COMMONWEALTH of VIRGINIA

Marine Resources Commission
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Douglas W. Domenech
Secretary of Natural Resources

Steven G. Bowman
Commissioner

December 1, 2010

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

All findings from the 2010 review of the status of the Chesapeake Bay blue crab stock indicate an improvement over the 2009 status of this stock and its fisheries.

The December 2009–March 2010 Bay-wide Winter Dredge Survey results indicate major improvement in the abundance of the blue crab, for the second consecutive winter. The abundance of spawning-age crabs was 315 million and was higher than the previous winter abundance (223 million). Spawning-age crabs include males and females, and these spawning-age females spawned in spring or summer of 2010, for the first or subsequent time. This marks two consecutive winters, wherein the abundance of this size category of crabs (> 2.4 inches, in carapace width) exceeded an interim target established, by Bay scientists and managers, as 200 million spawning-age crabs. That amount of crab abundance was last exceeded in winter 1992-93.

The production of new crabs or recruits (crabs less than 2.4 inches in carapace width) was 345 million, as determined from the winter 2009-10 survey. This abundance is twice the abundance

of the previous winter's sampling throughout the Bay, and is the highest abundance of recruits since the winter 1996-97 Bay-wide sampling. This component of the stock provides harvestable size crabs in the fall, and, more importantly, represents a substantial fraction of the future spawning stock.

The estimated 2009 Bay-wide crab commercial harvest was 54.7 million pounds, nearly 13% higher than the estimated 2008 Bay-wide crab harvest of 48.6 million pounds and nearly 26% higher than the record-low 2007 harvest of 43.5 million pounds. The 2009 Maryland commercial harvest was estimated as 28.5 million pounds. The 2009 Virginia harvest was 23.34 million pounds, while 2.86 million pounds were reported harvested in the jurisdictional waters of the Potomac River Fisheries Commission. The increase in harvest was proportionally greater in Virginia's Chesapeake area, as compared to the other jurisdictions. The 2009 Virginia harvest from the Chesapeake Bay, its tributaries and the Potomac River tributaries to Virginia was 35% higher than the 2008 Virginia harvest from these areas.

The impressive nature of the 2009 crab pot harvest was that it "tracked" the increase in abundance of spawning-age crabs, as a result of the Commission essentially maintaining the same regulations, in 2009, that were implemented in 2008. The other impressive statistic about the harvest of hard crabs in 2009 was that the harvest per trip, on average for 2009, was 406 pounds per trip, as compared to 356 pounds per trip in 2008 and 386 pounds per trip, on average, for the 2004-07 fisheries. So far, reported harvest data for 2010 are preliminary, but the March through June 2010 data indicate about a 12% increase in the harvest of hard crabs, as compared those months' harvests during 2008. These trends represent positive financial gains to the industry and the Commonwealth. The peeler and soft crab harvests (pounds) did not increase in 2009, and have remained relatively low, at about 900,000 pounds, since 2006. However, preliminary 2010 data indicate a 14% increase in peeler and soft crab harvests, as compared to 2009.

For the third consecutive crab pot and peeler pot season (March 17 through November 30), the Commission maintained crab fishery management measures that conserved female crabs, in an attempt to promote increases in spawning activities. Starting in 2008, the Commission enacted a regulatory management plan designed to reduce the harvest of female crabs by 34%. This reduction in female harvest plan 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 and 2010 crab fishing seasons included a closure of the winter dredge fishery, a closure of the spawning sanctuaries to harvest a month earlier than in the past (May 1, rather than June 1), a required higher minimum size limit for harvested peeler crabs, and a requirement for larger escape rings in crab pots.

For the second 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. The total amount of funding is $14,995,000, and most of the projects are nearing a second year of completion. This Disaster Relief Fund has provided various crab industry members (harvesters, buyers, processors) who experienced financial setbacks from the decade-long (through 2008) condition of very low abundance of the blue crab resource an opportunity to work in resource or habitat enhancement projects. These projects

have provided innovative work opportunities to approximately 250 individuals who were associated with the crab fishery or its industry. Progress, to date, in these projects is discussed below. Commission staff also participated directly in certain aquaculture projects, by introducing state-of-the art growing techniques to crab industry members.

As reported last year, the Commission also completed a successful crab pot and peeler pot license buyback using 45 percent ($6.7 million) of the Disaster Relief Fund, and the removal of active and potential effort from fisheries that have experienced years of overcapacity in effort is a positive step towards sustainability of this valued blue crab resource. However, the resource faces a possible influx of effort from 326 former crab licensees who were inactive from 2004 through 2007 and placed on a waiting list, until such time that the interim target of 200 million spawning-age crabs is attained in three consecutive Bay-wide Winter Dredge Surveys. The third consecutive attainment of this interim target could occur in the winter of 2010-11, and the Commission will be challenged in 2011 by how to best address this issue. It is expected that the new analytical stock assessment scheduled to be completed at the end of 2011 will provide management with improved, long-term targets. These new targets may require reductions in effort to achieve a long-term sustainable harvest, rather than allowing the addition of effort to fisheries already in overcapacity.

THE 2010 VIRGINIA BLUE CRAB FISHERY MANAGEMENT PLAN

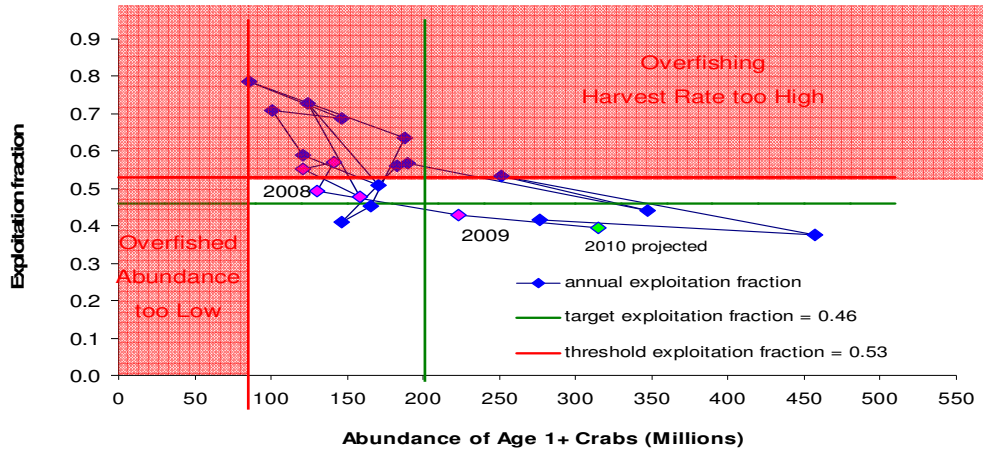
The Commission's 2010 blue crab management efforts were guided by the most recent CBSAC (Chesapeake Bay Stock Assessment Committee) Advisory Report, as well as advice from its Blue Crab Management Advisory Committee. However, the abundance estimates and exploitation rates (annual rates of removals of blue crab by fisheries, alone) derived from the Bay-wide Winter Dredge Survey (December 2009 - March 2010) have been key elements for the Commission's planning of the crab fisheries and conservation of the blue crab resource in recent years. Since the completion of the last recent mathematical stock assessment by Bay scientists in 2005, the Commission has benefited from that assessment's improved development of a control rule, first initiated by the Bi-state Blue Crab Advisory Committee in 2001, that can be used to assess the biological stability of this stock.

Abundance and Exploitation Rate Estimates

The current control rule, shown below and as Figure 7 in the CBSAC Advisory Report (Attachment I), allows managers to know, on an annual basis, whether estimated abundance and removal rates are below, at, or above safe limits for the stock. The 'safe' level of annual harvest or removals by the fisheries in the Chesapeake Bay is 53% (0.53 on the Figure, below, is known as the threshold or biologically safe limit for the stock) or less, with the target or the management-preferred harvest rate as 46 percent. A harvest rate over 53 percent, especially if it occurs in multiple years as it did 8 of 10 years from 1998 to 2007, can lead to an overfished condition of the stock. For now, the CBSAC and the control rule rely on the lowest observed (the 1998-99 Bay-wide Winter Dredge Survey) abundance of spawning-age crabs to indicate an overfished condition. As one would expect, the high removal rates during the 1998 – 2007 fisheries resulted in a low stock abundance of spawning-age crabs in subsequent years (see Table 1). At the time the CBSAC recommended an interim target of 200 million spawning-age crabs,

in January 2008, this abundance had not resulted from any winter survey since 1993. The abundance of spawning age crabs exceeded 200 million in 2009 and 2010.

The control rule used to manage the Chesapeake Bay blue crab fishery. An abundance of 86 million age 1+ crabs represents the overfished threshold. In 2009, abundance was above the overfished target and the exploitation rate was below the overfishing target.



Results from the December 2009 to March 2010 Chesapeake Bay-wide Blue Crab Winter Dredge Survey indicate the abundance of age-1+ blue crabs was 315 million crabs (see Table 1). This abundance of age-1+ crabs is above the interim target level of 200 million spawning age crabs established by the Chesapeake Bay Stock Assessment Committee (CBSAC). In January 2008, CBSAC established an interim target of 200 million spawning age crabs, based on analyses suggesting that 200 million age-1+ crabs is a minimum associated with consistently higher levels of recruitment. It is expected that the new analytical stock assessment scheduled to be completed at the end of 2011 will provide management with improved, long-term targets, as well as improved overfished and overfishing biological reference points.

The increase in abundance of spawning-age adults (male and female crabs) in the 2009-2010 Chesapeake Bay-wide Winter Dredge Survey was mainly due to an increase in the number of female crabs that are likely to spawn in 2010, as was the case in the 2008-2009 survey. The 2009-2010 abundance of spawning-age females was estimated to be 240 million. The abundance of spawning-age male crabs in 2009-2010 was only 75 million crabs, and represented a more moderate increase than was determined for female crabs.

The percentage of the population of crabs removed by commercial and recreational fishing (exploitation rate or fraction) in 2009 was estimated to be 43%. This annual removal rate by fisheries is below the target exploitation rate of 46% and overfishing threshold of 53%. This rate of removals is the lowest since 1997 (see Table 1). In 8 of the last 12 years, the removal rate, by fisheries, has been above the threshold (53%). A series of years with fisheries-based removal rates at or near the target level (46%) will be needed to allow this stock to achieve reproductive efforts that lead to a sustainable Bay-wide harvest.

Table 1 provides a time-series summary of the parameters which guide managers throughout the Bay review each year in their development of conservation management plan. In any year, the expected amount (pounds) of harvest that can occur, without posing risk to the biological stability of the crab stock, depends on the estimated overall abundance of crabs and the expected rate of removals for that harvest amount and estimated abundance. This relationship allows managers to implement conservation measures intended to achieve that harvest; however, since there is not a quota-based system for blue crab, the conservation measures cannot guarantee a particular harvest or removal rate. For that reason, the target removal rate of 0.46 (46% of the crab stock removed by fishing activities, alone) is the management objective, and the expectation is that implemented management measures and realized harvest amounts will result in removal rates near the target of 0.46 but below the overfishing threshold of 0.53 (53% removed annually).

Table 1. A summary of annual estimates of the total number of crabs, and of the number of spawning-age adults and age-0 crabs, from the Bay-wide winter dredge survey, as well as annual commercial harvest and exploitation fraction (percentage of crabs removed). Years when the total number of crabs was equal to or greater than in 2010 are highlighted. Harvest during these years averaged 88 million pounds, with exploitation below the target level of 46%.

Winter of Survey	Survey Year (Year the 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
1989 - 1990	1990	791	463	276	96	42
1990 - 1991	1991	828	356	457	90	38
1991 - 1992	1992	367	105	251	53	54
1992 - 1993	1993	852	503	347	107	44
1993 - 1994	1994	487	295	190	77	57
1994 - 1995	1995	487	300	183	72	56
1995 - 1996	1996	661	476	146	69	41
1996 - 1997	1997	678	512	165	77	45
1997 - 1998	1998	353	166	187	56	64
1998 - 1999	1999	308	223	86	62	79
1999 - 2000	2000	281	135	146	49	69
2000 - 2001	2001	254	156	101	47	71
2001 - 2002	2002	315	194	121	50	59
2002 - 2003	2003	334	172	171	47	51
2003 - 2004	2004	268	146	124	47	72
2004 - 2005	2005	396	247	158	58	47
2005 - 2006	2006	311	199	121	54	54
2006 - 2007	2007	249	114	141	49	56
2007 - 2008	2008	291	169	131	43	48
2008 - 2009	2009	393	173	223	49	43
2009 - 2010	2010	658	345	315		

Harvest and Effort Statistics

The estimated 2009 Bay-wide crab commercial harvest was 54.7 million pounds, nearly 13% higher than the estimated 2008 Bay-wide crab harvest of 48.6 million pounds, and nearly 26% higher than the record-low 2007 harvest of 43.5 million pounds. The 2009 Maryland commercial harvest was estimated as 28.5 million pounds. The 2009 Virginia harvest was 23.34 million pounds, while 2.86 million pounds were reported harvested in the jurisdictional waters of the Potomac River Fisheries Commission. The increase in harvest was proportionally greater in Virginia's Chesapeake area, as compared to the other jurisdictions. The 2009 Virginia harvest from the Chesapeake Bay, its tributaries, and the Potomac River tributaries to Virginia was 35% higher than the 2008 Virginia harvest from these areas. Recreational harvest was estimated as a fraction (8%) of the total commercial harvest and that estimate is 4.4 million pounds.

The Commission was aware that harvesters could capitalize on the increased abundance of crabs in 2009, even with conservation measures equally effective, as in 2008. While 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. The 2009 harvest, from all Virginia tidal waters, did increase to 25.8 million pounds (Table 2). The 2009 harvest of the hard crab market category increased substantially, from 17.6 million pounds in 2008, to 24.8 million pounds. The 2009 hard crab harvest was nearly 18% higher than average (2004-07) hard crab harvests. Harvests of peeler and soft crabs increased in 2009 by 18% over the 2008 harvest, but were similar to harvests of this market category, on average, during 2004-2007 (see Table 2). The average per capita dockside earnings, by crab pot and peeler pot fishermen, combined, increased from $16,184 (on average, 2004-07) to $17,724 (2008) and $18,812 in 2009. There was a 10% increase in harvesters from average 2004-07 levels to 2009.

Preliminary 2010 data indicate a 14% increase in peeler and soft crab harvests, as compared to 2009. This increase will provide 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 (up to 70%) by female crabs. All of these factors prohibit full capitalization of increased abundance.

For the 2010 crab pot and peeler pot season, the Commission contracted its first effort (pot-counting) survey in the Chesapeake Bay and its tributaries. This survey was contracted to Versar, Inc. and provides supplemental funding ($40,000) to a joint enterprise with the NOAA-Chesapeake Bay office. In total, funding to Versar to conduct this first-ever effort survey in Virginia water is $210,000. NOAA initiated the funding for a pilot study of effort in the Virginia portion of the bay at the start of the 2010 crabbing season. In June 2010, VMRC approved $40,000 of funding in order to contribute to the pilot study and allow the continuation of survey through November. Versar Inc.'s Applied Ecosystem Assessment Program implemented a VMRC-approved stratified-random sampling regime to estimate crab pot density,

and has conducted a similar study in Maryland waters for the past six years. The survey was developed using 2009 crab fishing trips, according to water areas where crab pot or peeler pot harvesting took place. Sampling effort (counting crab and peeler pots via planar boards extended from both sides of a vessel) was more concentrated in geographic areas of the Virginia bay where there was a high probability of crab pots being located. However, all tributaries and the mainstem of Virginia's portion of the Chesapeake Bay were sampled according to expected crab pot or peeler pot densities. Catch rates were calculated monthly as the reported landings (pounds) divided by the estimated number of survey tows for that month. Initial results from April through July have been submitted to VMRC in a progress report. This period had similar amounts of total estimated effort, with the highest number of instantaneous crab pots in May (193,414 crab pots). Sampling will continue through November.

Table 2. Recent harvests of blue crab: (A) hard crabs; (B) peeler and soft crabs; and, (C) all crab categories combined), by pots**, from Virginia tidal waters.

(A)

Month	Average (2004 - 2007)	2008	2009
March	451,592	595,641	332,635
April	2,910,846	1,973,432	4,075,809
May	2,323,579	1,529,646	3,182,982
June	2,863,511	2,430,562	3,379,192
July	3,066,122	3,162,940	3,264,251
August	3,123,236	2,950,900	3,494,543
September	2,589,947	2,523,469	3,030,534
October	2,775,802	2,258,278	3,028,900
November	1,339,469	194,361	1,038,618
Total Hard Crabs	21,105,411	17,619,229	24,827,464

(B)

Month	Average (2004 - 2007)	2008	2009
April	19,618	29,991	17,817
May	484,030	430,179	414,510
June	126,082	115,048	132,851
July	142,449	111,030	168,096
August	100,320	77,000	133,118
September	51,046	48,729	94,340
October	11,078	7,004	12,954
November	24	2	1
Total Peeler Crabs	934,650	818,983	973,687

(C)

	Average (2004 - 2007)	2008	2009
All Crab Categories	22,040,061	18,438,212	25,801,151

Notes: 1) 95% of all peeler or soft or hard crabs harvested by pots (peeler pot or crab pot) are harvested by crab pot; and, 2) Of the peeler or soft crab category, peeler crabs account for 98.6% of harvests of that category (based on 2004 through 2009 data).

Blue Crab Conservation Measures For the 2010 crab fisheries, the Commission made few regulatory amendments to the management plan of 2008 that was designed, by all Bay jurisdictions, to promote a 34% savings (in pounds) of female crabs, as compared to average (2004-07 harvests). Attachment II provides a summary of all recent Commission actions since 2008.

There was a harvest increase in 2009 because of the increase in exploitable spawning-age crabs (see Table 1), and an additional increase in harvest is expected in 2010. In 2010, harvesters will benefit not only from a better than average abundance of spawning-age crabs but also from the high abundance of recruits. Many of these recruits are available to fall fisheries, and the 2010 harvest should be more consistent throughout the months of the April-November season, as compared to the 2009 harvest. At the May 2010 public hearing, the Commission was guided in its decision-making process by provisions established in §§ 28.2-201, 28.2-202, 28.2-203 and 28.2-203.1 of the Code of Virginia.

Over the course of several meetings of the Commission's Crab Management Advisory Committee (CMAC), several members requested that the prohibition on sponge crab harvest and possession be modified, from its March 17 through July 15 effective period, to a March 17 through May 31 effective period. In May 2010, the Commission modified the time period when harvesters are prohibited to possess dark-colored (mature larvae) sponge crabs. Formerly, the prohibition extended from March 17 through July 15, but the Commission modified the extent of this no-possession prohibition to March 17 through June 30. This action followed advice from scientists from VIMS and Old Dominion University who indicated that a high degree of mortality of sponges and handled female crabs occurred by July 1.

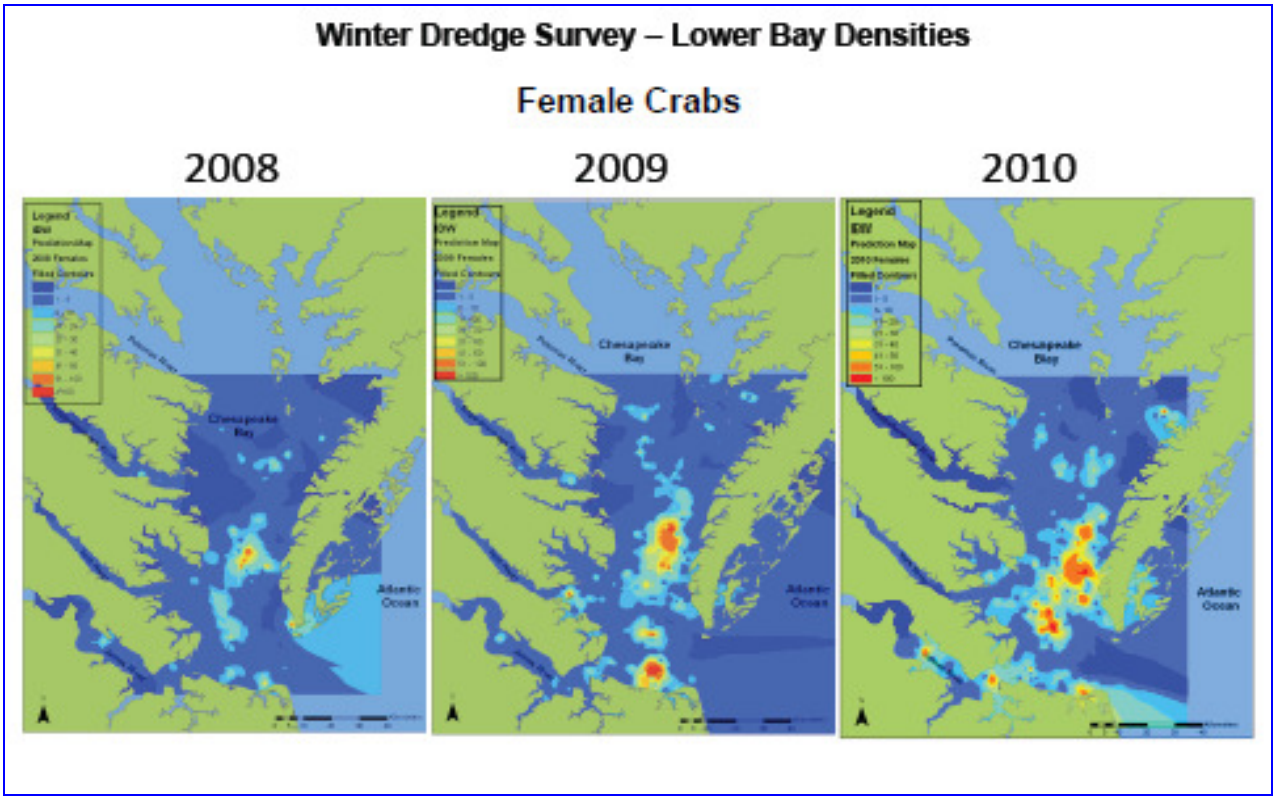
The most frequent discussion by the CMAC concerned the blue crab sanctuaries. A number of CMAC members thought the closure of sanctuary areas to the harvest of crabs, on May 1, should be changed to a May 15 starting date of the closure. The Commission determined that the increase in the 2009-2010 abundance of recruits was a positive sign towards stock health but also recognized that this high abundance was only a one-year event and followed several years of low abundance of recruits (see Table 1). For these reasons, the Commission maintained the harvest prohibition in sanctuary areas from May 1 through September 15, 2010. This issue will be re-considered by the CMAC and Commission by mid-April 2011, once the data from the winter 2010-11 Bay-wide Winter Dredge Survey are available.

The Commission also extended the moratorium on additional crab fishery licenses indefinitely, and that moratorium has been in place since 1999 and represents a cap on a fishery that is at overcapacity with licensees. The 2008 report by the Blue Crab Regulatory Review Committee http://www.mrc.state.va.us/BCAC/Blue%20Crab%20Review%20Report%20March%202008.pdf that reviewed the effectiveness of earlier conservation measures adopted by the Commission, as shown in Attachment V, and information from the VMRC staff strongly supported the Commission's decision to place inactive harvesters on a waiting list, until such time that the resource was more stable. The Commission decided there was too much risk on the resource involved to allow inactive licensees to become active, once there was even a marginal improvement in the blue crab stock. That added effort could further erode stock abundance and delay a rebuilding of the stock. Therefore, those eligible licensees in 2008 who had failed to harvest a single pound of

crab, by either peeler pot or crab pot, from 2004-07, were declared ineligible to purchase a crab fishery license until the abundance of spawning-age crabs reached 200 million in three successive winter surveys. So far, that standard has been met in two consecutive seasons. Given the upturn in the abundance of recruits in the 2010-11 winter survey, it is likely that the 3-year standard will be achieved once the 2010-11 winter survey is complete. The dilemma is that the successful 2009 crab license buyback that resulted in the purchase of 359 licenses could be mostly offset by the entry of 326 previously (2004-07) inactive fishermen from the waiting list.

At the May 2010 public hearing, the Commission closed the December 2010-March 2011 winter crab dredge fishery. This was the third consecutive closing of the winter crab dredge season, and the Commission has been concerned for several years over the amount of waste (damaged crabs) associated with this fishery. Most of all, the Commission has viewed the dredge fishery removals of female crabs, prior to their spring or summer spawning, as deleterious to the stability of the spawning stock that has mostly been in low abundance for many years (see Table 1). The winter dredge fishery exploits principally female crabs, as up to 97% of the harvest consists of female crabs, and most of the female crabs have not spawned for the first time. Since the abundance of spawning-age crabs was low from 1993 through 2008, the removal of pre-spawn crabs by the winter dredge fishery has been problematic.

VIMS presented documentation 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 below, the orange to red colors denote high densities of female crabs within the lower Bay during winter.



The captions: 2008, 2009 and 2010, refer to December of the preceding year and January through March of the current year. For example, 2008 = December 2007 and January through March 2008. The last crab dredge season was December 2007 through March 2008, and these figures are results from the Bay-wide Winter Dredge Survey.

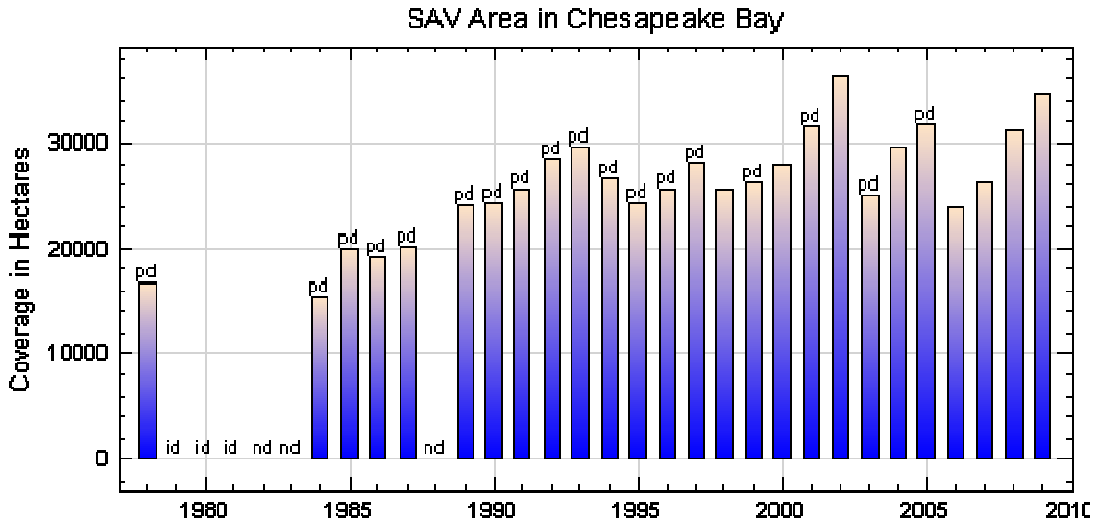
It is evident there were more areas with high densities of crabs in 2009 and 2010, as compared to 2008. The 2009 and 2010 densities correspond to successive seasonal closures of the crab dredge fishery by the Commission.

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. Governor Robert McDonnell has announced his commitment to conserve 400,000 acres of land in the Commonwealth during his term in office, which will assist in water quality protection. In addition, the Governor and the 2010 Virginia General Assembly have approved a dedicated funding source for the Virginia Water Quality Improvement Fund for the installation of agricultural conservation best management practices.

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

Nutrient enrichment and the systemic increase of hypoxic and anoxic zones within the Chesapeake Bay are cited as potential contributors to the sustained (1997 – 2007) 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. Dr. Denise Breitberg of the Smithsonian Environmental Research Center states that the growing dead zone in the Bay each summer is creating a habitat that favors jellyfish over commercially valuable species, such as blue crabs, finfish and oysters. A five-year grant amounting to nearly $1.6 million has been awarded by the National Oceanic and Atmospheric Administration (NOAA) to allow a team of researchers, led by Dr. Brietberg, to investigate the impact of hypoxia on these important species of the Bay. The study will aid state agencies in better protecting and restoring the Bay's habitats.

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. An annual aerial submerged aquatic vegetation (SAV) monitoring program has been conducted throughout the Chesapeake Bay and its tributaries since 1984. Recently, Dr. Robert Orth (VIMS) provided the Commission with an update of the completed 2009 SAV status survey, and also emphasized the importance of reducing human-induced damages to SAV. In 2009, the distribution of SAV in the Chesapeake Bay and surrounding areas was calculated using aerial photography and totaled 85,914 acres (34,768 hectares) (a 12% increase from 2008 SAV measurements) (see figure below). This 9,054 acre increase in Bay-wide SAV coverage occurred primarily in the Middle (5,090 acres) and Lower (3,321 acres) Bay zones, and reflected a large increase in widgeongrass. In addition, 2009 marked the third year of SAV increase in the Lower Bay Zone since the eelgrass dieback. Total area in the Upper Bay Zone remained relatively unchanged from 2008 levels, although there were local offsetting shifts within the zone. 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.



SAV monitoring results by year. Coverage areas measured in hectares; "nd" indicates that the area was not mapped, "pd" indicates that the area was not fully mapped, and "id" indicates

Predators of blue crab, especially striped bass and, more recently, blue catfish, have been linked by many, in industry and elsewhere, as contributors to the trend in low abundance of blue crab. These predator-prey relationships have been explored for striped bass and blue crab by a number of researchers. Blue crab removals from grass beds and other areas of the bay, by striped bass, have been documented, and the results, to date, indicate that blue crab have become a more important prey item of striped bass in recent years, but there is variability by area and time of year. Prior to the 1995–present period of high biomass of striped bass, the 1960- 1972 period was also one of high striped bass biomass. High landings during part of this 13-year period suggest that blue crab biomass was also high during several of those years, despite high striped bass biomass.

VIMS continues to analyze gut contents (diet) of striped bass collected from its Chesapeake Bay Multispecies Monitoring and Assessment Program (CHESMMAP)--a Chesapeake Bay-wide trawl survey designed to collect, enumerate, age and analyze adult fishes. Combined diet data from 2002 through 2009 trawl cruises indicate that crabs (19 different types) comprise < 2% of the 8-year collection of striped bass (N = 2375 striped bass). The investigators do indicate a different approach was used to calculate the fish diet. This and other information on the Virginia Institute of Marine Science program can be found at: http://www.fisheries.vims.edu/chesmmap (currently undergoing repair).

The Virginia Department of Game and Inland Fisheries has been conducting diet studies on blue catfish. These studies can help us to learn more about the effect of blue catfish predation on blue crab. However, in all cases more directed efforts may be needed to adequately quantify the impacts on blue crab from these predators. For example, there is a need for an estimate of the abundance or biomass of blue catfish, in order that any derived blue catfish predation rates on blue crab can be expanded to a blue catfish population basis. Without these blue catfish population estimates, estimates of predation on blue crab are speculative. VIMS[1] and VCU[2] provided a report in November 2009, entitled *Blue Catfish Research in Virginia: A synopsis of current knowledge and identification of research needs.* This report includes some life history aspects, relative abundance estimates and recent spatial distribution of blue catfish, as well as feeding habits of certain size groups of blue catfish.

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2 Greg Garman

Ecosystem Based Fisheries Management (EBFM) in the Chesapeake Bay (Attachment III) has made recent progress in assessing the interconnections between species, their physical and living environments, and human influences. As part of this effort, a Blue Crab Species Team (Table 1) consisting of blue crab experts from Virginia, Maryland, and Delaware assembled to identify and articulate the critical ecosystem stressors impacting blue crabs in the Chesapeake Bay. The Blue Crab Species Team focused on four areas in their analysis: Habitat, Foodwebs, Stock Dynamics, and Socioeconomics, and has outlined the critical ecosystem stressors and issues impacting blue crabs for each (Table 2). 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.

The goals of the EBFM project are to build a sustainable mechanism for addressing ecosystem issues for fisheries within Chesapeake Bay and to develop ecosystem tools and ecosystem based fishery management plans for the five key species. Currently the project involves 85 scientists, managers, and stakeholders from within and beyond the Chesapeake Bay region. For more information on Maryland Sea Grant's Ecosystem Based Fishery Management Project, please visit: www.mdsg.umd.edu/ebfm.

Disaster Relief Plan Accomplishments 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. 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 most will continue into 2011. These projects have provided opportunities for approximately 250 eligible crab licensees to participate in resource or habitat conservation projects, and associated accomplishments are detailed in Attachment IV.

- The Derelict Blue Crab Pot and Marine Debris Removal Project employed 66 previously-active crab dredge fishermen in its first two seasons, and successfully collected 18,225 derelict pots from mid-December to mid-March. The third season of the project is scheduled to begin in December 2010 and will employ 70 total previously-active crab dredge fishermen. At this time, the Commission expects there will be enough funds to implement a partial fourth season of 17 work days.
- The Commission's Conservation and Replenishment Department has successfully trained 135 crab fishermen as participants in the cage oyster aquaculture program and 35 crab fishermen as participants in the spat-on-shell oyster aquaculture program, as part of the Oyster Aquaculture Program. 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 Cull Ring and Terrapin Excluder Device Project employed eight 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, and Great Wicomico Rivers, Tangier and Pocomoke Sounds, and seaside of Eastern Shore). This study has also equipped crab pots with bycatch reduction devices to assess escapement of terrapins and finfish.
- A collaborative analytical stock assessment continues to be conducted by a Bay-wide group of scientists and is scheduled to continue through August 2011. With funding provided jointly by the states of Maryland and Virginia as well as the federal government, an aggressive and comprehensive program has been outlined that seeks to produce the next Bay-wide assessment of the blue crab stock, and initiate new sampling designed to provide critical data to assess the feasibility of new sampling programs to improve the assessment framework. Task IV of Attachment IV provides a summary of the progress of the assessment process through September 2010.
- The Virginia Fishery Resource Grant Program has funded a project entitled "Reducing Derelict Crab Pots Impact on Marine Resources Utilizing Practical and Inexpensive Degradable Panels". In addition, the 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.
- 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.

ATTACHMENT I. 2010 Chesapeake Bay Blue Crab Advisory Report

CBSAC Meeting Date: May 19, 2010 Annapolis, Maryland
Report Approved by the Fisheries Goal Implementation Team:
June 14, 2010

The Chesapeake Bay Stock Assessment Committee combines the expertise of scientists from the Chesapeake Bay region, with that of Federal Fisheries Scientists from the National Marine Fisheries Service Northeast and Southeast Fisheries Science Centers. This group meets each year to review the results of annual Chesapeake Bay blue crab surveys and harvest data, and develop management advice for the Bay Jurisdictions. The annual Chesapeake Bay surveys of blue crabs include the baywide winter dredge survey, the Maryland trawl survey, the Virginia trawl survey and the Calvert Cliffs pot survey.

In 2006, the NOAA Chesapeake Bay Stock Assessment Committee (CBSAC) adopted the baywide winter dredge survey (WDS) as the primary indicator of blue crab stock status because it is the most comprehensive and statistically robust of the blue crab surveys conducted in the Bay1. The WDS measures the density of crabs (number per 1,000 square meters) at approximately 1,500 sites around the Bay (Figure 1). The measured densities of crabs are adjusted to account for the 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 (Sharov et al. 2000).

Population Size

The number of spawning-age crabs (age 1+) is a key indicator of stock status and is used to determine if the population is overfished (see control rule section below). At the beginning of the 2010 crabbing season, results of the 2009 - 2010 WDS (referred to as 2010) provide an estimate of 315 million age 1+ blue crabs. This represents a 41% increase over the 2009 estimate of 223 million age 1+ crabs. For the first time in 15 years, the number of spawning-age crabs has been above the interim target level of 200 million for two consecutive years (Figure 2). As in 2009, the increase in the number of spawning-age adults in 2010 was primarily the result of an increase in the number of females that are likely to spawn this season (females greater than 60 mm or 2.4 inches carapace width). The estimated number of these spawning-age females in the 2010 survey was approximately 240 million crabs (Figure 3). The abundance of mature males (number of males greater than 60mm or 2.4 inches carapace width) in 2010 was approximately 75 million crabs (Figure 4). Recruitment, as measured by the number of age 0 crabs (less than 60 mm or 2.4 inches carapace width) doubled from 173 million in 2009 to 345 million (Figure 5).

Data from three supporting blue crab surveys (the Maryland and Virginia trawls and the Calvert Cliffs Pot study) were reviewed. Results of these surveys are presented in Appendix 1 of this Report. These surveys are under review as part of the 2010 benchmark stock assessment. Therefore, details of these surveys are not presented in this report.

Harvest

The 2009 Maryland commercial harvest was estimated to be 28.5 million pounds. The 2009 Virginia commercial harvest was reported to be 22.5 million pounds, while in the jurisdictional waters of the Potomac River Fisheries Commission it was 2.9 million pounds (Figure 6). Recreational harvest is assumed to be 8% of the total Bay wide harvest in all years (Ashford and Jones 2001, 2002, 2005)2a, b, c. Therefore, the 2009 Bay wide recreational harvest was estimated to be 4.3 million pounds. Combining these categories, the estimated 2009 baywide commercial crab harvest from the Bay and tributaries was 57.2 million pounds, 24% higher than the record-low 2007 harvest of 43.5 million pounds, but well below the long-term (1968-2009) average of 74 million pounds. (Please note: these data were not updated to account for additional, reported harvest to the VMRC, as shown above).

Based on continued evidence of inflated harvest reports, Maryland's 2009 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 (CBSAC, 2009). While the reported commercial harvest of 36.4 million pounds may reflect a maximum possible value, the estimated 2009 harvest of 28.5 million pounds is closer to expected values based on recent inter-state distributions of harvest. In recent years, Maryland's commercial harvest has accounted for approximately 53%, by weight, of the Bay wide harvest, which in 2009, is equivalent to the estimated commercial harvest of 28.5 million pounds.

The estimated exploitation fraction in 2009 (total catch divided by 2009 WDS abundance) was 43%. If Maryland's 2009 reported commercial harvest of 36.4 million pounds is applied, the baywide commercial harvest increases to 61.8 million pounds. Adding the 8% recreational harvest would result in a 2009 exploitation fraction of 50%. This represents a potential upper bound on harvest and exploitation in 2009.

Control rule

The control rule, which was adopted by the Bi-State Blue Crab Advisory Committee in 2001 and updated in the 2005 stock assessment, is the foundation for sustainable management of the blue crab fishery in Chesapeake Bay (Figure 7). The control rule represents the relationship between the number of spawning-age crabs, exploitation (the fraction of crabs removed from the population by the commercial and recreational fisheries each year) and management reference points. In 2006, the CBSAC defined the overfished limit to be 86 million age 1+ crabs. This threshold value is applied as a proxy based on a lack of historical evidence that a sustainable fishery can be maintained at lower abundances than the minimum observed in the WDS. This value of 86 million age-1+ crabs was observed in the 1999 WDS. The overfishing definition, or exploitation threshold, for this stock is 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. The 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 (Fegley 2008,

CBSAC 2008)5, 6. The target level of 200 million is meant to be a goal for initial rebuilding and likely will be replaced by a subsequent target derived from a statistically structured assessment model that integrates all data sources. Based on current analyses, the target likely will be adjusted upwards. A benchmark stock assessment that will recommend new reference points, including abundance targets, is currently underway and will be completed in the spring of 2011.

Stock Status

The Chesapeake Bay blue crab stock is currently not overfished and overfishing is not occurring. The number of spawning-age crabs in 2010 exceeded the interim target level for the second consecutive year. The percentage of crabs removed from the population by commercial and recreational fishing (exploitation fraction) in 2009 was estimated as 43%, and is less than the overfishing threshold of 53% and the target of 46%. When considering both commercial and recreational harvest, the exploitation fraction has been less than the threshold exploitation fraction of 53% in 5 of the last 7 years (Figure 8) and less than the target of 46% for the second time in the last 5 years. Historically, low population sizes are associated with high levels of exploitation. The 2009 fishery represents the first year in the 21-year time series that exploitation was less than the target despite a relatively low population size (393 million crabs) at the start of the fishery, and only the second time (2005) that exploitation has been at or less than the target when abundance has been below 600 million crabs. The exploitation fraction has not been less than the threshold for more than two consecutive years since the mid-1990s.

2010 Potential Harvest and Exploitation

Based on the number of crabs estimated to be present in the Bay at the start of the 2010 crabbing season, the 2010 harvest should increase even under the current regulatory structure. The projected 2010 baywide harvest is approximately 90 million pounds based on the historic relationship between the population size and subsequent harvest. A harvest of this magnitude should not exceed the 46% exploitation target. This potential increase in harvest highlights the benefits of conservation measures taken during 2008 and again in 2009. It is noteworthy that the number of crabs estimated to be in the Bay has been equal to or greater than the 2010 abundance in only 5 of the last 21 years (Table 1). In these 5 years (1990, 1991, 1993, 1996 and 1997), baywide harvest averaged approximately 88 million pounds.

Management Advice – Short Term

1) Maintain conservation measures until full effects of these are known: Management actions since 2008 substantially restricted female harvest. Management actions are summarized in Attachment II. The 2008 management resulted in an increase in spawning-age females in 2009. This increased number of spawning-age females contributed to the production of a strong year-class in 2010. Crab recruitment is inherently variable, but it tends to be higher with high spawner abundance. Regulations should be maintained to ensure that exploitation on the spawning component of the stock remains within safe limits. Changes in regulations to achieve equivalent conservation should be carefully evaluated before they are implemented.

2) Latent effort: Conservation efforts since 2008 appear to have resulted in an increased number of crabs in Chesapeake Bay. One threat to the sustainability of the crab stock, even under conservation actions comparable to 2008 and 2009, is the substantial commercial and

recreational effort that remains latent in the fishery. The CBSAC recommends that management pursue methods for eliminating latent effort to prevent the addition of effort that would compromise the ability of Bay managers to constrain the fishery to the 46% target removal level. Control of active effort is impeded because of the unknown quantity of latent licenses that may become active and an unknown amount of recreational crabbing potential.

CBSAC Members:

Lynn Fegley (Chair)	Maryland Department of Natural Resources
Derek Orner	NOAA Chesapeake Bay Office
Tom Miller	UMCES, Chesapeake Biological Laboratory
Josef Idoine	NMFS, Northeast Fisheries Science Center
Alexei Sharov	Maryland Department of Natural Resources
Glenn Davis	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
Doug Vaughn (Absent)	NMFS, Southeast Fisheries Science Center, Absent
Other Attendees:	
Eric Johnson	Smithsonian Environmental Research Center
Amanda Colton	UMCES, Chesapeake Biological Laboratory

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1. Sharov, A. F., J. H. Volstad, G. R. Davis, B. K. Davis, R. N. Lipcius, and M. M. Montane. 2003. Abundance and exploitation rate of the blue crab (*Callinectes sapidus*) in Chesapeake Bay. Bulletin of Marine Science 72:543-565.

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2b. Ashford, J. R., and C. M. Jones. 2002. Survey of the blue crab recreational fishery in Maryland, 2002. Final Report to the Maryland Department of Natural Resources. Annapolis, MD. 31p.

2c. Ashford, J. R., and C. M. Jones. 2005. Survey of the blue crab recreational fishery in Maryland, 2005. Final Report to the Maryland Department of Natural Resources. Annapolis, MD. 31p.

3. Bi-State Blue Crab Advisory Committee. 2001. Taking Action for the Blue Crab: Managing and Protecting the Stock and its Fisheries. A report to the Chesapeake Bay Commission; Annapolis, Md, Richmond, Va. 24p.

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ATTACHMENT I. Figures

Figure 1. Winter dredge survey index of total blue crab abundance (density of males and females, all sizes combined) in Chesapeake Bay, 1989-2010.

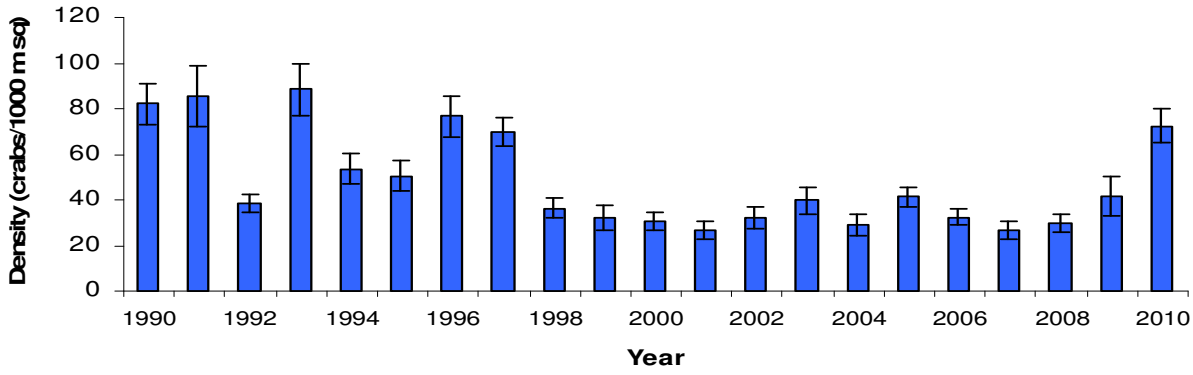


Figure 2. Winter dredge survey estimate of abundance of male and female blue crabs aged one year and older (age 1+) 1989-2010. These are crabs measuring greater than 60mm across the carapace and are considered the 'exploitable stock' that will spawn within the coming year. The lowest observed abundance of 86 million crabs was observed in the 1998-1999 survey. This is considered the overfished threshold. The interim target abundance is 200 million crabs.

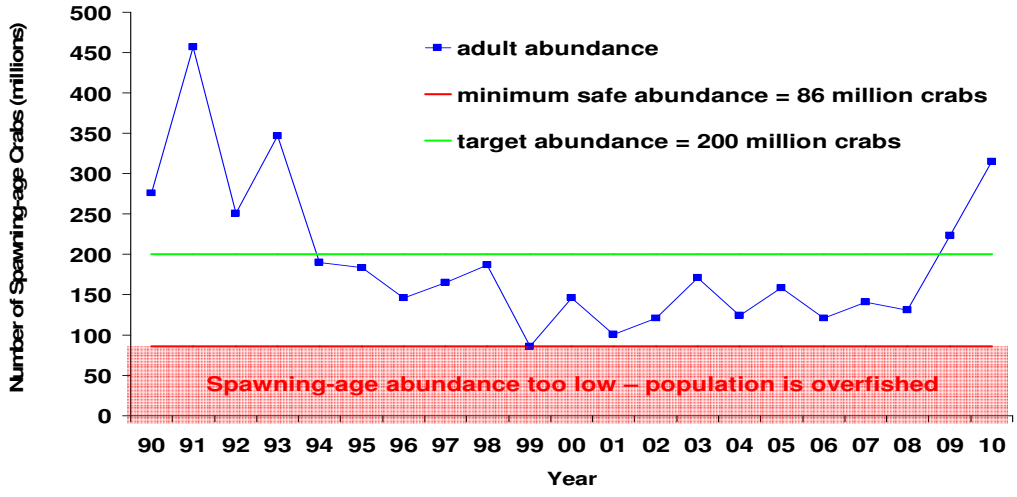


Figure 3. Winter dredge survey estimate of **abundance of female blue crabs aged one year and older** (age 1+) 1990-2010. These are female crabs measuring greater than 60mm across the carapace and are considered the 'exploitable stock' that will spawn within the coming year.

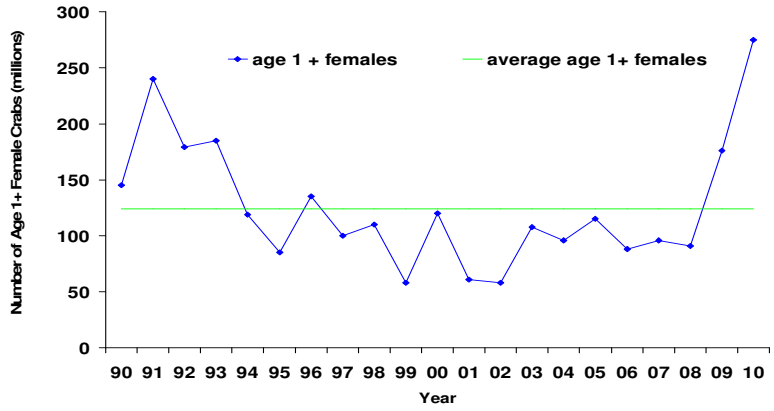


Figure 4. Winter dredge survey estimate of abundance of male blue crabs aged one year and older (age 1+) 1990-2010. These are male crabs measuring greater than 60mm across the carapace and are considered the 'exploitable stock' that will spawn within the coming year.

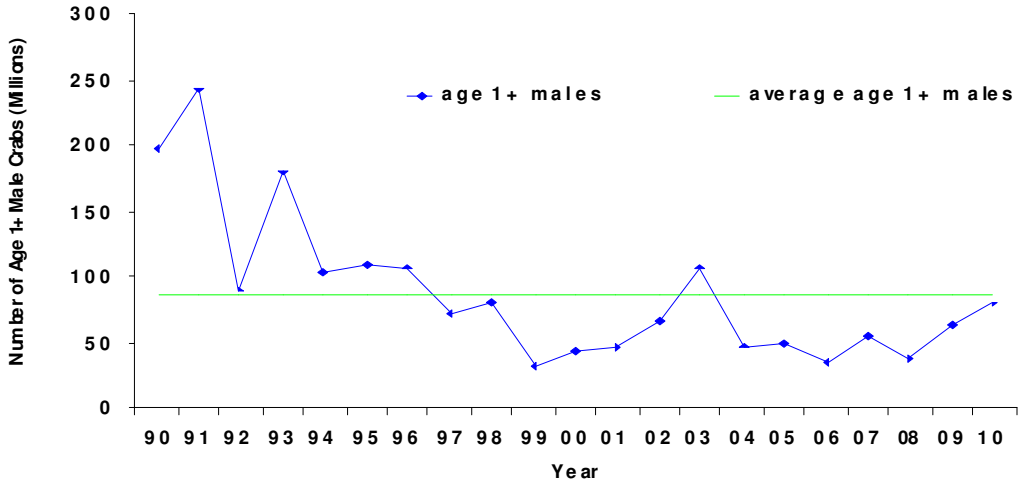


Figure 5. Winter dredge survey estimate of abundance of age 0 crabs. 1990-2010. These are male and female crabs measuring less than 60mm across the carapace.

Figure 6. Maryland and Virginia Chesapeake Bay Blue Crab harvest 1945-2009, adjusted for changes in reporting methods.

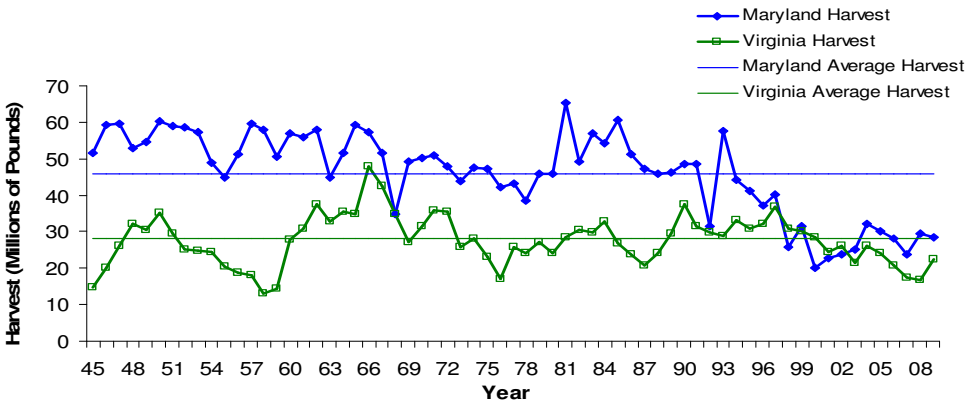


Figure 7. The control rule used to manage the Chesapeake Bay blue crab fishery. An abundance of 86 million age 1+ crabs represents the overfished threshold. In 2009, abundance was above the overfished target and the exploitation rate was below the overfishing target.

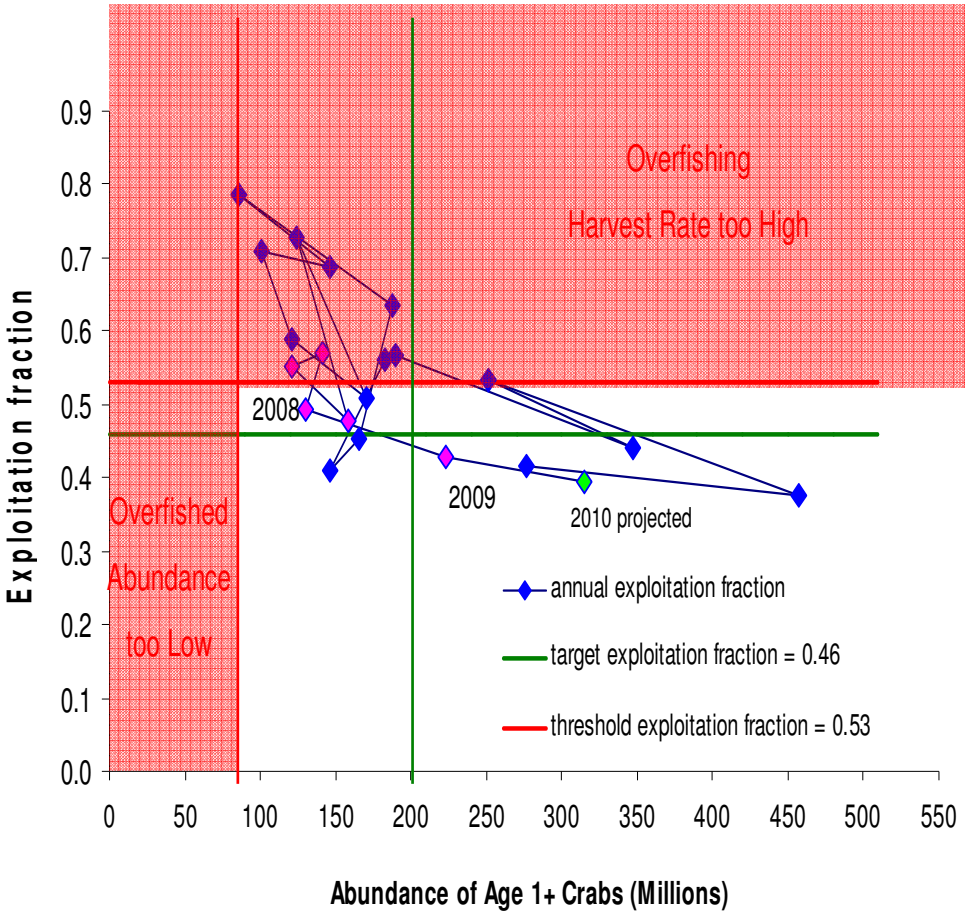
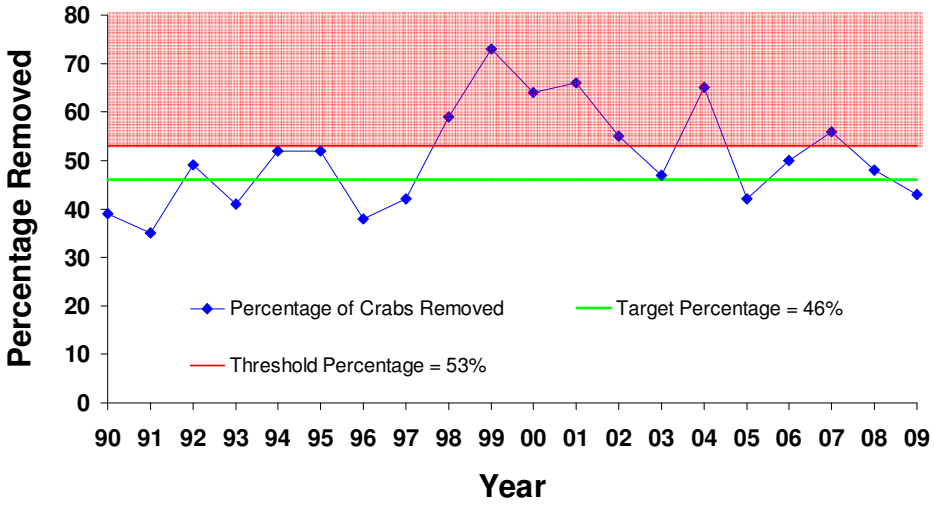


Figure 8. The percentage of crabs removed from the population each year by fishing relative to target and threshold levels between 1990 and 2009.



Appendix 1:
Supporting Survey Indices of Abundance

Data: Three additional fishery-independent surveys are used to monitor stock status: The Virginia trawl survey, the Maryland summer trawl survey, and the Calvert Cliffs crab pot survey. Data from the two trawl surveys and the Calvert Cliffs pot survey are based on calendar year collections through 2009. The indices are expressed as the geometric mean catch per unit effort. Standardized width-age cutoff values were used to differentiate age classes for three of the four surveys (Maryland and Virginia trawl and Calvert Cliffs pot survey) used to derive the abundance indices.

Result Summary: For age 0 crabs, the results of the two trawl surveys are consistent with the dredge survey, indicating a high abundance of age 0 crabs. The Maryland trawl survey indicated a substantial rise in the number of adult crabs (both male and female). The Calvert Cliffs Pot survey indicated that adult crab abundance remains at a high level, but adult female abundance declined in 2009. The Virginia trawl survey shows continued low abundance of adult crabs, and continued low abundance of adult female crabs in 2009.

ATTACHMENT II. Virginia Marine Resources Commission: Actions to Promote Rebuilding of Chesapeake Bay Blue Crab Stock, 2008 - 2010

- In 2007 the Commission sponsored a review of its regulations to determine the effectiveness of management measures established since 1994. This review was conducted by scientists from South Carolina to Maryland.

- One major finding from this review was that an overcapacity in the Virginia blue crab fisheries was complicated by latent effort.

As part of a Chesapeake Bay-wide plan to achieve a 34% reduction in the 2008 harvest of female blue crab, the VMRC adopted the following conservation measures during several months:

- *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.
  - There are currently 326 individuals on the waiting list. The VMRC has established that these individuals shall remain on the waiting list, until the abundance determined from the bay-wide winter dredge survey, of age-1+ crabs (2.4 inches or greater), exceeds 200 million, for three consecutive seasons.
  - To date, abundance of age-1+ crabs has been greater than 200 million, for two consecutive seasons.

- 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)

- *May 2010*
  - Made it unlawful (from March 17 - June 30) to possess dark sponge crabs exceeding regulation tolerance of 10 per bushel
  - 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

ATTACHMENT III. Ecosystem Based Fishery Management

(Shannon Green, MDSG; Eric Johnson, SERC; Tom Miller, UMCES; Jonathan Kramer MDSG)
An interdisciplinary team of scientists working in coordination with Virginia Marine Resources Commission, Maryland Department of Natural Resources, Potomac River Fisheries Commission, Atlantic States Marine Fisheries Commission, and NOAA is implementing a new technical and scientific foundation for Ecosystem Based Fisheries Management in Chesapeake Bay[1]. Central to this effort is the explicit consideration of the interconnections between species, their physical and living environments, and human influences. As part of this effort, a Blue Crab Species Team (Table 1) consisting of blue crab experts from Virginia, Maryland, and Delaware assembled to identify and articulate the critical ecosystem stressors impacting blue crabs in Chesapeake Bay.

[1] Maryland Sea Grant, in coordination with Virginia Marine Resources Commission, Maryland Department of Natural Resources, Potomac River Fisheries Commission, Atlantic States Marine Fisheries Commission, and NOAA has developed and coordinated the Ecosystem Based Fisheries Management (EBFM) Project for Chesapeake Bay since January, 2008. The EBFM Project targets five key species identified in the Ecosystem Planning for Chesapeake Bay document, including the blue crab. The goals of the EBFM project are to build a sustainable mechanism for addressing ecosystem issues for fisheries within Chesapeake Bay and to develop ecosystem tools and ecosystem based fishery management plans for the five key species. Currently the project involves 85 scientists, managers, and stakeholders from within and beyond the Chesapeake Bay region. For more information on Maryland Sea Grant's Ecosystem Based Fishery Management Project please visit: www.mdsg.umd.edu/ebfm.

Table 1. EBFM Blue Crab Species Team

Blue Crab Species Team	Name	Affiliation
	Eric G. Johnson, Chair	SERC
	Jacques van Montfrans	VIMS
	Romauld N. Lipcius	VIMS
	John C. McConaugha	Old Dominion University
	Jeffrey D. Shields	VIMS
	George Abbe	Morgan State Lab
	Anson H. Hines	SERC
	Gretchen A. Messick	NOAA Oxford Lab
	Thomas J. Miller	UMCES
	Eric Schott	UMCES
	Yonathan Zohar	UMBC
	Desmond M. Kahn	DNREC

The Blue Crab Species Team focused on four areas in their analysis: Habitat, Foodwebs, Stock Dynamics, and Socioeconomics, and outlined the critical ecosystem stressors and issues impacting blue crabs for each (Table 2). 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.

Table 2. Critical Ecosystem Concerns for Blue Crabs in Chesapeake Bay

	Ecosystem Stressor	Issues
1. Habitat	a. Climate Change	Direct effects on crabs • If climate change reduces the severity of winters, blue crab winter survival may increase and higher overall temperatures may promote more rapid growth. At the extreme, warmer winter temperature may allow crabs to grow and mature year round, increasing stock productivity. • Increased storm activity coinciding with the larval settlement season may promote increased settlement or cause major disturbances in larval settlement and juvenile dispersal • Warmer temperatures may reduce crab size at maturity. Ecosystem effects on crabs • Eelgrass and widgeon grass decrease during high summer temperatures and the decrease is correlated with localized declines in juvenile blue crab abundance, food, and survival. • 161,000 acres of juvenile salt marsh habitat are predicted to be lost by 2100 due to sea-level rise. • Warmer water temperatures may increase intertidal oysters and restore oyster reef habitat for blue crab food resources. • Warming, high rainfall and stratification may increase in extent and duration of hypoxia and reduce foraging resources and distribution of blue crabs.
	b. Habitat Degradation	Direct effects on crabs • Hypoxia may interfere with dispersal of juvenile

		blue crabs up the estuary and mature females down the estuary altering blue crab distribution in the Bay. • Hypoxia and depleted DO from habitat loss leads to increased mortality rates via exploitation and predation. Ecosystem effects on crabs • Prey populations are destroyed during long periods of severe hypoxia. • Seagrass loss limits primary nurseries and may lead to increased competition for resources and higher cannibalism rates. • Blue crab populations may be threatened by nutrient loading, the introduction of chemical contaminants, alterations to freshwater flow, and habitat destruction due to shoreline development.
	c. Fishing Pressure	Ecosystem effects • Salt marsh communities may suffer from top-down trophic cascades if blue crabs are over harvested. • An estimated 10-20% of pots are lost each year as ghost pots which remain in the water and actively trap blue crabs and finfish. • Trawl and dredge gear from other fisheries can reduce the complexity and refuge value of seagrass and oyster reef habitat for blue crabs.
	d. Disease	Ecosystem effects • Three critical juvenile blue crab habitats, eelgrass, oyster reef, and salt marsh, are diminished by disease.
2. Foodwebs	a. Predation	Direct effects on crabs • Density-dependent cannibalism is a major factor affecting juvenile blue crab mortality. • Finfish predation lowers the survival of all life-stages of the blue crab. Ecosystem effects • Protecting nearshore waters and structurally complex habitats may reduce cannibalism rates
	c. Prey	Ecosystem effects • Benthic prey abundance may exert bottom-up control of crab populations. Threats to benthic abundance include eutrophication, habitat alteration, and abundance of crab competitor species.
	d. Fishing Pressure	Direct effects on crabs • Fishery removals directly impact cannibalism rates and the relative abundance of life stages Ecosystem effects • Fishery exploitation impacts blue crab trophic dynamics as the blue crab is both a key predator and prey in the Bay ecosystem.
	e. Invasive Species	Ecosystem effects • Blue catfish may prey on blue crabs where the two populations overlap. • Some invasive flora may displace blue crab habitat while others offer alternative nursery

		habitats for juveniles. • Invasive crab species compete with blue crabs for prey resources and habitat; some invasive crab species may be prey species for blue crabs. • Blue crab predation is predicted to limit the down-stream spread of invasive zebra mussels.
	f. Disease	• Numerous pathogens and parasites found in blue crab predators and prey have differing impacts ranging from significant mortalities to no known threat.
3. Stock Dynamics	a. Population Dynamics	Direct effects on crabs • Genetic data indicate high diversity within population that make quantifying exchanges among systems difficult • Spatial approaches to management should be considered to maintain local connectivity for blue crabs within the Bay.
	b. Recruitment Variability	• Direct effects on crabs • Declines in the reproductive spawning stock may have depressed juvenile recruitment. • Changes in size structure in crab population have implications on recruitment. Larger crabs are more important to reproductive output than smaller crabs.
	c. Environmental Drivers of stock dynamics	• Stochastic environmental processes are major factors influencing inter-annual variation in the magnitude of recruitment to Chesapeake Bay. • Environmental drivers of mortality such as hypoxia, temperature, and salinity conditions are important sources of mortality. • A variety of infectious diseases have also been determined to cause mortality of blue crabs in Chesapeake Bay.
	e. Fishery Impacts	• Recent declines in landing may be explained by overfishing and changes in ecosystem production following hurricane passage. • Current crab success may be attributed to 2009 fishery management regulations and favorable environmental conditions.
4. Socioeconomic	a. Ecosystem Services	• Blue crab benefits from ecosystem services from other species such as oysters, SAV. • Indicator species to general population of overall Chesapeake Bay health.
	b. Competition with Imports	• Large variability in commercial harvests creates loss of market share to imports. • Need for harvest efficiency to compete.
	c. Equitable Management Alternatives	• Relative benefits to commercial and recreational fishermen. • Many part-time watermen sharing resource with full-time watermen.
	d. Management Options and Models	• Spatial Management • Catch shares including ITQ's, community quotas, co-ops, sector management.

The team detailed how each stressor affects the blue crab and the recommended metrics and indicators needed by fishery managers for increasing the long term viability and sustainability of

the crab stock in Chesapeake Bay. The briefs specifically address the importance of several of the primary considerations of the Virginia Blue Crab Fishery Management Plan including: (1) blue crab habitat and nursery areas; (2) the impacts of water quality conditions necessary for blue crab survival and reproduction; (3) (iii) the relative abundance of life stages including spawning stock; (iv) nursing sanctuaries; and (v) loss of SAV and marsh habitat.

The issues and stressors identified by the Blue Crab Team are currently being compared to those developed for other key Bay fisheries in an effort to develop an understanding of common issues that will lead to the development of new management tools that are ecosystem based. The DRAFT shared ecosystem stressors (see Table 3) are currently under consideration by Virginia Marine Resources Commission in conjunction with the Chesapeake Bay Program Goal Implementation Team. The focus of this effort is to develop an Index of Ecosystem Based Fisheries Management that will allow managers to consider how traditional single species targets are impacted by multiple factors in the ecosystem. Maryland Sea Grant anticipates finalizing this tool, in coordination with Virginia Marine Resources Commission and other state and federal agency partners, in 2011.

Table 3. DRAFT Shared Ecosystem Based Stressors Impacting the Five Key Species in Chesapeake Bay

1. Habitat	a. Hypoxia
	b. Thermal Regime
	c. Flow
	d. Structured Habitat
	e. Habitat Connectivity
2. Foodwebs	a. Trophic Structure
	b. Forage/Prey
	c. Competition
	d. Predation
3. Stock Dynamics	a. Stock and Recruitment Variability
	b. Demographic Structure
	c. Population Connectivity
	d. Disease
	e. Abundance
4. Socioeconomics	a. Regional Impacts
	b. Commercial Income
	c. Recreational Benefits
	d. Community Health
	e. Cultural Value

Final copies of the Blue Crab Species Team Background and Issue Briefs may be found here: http://www.mdsg.umd.edu/images/uploads/siteimages/MDSG_EBFM_Blue_Crab_Briefs.pdf

ATTACHMENT IV. Management of the Disaster Relief Fund

The Commission has initiated six projects using federal disaster relief assistance funds (three fiscal years, totaling $14,995,000) to provide opportunities for eligible crab licensees to participate in resource or habitat conservation projects. A complete listing of project costs, by year, is provided in the following table, and project accomplishments follow.

Complete listing of VMRC Blue Crab Fishery Resources Disaster Relief Plan projects and expenditures.

Task	Project		Year 1	Year 2	Year 3	Task Totals (all years)	Project Total (overall)
I	Derelict Crab Pot and Marine Debris Collection Project	VMRC	$1,345,980.00	$1,156,020.00	$1,156,020.00	$3,658,020.00	
		VMRC ADDENDUM		$187,200.00	$161,200.00	$348,400.00	
		VIMS	$247,170.00	$250,118.00	$270,307.00	$767,595.00	
		VIMS ADDENDUM		$151,670.00	$152,960.00	$304,630.00	**$5,078,645.00**
II	Oyster Aquaculture Project	VMRC - Shell	$500,000.00	$440,000.00		$940,000.00	
		VMRC - Cages	$480,000.00	$395,000.00		$875,000.00	
		VMRC ADDENDUM			$502,500.00	$502,500.00	
		MPB ADDENDUM		$32,500.00	$32,500.00	$65,000.00	**$2,382,500.00**
III	Cull Ring and Terrapin Excluder Project	VIMS	$339,500.00			$339,500.00	**$339,500.00**
IV	Update of Fisheries Stock Assessment Project	VMRC	$100,000.00			$100,000.00	
		VMRC ADDENDUM	$50,000.00			$50,000.00	**$150,000.00**
V	Fishery Resource Grant Program	VIMS	$300,000.00			$300,000.00	**$300,000.00**
VI	Crab/Peeler Pot License Buyback Project	VMRC	$3,000,000.00			$3,000,000.00	
		VMRC ADDENDUM	$3,724,470.00			$3,724,470.00	**$6,724,470.00**
VII	Administrative Costs	VMRC	$10,000.00	$6,500.00	$3,385.00	$19,885.00	**$19,885.00**
	Annual totals:		**$10,097,120.00**	**$2,619,008.00**	**$2,278,872.00**	**$14,995,000.00**	**$14,995,000.00**

Task 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. Eligibility was defined as those commercial fishermen who dredged during the seasons of December 2005-March 2006 and December 2006-March 2007. The program, led by scientists from the Virginia Institute of Marine Science (VIMS), extended from mid-December 2008 through Mid-March 2009, and December 1, 2009 through mid-March 2010.

The first season (2008-09) of the project employed 58 commercial fishermen, and total expenditure from the Disaster Relief Fund was $1,593,150. For the second season of the project (2009-10), eight additional fishermen were funded and total expenditure from the disaster fund was $1,745,008. During both project seasons, each participant was paid $15,000 for 50 days of work, plus all overhead costs except crew payments (averaging $1,426 per participant). During the two dredging seasons on which eligibility was based (December 2005-March 2006 and December 2006-March 2007), the average crab dredge fisherman earned $17,391 total per season. This value does not account for overhead costs, which include boat maintenance, fuel costs, and crew payments.

As the Commission has closed the 2010/2011 crab dredge season, the third year of this project is planned to begin December 1, 2010 and will continue through mid-March 2011 (costing

$1,740,487). Five additional fishermen will be added this year, with a total of 70 previously-active crab dredge fishermen assisting in the 2011/2012 program. Through the employment of these watermen, the project involves the environmentally-beneficial work of removing marine debris from Virginia's tidal waters. Derelict crab pots, eel pots, and fishing nets, if not collected and removed, may remain in the environment for years and continue to capture and kill fish, shellfish, birds and marine mammals.

The program utilized side-scan sonar techniques to retrieve 8,738 derelict pots ("ghost" pots) in several areas of the Chesapeake Bay during 2008/2009, and 9,487 derelict pots in 2009/2010. Over the two project seasons, approximately 14,000 organisms, most of which were blue crabs, were removed from the collected derelict pots. In addition, 100 derelict nets and 781 miscellaneous marine debris items were removed, and 13 sunken vessels were identified. Comprehensive information on the program is available on the VIMS website: http://ccrm.vims.edu/marine_debris_removal/.

Task II. Oyster Aquaculture

Cage Aquaculture Training

The Conservation and Replenishment Department has been training small numbers of watermen in oyster aquaculture for more than a decade. In cage aquaculture, cultchless, individual oysters are grown in structures to protect them from predation. These oysters are grown mostly for the more lucrative, though smaller, half shell market. Growout requires more labor, but the schedule for husbandry is flexible and works well with the schedules of many watermen in Chesapeake Bay. With Blue Crab Disaster funding, more training could be made available to many more watermen. The boats and crab pot handling equipment that the crab fishermen work with every day, work very well with small aquaculture cages that were designed for this training program. In the fall of 2009, 60 crab fishermen began the cage aquaculture training program with 50,000 cultchless oysters and all of the equipment that they needed to grow them to market. This group of crab fishermen has cared for these oysters for a year now, and some of the oysters are ready for market. An additional 71 crab fishermen signed up for the program in the spring of 2010, and they received the same amount of seed oysters and growout equipment. All of the oysters used in this program are triploid (sterile), and from oyster stocks that have been selected for disease tolerance. These traits allow the oysters to be sold at any time of the year, so that the fishermen can target the best marketing times of the season. Attachment IV provides site locations.

Spat on Shell Aquaculture Training

The Conservation and Replenishment Department has been training watermen since 2005 in setting hatchery produced oyster eyed larvae on shell (spat on shell), and deploying these shell loose on the bay bottom. This method of aquaculture requires that oyster shells be containerized, the containerized shells are placed in a large tank which is filled with bay water, and oyster eyed larvae are then added to the filled tanks. The eyed larvae attach to the shells in the tanks, and after a few days the shells are removed and the containers opened so that the shells with oysters

attached can be spread on the bottom. This program has depended on the expansion of the capacity for production by private oyster hatcheries in Virginia. Thirty-five crab fishermen were selected for this program in 2009, but eyed larvae production was inadequate to proceed very far. In 2010, four Virginia hatcheries produced approximately 1.1 billion eyed larvae for the program, and almost 25,000 bushels of spat on shell, with more than 15 million small oysters were placed on private oyster grounds by the 35 participants. An additional 35 participants will participate in 2011. As with the other project, only triploid, selectively bred oysters were provided by the hatcheries for this program. These oysters will be grown mostly for the shucking market, and the oysters can be harvested at anytime of the year when the market seems best for the fishermen. Attachment IV provides site locations.

Promotion of Markets for Oyster Aquaculture

The Virginia Marine Products Board (VMPB), the Commonwealth's seafood marketing and promotion agency, conducts a comprehensive marketing program designed to upgrade and expand both domestic and foreign seafood sales and markets. The board staff has launched an in-state public education program to help the Commonwealth citizens understand the part the seafood industry plays in the state's tradition and economy, as well as the part the citizens can play in keeping Virginia's waterways clean. The staff maintains an up-to-date website at www.virginiaseafood.org.

VMPB has developed a photo album to show the process of growing aquaculture oysters from larvae to marketable products. This album has been and will be used at all VMPB promotions to educate prospective customers of Virginia's strong aquaculture development. In addition, VMPB has developed a Virginia Aquaculture Oyster Growers Directory. This directory gives the growers' locations and contact information, and is distributed to prospective customers at all marketing events.

VMPB has maintained a display at a variety of trade shows, including the International Boston Seafood Show, the Virginia Food and Beverage Seafood Show, and the Fortune Fish Company Seafood Show in Chicago. At all events, the staff has been able to distribute information and hand-outs about the aquaculture industry. VMPB is also working on a geographical location map which, upon completion, will be added to the website.

Task III. Cull Ring and Terrapin Excluder Device Project

Goal:
To provide employment for Virginia's watermen, while concurrently generating information on the effectiveness of current regulations, restoration approaches, and potential ecosystem-based management measures for the blue crab and native oyster fisheries and populations in Chesapeake Bay. The following activities were endorsed by the Virginia Waterman's Association (VWA) and were conducted in collaboration with VWA and VMRC.

Project Objectives and Activities:
To employ Virginia's watermen, particularly crabbers, while conducting restoration activities aimed at enhancing secondary production of the blue crab and native oyster. In ALL of the following activities, watermen will be employed to do the bulk of the work.
To determine the effects of different cull ring sizes in crab pots on blue crab catch, biomass and survival.
To determine the effects of bycatch reduction devices in crab pots on blue crab catch, biomass and survival, on finfish bycatch, and on diamondback terrapin survival.

Study Sites:
Project activities were conducted in the Lynnhaven River system (Site a), James River (Site b), York River (Site c), Rappahannock River (Site d), Great Wicomico River (Site e), Tangier Sound (Site f), Pocomoke Sound (Site g), and bayside Eastern shore (Site h). Activity 2 was conducted at Sites a-h; activity 3 at a-c and h.

Methods and Rationale:
All activities were coordinated by VIMS and implemented by watermen in five tributaries of the western shore and three locations on the eastern shore of Virginia during two seasons in 2009 and 2010. The role of VIMS was to coordinate the effort with VMRC and VWA, analyze the data, and prepare reports on the results. All three entities (VIMS, VMRC and VWA) designed the work plan and cooperated in its conduct and analysis. Selection of the watermen was accomplished in discussions with and approval by VMRC and VWA so that the selection process was fair and equitable.

Activity 2 was conducted at downriver and upriver locations in the tributaries and bayside Eastern shore. On the bayside Eastern shore, the study was conducted near Sites f and g, and at two additional areas along the bayside Eastern shore south of Tangier Island (e.g. Silver Beach). There were upriver (nearshore) and downriver locations to achieve wide spatial coverage. There were five cull ring treatments across four sizes of cull rings and a no-ring control. Pots were sampled daily for different time periods by watermen. Final cull ring sizes and field sites were determined in consultation with VMRC and VWA. This activity used existing crab pots retrofitted with the cull rings so that there was not additional gear in the water as a result of the activity. The lines from the crab pots are short and simple enough that they do not typically cause problems for marine mammals or sea turtles. In fact, the PI is head of the VIMS Sea Turtle Program and is therefore keenly aware of any potential gear issues with sea turtles and marine mammals.

Activity 3, using bycatch reduction devices to reduce diamondback terrapin and finfish bycatch, was conducted in shallow marsh-fringed coves or shorelines where diamondback terrapins are known to reside. This project stemmed from work in summer 2008 where 20 crab pots were deployed at Felgate's Creek in the York River and at Fort Eustis in the James River. Those experiments demonstrated that crab catch was not reduced in pots with excluders, but that terrapin mortality was eliminated. The crab pots are outfitted with "breathing chimneys" which allow terrapins to surface and breathe while still being retained in the pot to allow estimation of terrapin capture. In the previous study, there were no terrapin injuries or mortalities in the experimental pots. This activity will also use existing crab pots retrofitted with the excluders and

breathing chimneys so that there will not be additional gear in the water as a result of the activity.

- Employment of watermen to conduct the study
- Conservation benefits of cull rings and terrapin excluder devices
- Crab catch effects of cull rings and terrapin excluder devices

Expenses:
Most of the expenses will be directed at employment of watermen; a smaller portion will cover some VIMS staff time, crab traps, travel, vessel use, and terrapin excluder devices. We expect to employ 20-30 watermen/crabbers, in the locations noted previously, at $300 per day plus fuel and supplies. VIMS will be reimbursed for staff time, pots, cull rings, excluders, vessels and travel.

Task IV. Update of Fisheries Stock Assessment

The assessment history for blue crab in Chesapeake Bay starts with the first Bay-wide stock assessment in 1977 (Rugolo et al. 1997). In 2001, the technical subcommittee of the Bi-State Blue Crab Advisory Committee (BBCAC) developed a new management framework that relied on exploitation and biomass threshold and target reference points (Miller 2001). Threshold reference points were proposed based on a maintaining 10% of the virgin spawning potential and on the lowest observed abundance in the surveys. A target exploitation rate that would lead to an effective doubling of the spawning stock present in 2001 was also selected. In 2005, Miller et al. (2005) produced the most recent Bay-wide benchmark assessment for blue crab in the Chesapeake Bay. This assessment critically evaluated and revised estimates of the natural mortality rate (Hewitt et al. 2007), the impact of reporting changes on landings estimates (Fogarty and Miller 2004), and spawning potential ratio reference points (Bunnell and Miller 2005). The 2005 assessment recommended adopting the exploitation fraction, defined as the proportion of crabs available at the beginning of the season that are subsequently harvested, in place of less intuitive measures (F) used in previous assessments. Estimates of exploitation fractions were calculated based on the winter dredge survey (WDS) and within a modified catch-survey analysis (Collie and Sissenwine 1983) that permitted the use of multiple surveys (Miller et al. 2005).

The approach used in the 2005 assessment was reviewed by a panel of international scientists with expertise in crustacean fisheries who found that it was a substantial improvement over previous assessments. However, the panel also identified issues to be addressed in future assessments (Haddon et al. 2005). In particular, the panel recommended exploration of the impact of density-dependent processes in life history traits, improvements to the fishery-independent surveys, particularly with regard to catchability, the possibility of developing a sex-specific assessment model and reference points, and a fuller analysis of the impacts of uncertainty on all aspects of the assessment.

With funding provided jointly by the states of Maryland and Virginia as well as the federal government, we outlined an aggressive and comprehensive program that seeks to produce the next Bay-wide assessment of the blue crab stock, and initiate new sampling designed to provide critical data to assess the feasibility of new sampling programs to improve the assessment

framework. The work will be undertaken by scientists from the Maryland Department of Natural Resources (MD DNR), the Smithsonian Environmental Research Center (SERC), the University of Maryland Center for Environmental Science Chesapeake Biological Laboratory (CBL) and the Virginia Institute of Marine Science (VIMS).

PROGRESS AGAINST ASSESSMENT TERMS OF REFERENCE

ToR 1. Review of Life History and Vital Rates.
All work for this objective was completed by April 2010 and is awaiting inclusion in the final assessment document.

ToR 2. Evaluate Reference Points.
Work for this objective was fully completed by April 2010.

ToR 3. Analysis of Fishery-Independent Surveys.
We have made considerable progress against this objective in the second six month period of the report.

ToR 4. Analysis of Catch and Effort Data.
We have made considerable progress on our analysis of the catch data in preparation for the assessment.

No progress has been made on analyzing the effort data.

ToR 5. Development of the Assessment Model.
We have made substantial progress on this TOR. We are proposing to bring forward two assessment models in the new assessment: a simple aggregate production model and a sex-specific catch – multiple survey model.

ToR 6. Evaluation of density-dependent exploitation
A draft manuscript based on this work has already been completed – and thus the analytical framework is well advanced.

ToR 7 & 8. Assessment of uncertainty in model estimates
No work is scheduled on these ToRs until after work on TOR 5 is completed in early 2011.

PROGRESS AGAINST RESEARCH OBJECTIVES

Task 3.1.1 Winter Dredge Efficiency Studies
The unusually harsh winter (2009/2010) precluded any additional winter dredge efficiency studies from being conducted. MD DNR and VIMS staff struggled to complete the routine annual WDS survey and could not fit in additional sampling efforts focused on dredge efficiency that were identified in the proposal. This sampling was postponed until the winter 2010-2011.

Task 3.1.2 Optimization of fishery-independent surveys
Research identified under this task broadly parallels the work proposed for ToR 3 in the assessment. The final products of these analyses will be available after the assessment has been reviewed in March 2011.

Task 3.2.1 Evaluation of sampling programs
No work was scheduled for this objective after the assessment has been completed.

Task 3.2.2 Baywide juvenile survey
PIs at SERC have initiated sampling in three research areas: design and implementation of a juvenile survey for blue crab in Chesapeake Bay.

Task 3.3 Life History Studies
As part of our efforts to test for potential impacts of sperm limitation, we collected mature female blue crabs in coordination with local watermen from sub-estuaries throughout the Maryland and Virginia portions of the Chesapeake Bay during late summer and early fall of 2009 and 2010.

We obtained a sample of sponge females for fecundity studies from the lower Bay spawning grounds, and conducted initial processing of the samples. Data was collected on ovigerous females, and egg masses were carefully removed following the methods of Prager (1990). The egg mass was measured, weighed, egg stage noted, then fixed in formalin and transferred to 70% ETOH for storage according to the procedure of Hines (1982). Now that our primary field season has ended, estimating fecundity from these samples will be a top priority during late fall/winter. We also intend to repeat this work in 2011 to provide estimates of fecundity from two years.

Beginning in spring of 2011, we will conduct a field experiment in the lower bay to estimate the average number of broods produced by a mature female blue crab during the Chesapeake spawning season, and how brood production varies with female size
In coordination with the NOAA Chesapeake Bay Office we have selected March 29-31, 2011 as the dates for the review of the completed assessment. The review meeting will be held in Annapolis, MD and will be run along similar lines to the last assessment.

Task V. Supplemental funding for the Fishery Resource Grant Program

The Virginia Legislature created the Fishery Resource Grant Program Trust Fund (VFRGP) within the state treasury to "protect and enhance the Commonwealth's coastal fishery resource through the awarding of grants" in four areas: 1) new marine fisheries equipment or gear; 2) environmental pilot studies on issues including water quality and fisheries habitat; 3) aquaculture or mariculture of marine-dependent species; 4) seafood technology. The Fishery Resource Grant Program invests in ideas generated by the fishing public through fair and competitive methods. The VFRGP used disaster relief funding for continuing the provision of grant funds for applied fishery development ideas. A request for proposals was posted in November 2009, soliciting additional projects aimed at assisting the blue crab industry sustainability. Additional information: http://www.vims.edu/research/units/centerspartners/map/econ/frgp/index.php, and a new request for proposals will be posted in November 2010.

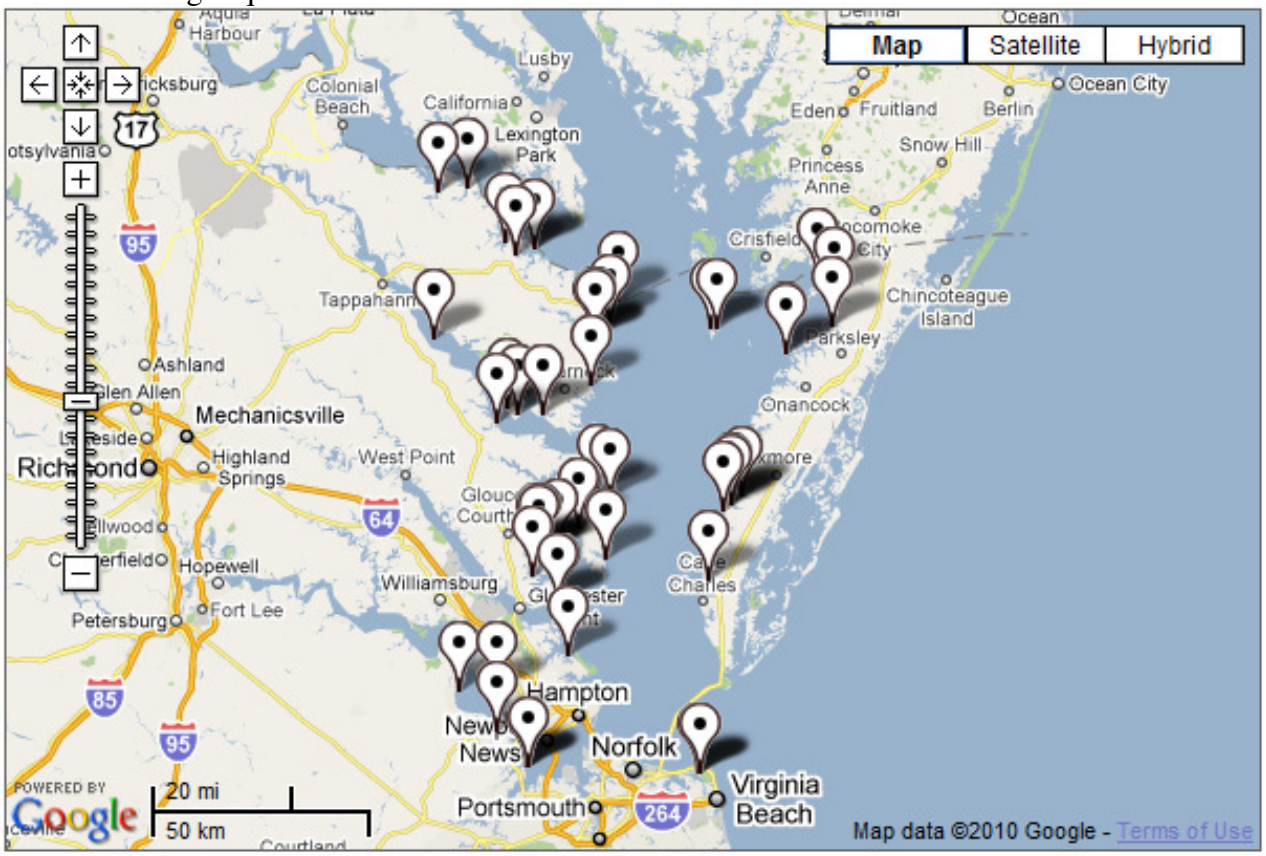
One project was selected from the 2009-2010 proposals and a summary of the work is as follows:
VFRGP Project Title: "*Reducing Derelict Crab Pots Impact on Marine Resources Utilizing Practical and Inexpensive Degradable Panels*"

Project Investigator: Catherine C. Jenkins

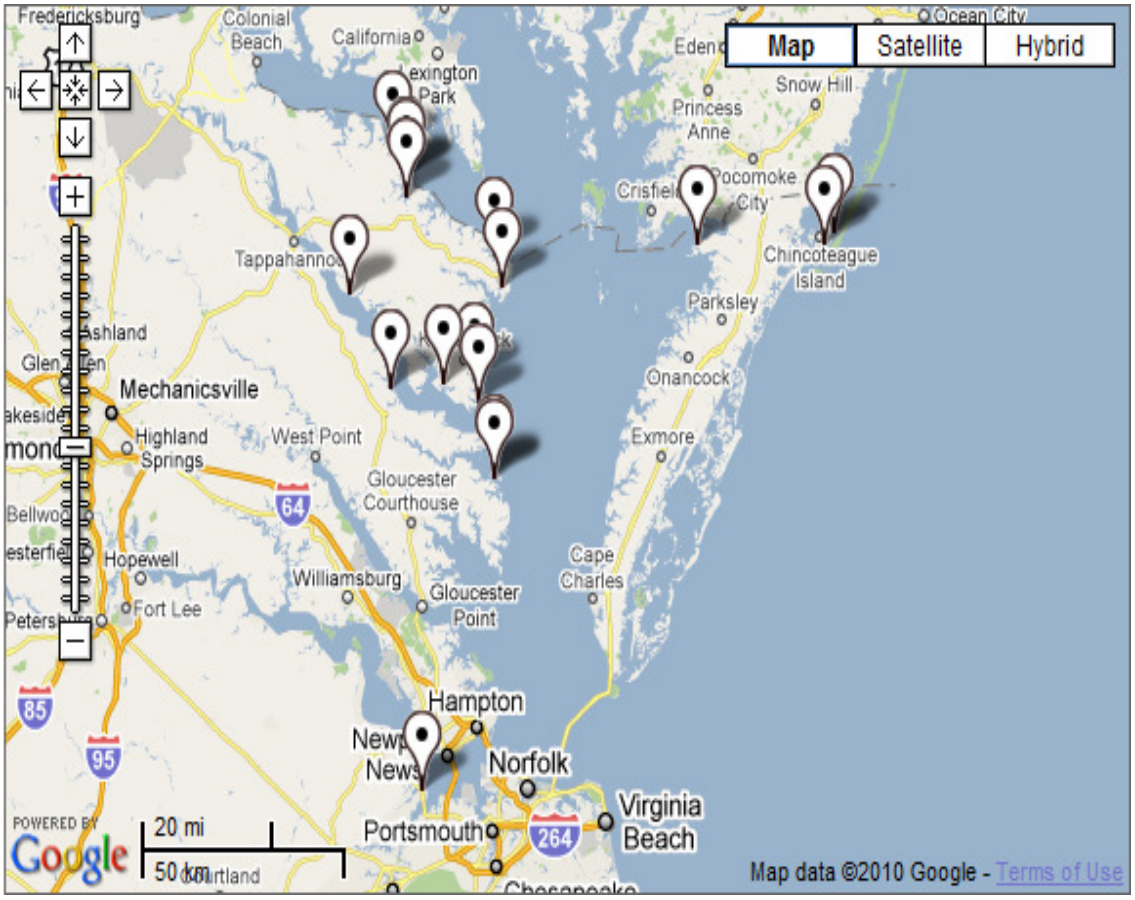
Period Covered by this Report: August 2009-October 2010
Summary of Progress and Work Accomplishments During the period:
Data collection was completed for final weeks of fall 2009 fishing. Pots were prepared for return to use by crab season opening (3/17/10). All goals were met during the fall and spring period. The winter time was off season so no activity was expected or conducted. Early 2010 data collected is available from Thomas Murray at VIMS Sea Grant.

In addition to funding a Fishery Resource Grant Fund proposal, the VFRGP assisted VMRC in implementing one-time disaster mitigation assistance by utilizing the Fund to support blue crab industry aquaculture training (which is detailed in Task II – Oyster Aquaculture). Advisory service personnel engaged in training crab license holders on all facets of "contained" oyster aquaculture. Advisory personnel traveled to participating industry sites (see first map below, provided by Thomas Murray of VIMS) to assist in labor aspects and to answer questions. The advisor was on location for preparation and inoculating setting tanks with eyed larvae, as well as assisting in maintenance, care and troubleshooting aspects of the cultchless oyster projects (see second map below, also provided by Thomas Murray). A basic pamphlet was also created by the advisor to assist in getting started with cultchless oyster aquaculture.

Location of cage aquaculture sites



Locations of spat on shell aquaculture sites:



Task VI. Crab license Buy-back program

In 2009, the Commission initiated a crab license buy-back program in order to reduce the overcapacity in the crab pot and peeler pot fisheries. The success of this program can be measured by the amount of actual or potential effort it removed from the fisheries. In total, 75,441 crab pots and peeler pots were removed from future fisheries, and this means the program reduced the number of crab pots or peeler pots by 17.87%. Since the moratorium on the purchase of additional crab fishery licenses that began in 1999 was recently extended indefinitely by the Commission, this removal of effort will not be replaced by new effort (notwithstanding the potential entry of inactive former licensees from the waiting list, as discussed above).

Nearly 45% of the disaster relief funds ($6,724,470) were allocated to the program, with proportional allocations according to status of crab harvest activity (full-time, part-time, or waiting list). A reverse-auction process involved the submission of bids from crab licensees, and the Commission accepted the lowest bids within the activity categories. The process was concluded on November 18, 2009, with a total of 359 licenses purchased from 59 full-time, 131

part-time, and 169 wait-listed crab harvesters. There were $6,724,470 allocated by the Commission to the buy-back program. The objectives of the program were to reduce both active and currently inactive effort (waiting list participants) in the crab pot and peeler pot fisheries. Buy outs were based on a fisherman-bid process, whereby the active or inactive licensees could negotiate a buy-out price with the Commission. Priority for buy-outs was given to active licensees, and it was intended that 50% of the budget funds would be used to buy out active licensees who can be considered "full-time" crab harvesters (e.g. fished crab pots at least 100 days or fished peeler pots at least 60 days).

Of total program funds, the Commission intended that 30% would be used to buy back licenses from less active crab fishermen (e.g. fished crab pots less than 100 days or fished peeler pots less than 60 days). The remainder of the funds (20%) were obligated to purchase inactive licenses of those individuals currently on the waiting list. At some future time, these currently inactive fishermen could become active, so a buy-out now will help lessen future overcapacity.

Low bids within an activity category (active, partly active, inactive) were targeted for buyouts (a reverse-auction process) after the Commission received bids from the peeler pot and crab pot crab fishermen on November 1, 2009. The reverse auction process was concluded by the Commission on November 18, 2009, and letters were sent to all bidders, regardless of whether their bids were accepted. The following statistics characterize this successful buy-back program.

Table 1. Summary of buy-back statistics, according to full time, part time or waiting list status.

	Relief Funds		Buy-Back		Bids	
Class	**Proportion**	**Allocation**	**Spent**	**Proportion**	**Offers**	**Accept**
Full-Time	0.50	3,362,235	3,320,397	0.49	76	59
Part-Time	0.30	2,017,341	2,036,131	0.30	358	131
Wait List	0.20	1,344,894	1,368,633	0.20	230	169
Total	1.00	6,724,470	6,725,161	1.00	664	359

Table 1 shows the Commission stayed within its pre-determined objectives, concerning the proportional allocation (50%, 30%, 20%), according to status of activity. The Commission expended $674 more than allocated to the buy-back program and will use part of its administrative costs to cover this extra expenditure. A total of 359 licenses were purchased.

Table 2. Total number and value of bids accepted, by harvester category and gear.									
		Full-Time		Part-Time		Wait List		Total	
Gear	# Pots	# Licenses	# Pots	# Licenses	# Pots	# Licenses	# Pots	# Licenses	# Pots
Crab Pot	85	3	255	18	1,530	42	3,570	63	5,355
Crab Pot	127	2	254	4	508	2	254	8	1,016
Crab Pot	170	0	0	4	680	6	1,020	10	1,700
Crab Pot	255	21	5,355	42	10,710	46	11,730	109	27,795
Crab Pot	425	7	2,975	5	2,125	7	2,975	19	8,075
Peeler Pot	210	26	5,460	58	12,180	66	13,860	150	31,500
	Total	59	14,299	131	27,733	169	33,409	359	75,441

Table 2 shows the number of licenses purchased, according to category (full time, part-time or waiting list) and the corresponding number of pots previously licensed by those individuals. By category, 59 full time (as of 2009) harvesters' licenses were purchased, and, collectively, 14,299 pots (5,460 peeler pots and 8,839 crab pots) are removed from the 2010 fisheries. Similarly, 15,553 crab pots from 73 part-time crab pot fishermen were retired, and 12,180 peeler pots were retired from the fishery from the purchase of 58 part-time peeler licenses. From the wait list, the Commission purchase 169 licenses (66 were former peeler pot licensees, the remainder were previously licensed for the crab pot fishery). Table 2 also summarizes the license purchases by gear category amounts (e.g. up to 85 crab pots, 425 crab pots or 210 peeler pots).

Table 3 provides a summary of statistics related to the overall buy-back program, in terms of the magnitude in value of bids that were accepted by the Commission, according to harvester and gear category. The median or mid-point statistic means that 50% of the successful bids were either less or more than this median (mid-point estimate).

The license buy-back program lowered the number of pots (peeler pot and crab pot) that could be used by the fishermen from 422,976 pots to 347,408 pots. This represents a 17.87% reduction in the number of pots available for these two fisheries. By gear-based fishery, the number of peeler pots available for the fishery was lowered by 22.2%, and the number of available crab pots was lowered by 15.7%.

Table 3. Statistics summarizing the value of purchased licenses, by gear and harvester category.

Harvester Category	Gear	Successful Bid Statistics			
		Lowest	Highest	Average	Median
Full-Time	Crab Pot	$6,000	$150,000	$57,667	$49,998
	Peeler Pot	$5,000	$175,000	$54,515	$39,500
Part-Time	Crab Pot	$500	$100,000	$18,555	$10,000
	Peeler Pot	$500	$50,000	$11,753	$9,500
Wait List	Crab Pot	$1,000	$35,000	$8,721	$6,000
	Peeler Pot	$500	$21,000	$7,127	$5,375

ATTACHMENT V. Virginia's 22-Point Blue Crab Management Plan: 1994 - 2007

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

1. Expanded the spawning sanctuary (146 sq. mi.) established in 1942 by 75 sq. mi., with no crab harvest allowed from June 1 through September 15
2. Established a 14,500-acre winter-dredge sanctuary in Hampton Roads
3. Shortened the crab pot season to April 1 through November 30. In 2007 the season opening date was established as March 17.
4. Required two cull (escape) rings in each commercial and recreational crab pot
5. Required four cull rings in each peeler pound that allows escapement of small peeler crabs
6. Capped the number of peeler pots per license to prevent expansion of the fishery
7. Limited the crab dredge size to 8 feet to prevent increases in effort

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

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

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

1. Lowered the maximum limit on peeler pots from 400 to 300 pots in 2000
2. Initiated a moratorium on additional commercial licenses for all commercial crabbing gear (This moratorium became effective May 26, 1999 and will continue until the end of the 2007 season.)
3. Established (in 2000) a Virginia Bay-wide Blue Crab Spawning Sanctuary, in effect June 1 through September 15. This additional sanctuary of 435 square miles increased the sanctuary to 656 square miles.

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

1. Enacted an 8-hour workday for commercial crabbers (2002) that replaced Wednesday closures of 2001
2. Established a 3-inch minimum size limit for peeler crabs in 2002
3. Reduced the winter dredge fishery limit from 20 to 17 barrels in 2001
4. Augmented (2002) the Virginia Blue Crab Sanctuary by 272 square miles (The spawning sanctuary extends 928 square miles.)
5. Reduced unlicensed recreational harvester limits to 1 bushel hard crabs, 2 dozen peelers (2002)
6. Reduced licensed recreational harvester limits to 1 bushel of hard crabs, 2 dozen peelers, with a vessel limit equal to number of crabbers on board multiplied by personal limits (2001)

Limited evidence that sponge crab mortality was offsetting any gains in spawning potential expected from the prohibition on the possession of dark-colored (late-stage) sponge crabs resulted in the Commission enacting the following management measures in 2007:

1. Possession of dark-colored (brown through black) sponge crabs is lawful starting July 16

2. To compensate for any loss in spawning potential resultant from a change to the sponge crab prohibition, an industry-backed extension of the spawning sanctuary extends out to the Three Nautical Mile Limit Line, from the mouth of the Chesapeake Bay southward along the Virginia Beach coast to the Virginia-North Carolina line, was adopted. This extension added 94 square miles to the sanctuary.