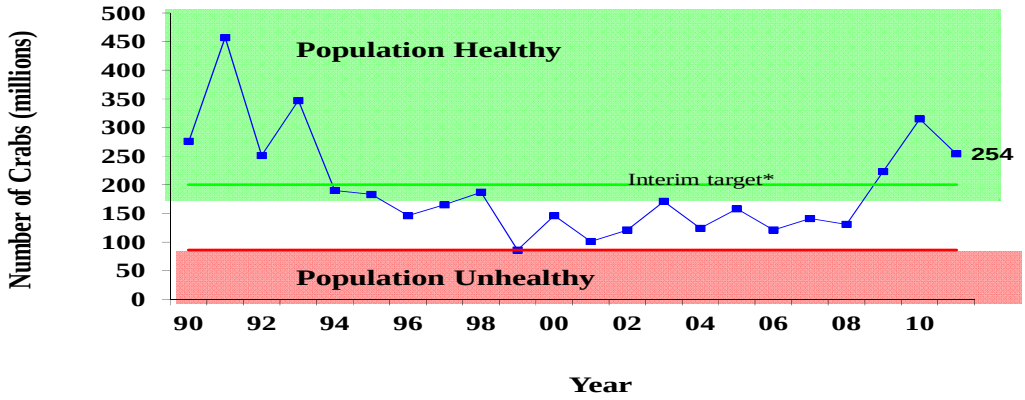
Total Number of Crabs Estimated to be in Chesapeake Bay

Total abundance declined in 2011 due to lower reproduction and high winter mortality



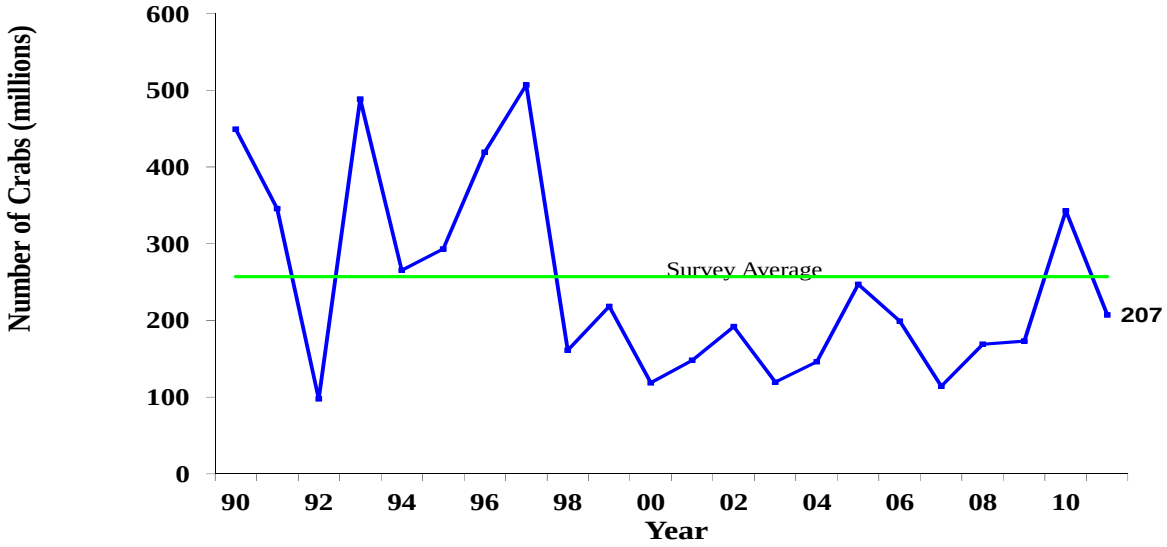
2010-2011 Bay wide Winter Blue Crab Dredge Survey

Number of Spawning-Age Crabs Estimated to be in Chesapeake Bay



2010-2011 Bay wide Winter Blue Crab Dredge Survey

Number of Juvenile Crabs Estimated to be in Chesapeake Bay



The abundance estimates and exploitation rates (annual percentage of removals of blue crab by fisheries, alone) derived from the Bay-wide Winter Dredge Survey have been key elements for the Commission's planning of the crab fisheries and conservation of the blue crab resource in recent years. Commission actions that have promoted rebuilding of the blue crab stock since

2008 can be found in Attachment I. Guidance from the 2011 stock assessment findings will aid the Commission and other Chesapeake Bay jurisdictions in a continuation of the rebuilding of this stock. The crab resource has improved the last two years, as compared to low abundance trends from 1998 to 2008. Yet, the blue crab stock can only be considered rebuilt once there is a multi-year success in production of recruits and the abundance of recruits and spawning-age crabs can sustain Bay-wide harvests at an optimum yield. Spawning-age is a term used for crabs that will spawn the spring or summer following the end of the seasonal (December-March) Bay-wide Winter Dredge Survey. Blue crab research scientists at Old Dominion University provide an alternative standard for assessing rebuilding of this stock (Attachment II). These scientists determined from a multi-year study that mature female size ranged from 131.3 mm in 2002 to 143.2 mm in 2010, and, in general, female size increased over the study period and has approached the mean size of females in the benchmark years. These scientists also indicate that eggs per brood data also showed a continuous climb from a low point in 2002 of 3.7×10^5 to 1.52×10^6 in 2010 and conclude that, while the number of eggs/brood has steadily increased, the high number in 2010 is still only half of the number of eggs/ brood found in the benchmark study of 1986-87.

It is well documented that environmental influences on this stock have resulted in years of low abundance and harvest (Table 1). For that reason, the 2008 Bay-wide endorsement to conserve female crabs, as well as the 2011 stock assessment that provides female-specific limits and targets, will help the Commission and other jurisdictions promote a continued rebuilding of this stock.

Table 1 below provides a 22-year summary of the results from the Chesapeake Bay-wide Winter Dredge Survey. The abundance of recruits (termed age-0 crabs) and the spawning-age crabs (termed age-1) are differentiated according to size, with 2.4 inches in carapace width as the separator of the two size classes of crabs. The 2011 abundance of age-1+ crabs (both sexes) was 254 million crabs. The abundance of age-0 crabs was 207 million crabs. The total number of crabs (460 million) represents the number of crabs (abundance) of age-0 (recruits) and spawning-age crabs. Any abundance estimate represents the number of crabs that will be available to the Chesapeake Bay fisheries following the end (March) of the seasonal (December-March) Bay-wide Winter Dredge Survey.

Low overall (all ages) abundance of less than 400 million crabs existed for many years of this 22-year period. High overall abundance occurred in the early 1990s, 1996-97 and 2010-11. Generally, this summary table shows that Bay-wide commercial harvests responded to overall abundance trends, but it is important to recognize that in some years the Bay-wide harvest was too high, as overfishing occurred (red-shaded rows). Overfishing, since 2005, has been based on a harvest removal rate that exceeds 53% annually. For example, from 1998 through 2008, overfishing occurred in all years except 2003, 2005, and 2008 (yellow-shaded rows). Yet, all three of these years were associated with a removal rate above the recommended target removal rate of 46%. In recent years, the removal rates of 2009 and 2010 were below the target removal rate of 46% (green-shaded rows) and well below the threshold or limit removal rate of 53 percent.

Table 1. Bay-Wide Winter Dredge Survey results (1990-2011).

Survey Year (Year Survey Ended)	Total Number of Crabs in Millions (All Ages)	Number of Age-0 Crabs in Millions	Number of Spawning-Age Crabs in Millions	Bay-wide Commercial Harvest (Millions of Pounds)	Percentage of Crabs Removed
1990	791	463	276	96	42
1991	828	356	457	90	38
1992	367	105	251	53	54
1993	852	503	347	107	44
1994	487	295	190	77	57
1995	487	300	183	72	56
1996	661	476	146	69	41
1997	678	512	165	77	45
1998	353	166	187	56	64
1999	308	223	86	62	79
2000	281	135	146	49	69
2001	254	156	101	47	71
2002	315	194	121	50	59
2003	334	172	171	47	51
2004	268	146	124	47	72
2005	396	247	158	58	47
2006	311	199	121	54	54
2007	249	114	141	49	56
2008	291	169	131	43	48
2009	393	173	223	55	43
2010	658	345	315	89	43
2011	460	207	254		

2011 Blue Crab Stock Assessment

Biological reference points are the primary outputs of stock assessments and fishery regulations are implemented to meet those biological standards. The recently peer-reviewed stock assessment provides new and more conservative reference points for overfishing (rate of exploitation or removal percentage of crabs, on an annual basis) and the biologically safe level of abundance. Should the crab stock abundance fall below this safe level of abundance (70 million age-1+ female crabs), the crab stock would be considered overfished, and rebuilding measures would need to occur immediately. In addition to new biological reference points, the recently peer-reviewed 2011 stock assessment differs from the 2005 stock assessment because the 2011-based biological reference points are only based on the biological status of female crabs.

The Chesapeake Bay Stock Assessment Committee (CBSAC) has provided the Bay-wide jurisdictions with its recommendations following the 2011 stock assessment, and its advisory report can be found in Attachment III. The CBSAC recommends jurisdictions adopt the female-specific target and threshold reference points developed in the 2011 stock assessment. The table below compares the current reference points based on a 2005 analytical (model-based) stock assessment to the biological reference points of the recent 2011 assessment.

2005 interim control rule	
Overfishing	53% of all crabs
Target	46% of all crabs
Overfished	86 million age-1+ crabs
Interim target	200 million age-1+ crabs

2011 stock assessment control rule	
Overfishing	34% of all female crabs
Target	25.5% of all female crabs
Overfished	70 million age-1+ female crabs
Interim target	215 million age-1+ female crabs

This table shows that an interim abundance target of 200 million age-1+ (spawning-age crabs of both sexes combined) would be replaced by a female crab-only target of 215 million crabs, according to the results from the 2011 stock assessment. Any target abundance is more conservative than a limit or threshold, in order to assure that the stock abundance does not approach an overfished condition. It is expected with any target that abundance will vary annually but will be near the target. Since the sex composition determined by the 2011 stock assessment, for recruit crabs, is 52% female crabs and 48% male crabs, the 2011 recommended target is equivalent to 413 million crabs of both sexes. The 2011 recommended target abundance is more than twice the interim target abundance (200 million age-1+ crabs) in current use. However, since the Bay-wide management has recently conserved female crabs, recent Bay-wide Winter Dredge Surveys result in a sex composition of age-1+ crabs that has been near 75% female. If this continues, the 215 million female age-1+ target would be equivalent to 287 crabs of both sexes, and that means the proposed 2011 target is 44% more conservative than the current interim target of 200 million crabs of both sexes.

The CBSAC recommends the development of threshold reference points for male crabs that would provide management with a trigger for male crab conservation. In the near term, the CBSAC recommends that managers monitor the ratio of the number of male crabs greater than 60mm carapace width to the number of immature female crabs greater than 60mm.

Concerning the overfished (unsafe abundance) reference point, the current control rule, based on the 2005 assessment, provides an overfished limit of 86 million crabs (both sexes combined). The proposed (2011) abundance threshold or limit that would indicate an overfished crab stock is 70 million age-1+ female crabs. This means 70 million age-1+ female crabs is a more conservative overfished limit than 86 million crabs of both sexes combined. Assuming a 52% female distribution of spawning-age crabs, were sexes combined, the 70 million female crabs is equivalent to 135 million crabs of both sexes combined. As mentioned above, should female crabs be as prevalent as has been the case in recent Bay-wide Winter Dredge Surveys, the

overfished limit of 70 million age-1+ female crabs would be equivalent to 93 million age-1+ crabs of both sexes.

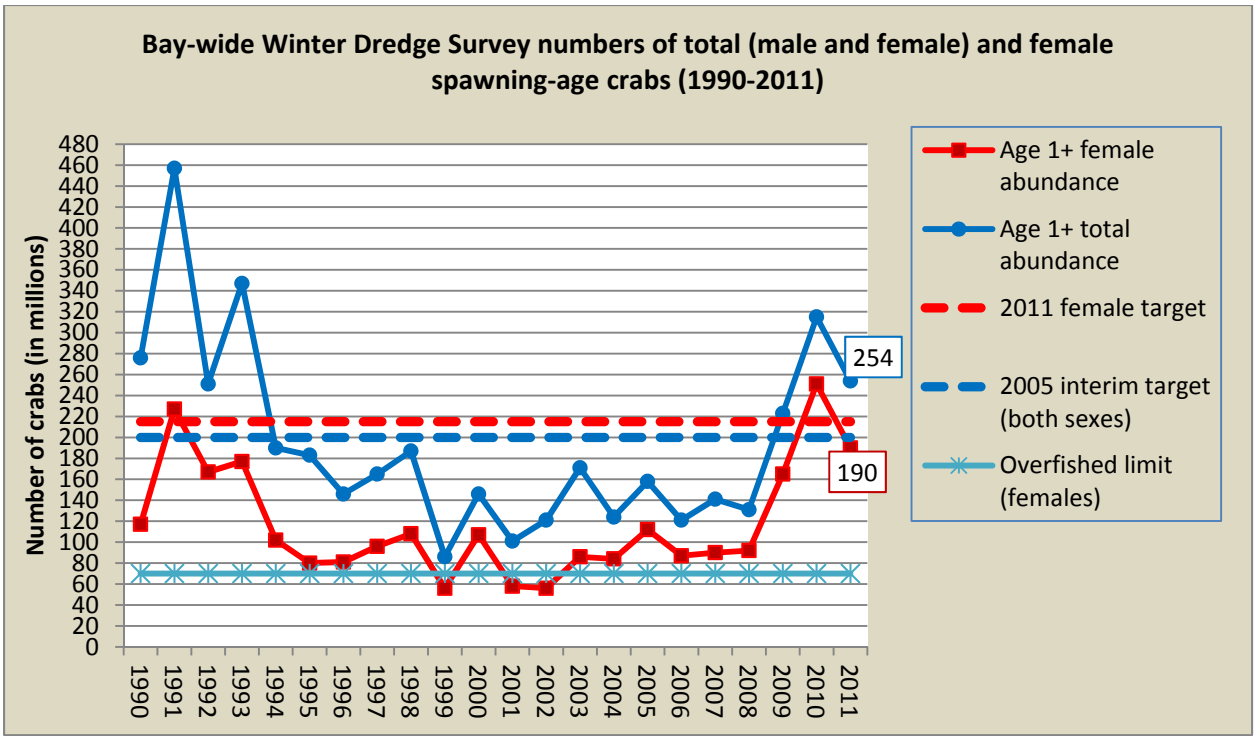
The scientists who conducted this stock assessment provide the following recommendations in their report:

1) The overfishing limit in the Chesapeake Bay blue crab fishery should be defined as the exploitation rate (U) of age-0+ crabs that coincides with maximum sustainable yield (MSY). The best estimate of UMSY for age-0+ female crabs is UMSY=0.34.
2) We consider blue crab as a data poor species. Following precedent from Restrepo et al., the New England Fishery Management Council and the Mid-Atlantic Fishery Management Council, we recommend a target exploitation rate be established equivalent to 0.75*UMSY. Our best estimate of the target exploitation rate is U0.75*UMSY=0.255 age-0+ female crabs.
3) We recommend an overfished abundance (N) threshold be established based on the estimate of 0.5*NMSY. Our best estimate of the overfished definition is 70 million age-1+ female crabs. This is equivalent to a total population abundance of approximately 135 million age-1+ crabs, if the pattern of exploitation is the same for males and females.
4) We recommend that a target abundance reference point be established equivalent to the equilibrium abundance expected if the target exploitation rate is achieved. Specifically, the target abundance should be defined a N0.75*UMSY. Our best estimate of the target abundance is 215 million age-1+ female crabs. This is a level of abundance that was observed in the population in the mid-1980s. The recommended target is equivalent to a total population abundance of approximately 415 million age-1+ crabs, if the pattern of exploitation is the same for males and females.

The figure below provides an additional comparison of current (2005 assessment advice) and proposed control rules based on overfishing and overfished biological limits and management targets. Notably, even though the interim target abundance for age-1+ crabs (both sexes) of 200 million was exceeded the last three consecutive Bay-wide surveys, the proposed 2011 target of 215 million age-1+ female crabs was only exceeded once in recent years (2010).

This newly-proposed target of 215 million age-1+ female crabs is attainable, as evidenced by the 2010 abundance. Even the 2011 female age-1+ abundance would have been above this target, except the third highest overwintering mortality event in 22 years reduced the viable abundance of spawning-age female crabs to 190 million. This updated, proposed target is one reason why the Commission postponed reinstating licenses to the 320 former licensees who remain on a waiting list for complete inactivity during 2004 through 2007.

Clearly, the new biological reference points and targets are based on a sounder mathematical basis. Previously, the overfished definition was simply the lowest abundance that was observed in the Winter Dredge Survey (1998-99; see Table 1). Now, there is a stock assessment basis for the proposed overfished limit of 70 million age-1+ female crabs. It is evident that these new reference points and the new target (215 million age-1+ female crabs) mean that the stock has only rarely reached the abundance levels that correspond to this proposed target. These more conservative reference points mean that the Commission's management plan of 2008 and subsequent years will need to remain intact, until such time a multi-year success in production of recruits and the abundance of recruits and spawning-age crabs can sustain the improved harvests of recent years.



At the same time, the Commission is aware that the 30% decrease in the 2011 abundance means that 2011 harvests should not exceed the 2010 harvest, if the removal rate for 2011 is to remain near the target, especially since three jurisdictions' fisheries are contributing to the removal rate. The CBSAC recommends that managers carefully consider the performance of 2011 fisheries relative to the recommended female-specific reference points as well as the outcome of the 2011-12 Winter Dredge Survey before making regulatory adjustments (see Attachment III).

A summary of the improvements associated with the 2011 Stock Assessment of the Blue Crab in Chesapeake Bay follows:

- Uses the latest available data
- Uses more recent life history and vital rates (growth rates, age and size at maturity, mortality, fecundity)
- Provides sex-specific reference points
- Model is able to replicate time series of total catch, sex-specific catch, and sex-specific abundances for the Bay-wide Dredge Survey, the VIMS trawl survey, and the Maryland trawl survey
- Avoids use of empirically-derived reference points
- Incorporates use of MSY (Maximum Sustained Yield). This is the largest average catch or yield that can continuously be taken from a stock under existing environmental conditions
- Accounts for inefficiency of dredge catch of age-0 crabs

Especially important to the Commission process is that the targets and thresholds are based on MSY. Practical management of any fishery is not designed to achieve the maximum sustained yield, since any miscalculations that result in realized yield beyond

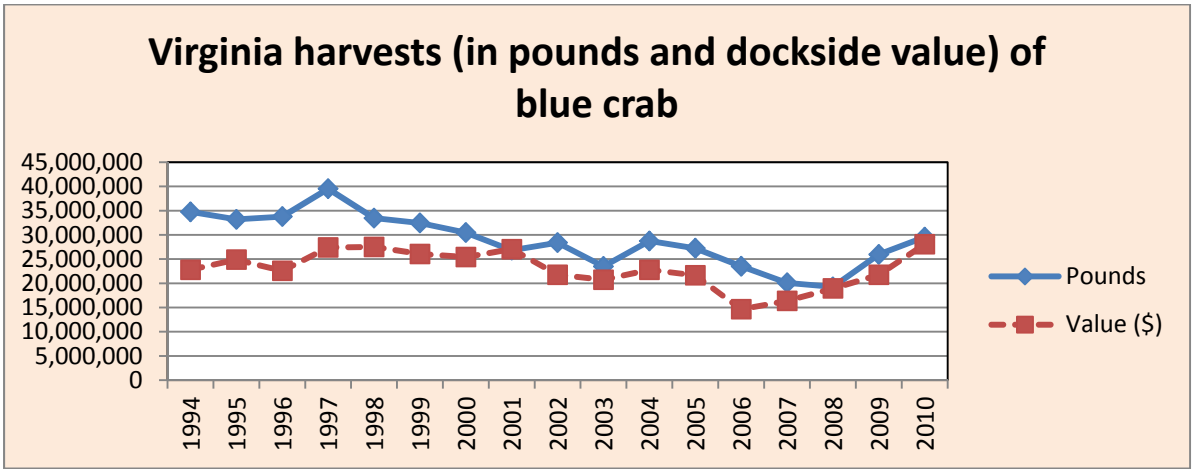
MSY could result in negative impacts on the stock status. A determination of MSY, which should be an estimate based upon the best scientific information available, is a biological measure necessary in the development of optimum yield, and optimum yield is prescribed by the Code of Virginia:

§ 28.2-203. Commission to prepare fishery management plans; standards:
Any fishery management plan prepared, and any regulation promulgated to implement the plan, shall be consistent with the following standards for fishery conservation and management:
1. Conservation and management measures shall prevent overfishing while achieving the optimum yield from each fishery. The "optimum yield" of a fishery means the amount of fish or shellfish which will provide the greatest overall benefit to the Commonwealth, with particular reference to commercial fishing for food production and to recreational fishing.

Harvest and Effort Statistics

The estimated 2010 Bay-wide crab commercial harvest was 89 million pounds or about 65% higher than the estimated 2009 Bay-wide crab harvest of 55 million pounds. The recreational harvest was estimated as 7.1 million pounds. It is evident that the high abundance of recruits (345 million age-0 crabs) and spawning-age crabs (315 million) in 2010 allowed for such a large Bay-wide harvest. The 2010 Bay-wide harvest was the third highest harvest of the last 22 years and the highest since 1993 (107 million pounds). The largest increase among the Chesapeake Bay jurisdictions occurred in Maryland, as the Maryland commercial crab harvest nearly doubled from 28.5 million pounds in 2009 to 53.4 million pounds in 2010. In 2010 the commercial crab harvest reported in the jurisdictional waters of the Potomac River Fisheries Commission was 4.5 million pounds. Bay-wide recreational harvest (7.1 million pounds) was estimated as a fraction (8%) of the total commercial harvest. Combining these categories, approximately 96.6 million pounds were harvested from Chesapeake Bay and its tributaries during the 2010 crabbing season.

Virginia crab harvests averaged just less than 26 million pounds from 1999-2008. The 2006-2008 harvests were lower, on average, and the 2007-2008 harvests were very low, at just near 20 million pounds, with the total 2008 harvest as 19.3 million pounds, as shown below:



The Commission was aware that Virginia harvests would increase after 2008, as abundance increased from the 2008 conservation measures that achieved a 34% Bay-wide reduction in the harvest of female crabs. The 2010 Virginia commercial crab harvest of 29.6 million pounds represents a 14% increase from 2009 but a 54% increase over the 2008 harvest. Total dockside value (first sale from harvester) increased by $9.2 million, from a 2008 dockside value of $18.9 million to $28.1 million. Table 2 shows the last three complete years of crab harvest data, for all Virginia tidal waters, according to market category (hard crabs and peeler crabs).

Table 2. Pounds harvested by market category, 2008-2010

YEAR	Hard Crab	Peeler Crab
2008	18,266,809	990,588
2009	24,999,155	953,895
2010	28,644,673	964,117

The crab pot fishery has accounted for nearly 96% of the total crab harvest from Virginia tidal waters since 2009. This gear type harvests primarily hard crabs (99.7%), with a small amount of peeler crabs in the total annual harvest. The sex composition of the crab pot harvest in 2009 and 2010 was 63% female crabs and 37% male crabs. Concerning effort in this fishery, the number of trips increased substantially from 46,453 harvest trips in 2008 to 57,904 trips in 2009. The number of trips in 2010 was slightly lower than in 2009 at 55,489 trips. Pounds of harvest per trip from the crab pot fishery increased from 376 pounds in 2008 to 428 pounds in 2009. For the 2010 crab pot season, the average harvest per trip was 511 pounds (nearly 13 bushels of crabs). The number of active harvesters was 885 (2008), 1010 (2009) and 934 in 2010. Total dockside value increased each year, since 2008. The 2008 dockside value was $16.4 million, while the 2009 first-sale value was $19.4 million. In 2010 the dockside value was $26.2 million. The average per capita dockside earnings by crab pot fishermen increased from $18,595 (2008) to $19,242 in 2009 and $28,092 in 2010.

The peeler pot fishery harvested mainly (75%) peeler (molting) crabs in 2009 and 2010, with 25% of the peeler pot harvest as hard crabs. Roughly, there are five peeler crabs to the pound, and in terms of numbers of crabs harvested, this fishery has accounted for seven to ten percent of the total in previous years. On average in 2009 and 2010, the peeler crab harvest accounted for 6 percent of the total harvest (in numbers). There are few opportunities to obtain sex composition from the peeler pot fishery, and Chesapeake Bay managers estimate the composition as 50% for each sex, based on fishery-independent trawl survey samples. There were 11,648 peeler pot trips in 2008. In 2009 there were 14,750 trips, and the 2010 peeler pot fishery consisted of 12,819 harvest trips. The per trip average harvests were 82 pounds, 66 pounds and 82 pounds, from 2008 through 2010, respectively. The number of active peeler pot harvesters has fluctuated from 342 (2008) to 438 (2009) and 361 in 2010. Total dockside value by year was $1.6 million (2008), $1.9 million (2009), and $1.6 million in 2010. The average per capita dockside earnings by peeler pot fishermen has decreased from $4,665 (2008) to $4,361 (2009), and increased to $4,503 in 2010. The peeler pot fishery does not seem to have responded to the increased abundance in recent years, as the crab pot fishery did. However, a major portion (50 – 55%) of

this fishery occurs in May, and bad weather events (especially wind) can impact the May harvest.

Preliminary 2011 data indicate an increased harvest of crabs may occur compared to the 2010 harvest. This is of some concern to the Commission because the overall abundance was 30% less in 2011 than in 2010, and a Bay-wide harvest in 2011 that equals the 2010 crab harvest could result in an overage of the exploitation target.

The harvests from 2009 and 2010 have provided a needed economic boost to industry members, but the crab industry continues to face economic challenges. Competition for markets from our neighboring states, as well as imported product from many different countries, limits economic advances. Even the recent upturn in abundance of crabs will not translate into a large increase in harvest because there are only a handful of picking houses in operation, and foreign (H-2B) workers are scarce at some sites each year to assist the crab-picking operations. The H-2B non-agricultural temporary worker program allows U.S. employers to bring foreign nationals to the United States to fill temporary nonagricultural jobs. Further, Virginia does not have the abundance of larger male crabs that end up in the lucrative basket trade. Virginia harvests are dominated by female crabs. All of these factors prohibit full capitalization of increased abundance.

Commission Blue Crab Conservation Actions in 2011

The Commission met in July, August and September 2011 concerning blue crab issues, proposals from its industry advisory committee (Crab Management Advisory Committee) and conservation recommendations by its staff. At its September meeting the Commission held a public hearing on all issues pertaining to blue crab. The main issues for decision by the Commission included a proposed closure of the 2011-2012 winter dredge fishery season and whether to reinstate licenses to 320 former crab fishery licensees who are on a waiting list because they were inactive during an entire four-year period (2004-2007).

The Commission was briefed by its staff on abundance and removal rates, harvest and effort statistics, the new stock assessment findings and recommendations, requests by its advisory committee, and comments on the issues provided by the public.

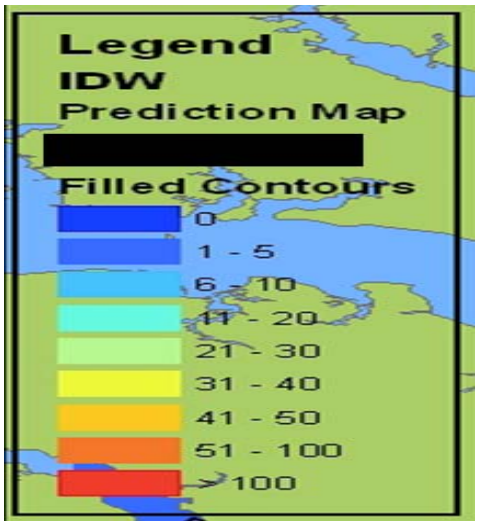
From a blue crab biological perspective, research scientists at Old Dominion University propose that the conservation measures implemented in 2008 and continued through 2011 have provided positive benefits to the blue crab stock. These scientists state that: while there was a general trend toward increased reproductive output in the Chesapeake Bay population, from 2005 through 2010, the strong increases in population fecundity are associated with the new harvest regulations adopted by the VMRC. While it is possible that there is no cause and effect here, the long-term decline in population abundance and fecundity prior to the change in regulations suggest otherwise. While the new level of reproductive output is highly improved, the number of eggs per brood has not yet reached the levels seen in the 1980's when the baseline was established. This suggests that continued restrictions on harvest pressure are need in the near future. Additional genetic evidence supports that argument (see Attachment II).

The Commission has closed the winter crab dredge season, one season at a time, since the December 1, 2008 through March 31, 2009 crab dredge season. The Crab Management Advisory Committee (CMAC) recommended the dredge season be reinstated, with a 30-bushel limit per harvester and a 27-day season during December 1, 2011 through March 31, 2012. The CMAC did not offer a conservation equivalency plan to compensate for the mortality source of dredging, and that was a major flaw in this proposal.

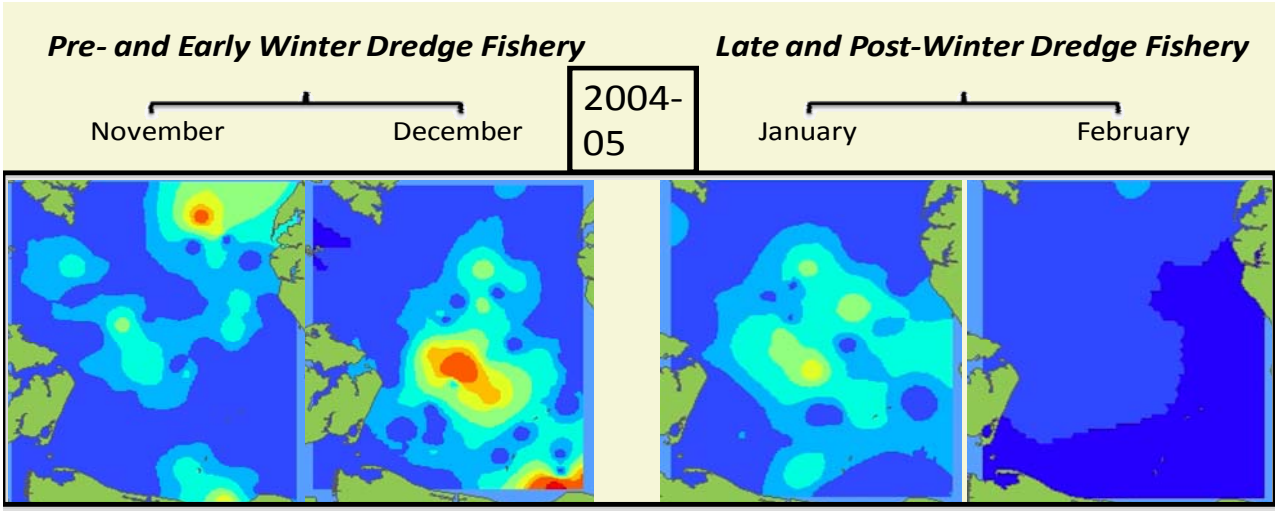
In September 2011, the Commission voted to continue this crab dredge season closure for the fourth consecutive season (2011-12). The justifications for the closure of the 2011-12 season were as follows:

- CMAC offered no conservation equivalency plan for opening the dredge fishery from December 1 through January 31 for 27 days, at 30 bushels per harvester per day.
  - Examples of ways to offset female crab harvest: Sanctuary closure of May 1 instead of May 15 and a reduction in the fall crab pot season or just a longer closed fall crab pot season (would affect many harvesters)
- An abundance of latent effort exists in crab pot and peeler pot fisheries and in most years since 1994, there was an excess capacity in these fisheries; conservation equivalency was essential.
  - In the 2010 crab pot fishery: 76% of eligible licensees were active
  - In the 2010 peeler pot fishery: 61% of eligible licensees were active
  - Any 2011 active harvesters are able to increase their effort
- Challenges to the 2011 exploitation rate already exist, without adding effort and harvest.
  - Need approximately a 25% decrease from the 91 million pound Bay-wide harvest of 2010 in 2011 to attain target exploitation rate
  - Potentially high Virginia 2011 harvest based on March-May which are equal to March-May 2010 harvest (when overall crab abundance was 43% higher)
  - Lower abundance in 2011 from 2010 (24% fewer age-1+ female crabs and 40% fewer age-0 female crabs). Many age-0 crabs can be exploited before 2012.
- At this time, the public is not assured that the economic benefits of the crab dredge fishery justify the potential negative impacts to the stock.

VIMS presented documentation to the Commission of the effects of the dredge fishery on the abundance of crabs, as compared to the seasons when the dredge fishery has been closed. As shown in the key below, the orange to red colors denote high densities of female crabs within the lower Bay during winter. The last crab dredge season was December 2007 through March 2008, and these figures are results from the Bay-wide Winter Dredge Survey.

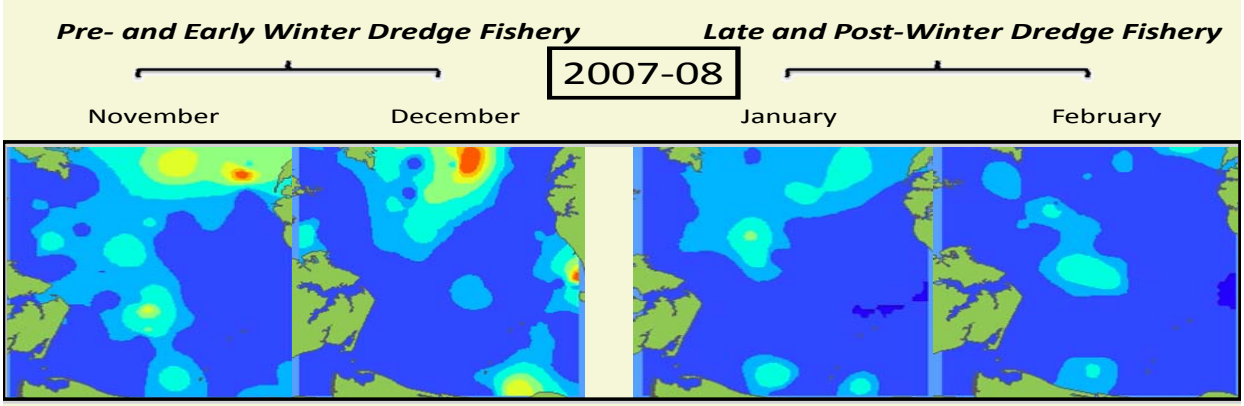


The following three figures show the progression of crab abundance from November through February in 2005 and 2008 (when the crab dredge fishery was active), and 2011 (the third consecutive winter the dredge fishery season was closed). The presence of crabs through February in 2011 is evident.



Note: Different random stations are sampled each month, such that the peaks of abundance will not necessarily be in the same locations each month.

These display the annual reductions in crab densities due to the winter dredge fishery from November-December through January-February. These years (2005 and 2008) are typical of years when crabs are moderately abundant, and show the potential of the winter dredge fishery to impede population recovery.



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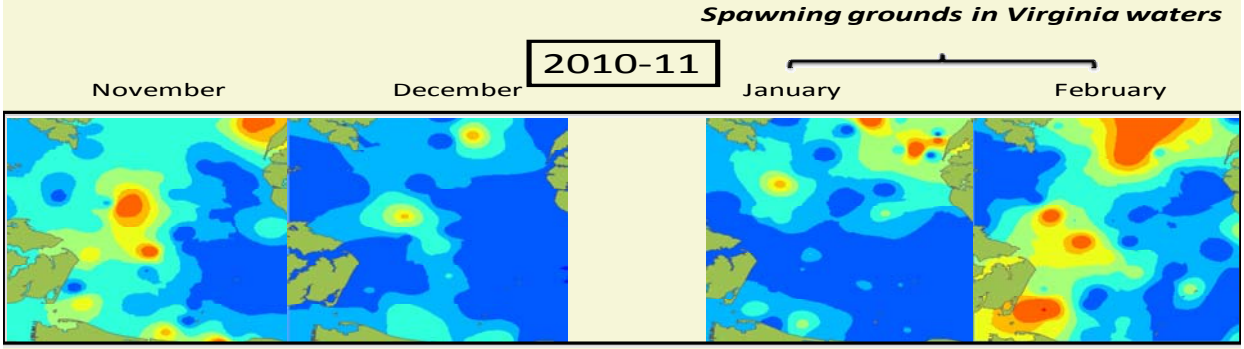


Old Dominion University blue crab research scientists indicate that a continuation of the current blue crab regulations especially the ban on winter dredging of the next year's spawning stock is supported by the data collected by various reproductive studies. These research scientists note that, while the reproductive output of the Bay population has increased, further improvements are needed, especially in light of the fact that the fishery is based on a single year class. Any catastrophic event that affects reproduction could result in a population collapse (see Attachment II).

The Commission continues to acknowledge the waste (damage) of crabs in this fishery, as past studies have determined as much as 24% of on-board dredged crabs are damaged and

unmarketable. The amount of crabs damaged and discarded on the substrate bottom remains unknown. The dredge fishery primarily exploits over-wintering pregnant female crabs, and it accounted for roughly 13% of female crab harvest on a seasonal basis. The new 2011 stock assessment indicates that the most recent (2011) estimate of female age-1+ abundance is not above the target of 215 million age-1+ female crabs. Because the stock cannot yet be considered fully repaired, the dredge fishery that removes overwintering female crabs poised to spawn in spring or summer remains closed for the fourth season. Additionally, there continues to be strong public support against this fishery. The Commission received approximately 50 public comments from concerned citizens as well as the Chesapeake Bay Foundation and other organizations in opposition to the reopening the crab dredge season.

Of the 53 former dredge fishermen (those active in 2007-08), 48 are currently licensed in the commercial crab pot fishery, and of those, 47 have been active in that fishery. There certainly is an indication that the Commission's recent blue crab management plan has benefited these and other fishermen, as an increased abundance leads to increased harvests and income. Despite the dredge season closures, the 53 former limited entry crab dredge licensees have recouped their harvest losses (pounds) in a short time. Aggregate income from blue crab gear fisheries for these 53 individuals was $2,848,166 in 2007, when the dredge season was open January-March and December, and 36 of the 53 individuals fished crab pots, while 52 individuals had crab dredge harvests in 2007. In 2009, the aggregate income of these same 53 individuals was $2,442,215, and 44 of 53 individuals fished crab pots. By 2010, the aggregate income was $3,430,902, and 47 individuals had crab pot harvests (see table below). On an individual basis, 25 of 53 individuals earned more from crab harvests in 2010, as compared to 2007. Accounting for inflation of 102% or 108% x 2007 value, for 2009 and 2010 values, respectively, indicates the 2010 aggregate income was substantially greater than the 2007 aggregate income.

Comparison of crab harvests (pounds), by 53 crab dredge fishermen of record (February 2008) to years when the fishery has been closed.

A			Pounds and % of total, by gear			
	Year		Peeler pot	Crab pot	Crab dredge	All gears
	2007	Pounds	9,170	2,790,079	1,426,805	4,228,890
		% Total	0.2	66	33.7	100
	2009	Pounds	15,619	3,576,879	N/A	3,594,958
		% Total	0.4	99.5		100
	2010	Pounds	10,102	4,408,675	N/A	4,428,246
		% Total	0.2	99.6		100

Comparison of activity, by crab gear type, of 53 crab dredge fishermen of record (February 2008) in 2007 (complete dredge year) to years when the dredge fishery was closed.

B				Gear Type		
		Year	Peeler pot	Crab pot	Crab dredge	
		2007	5	36	52	
		2009	14	44	N/A	
		2010	8	47	N/A	

Concerning the 320 wait-listed licensees, the Commission did not permit the re-instatement of any of these individuals at the September 2011 Commission meeting. Justifications for not reinstating any wait-listed individuals were as follows:

- Results from the recent stock assessment indicate the "interim" target of 200 million male and female age-1+ crabs equals only 104 million age-1+ female crabs, if the sex composition is 52% female
- That 2011 stock-assessment recommended target abundance (215 million age-1+ females) is more than double the number of female crabs of the interim target, and was reached in 2010 (251 million) but not in any other recent year including 2011
- Lower age-0 and age-1+ female crab abundance in 2011 from 2010:
  - Decrease in both female age-1+ crabs by 24%, and female age-0 crabs by 40%
- Latent effort of those not on a waiting list but eligible for licenses already poses an overfishing threat:
  - Only 62% of those on crab pot waiting list were active between 2000-2007 and 61% of those on peeler pot waiting list were active between 2000-2007

Individuals placed on the waiting list reported no crab harvest from 2004-07, and many of these individuals were also inactive in 2000-03 as well. CMAC recommended that (currently) full-time watermen from the waiting list be permitted to re-enter the crab fisheries before anyone else. The table below shows the activity (by number of licensees) of wait-listed individuals from the crab pot waiting list (top) and peeler pot waiting list (bottom). Six crab pot licensees and eight peeler pot licensees were considered full-time watermen in other fisheries in 2008-10, and also reported some crab harvest in 2000-03 (the years preceding the wait listing period). However, the Commission chose to not allow these 14 individuals to be reinstated at this time.

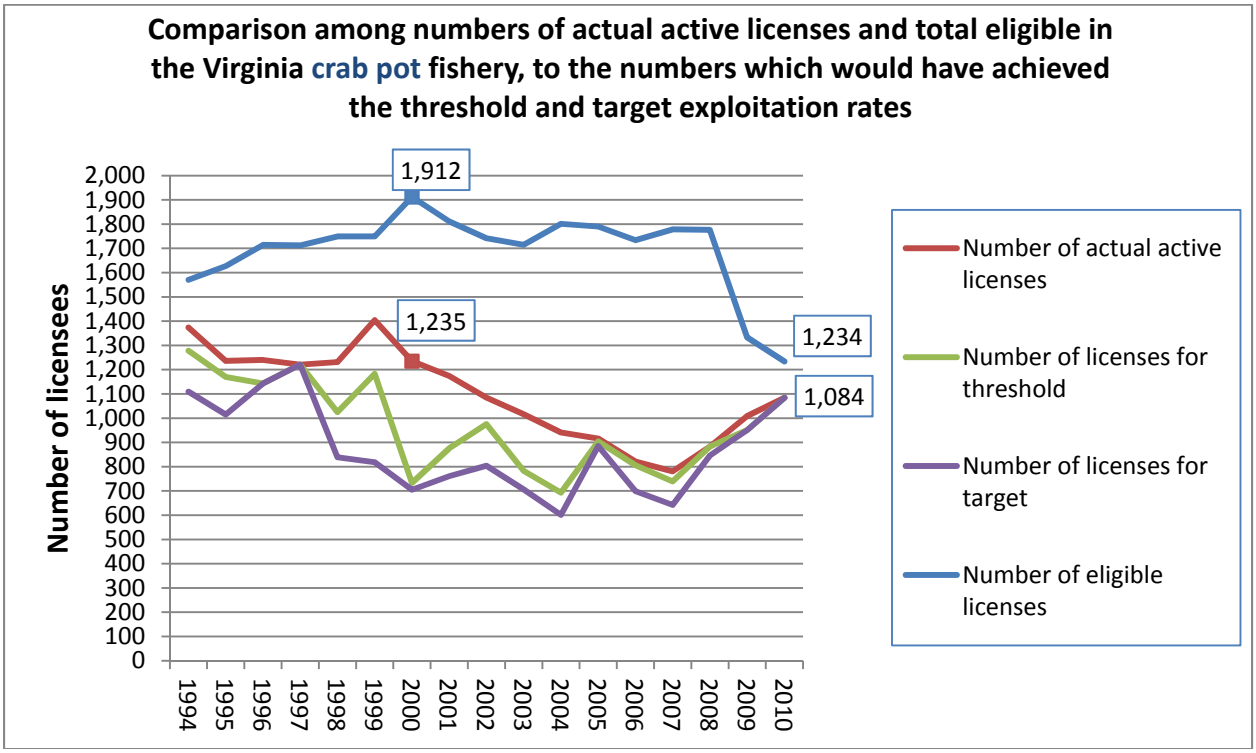
Crab Pot Waiting List Activity		2008-2010 Activity in Fisheries other than Crab		
		Full-Time (Average more than 100 Days Worked)	Part-Time (Average Less than 100 Days)	No Activity (No Days Worked)
2000-2003	Crab Activity	6	28	36
	No Crab Activity	23	30	67

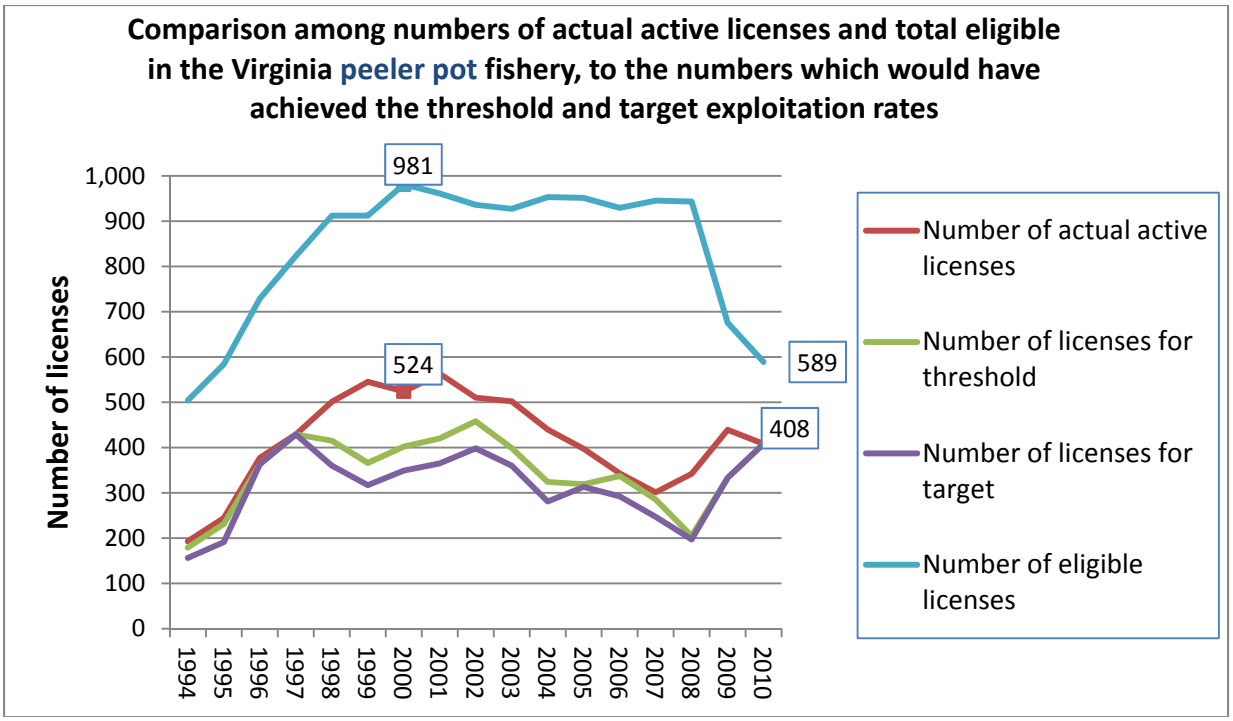
Peeler Pot Waiting List Activity		2008-2010 Activity in Fisheries other than Crab		
		Full-Time (Average more than 100 Days Worked)	Part-Time (Average Less than 100 Days)	No Activity (No Days Worked)
2000-2003	Crab Activity	8	26	17
	No Crab Activity	15	39	25

Two individuals are on both waiting lists with crab pot and peeler pot activity in 2000-2003 and were full-time harvesters in 2008-2010.

The issue of eligibility remains a problem in the crab pot and peeler pot fisheries. In both fisheries, individuals who retain eligibility, but have been recently inactive, can purchase a license and begin harvesting at any time. This potential additional effort, combined with any effort from the re-entry of wait-listed individuals, could undermine the effort reductions that have occurred since 2008 and overcapacity could increase. Any additional effort of consequence added to the fishery, whether from the waiting list or the other pools of potential effort can easily lead to overfishing, especially in 2011, as the harvesting effort that would occur from the release of wait-listed licensees must be considered in light of the new science-based stock assessment.

As determined by the capacity analysis performed earlier this year by Dr. James Kirkley (VIMS), 2010 was the first year since 1997 that the amount of active effort (licenses) in the crab pot and peeler pot fisheries did not exceed the amount of effort required for overfishing. The two figures below show effort in both pot fisheries has increased since the recent management plan was initiated in 2008. That increase in effort tracks the increases in abundance, overall, since 2008, but the increase in effort was not enough to cause overfishing or to exceed the exploitation target. As Dr. Kirkley has shown, most years, except 1997 and 2010, can be characterized as a poor fit between capacity of licenses and harvest, as most years' harvests have been associated with too much active effort. For this reason, increases in active effort from the pools of latent effort can easily outstrip the relative increase in stock abundance the last two years.





The Commission has been concerned for crab harvesters' social and economic welfare. Thirteen former dredge fishermen were allowed to leave the crab pot waiting lists to purchase crab pot or peeler pot licenses. The Commission has provided an average of $17,000 to 47 of these 53 individuals that have participated in the Derelict Blue Crab Pot and Marine Debris Removal Project sponsored by VMRC and VIMS for each of the last three years. A request for a disaster assistance evaluation in 2008 from the National Marine Fisheries Service, and for a subsequent three-year period, was based mainly on commercial fishery losses (harvest opportunities) due to adverse environmental conditions in Chesapeake Bay. Following the successful petitioning of the National Marine Fisheries Service (NMFS) in 2008 by Commissioner Steve Bowman and the Director of the Maryland Department of Natural Resources to declare a blue crab fishery disaster, Virginia was awarded $14,995,000 in disaster relief funds (Attachment IV).

The Commission implemented a set of six projects, starting as early as December 2008, with the Derelict Crab Pot and Marine Debris Removal Project. The remaining five projects were initiated in 2009, and two will continue into the winter 2011-12. These projects have provided opportunities for 288 eligible crab licensees to participate in resource or habitat conservation projects. A truncated Derelict Blue Crab Pot and Marine Debris Removal Project will be in effect starting this December, as only 22 days per participant (70 total participants last year) is presently funded. Continued oyster aquaculture opportunities, provided to previous crab licensees, will also continue in 2012.

Ecosystem Constraints on the Blue Crab Resource

§28.2.203.1 of the Code of Virginia provides that the Blue Crab 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. Concerning environmental stress and habitat deterioration, the Commission relies on the efforts of its sister agencies to promote and sponsor improvements in the Chesapeake's water quality.

The Commission and the industry recognize that improvements in blue crab habitat and water quality could increase the probability for improved recruitment to the stock and the fisheries; however, many water quality and habitat impacts on this stock are not fully quantified or understood, and the relationship of blue crab among other components of the ecosystem is still being explored by Chesapeake Bay scientists. Many natural and man-induced impediments continue to challenge the stability of the blue crab stock, including hypoxia (low oxygen levels in the water), loss of seagrass beds, shoreline development and pollution.

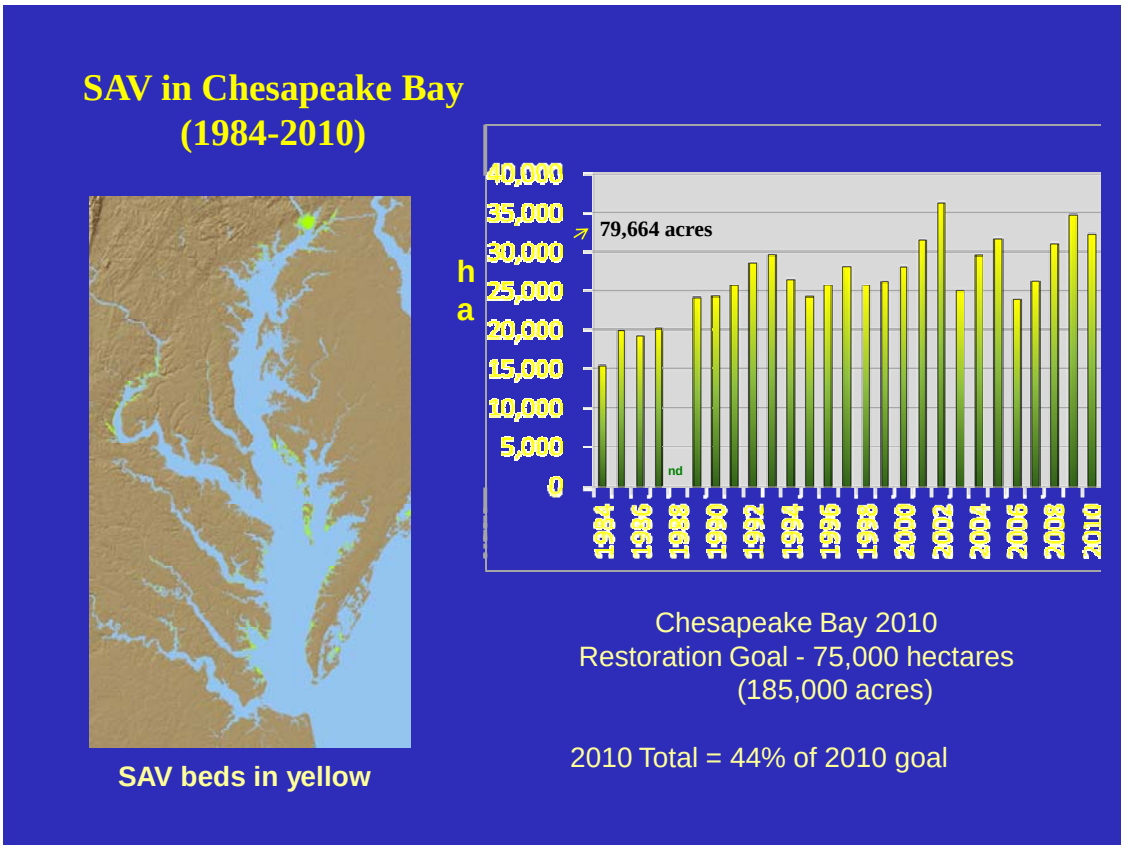
These negative environmental conditions include the catastrophic loss of essential habitat, a decline in water quality, an overabundance of native and non-native predators, and the decimation of key prey species for the blue crab. Nutrient enrichment and the systemic increase of hypoxic and anoxic zones within the Chesapeake Bay are cited as potential contributors to the sustained (1998 – 2008) low abundance of blue crab. Dead zones, hypoxic areas where oxygen is so low that organisms cannot survive, tend to develop in quiet, deep water several miles offshore where rivers dump rich plumes of nutrients into stratified water. When this water does not mix, oxygen is not replenished in the lower half of the water column, affecting the growth, reproduction and immune responses of benthic organisms (including the blue crab). The deep waters of the Chesapeake's main stem, as well as some of its tributaries, experience this hypoxia every summer.

In addition to depressed levels of oxygen in the Chesapeake Bay, the near-elimination of seagrass beds has also likely impacted the blue crab stock. Seagrass beds provide nursery habitat for newly settled, young juvenile and mating blue crabs. Since 2001, the Commission has approved a set-aside area for seagrass restoration in South Bay. In 2006, this area was expanded to total 727.85 acres of protected area. The South Bay set-aside area has developed into one of the largest eelgrass beds in the lower Delmarva Peninsula and is now self sustaining. In 2011, the Commission voted to protect this set-aside area for an indefinite amount of time. Dredging is also prohibited in the protected area.

An annual aerial submerged aquatic vegetation (SAV) monitoring program has been conducted throughout the Chesapeake Bay and its tributaries since 1984. In September 2011, Dr. Robert Orth (VIMS) provided the Commission with an update of the completed 2010 SAV status survey, and also emphasized the importance of reducing human-induced damages to SAV. Threats to SAV recovery in Virginia include water quality degradation, propeller scarring, and climate change (including increased rainfall events and rising water temperatures). Crab dredging has also been linked to damaging SAV beds.

The 2010 Chesapeake Bay Program restoration goal for SAV in the Chesapeake Bay was 185,000 acres. During the 2010 SAV survey, 79,675 acres (44% of the goal) were mapped. This was a 7% decline from the 2009 SAV survey of 85,914 acres. In order to continue restoration, propeller scars that damage SAV beds and water quality must be monitored. An interactive map

of SAV distribution mapping with interactive charts can be accessed at the following web address: http://web.vims.edu/bio/sav/maps.html.



The protection and enhancement of blue crab habitat continues in 2011 with the transition from traditional, single-species management to ecosystem-based management in the Chesapeake Bay. The Ecosystem-Based Fisheries Management (EBFM) project, consisting of 85 scientists, stakeholders and managers within and beyond the Chesapeake Bay region, has made progress in assessing the interconnections between important Bay species, their physical environments, and human influences. The goals of the EBFM project include building a sustainable mechanism for addressing ecosystem issues for fisheries within the Chesapeake Bay, and developing ecosystem-based tools and fishery management plans for key species, including the blue crab.

The EBFM project is guided by the Sustainable Fisheries Goal Implementation Team (GIT), which in 2011 continues to facilitate coordination between the Bay jurisdictions and develop a transitional framework. The GIT has identified research needs pertaining to blue crabs, including a comprehensive, Bay-wide recreational crab survey and an integrated Bay-wide fishery-dependent crab survey. As part of this effort, a Blue Crab Species Team consisting of blue crab experts assembled to identify the critical ecosystem stressors impacting blue crabs in the Chesapeake Bay. These blue crab ecosystem issue briefs were distributed to VMRC and MD DNR staff for review prior to publication, and were circulated to fishery managers and scientists in the Chesapeake Bay region.

Water quality issues in the Chesapeake Bay are of top priority with the establishment of Executive Order 13508. Despite extensive restoration efforts during the last 25 years, water

quality in the Chesapeake Bay cannot be considered acceptable under state water quality standards or the Clean Water Act's criteria to be "fishable and swimmable". The Executive Order established a Federal Leadership Committee, which it directed to publish an annual Chesapeake Bay Action Plan. The Fiscal Year 2011 Action Plan can be found at the following website:
http://executiveorder.chesapeakebay.net/file.axd?file=2010%2F9%2FChesapeake+EO+Action+Plan+FY2011.pdf.

The Commission has been committed to working to achieve goals that have been in place since the establishment of Chesapeake 2000 (C2K), including that of restoring the blue crab fishery to a healthy spawning biomass and to establish harvest targets for the fishery. Overfished and overfishing targets for the blue crab fisheries have been in place since 2001, and were refined with the establishment of the interim target abundance of spawning-age crabs and then with the 2011 stock assessment target. While spawning-age female crab abundance declined below target in 2011, their abundance did surpass the target the previous year (2009-10 winter survey), and that marks the first time the original C2K goal of a healthy spawning stock biomass was met.

ATTACHMENT I. Virginia Marine Resources Commission: Actions to Promote Rebuilding of Chesapeake Bay Blue Crab Stock, 2008 – 2011.

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 2008/09 winter dredge fishery season
- Required use of two 3/8" cull rings for all areas (except Seaside of Eastern Shore) effective July 1
- Eliminated 5-crab pot recreational license
- Revamped revocation procedures, to allow a hearing after just two crab violations in a 12-month period

November 2008

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

May 2009

- Shortened closed season for female crabs to November 21 - November 30
- Closed 2009/10 winter dredge 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)

April 2010

- Changed closed season on harvest from Virginia Blue Crab Sanctuaries from May 1 to May 16

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 2010/11 winter dredging 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 2011/12 winter dredging season
- Established 5-day maximum tending requirement for crab pots and peeler pots

ATTACHMENT II. Blue Crab Reproductive Biology: A Summary of Studies Conducted by Drs. John McConaugha and Shannon Wells, Department of Ocean, Earth and Atmospheric Sciences, Old Dominion University

It is now generally accepted that both abiotic and biotic interactions can alter the phenotypic expression in individual animals and populations. Phenotypic plasticity allows a single genotype to respond to its environment producing phenotypes that are well adapted to current conditions. For any given individual there is a range (Reaction norm) of responses to changing environmental conditions that leads to the expressed phenotype. High levels of predation or commercial exploitation have been shown to alter the reproductive patterns of numerous fin and shellfish species. These changes often include reduced age and size at maturity.

The blue crab is a heavily exploited species in Chesapeake Bay. In general there is only 1 year class in the fishery and over exploitation could lead to a sudden decline. Historically the blue crab in Chesapeake Bay has displayed raid fluctuation from year to year most likely associated with variation in larval/juvenile recruitment from the offshore nursery grounds. In 1993 the population as measured by harvests declined sharply and remained low for the next 15 years. Associated with this decline in abundance there was a decline in the size of mature female crabs (VIMS trawl survey) with mature females as small as 60mm (Figure 1) being taken in the winter dredge fishery. In 1998 we hypothesized that this reduction in female size was a phenotypic response to the heavy exploitation (60-70% exploitation of the female population) in the Bay. The end point of this reaction norm was the 60mm, <1 year old mature females that were found in the winter dredge fishery. In an effort to examine the interaction between exploitation, female size, fecundity and egg size we under took a long-term study of these parameters in the Bay population.

We currently have 7 years of data measuring female size, number eggs/brood, egg diameter, lipid content, protein content and total energy per egg. The data clearly show differences both within and between years. These data can be compared to a bench mark of egg number/brood and egg diameter from 1986-87 spawning seasons (Prager et al., 1990). The bench mark data taken during a period of high crab abundance showed a mean size for mature females of 145 mm, fecundity of 3.6×10^6 eggs/brood and a mean egg diameter of 240 µm. Egg lipid and protein were not measured in the earlier study. In comparison all of these parameters varied widely from 2002 to 2010 (Table 1). Mature female size range from 131.3 mm in 2002 to 143.2 mm in 2010. In general female size increased over the study period and has approached the mean size of females in the benchmark years. Eggs/brood data also showed a continuous climb from a low point in 2002 of 3.7×10^5 to 1.52×10^6 in 2010. While the number of eggs/brood has steadily increased the high number in 2010 is still only half of the number of eggs/ brood found in the benchmark study.

Egg size also varied with eggs/brood. In 2002 when fecundity/female was the lowest, egg size was large at 252 µm (Table 1). As egg number/brood increased over the next 4 years egg size was significantly smaller ranging in size from 205-230 µm. In 2010 when eggs/brood reached their highest levels, egg size exceeded that of both 2002 and the baseline suggesting that there was sufficient energy to produce large brood numbers and large energetic eggs. The benchmark study also reported a size fecundity relationship for Bay population of blue crab. When this size

fecundity relationship was applied to the data from 2002 to 2010 it was found that females were producing significantly fewer eggs/brood than this equation would have predicted. So the decline in egg numbers could not be directly related to the decline in female size. Other factors were acting to further reduce the reproductive output for the Bay crab population.

As a result of this observation we examine the energy content of the eggs both intra- and inter-annually. We have lipid and protein data for 2005-07 and 2010. Inter-annually there was a significant change in total energy/egg as well as lipid and protein content. Total energy increased each year from 2005 through 2010 (Table 2) with total energy approximately twice as large in 2007 and 2010 compared with the 2005 data. Intra-annually there was a general trend toward high total lipid energy in the first month of the spawning season and declined throughout the season. As lipid energy declined, protein content and energy derived from protein increased in the eggs. There was a slight increase in lipid energy late in the spawning season possibly associated with primiparous females entering the spawning stock.

Comparing egg size and energy content there is a clear pattern of increased energy per egg with larger eggs. In 2005 when lipid, protein and total energy per egg was the lowest of the entire study (table 2) egg size was the smallest. As egg size increased (2006, 2007, 2010) energy levels/ egg increased and nearly doubled in the last 2 years. While there was a general trend toward increased reproductive output in the Chesapeake Bay population throughout the study period, the strong increases in population fecundity are associated with the new harvest regulations adopted by the VMRC. While it is possible that there is no cause and effect here, the long-term decline in population abundance and fecundity prior to the change in regulations suggest otherwise. While the new level of reproductive output is highly improved, the number of eggs per brood has not yet reached the levels seen in the 1980's when the baseline was established. This suggests that continued restrictions on harvest pressure are need in the near future. Additional genetic evidence supports that argument.

It is generally accepted that female blue crab molt to maturity while being mated guarded by a mature male crab. The male mates with the female and then continues to mate guard until the female is no longer receptive. Using micro-satellite DNA markers, we determined the number of males mating with each mature female crab. The results indicate that 98% of the females sampled in the Chesapeake Bay have mated multiple times, with the majority having mated with more than two males (Figure 1). Even with multiple males contributing to the sperm reserves of most females, sperm limitation may still be a factor affecting reproductive output. We based this assessment on the low numbers of potential broods that could be produced with the number of available sperm. In a number of studies female blue crabs can produce 8-10 broods while held in captivity. Given the number of sperm found in the females spermatheaca, 52% of the sampled population only have enough sperm to produce $\leq$6 broods. 23% can only produce $\leq$3 broods. Only 39% can produce 8+ broods (Figure 2).

A continuation of the current blue crab regulations especially the ban on winter dredging of the next year's spawning stock is supported by this data. While the reproductive output of the Bay population has increased, further improvements are needed, especially in light of the fact that the fishery is based on a single year class. Any catastrophic event that affects reproduction could result in a population collapse(see Attachment II).

Table 1 Mean Reproductive Output and Egg Size for 2002-07, 2010

Year	Mean Carapace Width (mm)	SE	Mean Number of Eggs ($x10^5$)	SE ($x10^5$)	Mean Egg Diameter (μm)	SE
2002	**131.3**	**0.27**	**3.7**	**0.25**	**252.00**	**1.55**
2003	**134.1**	**0.14**	**4.3**	**0.19**	**224.84**	**1.58**
2004	**128.6**	**0.10**	**9.6**	**0.28**	**204.95**	**0.63**
2005	**133.8**	**0.07**	**9.1**	**0.24**	**205.63**	**1.10**
2006	**137.5**	**0.11**	**13.1**	**0.65**	**229.75**	**1.55**
2007	**136.0**	**0.12**	**11.1**	**1.07**	**258.71**	**1.42**
2010	**143.2**	**0.06**	**15.2**	**0.8**	**257.37**	**0.06**

Table 2 Intra- and Inter-annually Egg Energy based on Lipid and Protein Content

Sampling Period	Mean Lipid Conc. (μg)	Lipid Energy (J) per egg	Mean Protein Conc. (μg)	Protein Energy (J) per egg	Total Energy (J)
Jun-05	1.58	6.15×10^{-2}	2.97	6.83×10^{-2}	12.98×10^{-2}
Jul-05	1.77	6.89×10^{-2}	2.25	5.18×10^{-2}	12.07×10^{-2}
Aug-05	1	3.89×10^{-2}	2.91	6.70×10^{-2}	10.59×10^{-2}
May-06	2.75	10.70×10^{-2}	2.9	6.67×10^{-2}	17.37×10^{-2}
Jun-06	2.18	8.48×10^{-2}	2.26	5.20×10^{-2}	13.68×10^{-2}
Jul-06	1.82	7.08×10^{-2}	2.95	6.79×10^{-2}	13.87×10^{-2}
Aug-06	1.55	6.03×10^{-2}	3.46	7.96×10^{-2}	13.99×10^{-2}
Sep-06	1.95	7.59×10^{-2}	3.54	8.15×10^{-2}	15.73×10^{-2}
Jun-07	4.95	19.25×10^{-2}	2.83	6.50×10^{-2}	25.76×10^{-2}
Jul-07	3.3	12.84×10^{-2}	3.93	9.03×10^{-2}	21.87×10^{-2}
Aug-07	4.05	15.76×10^{-2}	4.05	9.32×10^{-2}	25.09×10^{-2}
May-10	1.46	5.69×10^{-2}	6.43	14.8×10^{-2}	20.50×10^{-2}
Jun-10	3.56	13.87×10^{-2}	11.11	25.56×10^{-2}	39.43×10^{-2}
Jul-10	2.98	11.61×10^{-2}	6.84	15.74×10^{-2}	27.35×10^{-2}
Aug-10	2.54	9.89×10^{-2}	4.81	11.06×10^{-2}	20.95×10^{-2}
Sep-10	3.73	14.53×10^{-2}	6.91	15.91×10^{-2}	30.43×10^{-2}

Figure 1. Number of Males mating with Female Blue Crabs

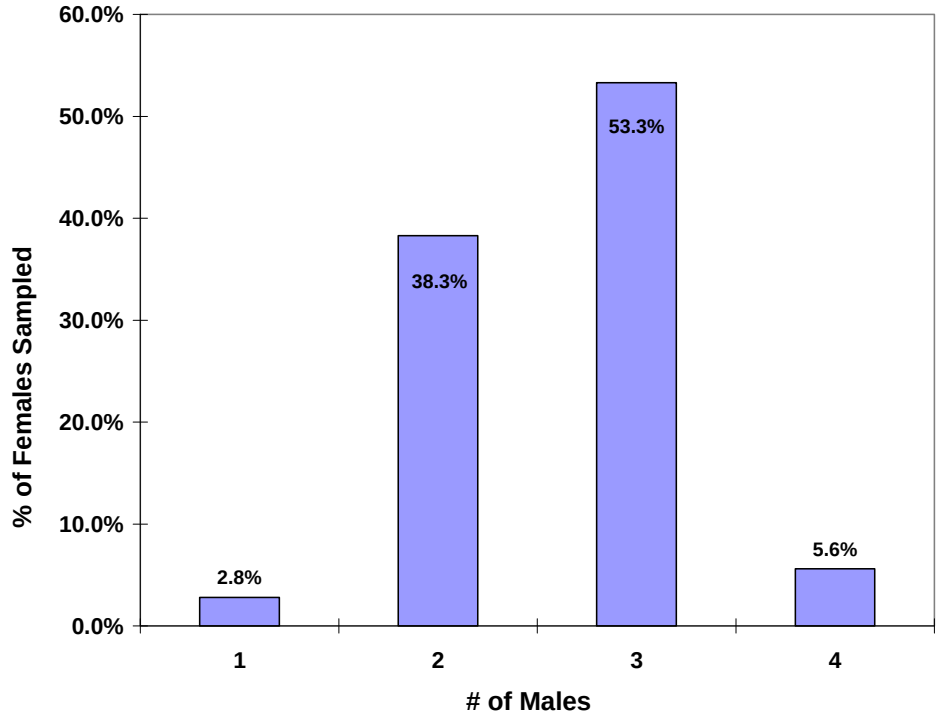
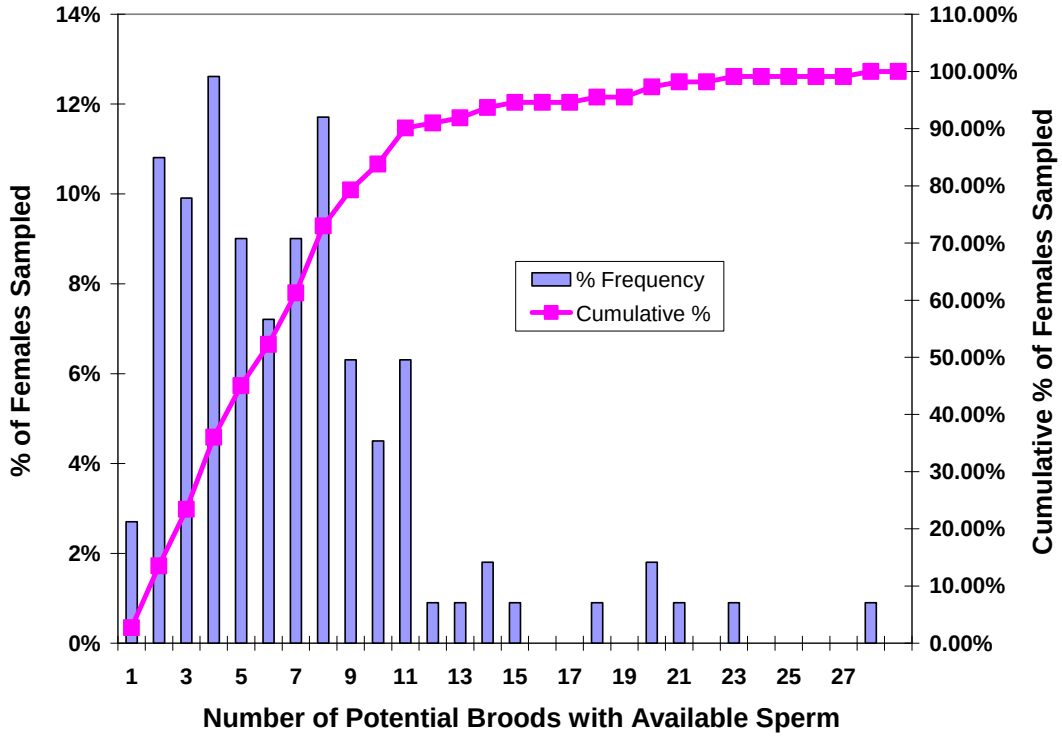


Figure 2. Number of Potential Broods/Female Based on Total Sperm Supply



ATTACHMENT III. 2011 Chesapeake Bay Blue Crab Advisory Report

CBSAC Meeting Date: Sept. 19-20, 2011
Beaufort, NC

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 Northeast and Southeast Fisheries Science Centers of the National Marine Fisheries Service. This group meets each year to review the results of annual Chesapeake Bay blue crab surveys and harvest data, and to develop management advice for the Bay jurisdictions: Maryland, Virginia and the Potomac River Fisheries Commission.

With support from the Virginia Marine Resources Commission, Maryland DNR, and the NOAA Chesapeake Bay Office, benchmark stock assessments of the Chesapeake Bay blue crab have been conducted every 3-7 years since 1992. The most recent assessment, completed in 2011, generated new reference points for the female component of the blue crab population. These MSY-based female reference points are recommended as replacements for the current Maximum Spawning Potential overfishing reference points (Table 1.1). Similarly, the 2011 stock assessment recommends replacing the empirical overfished age-1+ (both sexes) abundance threshold and interim target with an MSY-based threshold and target based solely on female age-1+ crabs.

1.2 Terms of Reference

With the completion of the 2011 benchmark blue crab stock assessment, the Chesapeake Bay Sustainable Fisheries Goal Implementation Team has requested that CBSAC address the following terms of reference within this report:

1) Provide guidance for the management agencies on:
   a. Implementation of the biological reference points developed within the 2011 assessment.
   b. Methods for determining appropriate reference points for the male component of the population.
2) Provide a description of how the reference points recommended under task one differ from the current reference points.
3) Prioritize research needs and science gaps – as identified in the 2011 assessment and Center for Independent Experts (CIE) review.

The second term of reference requesting a comparison of current and recommended reference points is addressed below and stock status is updated according to both sets of reference points. Within this report and future reports, annual updates of population size and exploitation fraction will be calculated directly from the annual results of the winter dredge survey and from annual estimates of harvest and compared to the new reference points. CBSAC has adopted the winter dredge survey as the primary indicator of blue crab population health because it is the most comprehensive and statistically robust of the blue crab surveys conducted in the Bay[2]. The survey measures the density of crabs (number per 1,000 square meters – Figure 1) at approximately 1,500 sites around the Bay. The measured densities of crabs are adjusted to account for the efficiency of the sampling gear and then are expanded to reflect the area of Chesapeake Bay, providing an annual estimate of the number of over-wintering crabs by age and gender[2].

Table 1.1: A comparison of the current (sexes combined) and recommended female-specific biological reference points for Chesapeake Bay blue crab. 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 crabs divided by the total number of crabs (age-0+) estimated in the population at the start of the season. The population estimate is derived from the winter dredge survey. When calculating female-specific exploitation, the annual female harvest is divided by the total number of female crabs (age-0+) estimated in the population at the start of the season. The recommended, female-specific target and threshold abundance refer to the number of female crabs age one and older estimated to be in the population according to the winter dredge survey. The 2011 exploitation fraction cannot be calculated until the completion of the 2011 fishery and estimation of harvest.

		Target	Threshold	2010 Stock Status	2011 Stock Status
Exploitation Fraction	Current	46%	53%	39%	*To be determined*
	Recommended female-specific	25.5%	34%	18%	*To be determined*
Abundance (millions of crabs)	Current	200	86	315	254
	Recommended female-specific	215	70	251	190

2. CONTROL RULES

2.1 Recommended Control Rule from 2011 Benchmark Assessment

The 2011 Benchmark assessment recommends a new framework (control rule) based on biological reference points for the female component of the population (Figure 2). The recommended targets and thresholds for exploitation (U) and abundance (N) were developed using the concept of maximum sustainable yield (MSY). U_{MSY} is defined as the annual rate of exploitation by the fisheries 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 rate that is associated with 75% of U_{MSY} and a threshold set equal to U_{MSY}. The female-specific, age-1+ abundance target and threshold were set accordingly at abundances 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 and age-1+ female crabs estimated to be in the Bay at the beginning of the fishing season. Within this calculation, the juvenile component (age-0) of the total estimated number of crabs was scaled up by a factor of 1.6 to achieve the best fits of the model to the observed data. The recommended target and threshold reference points are presented in Table 1.1 of this document.

2.2 Former Control Rule

The former control rule was adopted by the Bi-State Blue Crab Advisory Committee in 2001[3] and updated in the 2005 Benchmark Stock Assessment[4] (Figure 3). This control rule represents the relationship between removals by fisheries (exploitation fraction) and the number of spawning-age crabs (both sexes combined), compared with established target and threshold reference points for exploitation and abundance. In 2006, the CBSAC defined the minimum safe number (overfished threshold) of spawning-age crabs to be 86 million crabs. This threshold value was applied based on a lack of historical evidence that a sustainable fishery can be maintained at lower abundances than the minimum observed abundance in the Winter Dredge Survey, which occurred in 1999. A threshold or maximum level of exploitation was determined to be 53%, based on the consensus that a minimum of 10% of the spawning potential of an unfished population must be preserved to minimize the risk of recruitment failure and stock collapse. Therefore, if more than 53% of crabs were removed in a given year, overfishing would be occurring. The established target exploitation fraction of 46%, maintained over several years, represents an exploitation fraction that would preserve 20% of the unfished spawning potential.

In January 2008, CBSAC established an interim target of 200 million spawning-age (1+) crabs. This target was established based on analyses suggesting that 200 million age-1+ crabs is the lowest abundance associated with consistently higher levels of recruitment.[5,6] The target level of 200 million was meant to be a goal for initial rebuilding of the stock.

3. POPULATION SIZE (ABUNDANCE)

3.1 Spawning-age Female Crabs: Recommended Reference Points

The 2011 benchmark assessment recommends replacing the current interim target of 200 million total spawning-age crabs with a target of 215 million female spawning-age crabs.

Approximately 190 million female age-1+ crabs were estimated to be present in the Bay at the start of the 2011 crabbing season. This number is below the recommended target but more than twice the recommended threshold number of 70 million female spawning-age crabs (Figure 4). CBSAC notes that, according to the recommended female-specific abundance threshold of 70 million crabs, the blue crab stock would have been classified as overfished for three years between 1999 and 2002 (Figure 4), whereas based on the former control rule the blue crab stock has not been overfished within the last two decades (Figure 5). CBSAC also notes that the estimated abundance in 2011 was lower than observed in 2010. This decline in abundance of age-1+ was the result of substantial over-winter mortality, particularly in Maryland. Approximately 30% of adult crabs estimated to be in the Maryland waters of Chesapeake Bay perished due to a precipitous drop in December water temperature, followed by sustained below-average temperatures for the remainder of the 2010-2011 winter (Figure 6).

3.2 Spawning-age Male and Female Crabs: Current Reference Points

The number of spawning-age crabs (age-1+) is a key indicator of population health and is used to determine if the population abundance is too low (i.e., is overfished - see section 4 – Control Rules). Approximately 245 million spawning-age crabs (sexes combined) were estimated to be in the Bay at the beginning of the 2011 crabbing season (Figure 5). This represents a 19% decrease from the 2010 estimate of 315 million. Despite the mortality event noted above, the number of spawning-age male and female crabs remained above the former interim target of 200 million for the third consecutive year.

3.3 Age-1+ Male and Age-0 Crabs

In 2011, 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 63 million crabs (Figure 7). Although this represents a 70% increase from male abundance in 2008, the number of male crabs remains below the survey average of 87 million crabs. CBSAC notes that male abundance has not increased proportionally to female abundance because the recent management actions promoted recovery and conservation of the female spawning stock. Recruitment, as measured by the number of age-0 crabs (less than 60 mm or 2.4 inches carapace width) appears to have increased, since the female-specific conservation measures were implemented (Figure 8). The number of recruits dropped from 345 million in 2010 to 207 million in 2011 (Figure 8), which was not unexpected given the vagaries of recruitment.

4. HARVEST

4.1 2010 Commercial and Recreational Harvest

The 2010 Maryland commercial crab harvest from the Bay and its tributaries was estimated as 53.4 million pounds. The 2010 commercial harvest in Virginia was reported to be 26.9 million pounds (Figure 9). An additional 4.5 million pounds were reported harvested from the jurisdictional waters of the Potomac River Fisheries Commission. Recreational harvest is assumed to be 8% of the total Bay wide commercial harvest.[7a, b, c] Therefore, the 2010 Bay-wide recreational harvest was estimated to be 6.8 million pounds. Combining these categories, approximately 91.6 million pounds were harvested from Chesapeake Bay and its tributaries during the 2010 crabbing season. This is the highest harvest since 1994, and is 22% above the long-term (1990-2010) average of 75 million pounds.

Based on continued evidence of inflated harvest reports, Maryland's 2010 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 Bay[8]. The difference between Maryland's 2010 estimated harvest of 53.4 million pounds and reported harvest of 57.7 million pounds was less than in the two previous years. However, Maryland's 2010 harvest represents a departure from the historic proportion of each jurisdiction's harvest. In recent years, Maryland's commercial harvest has accounted for approximately 53%, by weight, of the Bay-wide harvest. In 2010, that fraction was 59.7%, affected more so by males, whose catch increased by 92.8% from 2009.

4.2 Exploitation Fraction: Recommended and Current Reference Points.

Despite the elevated 2010 harvest, the percentage of female crabs removed by fishing (exploitation fraction) in 2010 was approximately 18%, well below both the new recommended target of 25.5% and threshold of 34% (Figure 10). When considering the former reference points, the percentage of crabs removed by fishing (exploitation fraction) was approximately 39%, compared to the former target of 46% and threshold of 53% (Figure 11).

5. STOCK STATUS

The Chesapeake Bay blue crab stock is currently not overfished and overfishing is not occurring. This is true according to both the new recommended female-only framework developed in the 2011 Benchmark assessment and the former management framework.

6. TERMS OF REFERENCE

6.1 Provide Guidance for the Management Agencies on Implementation of the Biological Reference Points Developed within the 2011 Assessment.

The CBSAC recommends that the jurisdictions place primary management focus on the female-specific target exploitation fraction. If the annual female exploitation fraction is, on average, equal to the target of 25.5%, the assessment model predicts that female abundance should vary around the target level of 215 million crabs. However, given the uncertainty in the abundance component of the model, jurisdictions should focus primarily on the exploitation fraction when deliberating on management strategies, as long as the abundance of age-1+ female crabs is not substantially lower than the target for consecutive years.

The CBSAC recommends that the jurisdictions adopt the female-specific target and threshold reference points developed in the 2011 Benchmark Blue Crab Stock Assessment. The CBSAC suggests that the recommended female-specific reference points be reviewed in the 2012 CBSAC report, relative to model refinements that were recommended by the CIE peer review panel, and which will be undertaken during the coming year. Finally, the CBSAC stresses the importance of updating benchmark assessments every four to six years. This is necessary to fully evaluate the newly adopted reference points relative to stock status and to incorporate important new data and science into the assessment.

In implementing female-specific reference points, annual estimates of spawning-age female abundance and female exploitation fraction can be derived directly from results of the winter dredge survey and annual estimates of harvest. These calculations can be compared to the new framework to determine stock status, thereby eliminating the need to run the full assessment model each year. The CBSAC notes that overall crab abundance was 30% lower at the beginning of the 2011 crabbing season than it was at the start of the 2010 season. Although this decrease in abundance was due to lower recruitment and higher winter mortality, rather than elevated fishing pressure during the 2010 crabbing season, having fewer crabs at the start of the 2011 season elevates the risk that the 2011 harvest will exceed the recommended female harvest target of 25.5%. If the 2011 Bay-wide harvest of female crabs is equal to the 2010 female harvest of 27.9 million pounds, the resulting exploitation fraction will be near the target level of 25.5%. Given this, the CBSAC recommends that the jurisdictions closely monitor the 2011 harvest prior to adjusting management measures.

6.2 Provide Guidance for the Management Agencies on Methods for Determining Appropriate Reference Points for Male Blue Crabs

In order to ensure that male abundance does not drop below a critical level relative to female abundance, the CBSAC recommends development of threshold reference points for male crabs that would provide management with a trigger for male conservation. One possibility to explore is a ratio of male to female abundance, which could be derived from annual winter dredge survey results. To properly define a threshold based on an abundance ratio, several key analytical issues need to be addressed and the results of ongoing research on crab reproductive biology need to be reviewed. These issues include: estimation procedures of winter dredge survey gear efficiency, estimation of winter dredge survey gear selectivity for differing sizes of crabs, crab reproductive biology (sperm limitation) and estimation procedures for over-wintering mortality. The CBSAC suggests addressing these issues and to explore appropriate male reference points during a workshop that could be convened in late May or early June of 2012.

In the near term, the CBSAC recommends that management jurisdictions monitor the ratio of the number male crabs greater than 60 mm in carapace width to the number of immature female crabs greater than 60 mm, as calculated from the dredge survey, to ensure that annual ratios stay within the range observed since 1990 (Figure 12). This represents the best estimate of an operational sex ratio, which refers to the relative numbers of sexually mature male crabs (greater than 110 mm) and pre-molt female crabs who are actively seeking mates. Because there is no current evidence of sperm limitation in the population, maintaining the sex ratio within observed values should ensure maintenance of sufficient males for reproduction. Refining this ratio should be a primary topic during the proposed workshop mentioned above. Finally, to ensure that male reproductive capacity is not compromised in the face of female conservation measures, CBSAC recommends maintaining current male conservation measures such as size limits. Size limits are important in that they ensure that males have an opportunity to mate prior to being harvested.

6.3 Prioritize research needs and science gaps – as identified in the 2011 assessment and Center for Independent Experts (CIE) review.

The Center of Independent experts thoroughly reviewed the 2011 blue crab benchmark stock assessment with positive results. Dr. Cathy Dichmont, whose comments were consistent with the panel, said in her review: "*This assessment is a valid approach and an improvement on the previous assessments and therefore should be adopted as the basis for management advice.*" However, several gaps in the current knowledge of the blue crab and the fisheries were noted by the CIE review panel. The CBSAC has prioritized the review panel's findings.

The three highest priorities for research and surveys are:

1. Implement monitoring to characterize the sex, size, and life-stage composition of the commercial harvest Bay-wide. This is of the highest priority given the sex-specific nature of the current management framework.
2. A recreational survey is high priority as it is likely that recreational effort may be increasing with improved stock status.
3. Continue the winter dredge survey and work to refine gear efficiency and over-winter mortality calculations as this could impact reference point values. The CBSAC recommends a workshop is held to address issues such as gear efficiency, selectivity of the dredge gear and dredge survey sex ratios as a reference point.

Other important research projects would include:

- Analysis of existing reported effort data to get at spatial and temporal patterns in CPUE for specific gears and fishery sectors.
- Design a shallow-water complement to the winter dredge survey to estimate the fraction of crabs that are not vulnerable to the winter dredge survey due to their shallow water residence. Pilot studies are ongoing.
- Sex-specific natural mortality rates (research based).
- Variations in fecundity based on season and size (ongoing).
- Determine threshold sex ratio when sperm limitation becomes a problem (research - ongoing).

In addition to recommending research areas to improve critical knowledge of the blue crab population and fisheries, all three peer reviewers had specific concerns that they felt needed to be addressed within the model as a high priority. Therefore, CBSAC recommends that, within the next 12 months, the assessment team explore the impacts of the following modifications to the model:

1) Incorporate an internal correction factor for the time series of commercial harvest from Virginia and Maryland. In both jurisdictions, there have been significant changes to the reporting systems, which appear to have artificially impacted reported harvest. Currently, the time series of harvest is corrected for changes in reporting procedure externally to the model. Although the method appears reasonable, the very large effect on the resultant harvest time series should be validated. Ideally, a reporting change parameter (with variances) should be included in the model so that the sensitivity of the parameter on results can be explored and error can be accounted for within the model.

2) Provide probability distributions around the recommended reference points. This will provide a clear picture for managers and stakeholders of the model-based uncertainty surrounding the recommended reference points and will be important for managers when crafting decision rules and deliberating on adjusting management strategies.
3) Include a sensitivity analysis for various levels of recreational harvest. Given the poorly quantified recreational harvest, it is essential that managers understand a range of potential impacts from recreational harvest. This will assist in crafting management actions including the design of recreational crabbing licenses.
4) Modify the stock-recruitment relationship that is used in the model to include a penalty for male-biased abundance sex ratios.

In addition, the CBSAC recommends that the following modifications to the assessment occur in the longer term:

1) Incorporate gear-specific harvest and partial recruitment.

7. Management Advice – Short Term

1) Monitor fishery performance and stock status relative to recommended reference points before adjusting regulations:
Management actions since 2008 continue to be effective at rebuilding the spawning component of the population. Empirical estimates of 2011 age-1+ female abundance are close to the recommended target level of 215 million crabs. The female exploitation fraction in 2010 was below the recommended target of 25.5% for the 3rd consecutive year. Management jurisdictions should carefully consider the performance of 2011 fisheries relative to the recommended female-specific reference points and the outcome of the 2011-2012 winter dredge survey before making regulatory adjustments. The CBSAC notes that overall crab abundance was 30% lower at the beginning of the 2011 crabbing season than it was at the start of the 2010 season. Although this decrease in abundance was due to lower recruitment and higher winter mortality, rather than elevated fishing pressure during the 2010 crabbing season, having fewer crabs at the start of the 2011 season elevates the risk that the 2011 harvest will exceed the recommended female harvest target of 25.5%. If the 2011 Bay-wide harvest of female crabs is equal to the 2010 female harvest of 27.9 million pounds, the resulting exploitation fraction will be near the target level of 25.5%.

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.

3) Recreational Catch and Effort:
Recreational catch and effort remains poorly quantified in Chesapeake Bay. The jurisdictions should consider methods for more precisely calculating recreational catch and effort, possibly through licensing systems.

4**) Latent effort:**
In both states, significant numbers of commercial crabbing licenses are unused. An increase in the blue crab population will likely 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. Federal fishery disaster relief money was used by both states to buy back commercial licenses.

5) Effort Control:
Controlling effort has been the foundation of crab management in recent years. The principal tools used by managers have been limited entry, size limits, catch limits, and seasonal closures. However, the total amount of effort expended in the fishery remains poorly quantified. Thus, the effectiveness of management actions remains difficult to quantify. Effort monitoring programs could be improved by incorporating pot tagging so that pot effort is measurable and enforceable.

8. Management Advice – Long Term

1) Catch Control:
A management strategy that sets annual catch levels based on estimates of abundance from the winter dredge survey could potentially balance annual harvests with highly variable recruitment. The CBSAC recommends that jurisdictions evaluate the benefits of quota-based 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.

9. 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 effects and gear effects, would potentially improve reliability of exploitation estimates, and inform future assessments.

CBSAC Members:

Lynn Fegley (Chair)	Maryland Department of Natural Resources
Derek Orner	NOAA Chesapeake Bay Office
Tom Miller	UMCES, Chesapeake Biological Laboratory
Daniel Hennen	NMFS, Northeast Fisheries Science Center
Alexei Sharov	Maryland Department of Natural Resources
Rob O'Reilly	Virginia Marine Resource Commission
John Hoenig	Virginia Institute of Marine Science
Rom Lipcius	Virginia Institute of Marine Science
Amy Schueller	NMFS, Southeast Fisheries Science Center
Eric Johnson	University of North Florida

Other Attendees:

Glenn Davis	Maryland Department of Natural Resources
Doug Vaughn	NMFS, Southeast Fisheries Science Center

Figure 1. Winter dredge survey index of total blue crab abundance (density of males and females, all sizes combined) in Chesapeake Bay, 1990 through 2011. Error bars represent 95% confidence intervals.

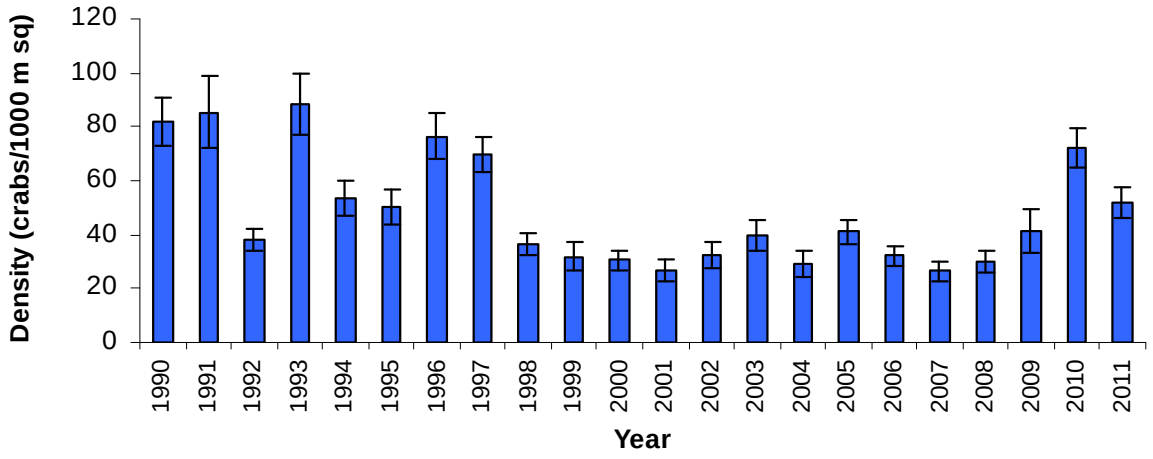


Figure 2. The recommended control rule for the Chesapeake Bay blue crab fishery. An abundance of 70 million age 1+ female crabs represents the overfished threshold. In 2010, abundance was above the overfished target and the exploitation rate was below the overfishing target. Reference points were derived from a statistical assessment model incorporating multiple surveys. Please see text for explanation of terms.

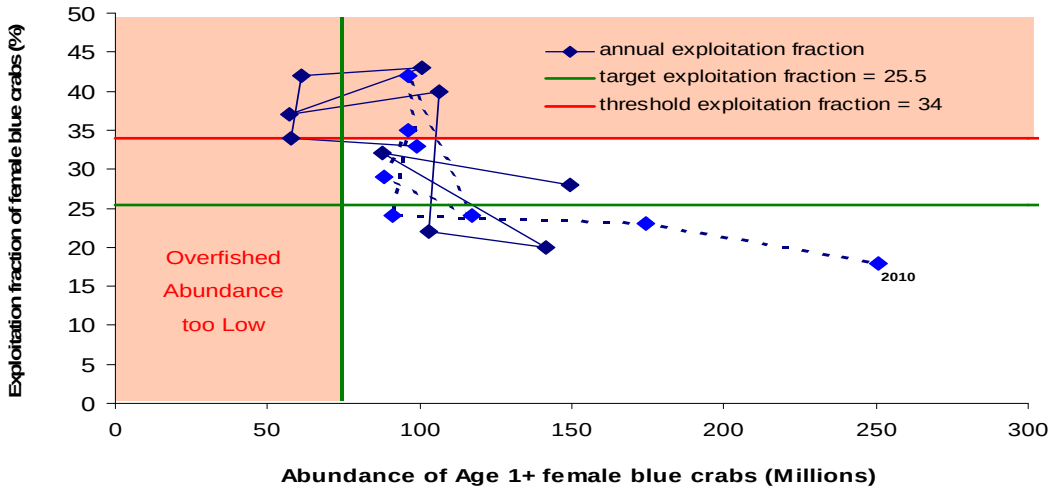


Figure 3. The former control rule used to manage the Chesapeake Bay blue crab fishery. An abundance of 86 million age 1+ (male and female) crabs represents the overfished threshold. In 2010, abundance was above the overfished target and the exploitation rate was below the overfishing target.

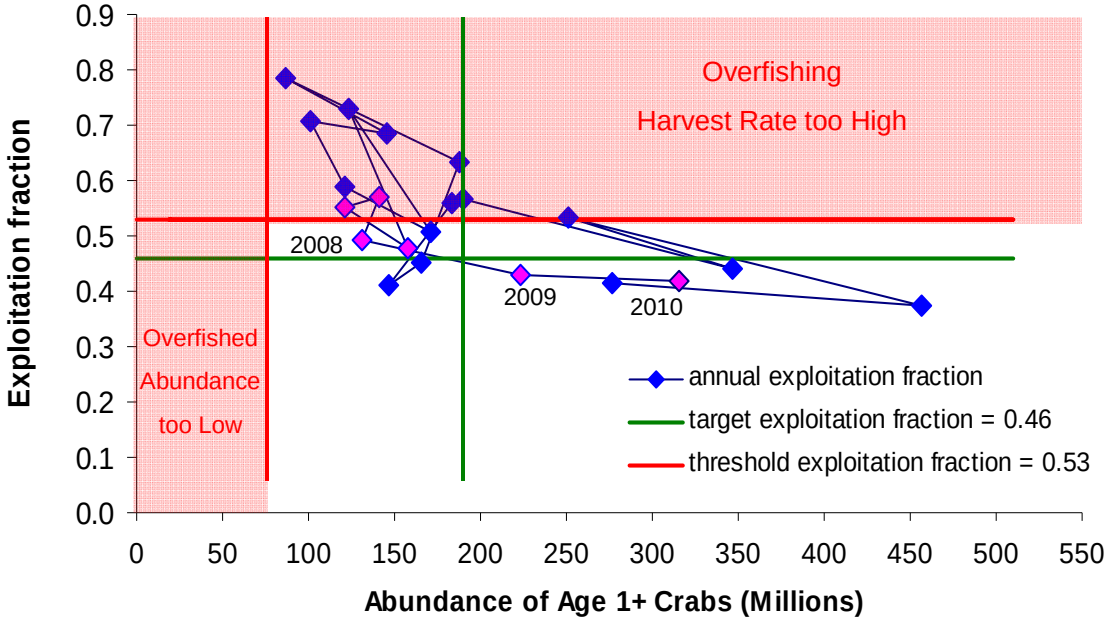


Figure 4. Winter dredge survey estimate of **abundance of female blue crabs age one year and older** (age 1+) 1990-2011 with recommended reference points. These are female crabs measuring greater than 60mm across the carapace and are considered the 'exploitable stock' that will spawn within the coming year.

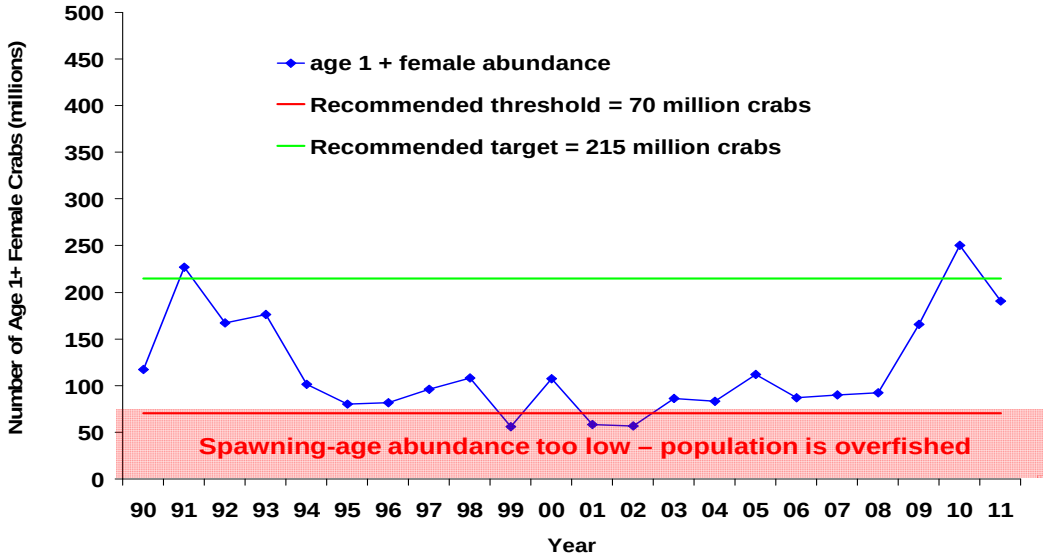


Figure 5. Winter dredge survey estimate of **abundance of male and female blue crabs age one year and older (age 1+) 1990-2011.** These are crabs measuring greater than 60mm across the carapace and are considered the 'exploitable stock' that will spawn within the coming year. The lowest abundance of 86 million crabs was observed in the 1998-1999 survey and is considered the overfished threshold. The interim target abundance was 200 million crabs.

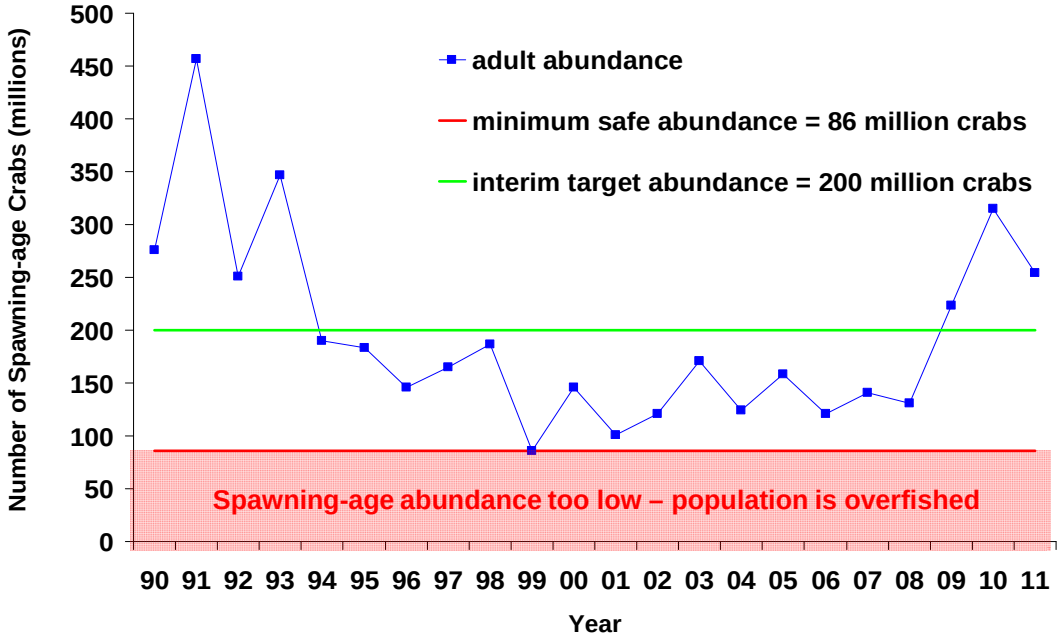


Figure 6. Beginning in December 2010, water temperature during winter in Chesapeake Bay declined to the coldest temperatures observed since 1996. Temperatures remained below average from January through February, causing high mortality of large crabs.

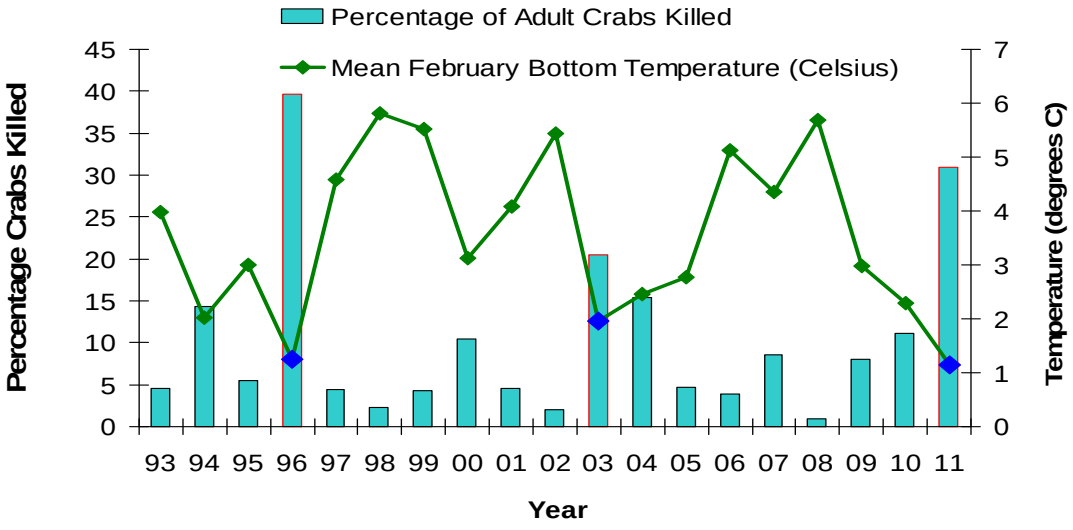


Figure 7. Winter dredge survey estimate of **abundance of male blue crabs age one year and older (age 1+)** 1990-2011. These are male crabs measuring greater than 60mm across the carapace and are considered the 'exploitable stock' that will spawn within the coming year.

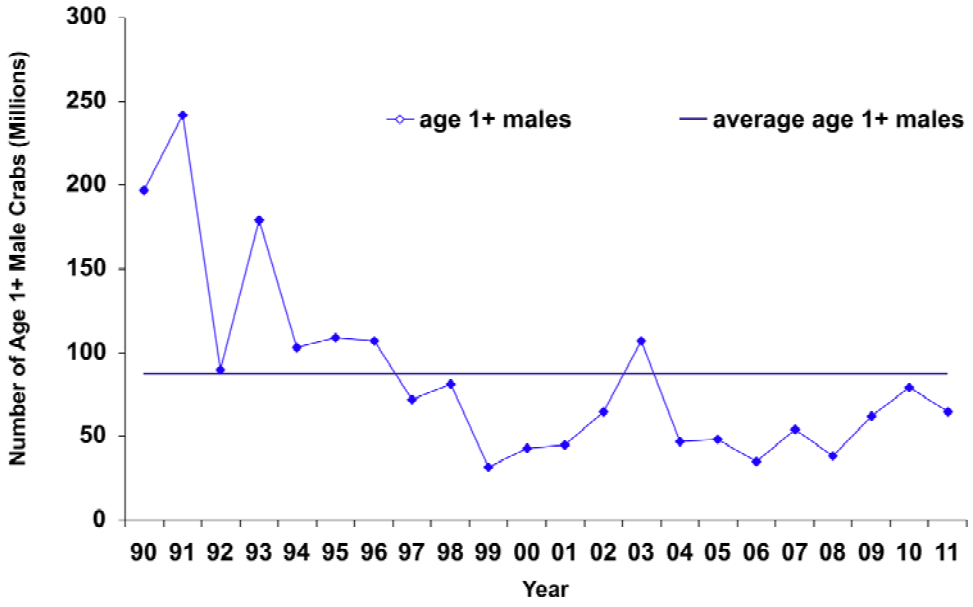


Figure 8. Winter dredge survey estimate of **abundance of age 0 crabs,** 1990-2011. These are male and female crabs measuring less than 60mm across the carapace.

Figure 9. Maryland and Virginia Chesapeake Bay commercial blue crab harvest 1993-2011.

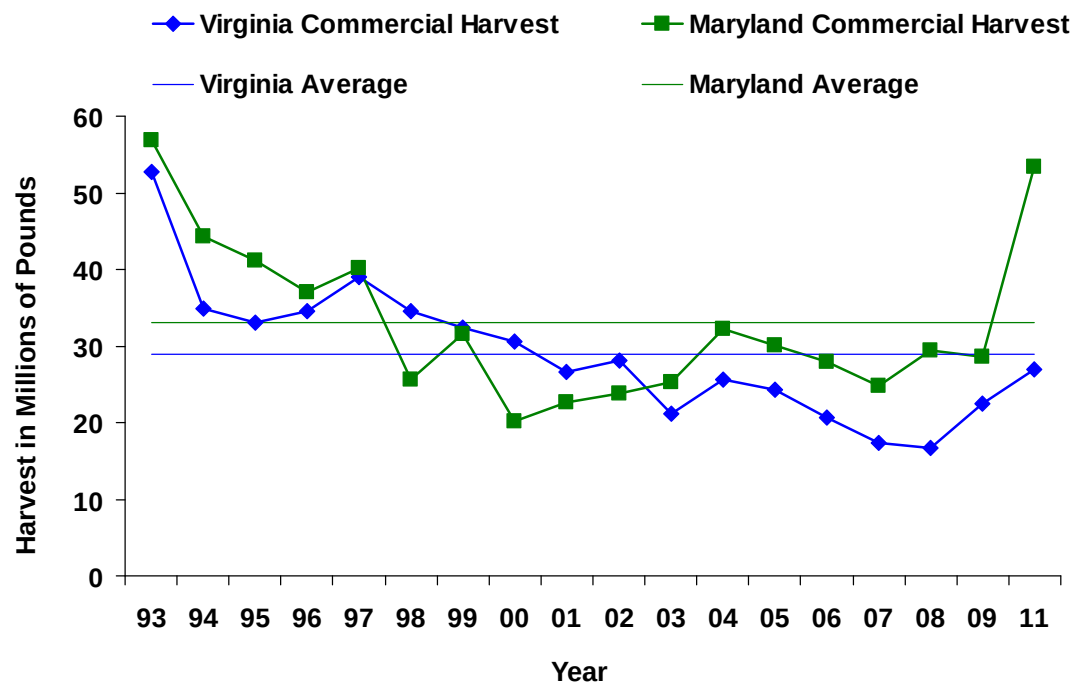


Figure 10. The percentage of female crabs removed from the population each year by fishing relative to recommended female-specific target and threshold levels 1990 through 2010.

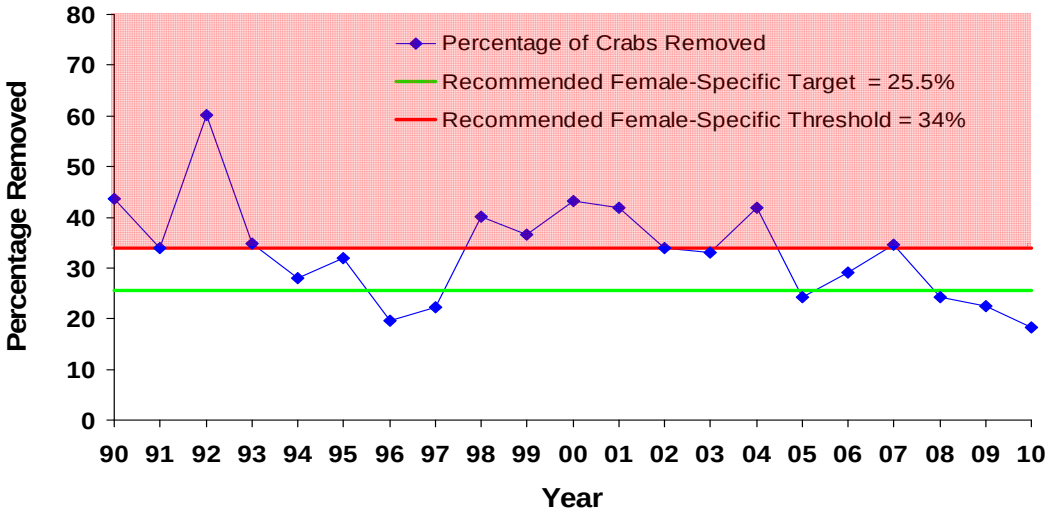
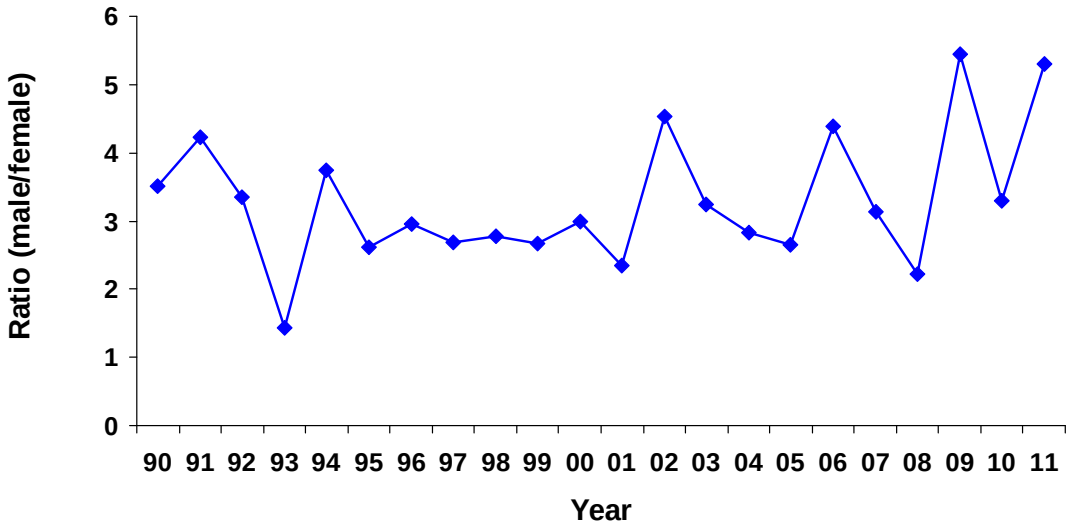


Figure 12. An 'operational' sex ratio for blue crab in Chesapeake Bay based on abundance estimates from the Winter Dredge Survey. The ratio is the density reproductive males (greater than 60 mm across the carapace) divided by the density of female crabs which would actively be seeking mates (immature female crabs greater than 60 mm across the carapace).



ATTACHMENT IV. **Virginia Marine Resources Commission**
Blue Crab Fishery Resource Disaster Relief Plan

The Commonwealth of Virginia's plan for the blue crab fishery resource disaster funding consists of several projects that are designed to provide additional work opportunities to those in the crab industry and to restructure the blue crab fishery. It was intended that various crab industry members (harvesters, buyers, processors), who have experienced financial setbacks from the decade-long condition of very low abundance of the blue crab resource, are provided an opportunity to work in resource enhancement projects. Specific details and budget narratives, for each component, are summarized below.

I. DERELICT BLUE CRAB POT AND MARINE DEBRIS REMOVAL PROJECT

- The Derelict Blue Crab Pot and Marine Debris Removal Project was designed to assist previously-active crab dredge fishermen who would have been eligible to dredge during the December 2008 through March 2009 winter crab dredge season, and were impacted by the Commission's initial closure of that winter dredge season. During the third year of Marine Debris Location and Removal Program (Dec 2010-Mar 2011), a total of 70 participants surveyed the Virginia portion of the Chesapeake Bay. Over 10,000 items were removed (94% were crab, peeler, or eel pots) during the 2010-2011 season. The three year total of debris removed is over 29,646 items. In addition, in the three years over 27,000 animals (mostly blue crabs but also including ducks, fish, muskrats, and turtles) were documented in the recovered derelict pots.

II. CULL RING AND TERRAPIN EXCLUDER DEVICE PROJECT

- The Cull Ring and Terrapin Excluder Device Project has employed 15 commercial crab fishermen to study the effects of different cull ring (escape ring) sizes on the escapement of sublegal and some mature crabs, according to geographic location (Lynnhaven, James, York, Rappahannock, Great Wicomico, Tangier Sound, Pocomoke Sound, and seaside of Eastern Shore), from fall 2009 to fall 2010. This study has also equipped crab pots with bycatch reduction devices to assess escapement of terrapins and finfish. Results are still being analyzed.

III. SUPPLEMENTAL FUNDING FOR THE FISHERY RESOURCE GRANT PROGRAM

- The Virginia Fishery Resource Grant Program has assisted in VMRC's Oyster Aquaculture Program, by providing advisory personnel to train crab license holders in all facets of oyster aquaculture. Seventy-two participants have involved with VIMS personnel through this project.

IV. OYSTER AQUACULTURE

- A total of 131 crab industry participants participated in the cage aquaculture program in 2011 as part of VMRC's Oyster Aquaculture Program. In total, 6,795 bushels of shells have been set and deployed in 2011. In the spat-on-shell aquaculture program, four Virginia hatcheries produced approximately 1.1 billion eyed larvae and almost 25,000 bushels of spat on shell. More than 15 million small oysters were placed on private oyster grounds by 35 participants. An additional 30 participants began in 2011. About 500 million eyed larvae were produced by the private hatcheries in Virginia in 2011. The Virginia Marine Products Board has assisted in the promotion of oyster aquaculture in the Commonwealth with a variety of outreach events and products. The Marine Products Board contracted with the Virginia Tech Seafood Lab-Hampton to develop an Oyster Taste Panel to differentiate the taste of oysters from the seven regions where Virginia aquaculture oysters are grown. The Board has participated in numerous events in 2011, including the International Boston Seafood Show, the Demystifying Seafood Event in Washington, D.C., and the Sensible Seafood Feast at the Virginia Aquarium.

V. CRAB POT AND PEELER POT LICENSE BUY OUT PROGRAM

- The Crab License Buy-Back Program was initiated and completed in 2009, in order to reduce the overcapacity in the crab pot and peeler pot fisheries. In total, 75,441 crab pots or peeler pots and 359 crab licenses were purchased and removed from future fisheries.

VI. UPDATE OF BLUE CRAB STOCK ASSESSMENT

- The 2011 stock assessment of blue crabs has been completed. For additional details, please see the CBSAC report (Attachment II).