COMMONWEALTH of VIRGINIA

L. Preston Bryant, Jr.
Secretary of Natural Resources

Marine Resources Commission
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Steven G. Bowman
Commissioner

November 15, 2007

MEMORANDUM

TO: The Honorable Timothy M. Kaine
Governor of the Commonwealth of Virginia
And,
Members of the Virginia General Assembly

THROUGH: The Honorable L. Preston Bryant, Jr.
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 Section 28.2-203.1 of the Code of Virginia.

EXECUTIVE SUMMARY

The Chesapeake Bay blue crab stock is not overfished (an overfished condition would mean that stock maintenance capability could be jeopardized), and overfishing is not occurring.

All findings from recent reviews of the status of the Chesapeake Bay blue crab stock indicate a continuation of a low abundance of both exploitable size (2.4 inches and greater, in carapace width) blue crabs and mature female blue crabs. The most recent exploitation rate (2006 season) indicates that 50% of the stock is being removed, on an annual basis, strictly from harvesting activities. This 2006 exploitation rate is above the target exploitation rate of 46% but below the overfishing exploitation rate (also termed threshold exploitation rate) of 0.53. Managers within the Chesapeake Bay jurisdictions have the benefit of a control rule, whereby annual estimates of abundance, as well as exploitation rates, are referenced against empirical and

model-based standards, respectively, to guide management efforts. One standard is the overfished threshold, equal to an annual percentage removal rate of 53%. Current scientific advice indicates that it will take several years of maintaining an exploitation rate on blue crab at or near the target exploitation rate (0.46) to increase the spawning potential to 20% of an un-fished stock. The 20% spawning potential is the goal of both the Chesapeake Bay Commission's Bi-State Blue Crab Committee and the NOAA-sponsored Chesapeake Bay Stock Assessment Committee.

The Chesapeake Bay Commission's Bi-State Blue Crab Technical Advisory Committee (BBTAC) released an August 2006 report, "*Blue Crab2005, Status of the Chesapeake Population and its Fisheries*" that presents the findings advice, following the 2005 crabbing season and the 2005-2006 winter dredge survey. The report states that 2005 can be reported as a slightly above average year in nearly a decade of low abundance. The lower stock levels of the winter dredge survey in 2005-2006 offer a preliminary indication that modest improvements seen in 2005 may not mean the beginning of a long-term trend. "Cautious management should continue." That was sound advice, as the 2006 abundance of exploitable crabs was slightly higher than in 2005, but the harvest or exploitation rate also increased in 2006.

More recently, the 2007 Chesapeake Bay Blue Crab Advisory Report, prepared by the Chesapeake Bay Stock Assessment Committee (CBSAC), and provided below, compared the current status of the blue crab stock to thresholds and targets defined by the control rule initiated by the stock assessment of 2005. Stock abundance in 2006 was greater than the overfished threshold (an empirically observed minimum level of abundance thought necessary for stock maintenance). The exploitation rate or harvest rate, defined as the proportion of the legal-sized crabs available at the beginning of the year that were harvested during the year increased from 36% in 2005 to 50% in 2006. Low abundance, especially of recruits (within-year production), combined with an extended period of high exploitation rates, indicate a stock condition that warrants concern for the tenth consecutive year

THE 2007 VIRGINIA BLUE CRAB FISHERY MANAGEMENT PLAN

A major basis for the 2007 plan is the analytical, model-based stock assessment that determined recent and past exploitation rates was completed and reviewed in 2005. The assessment contained fishery data through 2003, but the CBSAC has consistently analyzed each additional year's fishery-independent (winter dredge survey, e.g.) and fishery-dependent (harvest) data through 2006, to compare exploitation rates and abundance against the standards outlined above and contained in the 2007 Chesapeake Bay Blue Crab Advisory Report, as provided below. The stock assessment and subsequent Chesapeake Bay Blue Crab Advisory Reports examined the health of the Chesapeake Bay blue crab spawning stock, and determined the effects of the annual harvest rate on the blue crab stock.

The 2006 Chesapeake Bay-wide blue crab harvest of 48.9 million pounds is among the lowest recorded since 1945 and well below the long-term (1968 – 2005) average harvest of 73 million pounds. A summary of the Virginia harvests of blue crab (from all state waters) during the last 12 years is included in this report (Table 2). The Virginia harvest of hard crabs in 2006 was 22.5 million pounds, compared to a 2005 harvest of 25.4 million pounds, and represents the lowest harvest, since 1995. The 2006 harvest of peeler crabs from Virginia waters totaled 929,799 pounds and was the lowest harvest during the 12-year period. Lower harvests mostly result from the persistent low abundance levels, over several years. However, the many

regulations adopted by the Marine Resources Commission, since 1994, seem to have forestalled even lower abundance levels or higher exploitation rates.

The Marine Resources Commission maintained all of its blue crab management measures in place in 2007, with the exception of a modification to the sponge crab possession prohibition (see below). A summary of the 22 management measures that have been adopted, from 1994 through 2007, are provided below. Additional management measures may be necessary to maintain or to improve the status of the blue crab resource, and the Marine Resources Commission has recently initiated investigations into several potential conservation measures, with the assistance of its Blue Crab Citizen Advisory Committee and scientific advisors at the Virginia Institute of Marine Science and Old Dominion University. In addition, as discussed below, under current issues, the Commission convened a panel of blue crab scientists, in 2007, and asked the scientists to weigh the conservation benefits from current regulations against the performance of the blue crab stock. The Commission also sought the panel's advice, concerning the need for alternatives to current regulations.

CURRENT ISSUES:

A summary of the Commission's recent blue crab issues and discussions have centered on the issues presented below. The Commission will convene its Blue Crab Citizen Advisory Committee, prior to the start of the 2008 crab potting season, for the purpose of discussing the problems identified below and developing effort control strategies.

Conservation of female blue crab sponge crabs, an update

Prior to spawning, a female blue crab extrudes its eggs onto its abdomen. Following approximately a 15-day period, these eggs (larvae) are released or rubbed off by the female crab. During summer months, especially mid-July to mid-August, an abundance of sponge crabs is distributed throughout the lower Chesapeake Bay. In 1996 the Commission adopted a prohibition on the possession of dark-colored (late-stage of crab egg development) sponge crabs, for the entire crab harvest season. By 2006, scientific evidence from VIMS suggests that a large fraction of sponges, and even some of the female crabs, suffer mortality from the harvesting and handling by the harvesters. The conservation benefits of this regulatory requirement appear to be less than originally promoted by VIMS and the Commission in 1996. In March 2007 the Commission modified the prohibitions on the harvesting of sponge crabs, in that harvesters are allowed to possess sponge crabs, starting July 16. The Commission decision was based on advice from Old Dominion University and VIMS crab ecologists who provided indications that the high water temperatures of mid summer, combined with stress from entrapment in pots and additional handling stress induced by the harvester, are responsible for a large portion of the mortality experienced by the sponge (larvae) and sponge-bearing female crab. Additional studies by VIMS in 2007 and 2008 will further assess the effects of temperature, but will also determine area-specific effects on the survivability of sponges and associated female crabs.

Expansion of the current 927 square-mile Virginia Blue Crab Sanctuary, an update:

The purpose of the original 146-square mile sanctuary (adopted by the General Assembly in 1942) was to relieve harvest pressure on female blue crabs during peak spawning times. June 1 – September 15 continues, as the time when harvest within the sanctuary is prohibited. The Marine Resources Commission expanded this important spawning sanctuary by 75 additional square miles in 1994. In 2000 the Commission protected another 434 square miles from the

harvest of blue crabs during June 1 through September 15, with an additional 272 square miles of sanctuary established in 2002.

In 2006 the Commission's Blue Crab Citizen Advisory Committee assessed current harvest areas that may be suitable for incorporation into the summertime Virginia Blue Crab Sanctuary. A new sanctuary area was viewed as a precautionary measure to offset the possibility that the relaxation of the sponge crab prohibition would result in a loss in crab conservation benefits (the 2007-2008 studies by VIMS should help to resolve this question). An area that includes ocean waters that stretch south, from near the Capes of Virginia to the North Carolina-Virginia Line, was viewed favorably for inclusion in the sanctuary. This area is dense with sponge crabs during summer, and with the 2007 modification of the dark sponge crab ban, it was important to this area from harvesting pressure. The Blue Crab Citizen Advisory Committee viewed this ocean sanctuary as a beneficial conservation measure, and the Commission agreed. In March 2007, this coastal area of 95 square miles was adopted as a sanctuary, with harvest prohibited, from June 1 through September 15. Currently, the Virginia Blue Crab Sanctuary provides protection, from harvest, to crabs, from June 1 through September 15, within 1,022 square miles of Virginia waters.

Ghost Pots: An update

"Ghost pots," refer to lost or abandoned fishing gear and crab pots. When left alone, the pots sink to the bottom of the water but continue to trap and kill marine life. They are typically lost during storms or when boat propellers accidentally slice through a marker buoy and rope that holds them in place. Ghost pots are also considered marine debris. Studies by the Virginia Institute of Marine Science indicate that as many as 60,000 crabs are trapped in ghost pots each year in the lower York River, alone.

The "ghost" pot study is currently (2007) analyzing existing data to determine the escapement rates (depending on how "old" each derelict pot is). There are some preliminary data on different mechanisms to make derelict pots less efficient, and an exploration of those mechanisms is funded by a new grant from the National Marine Fisheries Service. There is also the possibility that VIMS may receive additional funding, for an expanded survey with side scan sonar. VIMS has already employed this technique within the York River. Sonar technology is extremely useful, as a data gathering tool, in that it can be used in low visibility conditions and cover large areas that would severely limit a diver or optical camera.

VIMS plans to report findings, from these studies, to the General Assembly. As far as funding a removal of ghost pots, preliminary surveys have shown that the suspected high abundance of derelict pots, within various tributary systems, may render removal cost-prohibitive, and such removal may produce deleterious effects on the bottom habitat. The focus of VIMS is to find a way to make these pots less efficient in catching crabs by mechanically inhibiting the self-baiting of the pots that occurs from trapped finfish.

The VMRC Blue Crab Regulatory Review Committee

In 2007, the Virginia Marine Resources Commission convened a Blue Crab Regulatory Review Committee (BCRRC) to investigate the potential of existing or alternative regulations to reverse current resource conditions of low overall abundance, low spawning potential and high exploitation rates. Specifically, this review panel, composed of 8 scientists from South Carolina,

North Carolina, Maryland and Virginia, was asked to assess current regulations, in terms of their ability to promote optimum yield and effectively control effort in the fisheries and promote increased abundance of the stock.

During the course of three meetings, the scientist reviewed the existing VMRC regulations and harvest and effort data from the crab fisheries. A report, from these proceedings, will be available in December 2007. The review panel determined that the objectives of regulations, for the blue crab resource and its fisheries, should be to promote an abundance of exploitable crabs (2.4 inches and greater) that sustains an optimum yield. The consensus of the panel was that despite the implementation of a 22-point management plan during 1994 through 2007, there is no evidence that the current regulations have improved stock abundance, but these same regulations have probably helped avert even lower stock abundance. Preliminary findings by the review panel include:

- Age 1+ abundance estimated from the 2006-07 winter dredge survey was 122 million crabs and was similar to the estimated abundance of 2005. Yet, this abundance estimate is as much as 70% less than abundance estimates for the early 1990s. Especially troubling is that the spawning potential has remained at low levels, since 1992, despite implementation of measures such as several increases to the summertime spawning sanctuary.

- A major problem is that exploitation rates have exceeded the overfishing threshold ($u = 0.53$), for 6 of the last 8 years, and the 2006 exploitation rate ($u = 0.5$) is only slightly lower than the overfishing threshold. The current blue crab management plan may not directly promote increases in abundance of this stock or decreases in the surplus of fishing effort.

- Although the current management plan may have staved off even lower levels of abundance or landings, more aggressive, direct methods of increasing stock size are warranted. Previously, sanctuaries, minimum size limits, and cull ring requirements were attempts to increase overall abundance; however, there has been no observed improvement in the stock, since 1994. Ultimately, the management plan should be capable of adapting to environmental effects, especially the effects on recruitment strength, but current management measures seem to fall short of that objective.

- As a first step, the BCRRC finds there is a need for managers and stakeholders to define the attributes of a successful or quality fishery, as opposed to a marginal or collapsed fishery, and develop a comprehensive management plan that fits those attributes. Once there is some form of consensus on the attributes of a quality fishery, it should be more evident which existing management measures are important components of an overall blue crab management plan.

- Ultimately, the management plan should be capable of adapting to environmental effects, especially the effects on recruitment strength, but current management measures seem to fall short of that objective.

- A program, such as a crab pot tagging program, is an essential need. As a first step, Virginia needs to be able to quantify existing levels of effort through a pot-tagging program. At present there is not an adequate basis to monitor effort in the crab fisheries, by either fisheries managers or law enforcement personnel, and a pot-tagging system would provide for more effective monitoring of these fisheries.

- Once a baseline of effort is established, Virginia should begin an effort control program, for its various crab fisheries. A limited access system, of sorts, has been in place since 1999, but the only reason effort has remained relatively low is because abundance of the stock has been low. There is concern that with any moderate increase in abundance, effort will quickly increase in the Virginia crab fisheries because there are many licenses currently not in use (latent effort) that would become active. The result could be overfishing beyond levels seen in the recent past, to the extent that an overfished stock condition may emerge.

- Many fisheries, throughout the world, are managed by transferable quota systems. In Virginia striped bass are managed by an ITQ (individual transferrable quota) system, and an IFQ (individual fisherman quota) system is the management tool for ensuring the black sea bass fishery does not exceed its quota. For the blue crab fishery, once current effort levels are known and unused licenses can remain dormant, an ITE (individual transferrable effort) system should be developed. The ITE system is practical, in that the allocation of individual effort can be based on recent historical participation (days of crab harvesting), and this system can be used to adjust ITE's, on a yearly basis, according to the previous year's exploitation rate or, perhaps, abundance of exploitable crabs.

Development of an Action Plan

Now that managers within the Chesapeake Bay jurisdictions have the benefit of a control rule, the corresponding elements of that rule, annual exploitation rates and stock abundance estimates can be utilized to trigger actions designed to promote a lower exploitation rate and build abundance. Currently, the stock is not overfished and overfishing is not occurring, but the Chesapeake Bay jurisdictions have discussed adoption of an action plan that contains triggers, should multiple years of overfishing occur or it is determined that blue crab stock is overfished. For Virginia, the advisory committee and interested stakeholders need to assist the Commission with their perspectives on, and commitment to, an action plan. At this time, it is envisioned by the Commission that conservation measures triggered by overfishing in multiple years, such as effort reductions, seasonal restrictions or changes in size limits, would be attempts to afford an increase in stock abundance. However, the Commission recognizes that greater urgency would be associated with responding to an overfished stock (an abundance that is less than the 1999 estimate of age 1+ abundance or 90 million crabs). It is anticipated that remediation of either an overfished stock or persistent overfishing of the blue crab stock would involve all Chesapeake Bay jurisdictions, but the Commission recognizes that each jurisdiction may choose different, but complementary, conservation strategies.

2007 Chesapeake Bay Blue Crab Advisory Report

Accepted by the Fisheries Steering Committee: 26 September 2007

Status of the Stock:

In 2006, the NOAA Chesapeake Bay Stock Assessment Committee (CBSAC) adopted the Bay-wide 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 Bay[1]. At the beginning of the 2007 commercial season, results of the 2006-2007 WDS indicated that the abundance of age 1+ (crabs 2.4 inches or greater, in carapace width) crabs remained depressed compared to historical levels. The overall decline in abundance that began in 1993 ended in 2001. However, since 2002, abundance has stabilized below the survey average (Figure 1). Recruitment, as measured by the abundance of age 0 crabs, was low in the 2006-2007 WDS, and was the second lowest estimate of recruits since the survey began in 1989 (Figure 2). This low level of recruits continues a prolonged period of low recruitment that has persisted since 1997-1998. In the 2006-2007 WDS, female spawning potential (abundance of females greater than 60mm or 2.4 inches carapace width) was below the average level for the WDS (Figure 3).

A management control rule is used to determine the status of the stock (see Control Rule below for explanation). Despite continued low abundance, the blue crab stock remains above the abundance (overfished) threshold of 86 million age 1+ crabs (Figure 4). Age 1+ abundance from the 2006-2007 WDS was estimated as 122 million crabs. The exploitation fraction for 2006 (percentage of crabs removed from the population by fishing) was estimated as 50%, which is below the overfishing threshold of 53%. Therefore, overfishing is not occurring. Although the exploitation fraction has been below the overfishing threshold for 3 of the last 4 years, it has been above the target exploitation fraction of 46% in 8 of the last 10 years.

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 data show differing trends to the WDS. The divergent results of these supporting surveys are possibly a reflection of patchy distribution of crabs in space and time within the overall low abundance measured by the dredge survey.

Harvest:

The 2006 Bay-wide crab harvest of 48.9 million pounds is among the lowest recorded since 1945 (Figure 5). The 2006 Maryland harvest of 28.1 million pounds is among the lowest recorded, but above the historical low of 20 million pounds observed in 2000. Virginia's harvest of 20.8 million pounds (Chesapeake Area, only) was below the time series average for the state, but above the lowest values observed in the 1940's, 1950's and 1970's (Figure 6). Based on the historical relationship between crab abundance estimated from the WDS and the subsequent harvest, the 2007 harvest is predicted to be 48.7 million pounds with a possible range of 32.3 to 65.1 million pounds based on 95% prediction intervals (Figure 7).

Projected Harvest and Exploitation:
The 2006-2007 WDS resulted in an estimated total abundance of 273 million crabs. Given this estimate of abundance and the projected harvest described above, we can predict a range of exploitation fraction (U) for the 2007 crabbing season. The predicted harvest of 48.7 million lbs would result in a U of 63% which exceeds the overfishing threshold of 53%. The range of values for the 2007 U, based on the possible range of the 2007 harvest (32.3 million lbs to 65.1 million lbs) is 44% to 80%. It is important to note that a harvest of 32.3 million lbs would represent an historical low for the Bay-wide crab fishery, and the associated U of 44% is only slightly below the target of 46%. Therefore, it is unlikely the 2007 exploitation fraction will fall below the target. The blue crab fishery is recruitment driven, meaning that the harvest in any given year is highly dependent on the influx of age 0 crabs from the previous year. Given the low recruitment observed in the 2006-2007 WDS, the 2007 harvest will rely heavily on age 1+ crabs surviving from the previous year. The reduction in recruitment levels apparent after 1996, combined with continued low levels of adult abundance, indicate that the blue crab stock and associated fisheries continue to warrant concern.

Control rule:
The control rule, which was adopted by the BiState Blue Crab Advisory Committee in 2001[2], and updated in the 2005 stock assessment[3], is the foundation for sustainable management of the blue crab fishery in Chesapeake Bay. The control rule represents the relationship between adult crab abundance (millions of crabs), exploitation (the fraction of crabs removed by the fishery in a year) and management reference points. In 2006 the CBSAC defined the overfished limit to be 86 million age 1+ crabs. This value, observed in the 1999-2000 WDS, is the lowest value in the 17-year WDS time series, and delineates the overfished threshold based on a lack of historical evidence that a sustainable fishery can be maintained at an age 1+ abundance that is less than 86 million crabs. 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 reliably produce the next generation of crabs. The target exploitation fraction of 46%, maintained over several years, represents an exploitation fraction that would preserve 20% of the unfished spawning potential.

Special comments:
The CBSAC recommends that management jurisdictions work with stakeholders to define goals for the blue crab fisheries, and subsequently develop a comprehensive management plan for achieving these goals. This plan should include specific management actions for rebuilding a depressed stock, for promoting sustainability, and for ensuring blue crab do not become overfished.

As a result of the 2005 blue crab stock assessment, a number of changes and improvements have been made in our analysis of stock status. Harvest has been adjusted to account for a number of historical changes in estimation methodology employed by the Maryland Department of Natural Resources and the Virginia Marine Resources Commission[4]. In constructing the Control Rule, the annual estimates of abundance and exploitation fraction use data from the WDS and reported fishery harvest. We no longer use an estimate of natural mortality rate (M) to calculate annual exploitation rates. An estimated M of 0.9 was employed to estimate the threshold and target exploitation rates.

Although the WDS is the most robust sampling program for blue crabs, the 17-year time series of the survey is significantly shorter than that of the supporting surveys. Therefore, the time series average for the survey is sensitive to each additional annual estimate. As a result, if

abundance continues to be depressed, the survey average and the annual estimates of abundance will begin to converge. It must be noted that an annual value that appears 'average' for the WDS is still well below historical levels estimated from the supporting survey indices. This phenomenon of 'shifting baseline' highlights the importance of selecting a stationary reference period to which the current blue crab stock status can be compared.

Critical data needs:
It is critical that robust, fishery-dependent data collection programs be implemented for blue crabs throughout the Chesapeake Bay. The design of these programs should be based on the need for improved information on biological characteristics of the harvest and reliable effort data for the commercial and recreational fisheries. Additionally, a collaborative and coordinated Bay-wide fishery-independent survey focused on the spring through fall distribution and abundance of blue crabs remains important.

Chesapeake Bay Stock Assessment Committee Members:

Chris Bonzek VIMS
Lynn Fegley Maryland DNR – chair
John Hoenig VIMS
Tom Miller CBL
Rob O'Reilly VMRC
Derek Orner NMFS/NCBO
Alexei Sharov Maryland DNR
Mark Terceiro NMFS/NEFSC
Doug Vaughan NMFS/SEFSC

Also participating: Mike Seebo, VIMS
Dave Hewitt – VIMS
Glenn Davis – Maryland DNR

Literature Cited

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.
2. 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.
3. Miller, T. J. et al. 2005. Stock Assessment of the Blue Crab in Chesapeake Bay. Technical Report Series No. TS-487-05 of the University of Maryland Center for Environmental Science, 162p.
4. Fogarty, M.F. and T.J. Miller. 2004. Impact of a Change in Reporting Systems in the Maryland Blue Crab Fishery. Fisheries Research. 68:37-43.

Figure 1. Winter dredge survey density of blue crabs aged one year and older (age 1+) 1989-2006. These are crabs measuring greater than 60mm across the carapace and are considered the 'exploitable stock'. 95% confidence intervals (1.96*std error) shown around individual points. The average range for the survey is defined as the standard deviation of the annual crab density values divided by the square root of three.

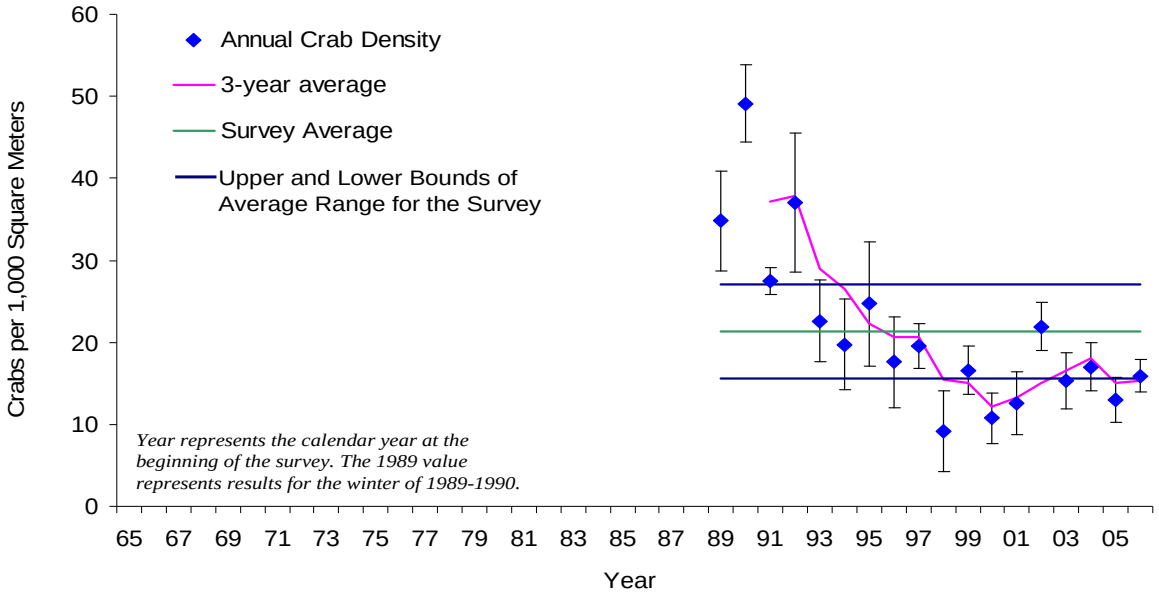


Figure 2. Winter dredge survey density of age 0 blue crabs (recruits) 1989-2006. These are crabs measuring less than 60mm (2.4 inches) across the carapace. 95% confidence intervals (1.96*std error) shown around individual points. The average range for the survey is defined as the standard deviation of the annual crab density values divided by the square root of three.

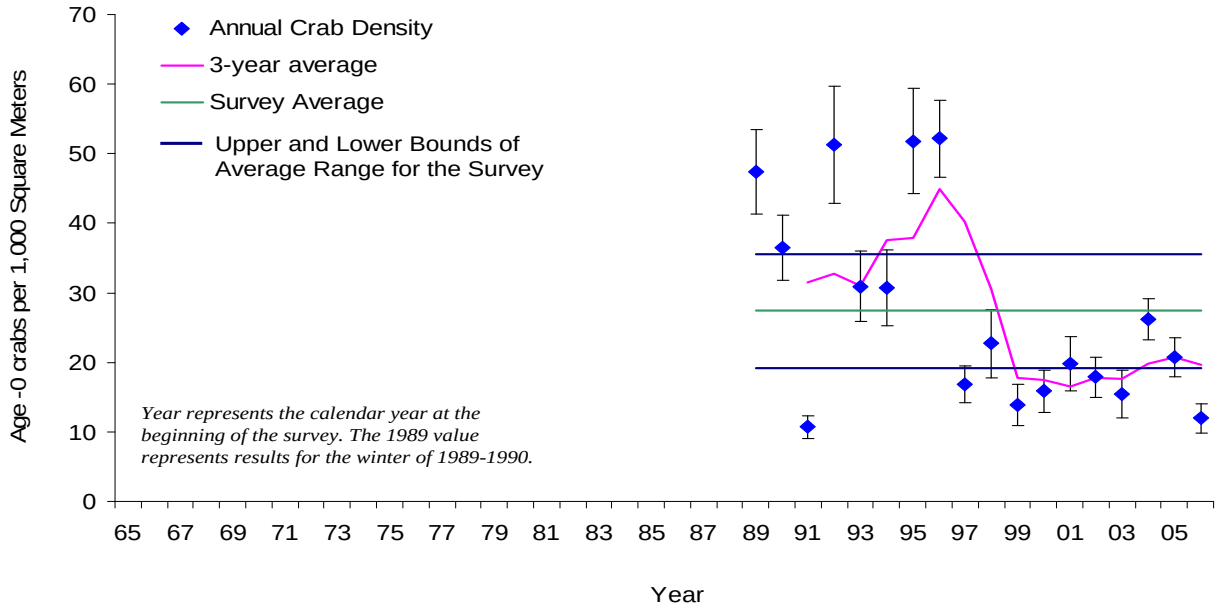


Figure 3. Winter dredge survey density of female spawning potential 1989-2006. These are immature and mature female crabs measuring greater than 60mm (2.4 inches) across the carapace. 95% confidence intervals (1.96*std error) shown around individual points. The average range for the survey is defined as the standard deviation of the annual crab density values divided by the square root of three.

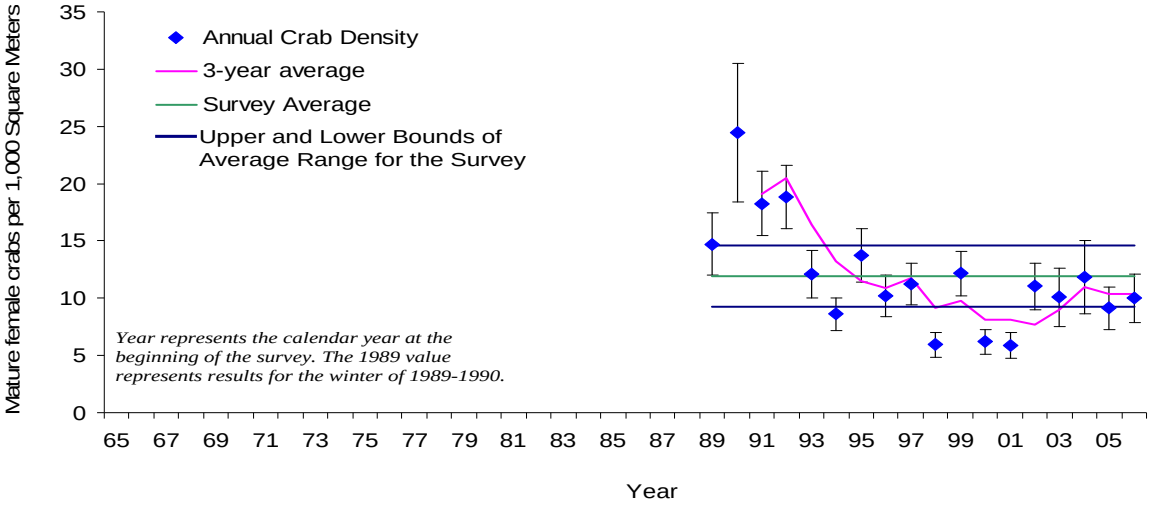


Figure 4. The control rule used to manage the Chesapeake Bay blue crab fishery. An abundance of 86 million age 1+ crabs represents the overfished threshold. In 2006, abundance was above the overfished threshold and the exploitation rate was below the overfishing threshold, but slightly above the target level. The red point is the projected 2007 exploitation fraction and has a possible range of 0.44 (44%) to 0.8 (80%), based on 95% prediction limits.

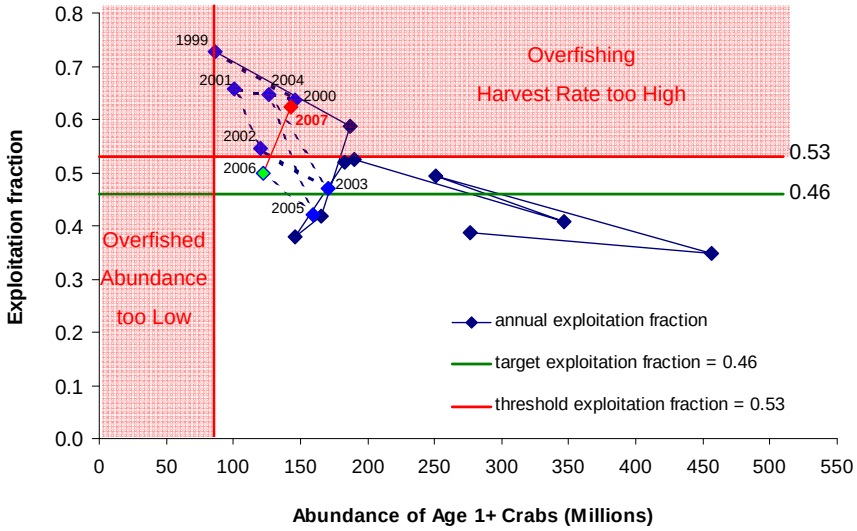


Figure 5. Chesapeake Bay Blue Crab harvest 1945-2006, adjusted for changes in reporting methods.

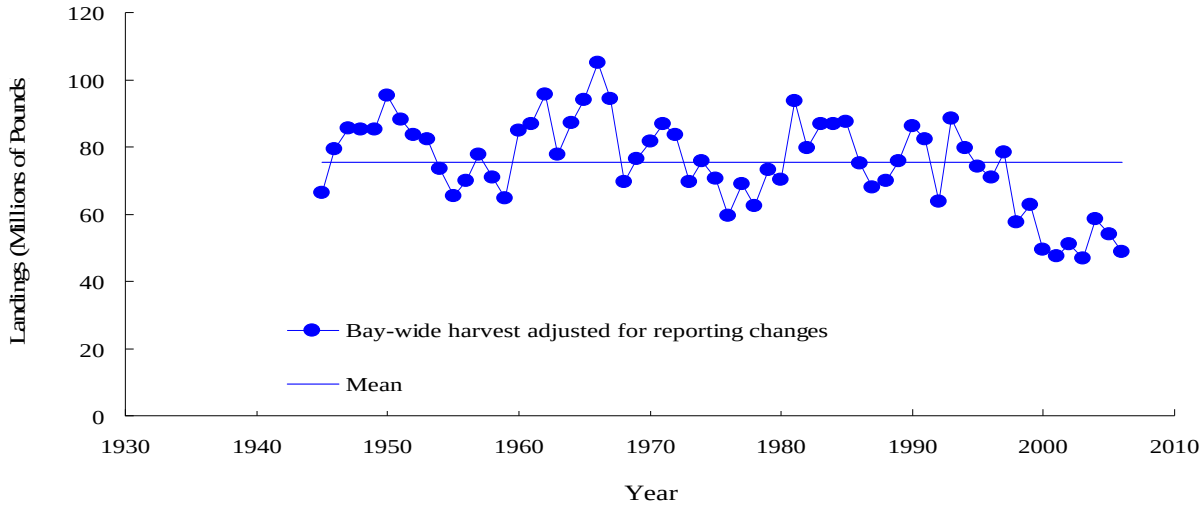
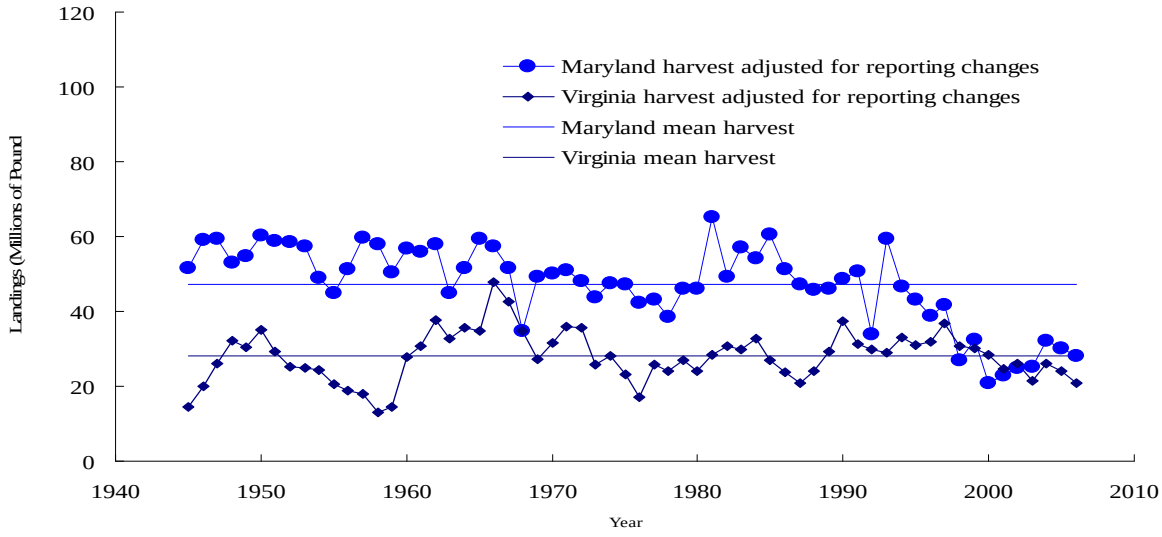


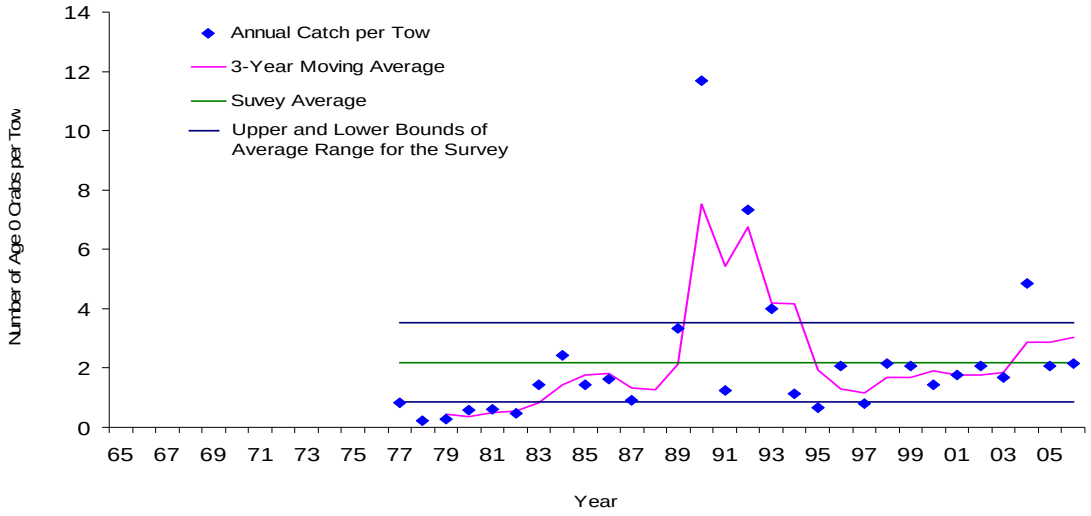
Figure 6. Maryland and Virginia Chesapeake Bay Blue Crab harvest 1945-2006, adjusted for changes in reporting methods.



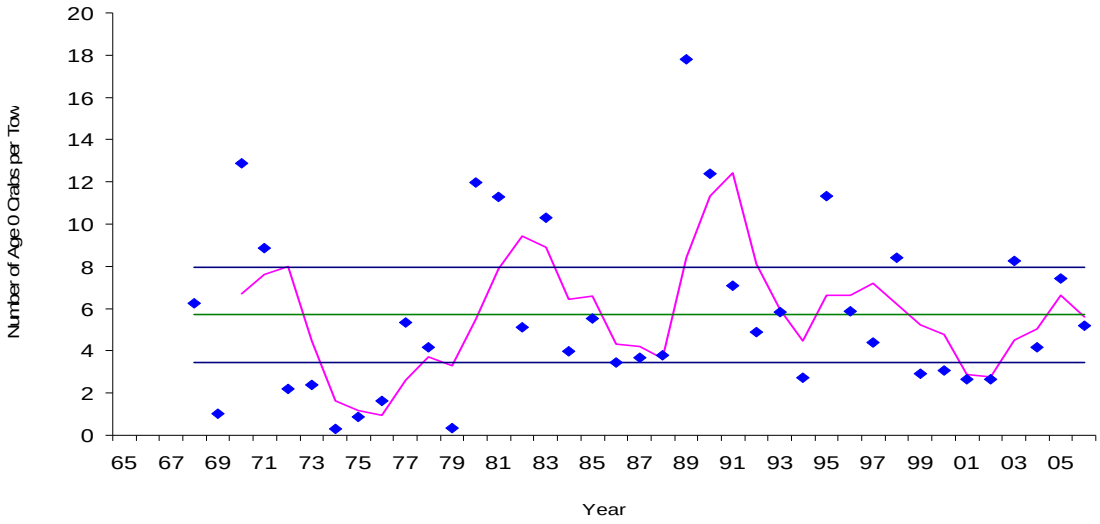
Appendix
Supporting Survey Indices of Abundance

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 2006. 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.

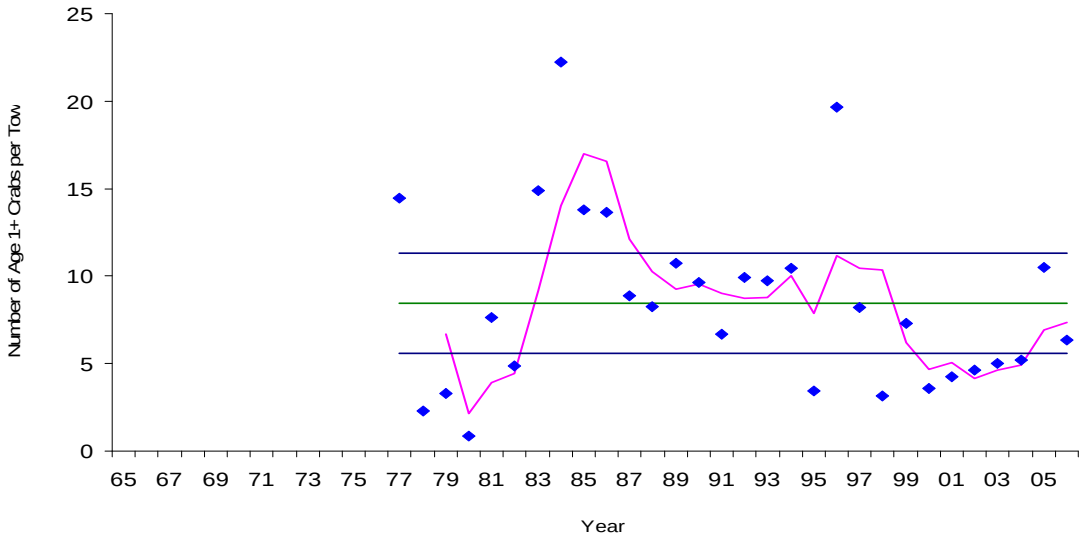
Appendix Figure 1. Maryland Trawl Survey catch per tow of age 0 crabs, 1977 - 2006. Age 0 is assigned to crabs caught during September and October that are less than or equal to 50 mm across the carapace. The average range is defined as the standard deviation of the annual crab density values divided by the square root of three.



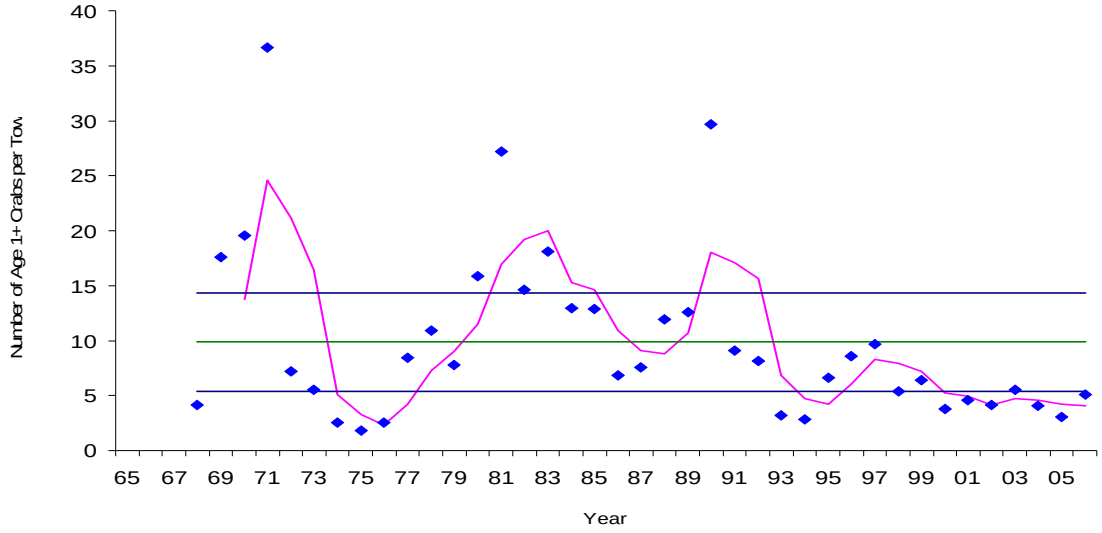
Appendix Figure 2. Virginia Trawl Survey catch per tow of age 0 crabs, 1968-2006, from sites in the upper and lower rivers. Age 0 is assigned to crabs that are less than or equal to 50 mm across the carapace in September, and less than or equal to 60 mm across the carapace in October and November.



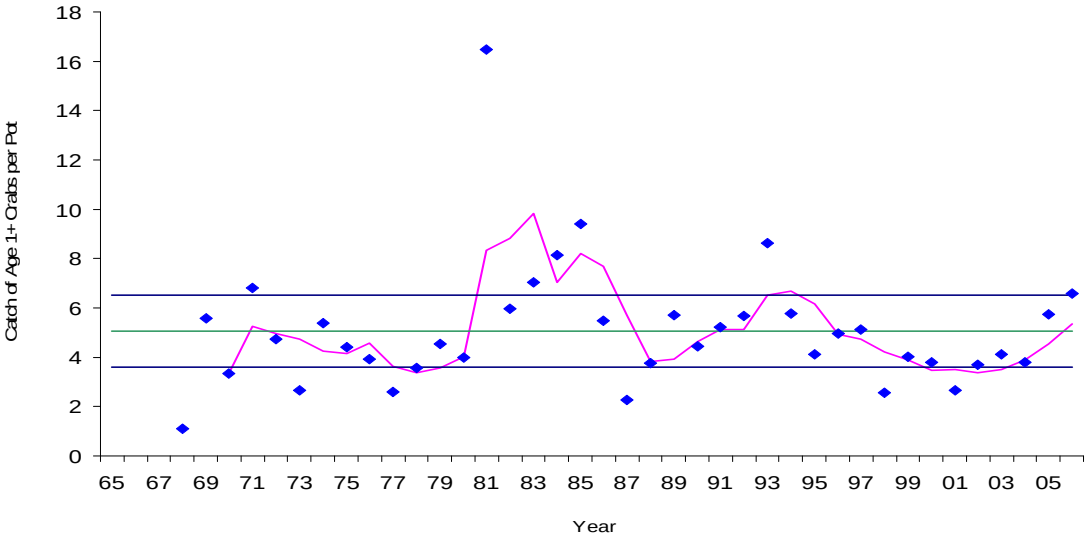
Appendix Figure 3. Maryland Trawl Survey catch per tow of age 1+ crabs, 1977 - 2006. Age 1+ crabs are defined as those caught from June through October that are greater than or equal to 51 mm across the carapace.



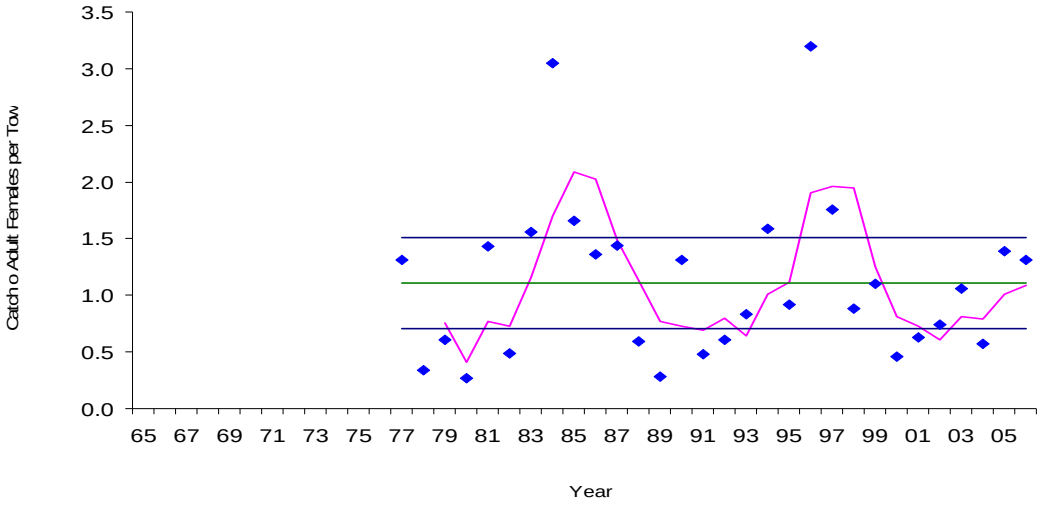
Appendix Figure 4. Virginia Trawl Survey catch per tow of age 1+ crabs, 1968-2006, from sites sampled in the upper and lower rivers. Age 1+ crabs are defined as those that are greater than or equal to 36 mm across the carapace in August, greater than or equal to 51 mm in September, and greater than or equal to 61 mm across the carapace in October.



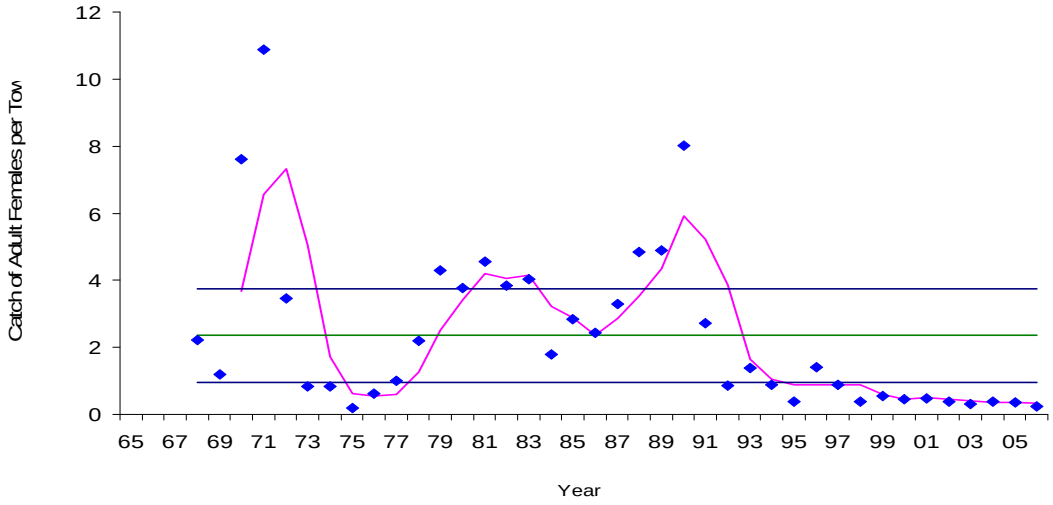
Appendix Figure 5. Calvert Cliffs pot survey catch per pot of age 1+ crabs, 1968-2006. Age 1+ crabs are defined as those caught from June through August that are greater than or equal to 95 mm across the carapace.



Appendix Figure 6. Maryland Trawl Survey catch per tow of adult female crabs, 1977 - 2006. Adult female crabs caught from August through October are classified in adult, in that they will likely spawn within one year.



Appendix Figure 7. Virginia Trawl Survey catch per tow of adult female crabs, 1968 through 2006, from sites in the upper and lower rivers, and the mainstem of Chesapeake Bay. All females caught from August through November are considered to be adult, in that they will likely spawn within 1 year.



Appendix Figure 8. Calvert Cliffs pot survey catch per pot of adult female crabs, 1968-2006. Adult female crabs are defined as those caught in September that are greater than or equal to 120 mm across the carapace.

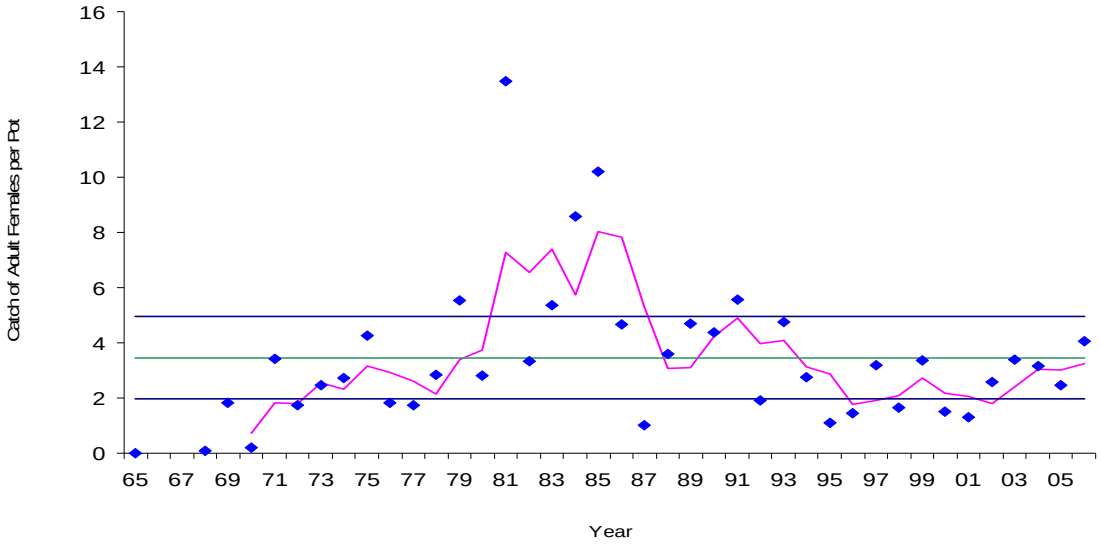


Table 1. Abundance and exploitation rates of age 1+ (2.4 inches and greater) blue crabs.

Year	Abundance (million) (**threshold)	Exploitation fraction (**overfishing, *below target)
1990	341.74	*0.39
1991	481.99	*0.35
1992	269.31	0.49
1993	363.63	*0.41
1994	221.91	0.52
1995	193.54	0.52
1996	242.22	*0.38
1997	172.64	*0.42
1998	191.78	**0.59
1999	**90.00	**0.73
2000	162.82	**0.64
2001	105.60	**0.66
2002	123.07	**0.54
2003	215.04	0.47
2004	150.75	**0.60
2005	170.38	*0.37
2006	122.0	*0.50

Table 2. Harvests (in pounds) of hard crabs and peeler crabs from Virginia waters, 1995 – 2006.

Virginia harvests of hard crabs by month (all areas), 1995-2006.

Month	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
January	401,013	1,620,518	1,765,253	1,045,613	375,856	752,751	438,042	807,441	367,964	853,879	815,052	655,434
February	135,102	678,958	903,453	527,340	93,525	993,359	177,227	304,811	440,521	671,744	800,793	310,351
March	54,560	201,972	172,351	333,793	51,301	236,910	132,056	198,129	237,910	306,942	330,845	121,778
April	2,282,438	601,437	2,813,466	3,300,654	3,253,588	4,287,438	1,290,719	3,417,745	1,208,053	2,722,471	2,201,070	4,100,484
May	2,411,356	2,168,338	2,669,977	1,958,251	2,074,695	3,162,424	1,643,394	2,494,483	2,159,471	2,578,277	2,541,080	2,410,089
June	3,867,050	3,278,371	5,116,924	4,359,075	3,046,710	3,591,376	2,723,672	3,211,911	1,906,196	3,851,955	2,642,184	2,636,181
July	4,227,288	4,302,239	6,011,618	5,061,836	4,427,563	3,325,680	3,220,089	4,055,830	3,051,304	3,659,893	3,317,113	2,808,726
August	5,490,050	4,659,500	5,223,631	4,108,799	4,062,842	3,432,835	3,895,212	3,707,174	3,366,307	3,505,588	3,644,700	2,641,561
September	4,248,237	4,261,491	3,658,057	4,002,663	3,986,883	3,124,198	3,625,598	2,980,198	2,487,301	3,096,670	3,279,249	1,753,399
October	4,065,654	4,635,921	4,078,321	3,878,969	3,990,888	3,089,210	4,154,181	2,881,012	3,361,607	3,315,339	3,172,401	2,148,484
November	1,547,565	1,205,341	1,272,374	1,422,609	1,929,515	1,172,115	1,884,885	1,128,805	1,660,737	1,320,622	1,714,238	1,019,799
December	2,652,643	4,417,598	3,679,732	932,180	3,045,408	1,662,921	1,193,376	1,025,707	1,565,595	1,344,505	951,111	993,833
Totals	31,382,956	32,031,684	37,365,157	30,931,782	30,338,774	28,831,217	24,378,451	26,213,246	21,812,966	27,227,885	25,409,836	21,600,119

Virginia harvests of peeler/soft crabs by month (all areas), 1995-2006.

Month	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
April	87,177	9,767	14,818	248,364	65,174	104,312	48,457	342,847	18,450	40,730	9,155	35,876
May	899,195	558,449	838,822	1,014,099	850,840	886,698	1,121,529	855,394	649,379	823,406	425,818	457,954
June	207,837	320,427	361,182	356,982	432,637	261,362	375,376	242,217	248,193	209,308	225,531	113,747
July	300,994	374,823	406,350	415,914	398,187	357,006	369,651	357,018	292,041	260,302	222,049	161,209
August	214,769	379,563	395,941	324,759	303,196	353,313	378,025	231,098	334,730	205,959	161,202	110,436
September	87,122	93,046	129,462	151,950	111,519	161,243	168,682	132,220	100,717	121,207	65,715	44,539
October	11,804	9,473	8,088	12,743	13,442	8,541	9,397	10,995	19,899	8,705	6,635	6,035
November		6	2	124	310	329	258	2	1,037	32	48	3
Totals	1,808,898	1,745,554	2,154,665	2,524,935	2,175,305	2,132,804	2,471,375	2,171,791	1,664,446	1,669,649	1,116,153	929,799
Grand Total	33,191,854	33,777,238	39,519,822	33,456,717	32,514,079	30,964,021	26,849,826	28,385,037	23,477,412	28,897,534	26,525,989	22,529,918

Blue Crab Management Efforts of the Virginia Marine Resources Commission:

A 22-Point Management Plan

The first Blue Crab Fishery Management Plan, adopted in 1989, placed controls on fishing effort and established other measures to reduce or eliminate wasteful harvesting practices in the blue crab fishery. By 1995, the Commission expanded, by 75 square miles, the Blue Crab Spawning Sanctuary (146 square miles), originally established by the General Assembly in 1942. It also shortened the crab pot season to the current April1 through November 30 period, and for the first time, required two cull rings in each crab pot to allow for the escapement of the smaller, immature, crabs.

In January 1996, the Commission reinforced it prior management efforts, by adoption of the following additional measures:

1. Prohibited the possession of dark-colored (brown through black) female sponge crabs, with a 10- sponge crab per bushel tolerance.

A sponge or cushion of eggs is caused by the extrusion of eggs onto the abdomen of the female crab. Prior to that time, female crabs carry their eggs internally, from the onset of maturity and mating (at approximately 1 ½ years of age), and can produce 2 or more batches of eggs within its lifetime. The prohibition on the taking of dark-colored sponge crabs is projected to protect approximately 28 percent of female crabs. This action effectively increases the spawning potential of the blue crab stock, yet allows the lower Bay crabbing industry, which depends on egg-bearing female crabs, to continue. Crabs are available to the fishery, within a few days after they release their eggs. Protection of the dark sponge crabs occurs over the entire spawning season, increasing the probability that those crabs that are allowed to spawn will do so during a period of favorable environmental conditions.

2. Limited license sales of hard crab and peeler pot licenses, based on previous eligibility or exemption requirements.

This moratorium on the sale of crab pot and peeler pot licenses was proposed for one year. Eligible participants for the 1996 crabbing season were limited to those who participated in the 1995 fishery. This element was considered as critical to preventing further expansion of the fishery in order to stabilize the resource and its fisheries.

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.

The 300-pot limit was the second element needed to cap effort and attempt to stabilize the resource and its fisheries. Only eight percent of the crabbers, from 1993 – 1995, reported fishing more than 300 hard crab pots. This measure was designed as a cap on effort and was not intended to reduce effort substantially.

4. Established a 3 ½-inch minimum possession size limit for all soft shell crabs.

The 3 ½-inch minimum size limit for soft shell crabs provides additional protections for the resource, by reducing harvests of small peeler crabs, at a time of low crab abundance. The measure complimented similar action in the State of Maryland and at the Potomac River

Fisheries Commission to protect small soft crabs. Continued concern over excess effort in the blue crab fisheries and a persistent trend of low spawning stock biomass during most of the 1990's led the Commission to adopt additional crab conservation measures in 1999 and 2000:

1. Lowered the maximum limit on peeler pots per licensee from 400 to 300 pots.

Effort reductions were clearly needed in this fishery that had grown significantly since 1994, but severe reductions on an immediate basis would result in severe economic burdens on the industry. Consequently, the Commission lowered the pot limit by 25 percent to minimize the economic impacts of the provision. Reports from many fishermen indicated that many did not fish the maximum 400 pots previously allowed.

2. In May 1999, the Commission initiated a one-year moratorium on the sale of all additional commercial crabbing licenses. In May 2000, the crabbing license sales moratorium was continued until May 26, 2001. The moratorium was again extended for 2002 and 2003, and, recently, this moratorium on the sale of additional crabbing licenses was extended through 2007.

Although scientists continue to debate the finer points of the blue crab stock assessment, all agree that the levels of effort in the peeler and hard crab fisheries have increased substantially, are too high to support viable incomes for many industry members, and may be eroding the abundance of the spawning stock

3. Established (in 2000) the Virginia Blue Crab Spawning Sanctuary. This additional sanctuary of 435 square miles was closed to all crabbing during the spawning season of June 1st through September 15th.

Through extensive research by Dr. Rom Lipcius (VIMS), the Commission was able to identify the proper boundaries of the sanctuary, in order to protect female crabs during their spawning migration down the Bay. To effectively protect females during their entire migration in Virginia waters and their entire spawning period, the sanctuary is closed from June 1 through September 15 and stretches from the VA-MD line to the mouth of the Bay. The sanctuary was further supported by research that indicated the blue crab abundance continued below average levels and the stock was fully exploited. Recruitment of young crabs to the fishery was also below average. Scientists also reported studies documenting a 70 percent decline in female spawning stock.

In 2000, the Commission entered into crab management discussions with the State of Maryland and the Potomac River Fisheries Commission, through the Bi-State Blue Crab Advisory Committee, a subcommittee of the Chesapeake Bay Commission. An Action Plan was adopted that recommended a harvest threshold that would preserve 10 percent of the blue crab spawning potential and a minimum stock size threshold that would be set at the lowest stock size that had been shown to have subsequently sustained a fishery. Managers further recommended the adoption of fishing targets that are more conservative than the thresholds and are the levels of fishing to be achieved each year. The recommended target level for blue crab fishing mortality was that level which achieves a doubling of the blue crab spawning potential. More importantly, it is estimated that a 15 percent decrease in harvest (based on the 1997-1999 landings average) was needed to achieve the target (F=0.7) in 2001. The Chesapeake Bay Commission recommended that the reductions be phased in over one to three years to minimize economic impacts associated with large reductions in harvest. The Marine Resources Commission endorsed the recommendations of the Chesapeake Bay Commission and its Bi-State Blue Crab Advisory Committee and promulgated the following regulations in 2002 to achieve the agreed

upon harvest reduction target.

1. Enacted an 8-hour workday for commercial crabbers (2002) that replaced a prior closure of crabbing on Wednesdays.

In April 2001, staff conducted analyses of the harvest reductions associated with a variety of restrictions such as hourly workday limits, day of week closures, seasonal or monthly closures, and catch limits. Percent harvest reductions were calculated for each targeted fishery as well as the contributions each measure provided to the overall goal of a five percent reduction in blue crab harvest for the first year. The Commission adopted a Wednesday closure of the crab pot and peeler pot fisheries from June 6 through August 22, calculated as a 5.7 percent reduction in harvest in the crab pot/peeler pot fishery. The advantages of this measure included equal treatment of all fishermen and ease of enforcement.

In January 2002, the Commission removed the Wednesday closure, at the request of industry, and replaced it with an 8-hour workday. There appeared to be more support from industry members for an 8-hour workday than there was in 2001. The new measure also was endorsed by the industry-based Crab Management Advisory Committee

2. Established a 3-inch minimum size limit for peeler crabs in 2002.

The size limit on soft crabs had proven to be difficult to enforce on the water, where conservation is best served, since the fishery harvests mostly peeler crabs. Consequently the Commission adopted a 3- inch size limit on peeler crabs, with the intent to improve enforcement and to protect a significant portion of the immature female crab population.

The previously adopted crab sanctuary and the ban on harvesting dark sponge crabs protects over half the female spawning stock. Yet, these measures are meaningless, if crabbing effort is redirected to the immature female crab portion that has not had an opportunity to spawn. The minimum peeler size limit provides protection for those immature females. Thus, the combined efforts, to protect the adult spawners and the immature portion of the population, work together to provide more biological stability to the population.

3. Reduced the winter dredge fishery trip limit from 20 to 17 barrels per boat per day in 2001.

The Crab Management Advisory Committee supported this measure and noted that it should be enforceable. Staff determined that a reduction of the catch limit of 20 barrels during the Virginia winter dredge season to 17 barrels would result in a 3.1 percent reduction in harvest from that fishery.

4. Augmented (2002) the Virginia Blue Crab Sanctuary by 272 sq. miles.

The expansion of the Virginia Blue Crab Sanctuary increased the closed area from 661 square miles to 947 square miles. Commercial and recreational harvesting of crabs is prohibited in the Sanctuary from June 1 through September 15. The benefit of the expanded sanctuary is its significant protection of spawning female crabs, about 70 percent of the spawning stock.

5. Reduced unlicensed recreational harvester limits to 1 bushel of hard crabs, 2-dozen peelers (2002).

Recreational fishermen willingly supported reductions in their crab harvest. The regulations established a harvest limit for the vessel regardless of the number of crabbers on board. Since most recreational harvesters take well less than one bushel per day, the total reduction in harvest was expected to be minimal. A 2001 study concluded that the Virginia recreational harvest was only a fraction (< 5%) of total blue crab harvests, but other studies show the Bay-wide recreational fishery can be significant when blue crab abundance is not low.

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).

In March 2007 the Commission modified its prohibition on the possession of dark sponge crabs, based on advice from scientists at Old Dominion University, and implemented an additional crab spawning sanctuary to compensate for any possible reinforced it prior management efforts, by adoption of the following additional measures:

1. Prohibited the possession of dark-colored (brown through black) female sponge crabs, with a 10- sponge crab per bushel tolerance, only through July 15 of the crab season.

2. Established an additional sanctuary (95 square miles) in coastal Virginia, to compensate for any loss of spawning potential resultant from the modification to the ban on sponge crabs regulation.

These measures were supported by the Crab Management Advisory Committee.