COMMONWEALTH of VIRGINIA

W. Tayloe Murphy, Jr.
Secretary of Natural Resources

Marine Resources Commission
2600 Washington Avenue
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Newport News, Virginia 23607

William A. Pruitt
Commissioner

November 10, 2005

MEMORANDUM

TO: The Honorable Mark R. Warner
Governor of the Commonwealth of Virginia
And,
Members of the Virginia General Assembly

THROUGH: The Honorable W. Tayloe Murphy, Jr.
Secretary of Natural Resources

FROM: William A. Pruitt

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.

The 2005 Chesapeake Bay Blue Crab Advisory Report, prepared by the Chesapeake Bay Stock Assessment Committee, indicates that blue crab abundance improved in 2003, compared to near historical low levels the previous four years, and the 2004 level of abundance was similar to that of 2003. Unfortunately, the results of all of the scientific surveys are not uniform, but stock abundance and spawning biomass remain at relatively low levels. Low abundance, combined with a high exploitation rate, underlines a stock condition that warrants concern, and this committee advised that states, at a minimum, should keep all current management measures in place. Accordingly, the Marine Resources Commission maintained all of its blue crab management measures in place in 2005.

Recently, a team of Virginia and Maryland scientists completed the first peer-reviewed, comprehensive assessment of the blue crab stock since 1997. The assessment 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. I have attached the Executive Summary of this stock assessment entitled "Stock Assessment of the Blue crab in Chesapeake Bay 2005.

The results of this assessment include an overfishing exploitation or annual harvest rate threshold of 53%, meaning that 53% of the stock, on an annual basis, can be removed by fishing activities, without compromising the biological stability of the Chesapeake stock of blue crab. This threshold exploitation rate corresponds to a level of spawning potential equal to 10% of un-fished stock and is thought to be the base level required for reproductive success of the stock. The assessment report also recommended a target exploitation rate of 46% annually, as this annual rate of exploitation would correspond to a spawning potential of 20% and would result in a stock condition that would be less prone to overfishing or being overfished.

Using the best available data through 2003, the assessment team concluded that the blue crab stock is not overfished nor is overfishing occurring. However, these results indicate the stock did experience overfishing recently (prior to 2003). As a result of this overfishing, the stock is currently at a relatively low level of abundance. The report also suggests that the potential for future short-term increases in abundance is good, if lower exploitation rates are maintained.

Following release of this report, we learned that the 2004 exploitation rate is slightly above the overfishing threshold. However, the scientists recommend that more than a single year's exploitation rates and abundance levels be used to determine the certainty of overfishing or an overfished condition, as the exploitable fraction of the stock encompasses a few years of longevity.

Should additional measures be necessary to maintain or to improve the status of the blue crab resource, the Commission will initiate the management process through discussions with our Blue Crab Citizen Advisory Committee and scientific advisors at the Virginia Institute of Marine Science. The Commission's final decisions for management action would be made prior to April 1, 2006, the start of next year's crabbing season.

A summary of the Commission's more recent blue crab management actions is attached.

Commercial harvests of blue crab (hard crab and peeler crab harvests, combined) in 2004 improved by 22 percent over 2003, one of the lowest harvest years on record. In spite of this improvement, the 2004 harvest was about 10 percent below the most recent 10-year average. It is important to note; however, that portions of the harvest reduction over the last few years are attributable to the Commission's reductions in fishing effort. These measures, implemented in 2001 and 2002, were designed to reduce the effort and catch in the fishery by 15 percent, in order to rebuild the spawning stock over the long term. Importantly, environmental factors that promote successful production of new crabs have not been favorable for several years, and management efforts have forestalled an even lower stock abundance.

Virginia harvests of hard crabs by month (all areas), 1994-2004.

Month	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1994-2003 avg
January	1,463,203	401,013	1,620,518	1,765,253	1,045,613	375,856	752,751	438,042	807,441	367,964	847,319	903,765
February	1,245,094	135,102	678,958	903,453	527,340	93,525	993,359	177,227	304,811	440,521	666,224	549,939
March	288,621	54,560	201,972	172,351	333,793	51,301	236,910	132,056	198,129	237,910	305,062	190,760
April	2,369,494	2,282,438	601,437	2,813,466	3,300,654	3,253,588	4,287,438	1,290,719	3,417,585	1,201,300	2,688,544	2,481,812
May	2,383,657	2,411,356	2,168,338	2,669,977	1,958,251	2,074,695	3,162,424	1,643,394	2,494,483	2,148,985	2,551,685	2,311,556
June	4,202,104	3,867,050	3,278,371	5,116,924	4,359,075	3,046,710	3,591,376	2,723,672	3,211,911	1,892,442	3,825,050	3,528,964
July	5,726,143	4,227,288	4,302,239	6,011,618	5,061,836	4,427,563	3,325,680	3,220,089	4,055,830	3,012,302	3,601,473	4,337,059
August	5,422,996	5,490,050	4,659,500	5,223,631	4,108,799	4,062,842	3,432,835	3,895,212	3,707,174	3,304,733	3,423,369	4,330,777
September	4,146,740	4,248,237	4,261,491	3,658,057	4,002,663	3,986,883	3,124,198	3,625,598	2,980,198	2,449,634	2,990,538	3,648,370
October	3,385,570	4,065,654	4,635,921	4,078,321	3,878,969	3,990,888	3,089,210	4,154,181	2,878,052	3,320,821	3,204,865	3,747,759
November	936,666	1,547,565	1,205,341	1,272,374	1,422,609	1,929,515	1,172,115	1,884,885	1,128,845	1,630,998	1,251,882	1,413,091
December	1,710,853	2,652,643	4,417,598	3,679,732	932,180	3,045,408	1,662,921	1,193,376	1,025,707	1,457,808	1,209,106	2,177,823
Totals	33,281,141	31,382,956	32,031,684	37,365,157	30,931,782	30,338,774	28,831,217	24,378,451	26,210,166	21,465,418	26,565,117	29,621,675

Virginia harvests of peeler/soft crabs by month (all areas), 1994-2004.

Month	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1994-2003 avg
April	95,286	87,177	9,767	14,818	248,364	65,174	104,312	48,457	342,847	15,114	40,700	103,132
May	586,326	899,195	558,449	838,822	1,014,099	850,840	886,698	1,121,529	855,394	648,070	821,759	825,942
June	223,382	207,837	320,427	361,182	356,982	432,637	261,362	375,376	242,217	247,892	206,599	302,929
July	259,407	300,994	374,823	406,350	415,914	398,187	357,006	369,651	355,917	291,947	272,923	353,020
August	242,718	214,769	379,563	395,941	324,759	303,196	353,313	378,025	231,098	334,676	205,568	315,806
September	67,323	87,122	93,046	129,462	151,950	111,519	161,243	168,682	132,220	100,699	120,997	120,327
October	1,665	11,804	9,473	8,088	12,743	13,442	8,541	9,397	10,995	19,897	8,705	10,605
November	551		6	2	124	310	329	258	2	1,037	32	291
Totals	1,476,658	1,808,898	1,745,554	2,154,665	2,524,935	2,175,305	2,132,804	2,471,375	2,170,690	1,659,332	1,677,283	2,032,022
Grand Total	34,757,799	33,191,854	33,777,238	39,519,822	33,456,717	32,514,079	30,964,021	26,849,826	28,380,856	23,124,750	28,242,400	31,653,696

Blue Crab Management Efforts of the Virginia Marine Resources Commission

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).

This measure was supported by the Crab Management Advisory Committee.

Since 2003, the Commission has followed the management advice provided by the Chesapeake Bay Stock assessment Committee and has maintained recently implemented conservation management measures, without any changes.

2005 Chesapeake Bay Blue Crab Advisory Report

Approved by the Fisheries Steering Committee: June 17, 2005

Status of the Stock: Analysis of long-term fishery-independent surveys conducted in Chesapeake Bay (Maryland and Virginia trawl surveys, Calvert Cliffs peeler pot survey and Baywide winter dredge survey) indicate that overall abundance of blue crabs in 2004 remained low but similar to the 2002 and 2003 abundance levels. While this represents an improvement compared to the near historically low abundance levels occurring in 2000 and 2001, stock abundance levels remain relatively low, and, notably, survey results are not uniform. Also, while the abundance of juvenile (age 0) crabs increased, the abundance of both exploitable crabs (age 1+) and mature female crabs declined slightly in 2004. Relatively low stock levels continue to create a risk of recruitment failure. The current status of the stock was compared to thresholds and targets endorsed by regional management agencies in January 2001. Stock abundance in 2004 was above the overfished threshold, but remained below the Bi-State Blue Crab Advisory Committee (BBCAC) abundance action threshold (Figure 1). Measures of fishing mortality (F) indicate high exploitation rates, and the fishing mortality rate, as measured by the winter dredge survey, was above the action threshold. Fishing mortality has been above the action threshold in every year since 1997, except in 2003. Low abundance, combined with a high exploitation rate, indicated a stock condition that warrants concern for the eighth consecutive year.

Estimated fishing mortality (F = 1.19) from the winter dredge survey (the Chesapeake Bay Stock Assessment Committee's [CBSAC] preferred method) increased substantially from 2003 (F = 0.80), after decreasing in three of the previous four years (Figure 2 – solid line). As estimated by this method, F was above both the overfishing threshold ($F_{10\%}$ = 1.0) and the target ($F_{20\%}$ = 0.7) The estimate of F derived from the length-based method (F = 0.78) suggests that F has remained relatively stable for several years (Figure 2 – dashed line), and was below the overfishing threshold, but above the target. Continued uncertainty about the appropriate rate of natural mortality (M) and the conversion rates used to change harvest data from pounds to numbers are primary factors contributing to uncertainty in the estimation of fishing mortality rates and biological reference points.

The 2004 Chesapeake Bay commercial harvest of approximately 60 million pounds represents a 25% increase from 2003. This contrasts with a significant downward trend in landings over the previous several years, but the 2004 harvest was well below the time series (1968-2004) average of 73 million pounds (Figure 3). The low harvest in 2004 was principally a result of low exploitable stock abundance. However, the harvest was also constrained by management measures implemented in prior seasons.

Despite uncertainty, it appears that fishing mortality was above the target level. Recruitment improved for the second consecutive year, and was above the long-term average. Female spawning stock biomass was average but declined after three years of moderate increases from previous near historically low levels. However, estimates of female abundance from the Virginia trawl survey have been below average for 11 of the past 14 years, including 2004. Exploitable stock abundance was below the Bi-State Blue Crab Advisory Committee (BBCAC) Decision Rule action threshold. There is a consensus among committee members that harvest restrictions should not be lifted until abundance indices show a significant improving trend, and until stock abundance and fishing mortality rates intersect outside the Control Rule precautionary range (Figure 1).

Data: Four fishery-independent surveys are used to determine stock status: Virginia trawl survey, Maryland summer trawl survey, Calvert Cliffs crab pot survey, and Baywide winter dredge survey. Data from the two trawl surveys and the Calvert Cliffs pot survey are based on calendar year collections through 2004. The winter dredge survey data represent seasonal collections from December 2004 through March 2005. Indices from the winter dredge survey are expressed as estimates of the number of crabs per unit area. All other indices are expressed as the geometric mean catch per unit effort. Modified and 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.

Biological Reference Points: A review of targets and thresholds for Chesapeake Bay blue crabs was conducted by an expert panel, convened by the BBCAC, in 2000. The panel identified exploitation and abundance thresholds and an exploitation target. The overfishing threshold ($F_{10\%}$ = 1.0) and target fishing mortality rate ($F_{20\%}$ = 0.7) refer to the levels of spawning potential which are 10% and 20%, respectively, of the spawning potential expected in a stock on which no fishing occurs. The overfished threshold (B_{low}) is equal to the lowest exploitable stock size observed in the fishery independent trawl, pot, and dredge surveys conducted in Chesapeake Bay from 1968 to the present and corresponds to the 1968 Virginia trawl survey estimate of stock size. There is considerable uncertainty about the appropriate value for natural mortality (M), but it is assumed to be 0.375.

Fishing Mortality: The winter dredge survey estimate of F was 1.19 in 2004. After falling below the BBCAC threshold in 2003, F was estimated to be above that threshold in 2004. This represents the sixth year in the last seven that the dredge survey estimate of F was higher than 1.0 ($F_{10\%}$) and it has been above the target F ($F_{20\%} = 0.70$) since 1997. The length-based F, as determined from the Maryland and Virginia trawl surveys, the Calvert Cliffs crab pot survey, and the Baywide winter dredge survey, was 0.78 in 2004 (range = 0.64 to 0.90). None of the current length-based fishing mortality rates, estimated from individual surveys, exceeded the threshold F = 1.0, and one was below the target F = 0.7 (Calvert Cliffs).

Recruitment (2002-2004): Recruitment, averaged over the most recent three years, was near the long-term average for the Maryland and Virginia trawl surveys, and, for the first time in five years, was within average bounds for the Baywide winter dredge survey. With data for the three surveys combined, it appears that recruitment improved in 2004 for the second year in a row (Figure 4). Recruitment has stayed within 'normal' bounds (between –1.0 and 1.0 in Figure 4) for 12 years, and in 2004 it exceeded the long-term average level (0-line in Figure 4), for the first time in the past six years.

Exploitable Stock Abundance (2002-2004): The three-year running average abundance of exploitable (age 1+) crabs was below the lower prediction bound (i.e. 'below average'), for two of the four surveys (Maryland and Virginia trawl surveys) and was within the prediction bounds (i.e. 'average') for two surveys (Calvert Cliffs and winter dredge). Data for all surveys combined indicate that the exploitable stock abundance was nearly unchanged, compared with 2003 (Figure 5). Though within 'normal' bounds (between –1.0 and 1.0 in Figure 5), abundance of exploitable blue crabs has been below the long-term average level (0-line in Figure 5) for ten of the past eleven years.

Spawning Stock Abundance (2002-2004): The three-year running average of mature female spawning stock abundance was within the prediction bounds (i.e. 'average') for three of the four fishery independent surveys (Calvert Cliffs, Maryland trawl, winter dredge). The three-year running average for the fourth survey (Virginia trawl survey) was below the prediction bound for the eleventh straight year. Data for all surveys combined indicated that spawning stock abundance was about the same in 2004 as in 2003, ending a three-year upward trend following a historical low in 2000 (Figure 6). Spawning stock abundance has been below the long-term average (0 line in Figure 6) for eleven of the past thirteen years.

Harvest: The three-year average (2002-2004) commercial Baywide harvest (54 million pounds) was 26% below the long-term (1968-2004) average of about 73 million pounds and was considerably below the prediction bounds (Figure 3). The 2004 Baywide harvest of approximately 60 million pounds was below average but represented a 25% one-year increase from 2003. Based on the historical relationship between winter dredge survey abundance and commercial harvest, it is expected that the 2005 Baywide commercial Chesapeake Bay harvest will be higher than the 2004 harvest.

Management Advice: Management measures implemented from 2001 through 2003 to conserve the blue crab stock were necessary, given the persistent condition of low stock abundance. Bay jurisdictions should, at a minimum, keep all current management measures in place. The primary management goal of doubling the blue crab spawning potential has yet to be achieved, and depends on maintaining a fishing mortality rate equal to the BBCAC target of F = 0.7.

Special Comments: Previously, the CBSAC suggested that fishing mortality rate estimates based on absolute estimates of abundance from the winter dredge survey and on estimates of total catch in the Baywide recreational and commercial fisheries (direct enumeration of F) were more accurate than F estimates derived from a length-based method. Now, the CBSAC endorses replacement of the length-based method by the direct enumeration method. The CBSAC has determined that the direct enumeration method is better at tracking annual changes in fishing mortality rates than the length-based method. The Control Rule graph (Figure 1) is presented this year with a time-series line connecting each data point. The fact that points on this graph tend to scatter around the equilibrium line is further evidence that the direct enumeration methodology is superior to the length-based method. For comparative purposes, we also include the BBCAC Control Rule graph based on the previous length-based measurements of F (Figure 7). Landings, survey results, and estimates of fishing mortality are summarized below, in tabular form (Table 1).

A comprehensive update of the blue crab stock assessment is nearing completion and will be released in 2005. It is anticipated that the new and updated assessment will include improved analyses, better estimates of blue crab stock parameters, and increasingly effective management.

Critical data needs: As was stated in previous advisory reports, it is critical that a carefully designed, Baywide data collection program be implemented for blue crabs in Chesapeake Bay. The design of the data collection program should be based, in part, on the need for improved information on: (1) harvest and effort data for the commercial and recreational fisheries; (2) growth and natural mortality rates; and (3) the age, size, sex, and maturity composition of the harvest and stock.

We anticipate that a thorough review of the methods of estimating F, M, and biological reference points (thresholds and targets) will be conducted as elements of the new assessment. Such a review is critical to successful future management.

Chesapeake Bay Stock Assessment Committee Members:

Chris Bonzek, VIMS, Chair
Lynn Fegley, Maryland DNR
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

Figure 1. Bi-State Blue Crab Advisory Committee (BBCAC) Control Rule, with Fishing Mortality Rate as Measured by the Winter Dredge Survey.

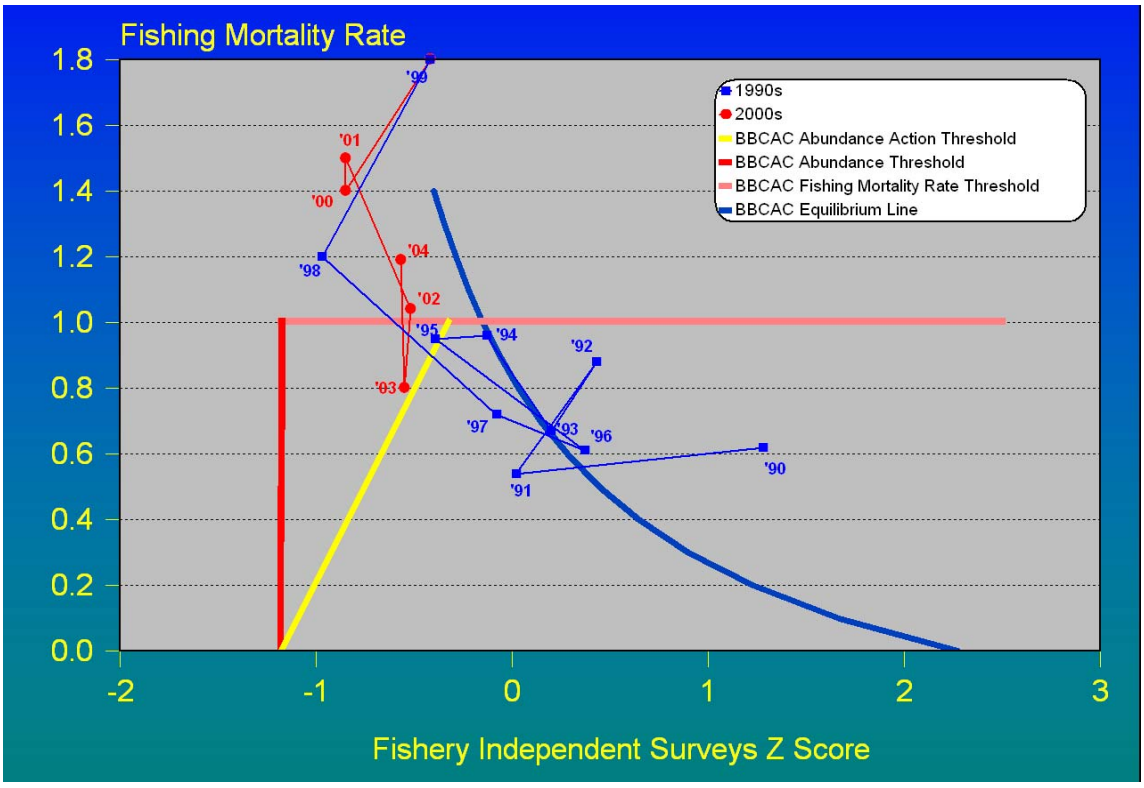


Figure 2. Fishing mortality rate as estimated by two methods, with target and threshold levels (assuming M = 0.375).

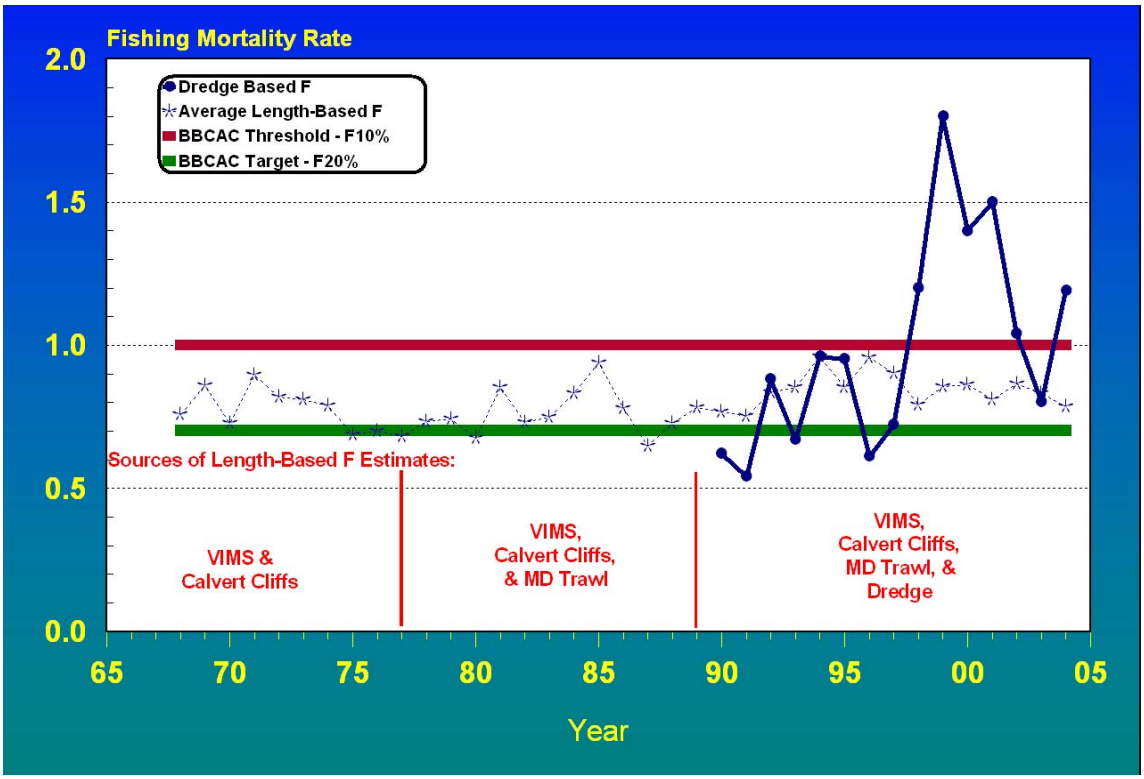


Figure 3. Combined Chesapeake Bay blue crab harvest.

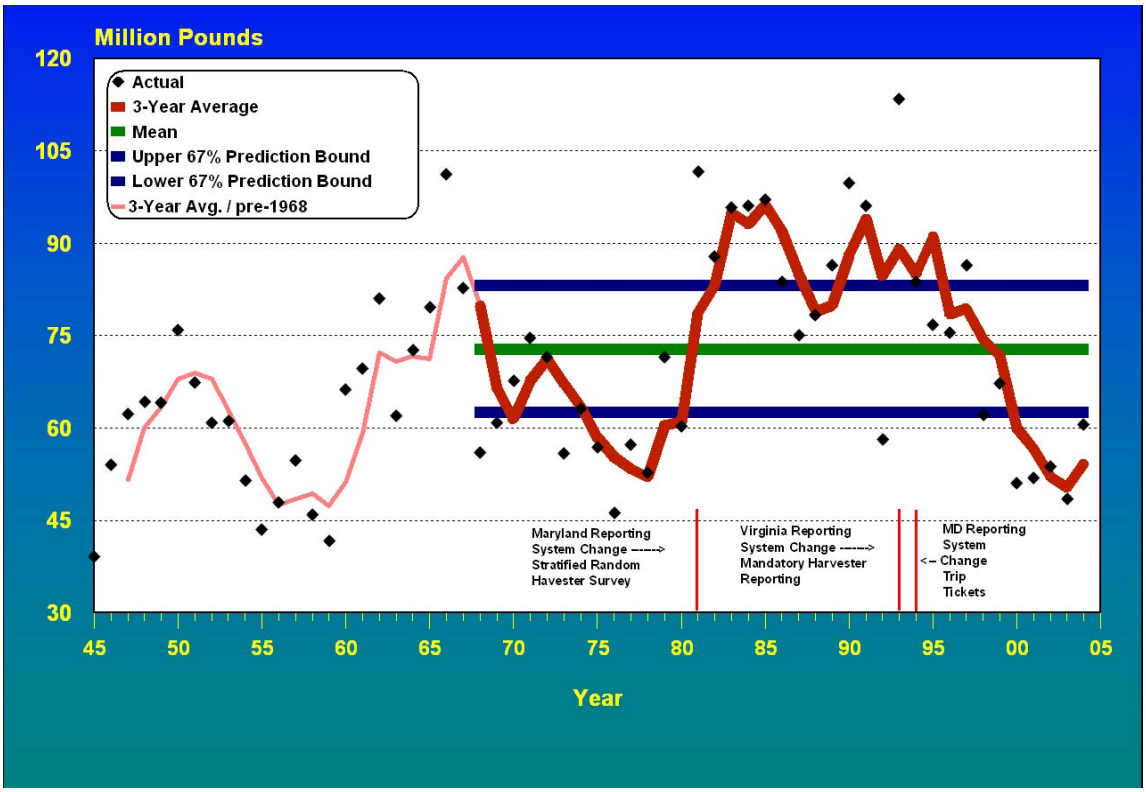


Figure 4. Average of standard normal transformed abundance indices for age 0 (juvenile) blue crabs.

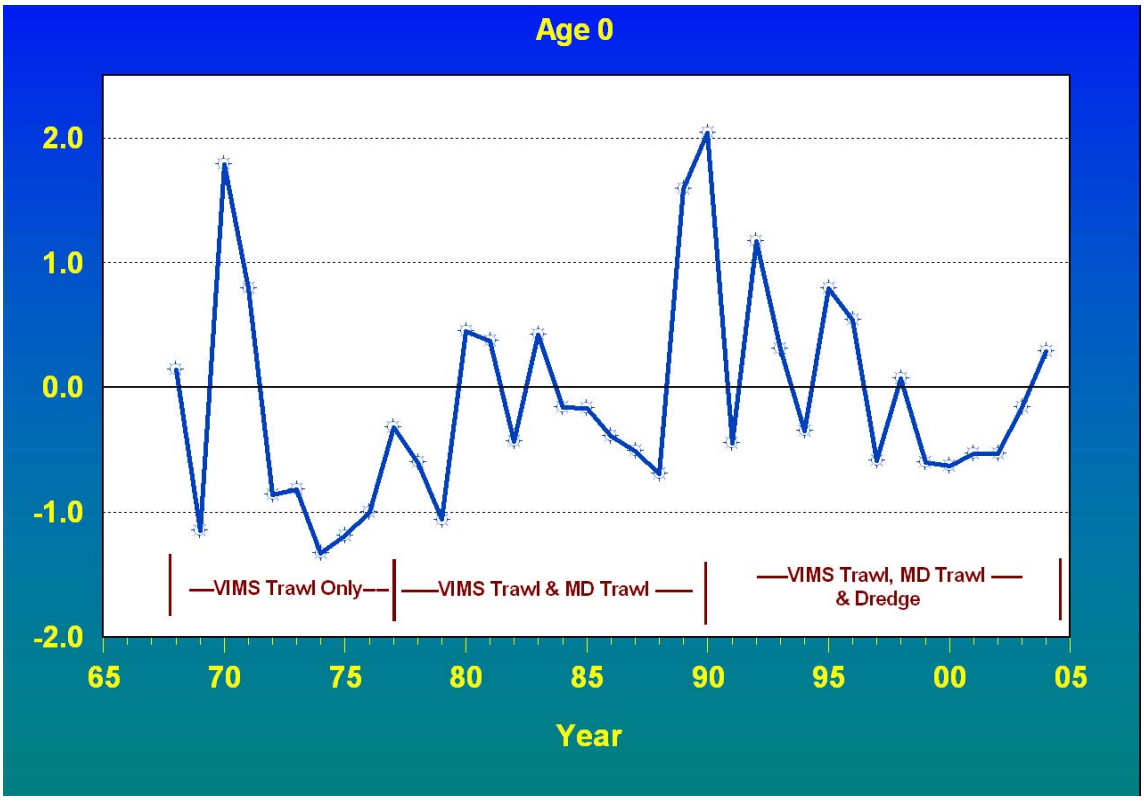


Figure 5. Average of standard normal transformed abundance indices for age 1+ (exploitable) blue crabs.

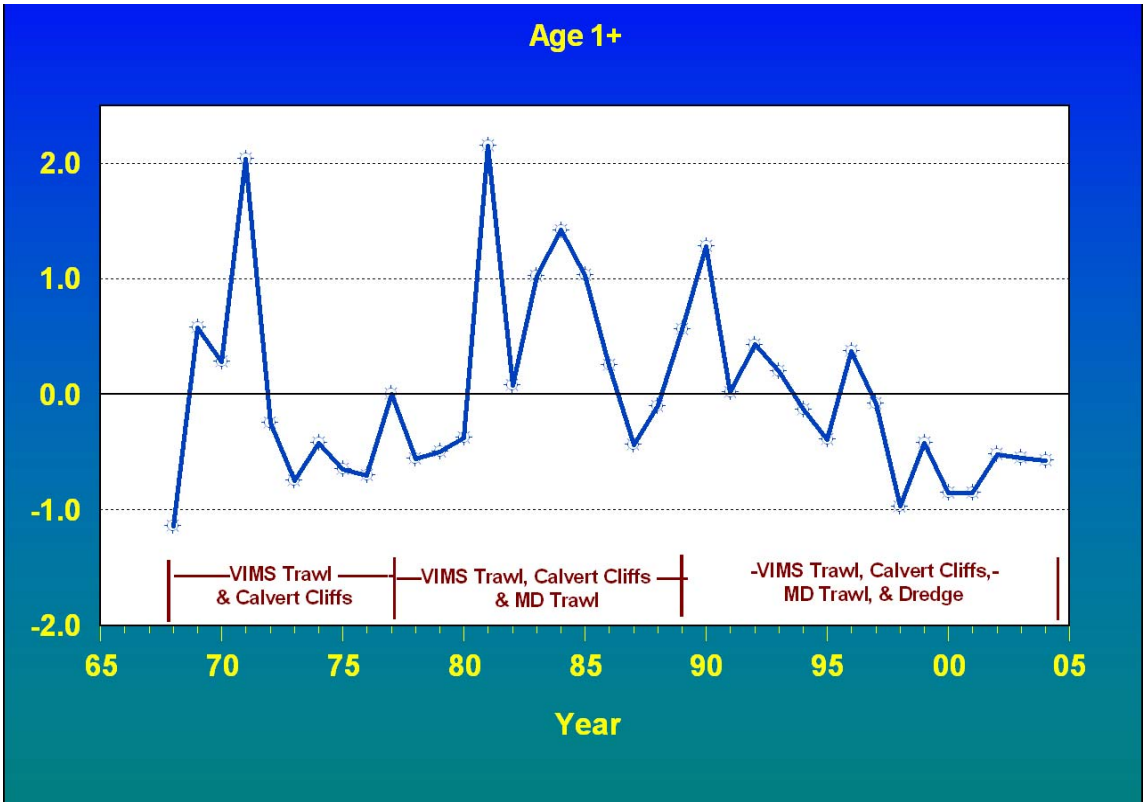


Figure 6. Average of standard normal transformed abundance indices for adult female blue crabs.

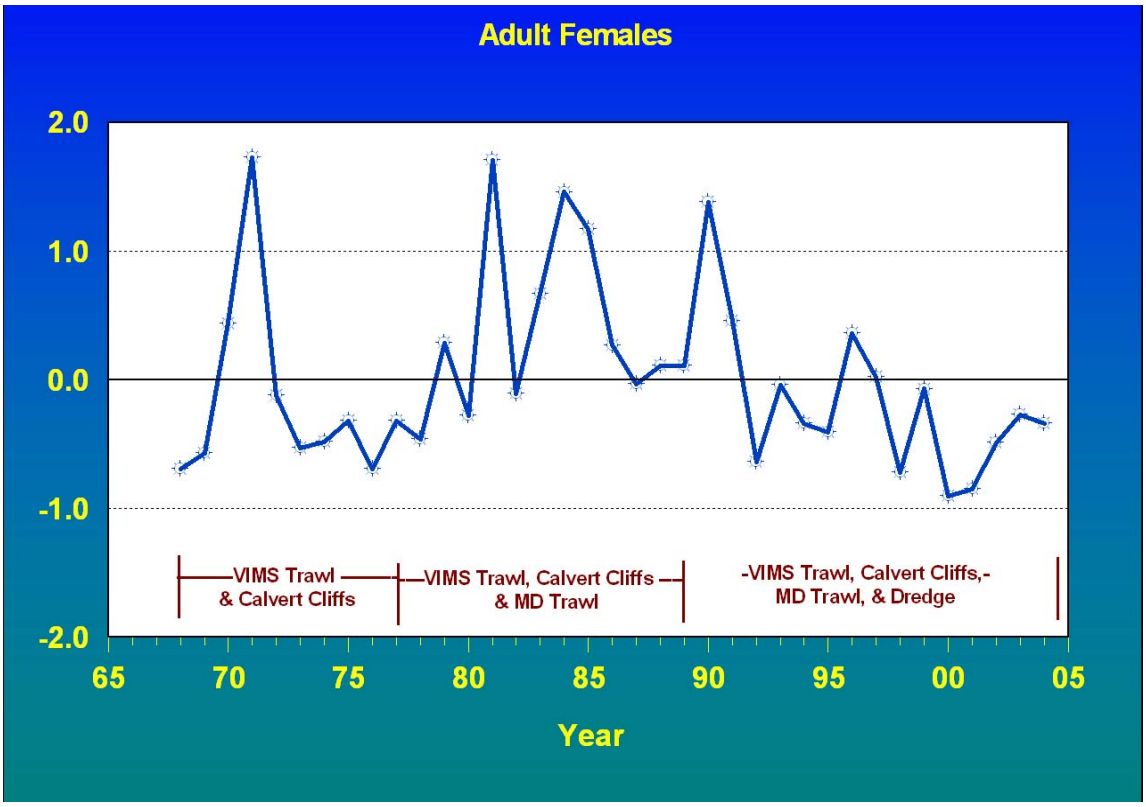


Figure 7. Bi-State Blue Crab Advisory Committee (BBCAC) Control Rule, with Fishing Mortality Rate as measured by the four-survey average of length-based Fs.

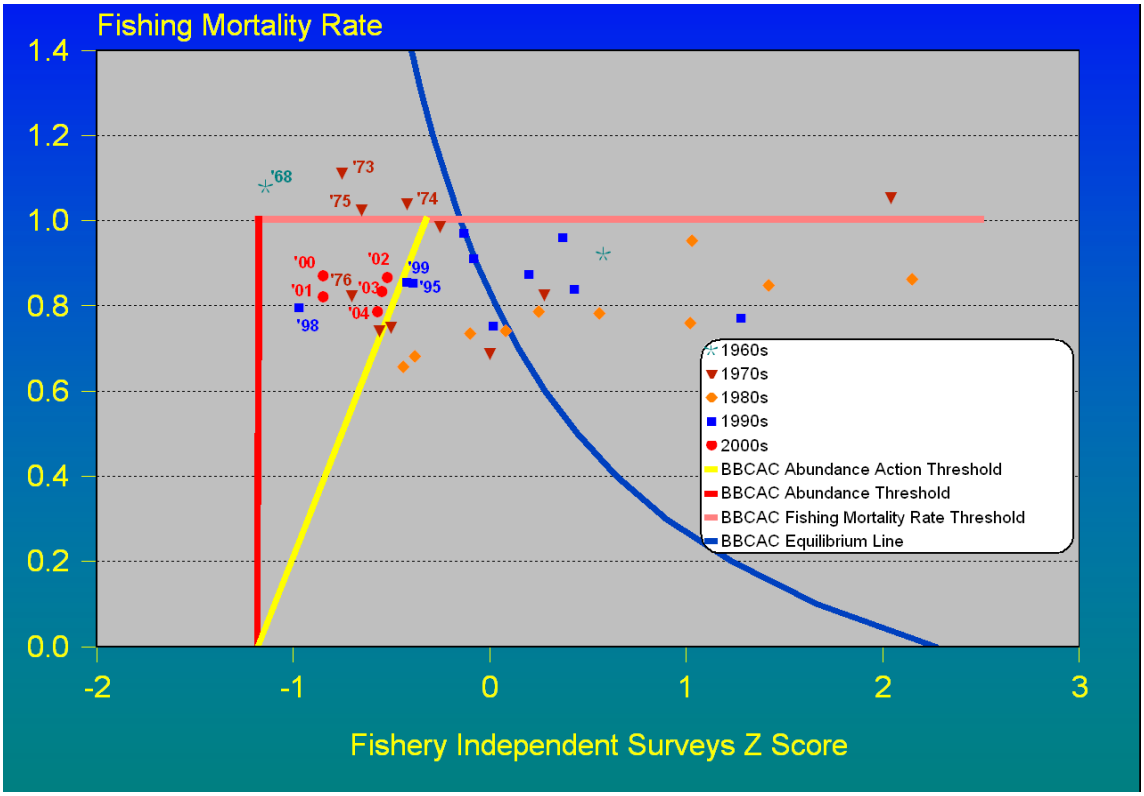


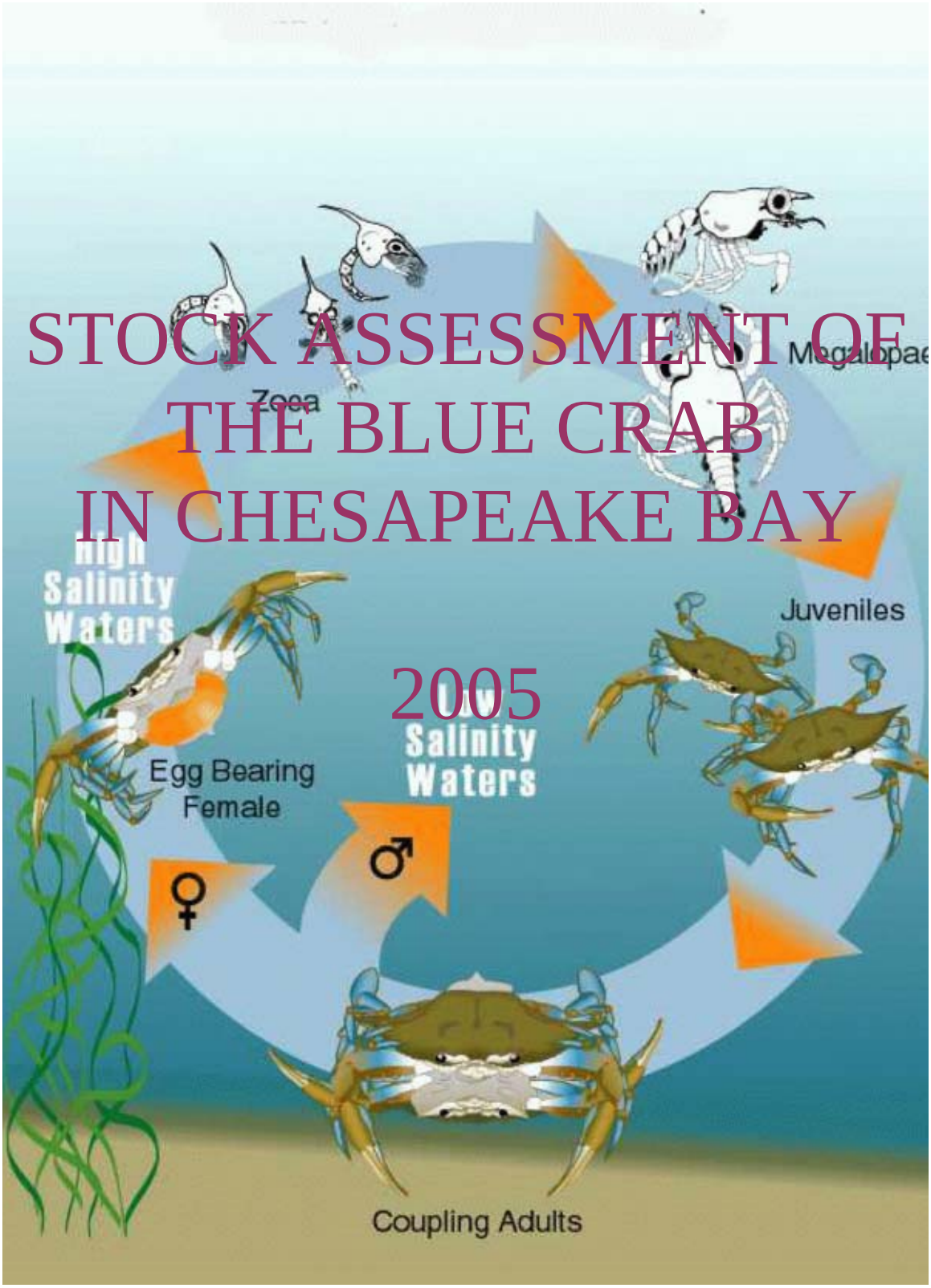
Table 1. Blue crab landings, survey results, and fishing mortality estimates.

Landings (million lbs.)			Surveys				Fishing Mortality	
Juris-diction	2004	2002 - 2004 Average	Survey	Recruits (Age 0)	(Age 1+)	Mature Females	Length Based F	Direct Enumeration F
MD	32.0	27.4	MD Trawl	Average	Below Average	Average	0.81	
VA	25.5	24.2	VA Trawl	Average	Below Average	Below Average	0.90	
Potomac	3.0	2.5	Winter Dredge	Average	Average	Average	0.79	1.19
Total	60.5	54.1	Calvert Cliffs	N/A	Average	Average	0.64	
Trend	Up in 2004 in all three jurisdictions, but below average Bay-wide since 2000.		Trend	Better in 2003 and 2004 than previous several years	Low, but constant for 2002-2004. Has only been overall Above Average once since 1994 (in 1996).	Higher for 2002-2004 than the historical lows of 2000-2001. Has only been overall Above Average twice since 1992 (in 1996 & 1997).	Steady. This method detects trends but is not as reliable for year-specific estimates.	Up significantly in 2004 after decreasing in each previous year since 1999.

Legend:

Above Average:	Greater than Mean + 1 Standard Error
Average:	Mean +- 1 Standard Error
Below Average:	Less than Mean - 1 Standard Error

STOCK ASSESSMENT OF THE BLUE CRAB IN CHESAPEAKE BAY



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Stock Assessment of Blue Crab in Chesapeake Bay 2005

Final Report

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Submitted on	8 July 2005
Technical Report Series No. TS-487-05 of the University of Maryland Center for Environmental Science.	

Executive Summary

The blue crab (Callinectes sapidus) is an icon for the Chesapeake Bay region. The commercial fisheries for blue crab in the Bay remain one of the most valuable fishery sectors in the Bay. Ecologically, blue crab is an important component of the Chesapeake Bay ecosystem. Thus, sound management to ensure the sustainability of this resource is critical.

The first bay wide assessment for blue crab was undertaken in 1995 and completed in 1997. It concluded that the stock was moderately to fully exploited and at average levels of abundance. Subsequent to this assessment concerns over the continuing status of blue crab were raised because of declines in abundance and harvests. In response to concerns from stakeholders, a Bi-State Blue Crab Advisory Committee was established in 1996. Work by this committee lead to the establishment in 2001 of biomass and exploitation thresholds and an exploitation target reference points. Since 2001, the status of the blue crab stock has been updated annually and its status determined relative to the reference points. Over the ensuing years, the approach to determining the status of blue crab in the Chesapeake Bay has been modified, but a new inclusive assessment has not been conducted.

In 2003, we proposed and were funded to complete a thorough revision of the stock assessment for the blue crab in Chesapeake Bay. The following terms of reference were adopted to guide our assessment activities. We sought to (i) assess and quantify the life history and vital rates of blue crab in the Chesapeake Bay that are relevant to an assessment of the stock, (ii) describe and quantify patterns in fishery-independent surveys of blue crab abundance, (iii) describe and quantify patterns in catch and effort by sector and region, (iv) develop and implement assessment models for the Chesapeake blue crab fisheries, and (v) re-evaluate, and where necessary, update control rules for Chesapeake Bay blue crab fishery.

In conducting the assessment we sought to overcome some of the challenges that the biology of and fisheries for blue crab present. For example, uncertainties in estimates of natural mortality and growth dynamics produced concerns over the reliability of previous population models. Furthermore, interpretation of data on the historical harvest of blue crab in the Chesapeake has been made more difficult because of changes in the way in which harvests are reported to the individual jurisdictions. Thus, we see the following elements of the assessment we have developed as representing substantial advances that increase the chance of maintaining a sustainable blue crab fishery. We have re-evaluated estimates of natural mortality rates using both empirical and life history-based approaches. We have applied time series analysis to adjust historical landings for the known reporting changes. We developed a new assessment model that uses the corrected landings and data from all relevant fishery-independent surveys to understand changes in abundance and exploitation pressure of blue crab. Previous reference points were based on the rate of fishing mortality, F. Calculation of these reference points and the status of the stock relative to them required an estimate of the rate of natural mortality. M. Changes in the estimate of M would cause changes in the

reference points and of our understanding of the historical pattern of exploitation that had operated in the fishery. To overcome this problem, we developed an individual-based spawning potential per recruit model to estimate reference points based on the fraction of the vulnerable population that was harvested each year.

Our review of the biology of the blue crab in Chesapeake Bay supported the assumption that there was a single unit stock of blue crab in the bay. While there is likely to be exchange of individuals with neighboring populations (e.g., Delaware Bay), the data indicate that these are likely not a substantial or persistent feature of the dynamics of the Chesapeake Bay population. Our review of the life history of blue crab indicated that the most likely value for M = 0.9. This estimate is supported by direct, empirical estimates from tagging studies in Chesapeake Bay, by an analysis of life history patterns in the species generally, and by the relationship between the rate of total mortality and effort in Delaware Bay.

Our review of relevant fishery-independent surveys indicated that the blue crab population in Chesapeake Bay is likely at below average abundances. Although some indices have increased in the most recent years, the majority of indices still indicate the population is below its average abundance levels. In particular, the low abundance of spawning females in the lower Chesapeake Bay is worthy of close monitoring. We noted that changes to size-at-age conventions used to convert size-specific abundance information to age classes implemented since the last assessment have improved the ability of these surveys to track changes in the population. However, our understanding of the dynamics of the blue crab in Chesapeake Bay would benefit from a rigorous evaluation of the size structure data in these surveys.

We applied time series techniques to adjust for the effects of reporting changes on estimated landings. We found that the 1993 reporting change in Virginia and the 1981 and 1993 reporting changes in Maryland all significantly affected the estimates of landings. The reporting change in Virginia lead to an average 20.3% decrease in estimated landings prior to 1993. The reporting changes in Maryland lead to an 84% change in the estimated landings. Our reconstructed estimate of total baywide landings suggest that the average landings for 1945-2003 was 34,887 ± 5,490 MT. The reconstructed landings indicate that removals have been 16.7% higher than previously reported. The highest recorded baywide harvest was 47,719MT in 1966. The lowest recorded baywide harvest was 21,539 MT in 2001. Landings in the three years 2000 - 2002 all set record lows for the time series.

We analyzed data from the winter dredge survey to estimate the proportion of the vulnerable population that is harvested each year. This was termed the exploitation fraction, μ. Estimates of μ have varied from 33% in 1991 to 71% in 1999. Current estimates of μ indicate that less than 50% of the vulnerable crabs are being caught each year. Importantly, the estimates of μ are independent of estimates of M, and will not change if estimates of M are changed by subsequent research. This is not the case with estimates of F, calculated from the same data. Thus, we recommend adoption of μ as the measure of fishing pressure for future assessments.

We developed an extension of the Collie Sissenwine Catch Survey model that permitted multiple fishery-independent time series to be used in assessing the population. The new catch-multiple survey (CMS) model utilized three fishery-independent surveys and the reconstructed commercial catch time series. Comparison of the predictions from the model with observed patterns of abundance and empirical estimate of exploitation fraction indicated that values of natural mortality $0.9<M<1.2$ were most likely. In all cases, the model indicated a disturbing pattern of exploitation in which the fraction exploited increases as abundance decreases. This depensatory pattern presents challenges to the sustainable management of the resource.

We used an individual-based model which captured the discrete nature of crab growth and the diverse sectors in the blue crab fishery to estimate exploitation fraction reference points using spawning potential per recruit criteria. The exploitation fraction threshold reference point was determined to be 53%, based on maintaining 10% of the virgin spawning potential. The exploitation fraction target reference point was determined to be 46%, based on maintaining 20% of the virgin spawning potential. We maintained the previously endorsed biomass threshold of the lowest abundance observed in fishery-independent time series. Based on these revised thresholds, we conclude that the blue crab stock is not overfished (i.e., it is at a higher level of abundance than the threshold), nor is it currently experiencing overfishing (i.e., the exploitation fraction is below the threshold). However, results indicate the stock did experience overfishing recently. As a result of this overfishing, the stock is currently at a relatively low level of abundance. Importantly, when exploitation fractions similarly to values currently observed have been seen in the past, abundances were substantial higher. This suggests potential for future short-term increases in abundance if the lower exploitation fractions are maintained.