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# *Atlantic States Marine Fisheries Commission*

*Working towards healthy, self-sustaining populations for all Atlantic coast fish species*
*or successful restoration well in progress by the year 2015*


## Status of the Blue Crab (*Callinectes sapidus*) on the Atlantic Coast

**October 2004**

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**FINAL REPORT**

A report of Blue Crab Symposium convened by the Crustacean Society, June 1-5, 2003 in Williamsburg, Virginia and a Blue Crab Workshop convened by the Atlantic States Marine Fisheries Commission's SEAMAP Crustacean Workgroup, November 6-7, 2003 in Baltimore, Maryland.

**October 2004**

## Preface

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**Acknowledgments**

This report is the product of discussions held at both a Blue Crab Symposium at the Crustacean Society Summer Meeting, June 1-5, 2003 in Williamsburg, Virginia and a Blue Crab Workshop, November 6-7, 2003 in Baltimore, Maryland.

The Symposium was convened and organized by both the Crustacean Society and the SEAMAP Crustacean Workgroup. The workshop was conducted by the SEAMAP Crustacean Workgroup as well as by a select group of biologists studying blue crabs from New York to Florida. Special thanks are extended to the symposium and workshop chairs and participants whose commitment of valuable time and effort helped make the both events successful. In particular, the Workgroup would like to thank Mr. Larry Delancey (South Carolina Department of Natural Resources), Dr. Paul Jivoff (Rider University), Mr. Jacques van Montfrans (Virginia Institute of Marine Science), Dr. Scott Quackenbush (University of North Carolina - Wilmington), Dr. Anson Hines (Smithsonian Environmental Research Center, Maryland), and Dr. David Eggleston (North Carolina State University) for chairing the various component. We would also like to acknowledge the efforts of the following people in preparing this document – Mr. Larry DeLancey (South Carolina Department of Natural Resources), Mr. Sean McKenna (North Carolina Division of Marine Fisheries), Elizabeth Wenner (South Carolina Department of Natural Resources), Dwayne Robertson (Georgia Department of Natural Resources), Anne McMillen-Jackson (Florida Fish and Wildlife Conservation Commission), Pat Geer (Georgia Department of Natural Resources), and Chris VanMaaren, (ASMFC SEAMAP-SA Coordinator).

## Executive Summary

This report seeks to define the common (crossover) issues being addressed by those studying and assessing blue crab stocks in the Atlantic Coast waters ranging from New York to Florida. Many of the states in this range have been facing significant declines in blue crab numbers and this report helps identify the issues that need to be addressed in order to make progress towards improving each state's blue crab fishery. This report does not make management recommendations but rather focuses on defining the status of blue crab stocks and on providing research recommendations. The following is a list of the crossover issues and research recommendations related to addressing these issues:

**Maximum Age**: Continue ongoing research to determine the maximum age of blue crabs, including:

- encourage cooperation for expansion of lipofuscin research,
- continue tagging methods with incorporation of verification,
- evaluate use of historical methods using parasitic worms, and
- conduct long-term holding experiments.

**Variation in Natural Mortality (M):** Evaluate age-specific mortality rates and determination of more accurate estimates of M possibly through use of closed areas.

- evaluate geographic variation in M
- evaluate annual variations in M

**Reproductive Biology:** Conduct research to better understand the reproductive biology of blue crabs in more detail, including:

- evaluate geographic variation in reproductive biology
- conduct field experiments to verify lab studies,
- determine maturity at age
- evaluate sperm limitation, fecundity schedule,

**Predation and Cannibalism:** There was agreement that predation occurs, but little scientific evidence that a single species is having a major impact on blue crab populations. However, the cumulative impacts of guilds of predators are unknown.

- Encourage foodweb dynamics studies and continue current research activities involving modeling and diet studies.

**Recruitment/Habitat Utilization:** Identify specific habitats for each system within each state.

**Dispersal:** Evaluate the stock structure on the Atlantic and Gulf coasts, including:

- evaluate the percentage of recruits from one bay system supporting other systems
- evaluate the magnitude of mixing between populations, especially at low abundance levels (metapopulations)
- evaluate transport systems between estuaries
- conduct larval dispersal and recruitment studies, particularly in southern region.
- research where females go after spawning

**Disease:** More research is needed to evaluate the impacts that diseases are having on crab stocks.

**Environmental Factors**

- Drought, Winter Mortality, and Hypoxia: The consequences of these factors effect the whole ecosystem, with some affects being positive and some being negative. Evaluate the effects of environmental effects on the distribution of blue crabs and potential for increased mortality on a state-by-state basis since these effects will be unique to each system.
- Hurricanes have affected all east coast states at one time or another through direct and indirect effects. Effects depend on timing, where you are in relation to hurricane, tidal stage, etc. Each state should quantify the direct and indirect impacts of hurricanes, and use this list as a tool for adaptive management.

**Human Development Effects:** Each state should evaluate the impacts of other indirect processes on blue crab populations, such as shoreline development, point and non-point source pollution, nutrient loading, and water control and utilization.

**Commercial Landings:** Regional trends can be separated into three regions:
- Delaware north - state landings with no evidence of drastic declines
- Chesapeake Bay - drastic declines in recent years
- South Atlantic - drastic declines in recent years with the exception of North Carolina

**Recreational Landings**: Each state should conduct a recreational survey at least once, with periodic updates if percentage of total landings are high. Evaluate the addition of an add-on question to the MRFSS telephone survey to collect participation data.

**Non-directed fisheries:** Evaluate non-directed fisheries for bycatch of blue crabs- gill net and shrimp trawl fisheries.

**Aquaculture:** Continue small scale aquaculture activities, including continuation of ongoing research studies, improvements to collaborative efforts, and evaluation of feasibility as a large scale enhancement tool for blue crab management.

**Monitoring Programs:** Compile information on trawl efficiency for blue crab sampling. States should continue to fund trawl and seine monitoring programs to support blue crab assessments.

**Assessments**: The data needs and monitoring programs will depend on the type of model being conducted and the benchmarks/goals identified by fisheries managers. The four basic levels are as follows:

1) *Production modeling approaches*: Requires good catch and effort data to estimate maximum sustainable yield.

2) *Non-age-specific models (catch survey analysis)*: Requires catch data, recruitment indices and adult indices to estimate fishing mortality and abundance, recruitment models to determine spawning stock biomass

3) *Stock-Recruitment models*:Indices of spawning stock biomass are used to predict levels of future recruitment.

4) *Age structured models*:
Given success with age determination, useful in estimating fishing mortality and spawning stock biomass per recruit.

Fisheries managers should develop clear management goals and benchmarks to guide the collection of blue crab data and development of assessment models. The Commission should act as a conduit to facilitate exchange of information between individual state management agencies involved in blue crab assessment and management.

**Regulations:** It is important to have a management goal to protect all phases of the blue crab life cycle, possibly through linked or rotating estuarine sanctuaries.
Evaluate a model blue crab pot marking system. The Commission should compile information on spiny and American lobster fisheries as examples.

**Socio-Economic:** Pursue collection of socio-economic data on a more consistent basis.

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## Introduction

Blue crab landings have declined in recent years on the Atlantic coast. In Chesapeake Bay, effort reductions were instituted in 2001 to reduce commercial crabbing effort by 15%. Based on stock assessments and trends in landings and population monitoring indices, most biologists that work with blue crab believe crabs are being fished at high, possibly unsustainable levels. Climatic conditions in the past decade have been extreme, ranging from cold winters to record warm summers, with periods of both drought and tropical storms impacting the east coast. Such extremes also impact blue crab stocks, often negatively. This report will attempt to summarize the current status of blue crab fisheries and stocks, with emphasis on the South Atlantic, and briefly summarize some findings on life history and research as presented at the Symposium on Blue Crab at the 2003 meeting of the Crustacean Society in Williamsburg, Virginia. This report is not designed to make management recommendations. As with many fisheries reports, this report may raise more questions than it answers and will stimulate discussion as to the direction of future blue crab studies.

## Section I. General Biology

Crustacea - Decapoda - Portunidae - *Callinectes sapidus* (Blue crab)

### Mating/Spawning

Mating of blue crabs occurs from June through October in New York's Hudson River, from May through October in the Chesapeake Bay and throughout the year in the St Johns River, Florida**.** Sperm collected from a female's one and only mating is stored in seminal receptacles and may be used each time she spawns. Mating primarily occurs in the low-salinity areas of estuaries and ovigerous females migrate out to the higher salinity areas, in and around the mouth of estuaries, to spawn. The timing between mating and spawning varies with location and can be anywhere from 2 to 9 months post mating (Van Den Avyle 1984). Spawning involves the formation of a "sponge" of 700,000 to 8,000,000 fertilized eggs held to a female's abdomen by the hairlike branches called setae (Van Heukelem 1991).

### Development

Incubation of eggs takes 1 to 2 weeks. Newly hatched larval crabs (zoeae) measure approximately 0.25 mm, are planktonic filter feeders, and share little morphological resemblance to the adult form. Zoeae molt 4 to 7 times during a 31 to 49 day period before developing into the second larval stage (megalops). Megalops are more crab-like in appearance and measure about 1.0 mm in width. Still within the nearshore or lower-estuarine areas, the megalops are bottom orientated free swimmers. Megalops molt into the juvenile stage within 6 to 20 days (Van Den Avyle 1984).

Juvenile crabs gradually migrate to lower salinity waters with males tending to seek lower salinities than females. The juvenile stage of growth and development takes a little over a year with crabs reaching the adult, sexually mature stage during the spring or summer of the year following their hatching. Size at maturity is highly variable. Upon maturity and mating, females stop molting and growth, whereas males continue to grow (Van Den Avyle 1984). Debate exists as to the maximum age that crabs can reach (see focus issue section).

Migrations

Movement occurs as part of the developmental life history of blue crabs as well as in response to environmental factors like water temperature. Newly hatched zoeae are transported via surface waters out of the lower estuarine area to offshore waters around the continental shelf. Development into megalops is followed by immigration back to estuaries, and young juveniles disperse throughout the estuary. As adults, females migrate from lower salinity mating grounds to the higher salinities found closer to ocean waters. Juvenile and adult crabs alike respond to cooling water temperatures by seeking out deeper water during winter months (Van Den Avyle 1984).

Ecological Role

The omnivorous blue crab plays a major role in energy transfer within estuaries. Their predominant food items vary greatly among localities but generally consists of dead and live fish, bivalves, shrimp, organic debris, aquatic plants and frequently other blue crabs. Upon settlement they are preyed upon by a variety of fish species, most notably American eel, striped bass and red drum (Van Den Avyle 1984). Cannibalism can be a major source of mortality.

Environmental/Habitat Requirements

Blue crabs can tolerate temperatures of 5-39$^{o}$C but try to avoid extremes by moving to deeper waters or burrowing into the substrate. Larval crabs require a salinity greater than 20 ppt but juvenile and adults may occupy anything from fresh to full strength sea water. Crabs will avoid hypoxic conditions by emerging from the water and can die when caught in traps that keep them in waters that drop below 2.0 ppm.

Grass beds, soft detritus, and mud or mud-shell bottoms are key nursery sites for juvenile crabs**.** Larger crabs prefer deeper waters with hard bottom substrates.

Focus Issues

The previous five subsections gave a quick overview of the general biology of blue crabs. This subsection focuses on those general biology issues where debate exists and where implications to management of the fishery are greatest.

**Maximum Age**: Maximum age estimates are valuable components of stock assessment calculations. Species with long life spans can be more sensitive to overfishing as older more

fecund individuals may play a critical role in a species overall reproductive success. Max age is a critical parameter in determining both F and M. There has been a great deal of difficulty in estimating the maximum age of blue crabs as has been the case with other crustaceans. Lacking boney structures that accumulate annuli, biologists have had to develop new techniques for ageing crustaceans.

Modal analysis of length frequency data is typically not a useful method in determining the max age of blue crabs because of varying growth rates particularly as crabs get older, and because crabs often have prolonged spawning seasons. Tagging studies have produced many of the age estimates in use today though there are difficulties associated with maintaining tags through the molting process and with assessing the true age of crabs when a tag is submitted without the corresponding crab. A maximum age of 8 (Rugulo et al.1996), obtained through a tagging study, is used for assessing the Chesapeake Bay stocks though some controversy exists as to the validity of the tag return (McConaugha 2001). Research has been completed evaluating the accuracy of a technique using the concentration of lipofuscins found in crab soft tissue.

Lipofuscins are molecules that respond to the need to remove free radicals and aldehydes that are formed during normal cellular metabolism. They accumulate in lysosomal granules and are readily detected using techniques like epiflourescent microscopy. Neural tissues do not divide and thus allow these granules to accumulate over the life of the animal. A positive relationship has been found between lipofuscin accumulation and age in blue crabs, though the rate of accumulation can vary with life stage and temperature (McConaugha 2001).

Use of this lipofuscin method of aging is still primarily experimental, though methodology refinements have been made at the University of Maryland's Chesapeake Biological Laboratory (CBL) (Ju et al 1999, 2000).

Research needs to be continued to determine the maximum age of blue crabs and should:

- encourage cooperation for expansion of lipofuscin research,
- continue tagging methods with incorporation of verification,
- evaluate use of historical methods using parasitic worms, and
- conduct long-term holding experiments.

**Variation in Natural Mortality:** Another parameter that is critical to stock assessments is the rate of natural mortality (M). Natural mortality rates may change throughout the life history of blue crabs and studies need to focus on defining age-specific mortality rates rather than assuming that M is a constant. Working in closed areas may provide the means to better understand the how natural mortality differs amongst different geographic settings and how it differs annually.

**Reproductive Biology:** Typically efforts to ensure successful reproduction for blue crabs have focused on protecting the female spawning stocks. However, evidence suggests that a more complete understanding of the reproductive biology of blue crabs is needed. The ratio of live to dead sperm and the number of sperm transferred are unaffected by male size, but number of sperm decreases with successive matings (Hopkins in progress). Reductions in the ratio of males to females may reduce the ability of females to mate with more than one male and may be increasing the frequency that each male mates. Work is being done at Rider University to examine what sperm:egg ratio is required for optimal spawning success, in order to determine if wild female sperm stores are reaching critical levels as a result of possible changes in sex ratio (Jivoff in progres). Additional work should evaluate if limitations are occurring in wild stocks where fishing pressure may negate any potential sperm limitations.

There are a number of pressing questions regarding the reproductive biology of blue crabs. Research should be conducted to:

- evaluate geographic variation in reproductive biology
- conduct field experiments to verify lab studies
- determine maturity at age
- evaluate sperm limitation, fecundity schedule

**Predation and Cannibalism:** Debate has occurred over the effects that enhancement of fish stocks may have on blue crab numbers. Some crabbers feel that the money being spent to enhance fish populations is in effect taking money from their pockets as crab numbers drop from possible excessive predation. A study done in the lower Chesapeake Bay estimated that striped bass consume a relatively small amount of the total blue crab population (Walter 2003). Additional work is being done by Dr. van Montfrans at VIMS to investigate the impacts of croaker, striped bass and red drum on blue crabs in SAV habitat. This is an initial attempt to quantify the predation impacts in the crab nursery areas. There is little scientific evidence to suggest that a single species is having a major impact on blue crab populations. However, the cumulative impacts of guilds of predators are unknown. There should be a push to encourage foodweb dynamics studies and continue current research activities involving modeling and diet studies.

**Recruitment/Habitat Utilization:** Several studies past and ongoing have examined blue crab larval distribution in nearshore oceanic waters, and which habitats are most important for postlarvae (megalopae) returning to estuaries. In Chesapeake Bay and Pamlico Sound (North Carolina), seagrass beds are important initially, but as crabs grow to the early crab stages, secondary dispersal, aided by wind and tides, takes them to habitats often dominated by marsh and detritus, which serve as nursery areas. Documentation of these areas in each state is important in defining critical habitat, and warrant continued protection as delineated in individual states' coastal protection regulations.

**Dispersal:** Offshore drift has shown the possibility for varied wide spread dispersal of larvae (Natunewicz et al. 2001). There is little understanding of possible interactions between crab populations of the various western Atlantic estuary systems. Genetic evidence shows that there is gene flow for crab populations from New York to Texas (McMillen-Jackson et al. 1993). This evidence does not support the possibility that recruitment involves inter-estuary dependencies as it takes minimal mixing to homogenize genes. Further research is needed to better understand if any inter-estuary recruitment dependencies exist. This may be of particular interest to protecting crab populations in smaller systems, as found south of North Carolina, where smaller populations are both more susceptible to disaster and more likely to benefit from seeding from neighboring systems.

Findings of large numbers of blue crabs in tuna gut counts off of the North Carolina coast along with crab tagging studies in North Carolina have spiked an interest in defining the fate of post spawned female crabs.

**Disease:** More research is needed to evaluate the impacts that diseases are having on crab stocks. Changes in the environment, such as the rise in salinity that accompanied the recent droughts in Georgia, can lead to large scale disease outbreaks. The parasitic dinoflagellate, *Hematodinium perez*, has been identified as the cause of many of the outbreaks but little is known about what conditions can lead to an outbreak or about the rate of mortality it can cause under more normal environmental conditions. Defining when crabs are stressed will lead to an ability to take preventative measures against diseases. Immunological biomarkers, such as hemolymph antibiotic activity, may serve as a diagnostic tool to monitor blue crab stress (Noga et al. 1998).

## Section II. Environmental Factors

**Drought:** Low flow conditions have been found to negatively affect juvenile blue crabs in the Apalachicola River estuary in northern Florida (Wilber 1993). Drought conditions from 1998-2001 is suspected as a major factor in Georgia's blue crab population crash. The drought in Georgia has dramatic impacts on the salinity of the crab habitat thus: 1) making conditions ripe for the parasitic dinoflagellate, *Hematodinium perez* 2) pushing crabs out of historic, and oftentimes legal, fishing grounds 3) pushing crabs into questionable habitat 4) possibly interfering with the natural reproduction process 5) possibly interfering with larval development 6) denuding *Spartina* beds.

These impacts can be felt in states other than Georgia though the impacts vary from location to location. In fact drought can have beneficial impacts under certain circumstances. Low river flow into Chesapeake Bay have been shown to reduce nutrient loading and turbidity helping SAVs reestablish. Likewise, recruitment of striped bass, a predator of blue crabs, is limited during drought years. Drought has consequences on the whole ecosystem, some good and some bad.

**Winter Mortality:** Monitoring of blue crab populations in Maryland and Delaware in the winter of 2003 found significant cold kill. Although generally less of a factor in southern states, some blue crab were reported dead in shallow areas in South Carolina. Cold temperatures are stressful, and are thought to be a factor in "grey" crab disease in the 1960s (infection by *Paramoeba*). As is the case with droughts, severe winters effect the whole ecosystem and may have positive as well as negative effects to crab populations. Severe winters have been shown to be beneficial for some major prey items thus increasing blue crab food availability.

**Hypoxia:** Low oxygen conditions are common in estuaries that receive excess nutrient loading. Blue crabs actively avoid low DO waters, seeking oxygenated shallow edges. In such cases, crabs and crabbers tend to get crowded, resulting in the possibility for excessive resource drain in either case. The Neuse River estuary in North Carolina has been the site of such hypoxic events. A study by Selberg et al. (2001) suggests that if the zones of low dissolved oxygen concentrations continue to grow in the Neuse River estuary, there may be impacts to blue crab population sustainability. There are many impacts low DO can have on blue crabs throughout their life history. Migration patterns can be disrupted by avoiding low DO waters and may reduce spawning success as in the case of mated female migrations to spawning grounds.

**Hurricanes:** Unlike drought, winter mortality and hypoxia, hurricanes have had impacts on all western Atlantic blue crab waters at one time or another. Flooding associated with hurricanes can cause massive relocation of crabs from up-estuary tributaries to central estuarine areas. Three sequential hurricanes that hit North Carolina's Pamlico Sound in the fall of 1999 are blamed for crowding crabs into the central sound where they were exposed to intense localized fishing pressure (Eggleston et al. Symposium). This event ran concurrent with the precipitous decline in NC's blue crab population beginning in 1999-2000.

Impacts vary by state and hurricane and tools need to be developed to assess the wide range of possible changes to each ecosystem. Typically the impacts of a hurricane are so wide spread and complex that it takes a number of years to get a real sense of what impacts the hurricane actually had. Development of a list of impacts associated with hurricanes may help biologists make quicker assessments and enable the use of adaptive management to appropriately protect blue crab populations.

**Human Development Effects:** Efforts to look at the whole set of human impacts to the ecosystem should be encouraged as a tool to improve blue crab fisheries. The diversity and magnitude of the impacts associated with an ever increasing coastal population have made cumulative impacts difficult to address. However, in the case of such impacts as coastal habitat loss due to development, these impacts can be the most devastating (Fox 1992).

Blue crab's complex life history makes them reliant on a wide range ofquality habitats. They are vulnerable to chemical and physical alterations to their habitat in different ways during their life. It is important to not only focus on correcting forms of pollution that have been in the spot light for many years like point source discharges, but also to continue to expand our focus to less visible sources of pollution like nutrient loading, water flow alterations and small scale physical destruction of estuarine habitats.

## Section III. Commercial Landings

Commercial blue crab landings data are thought to under-represent the total commercial harvest. Monitoring has historically focused on processing plants and often missed crabs that were sold directly from fisherman to the "steamer" or "basket" market. Additionally, some dealers refused to report data for fear that such records would be available for review for tax purposes. There has been a trend for states to switch to a trip ticket system of reporting landings directly from the fisherman. Despite the inconsistencies in reporting, commercial landings data can be valuable for depicting long-term trends.

Figures 1-11 represent landings data collected in cooperation between the states and the NMFS. Overall (Fig. 11), blue crab landings have declined every year since 1998 with 2001 coming in at 31.3 % below the average harvest (average harvest from 1980-2001). This downward trend is largely consistent across the states with antidotal evidence suggesting that the trend has continued to the present. The following state by state discussion will help shed light on the potential causes for the decline.

**NEW YORK**

A relatively small fishery, New York's commercial harvest took a plunge in 1997 after a record harvest in 1996. Since 1997, the harvest has remained fairly consistent in around 1 million pounds. A license cap was established in 1998 allowing those who had licenses in 1997 to retain them with a few exemptions for people who derived significant income from fishing who did not hold licenses in 1997. The final cap will be the greatest number of licenses sold between 1998 and 2003. The current number is 675 residents and 34 non-residents but that may change slightly after this year. Commercial CPUE has remained fairly constant since 1997 averaging 75 lbs/day. Data is collected directly from the crabbers.

**NEW JERSEY**

There was a dramatic increase in landings in the mid 90's as compared to the 80's as license sales increased. Total crabbing licenses went from 150 in the 1980s to 506 licenses in 1994. In 1995 a limited entry program was established and through attrition has since dropped the total licenses to 364. There was a drop in harvest in 1996 and then landings have increased to above average since 1997.

**DELAWARE**

There has been a decline in harvest from 1998 to present. Landings are based on mandatory reporting from crabbers. Harvest declined in 2002 by 18%, and 2003 shows signs of another decline in landings probably due to winter mortality. Recruitment has been at or below the mean for the last 5 years.

**MARYLAND**

There has been a long-term harvest decline since the early 1990s. The decline has continued to the present with 2003 slated to be 30% below the 2002 harvest. Effort surveys indicate that

effort is down between 10-40% from 2002 (may be due to weather and markets). Soft and peeler crab harvest has increased from 2002. A major hard crab reporting change was established in 1981 leading to the spike in harvest reported. Dealer reporting was implemented in 1991 and was made mandatory in 1995. Data collection for peeler and soft crabs needs to be improved.

## POTOMAC RIVER FISHERIES COMMISSION (PRFC)

The Potomac River is regulated separate and distinct from either Maryland or Virginia, only PRFC licensees can crab in the Potomac. Harvest records are obtained via a mandatory harvester reporting system, in place since 1963, which include the port of landing information such that 'harvest' is reported to NMFS by state of landings, i.e., either Maryland or Virginia. Therefore, the Potomac 'harvest' data, while separate and distinct from either state, is included in the MD and VA 'landings' and accounts for between 5% and 10% of the Chesapeake Bay-wide total. The report format was changed in 1990 from monthly reporting of daily activity to weekly reporting of daily activity, and since 1986, data is in an electronic format. There has been a long-term increasing harvest trend since the early 1970's through 1997, followed by a dramatic decline since then to levels not seen since the late 1960's.

## VIRGINIA

There was a reporting change in 1993 followed by a spike in harvest in 1994. This could have been due to the reporting change but is consistent with MD's peak in1994. There has been a decline in harvest every year from 1997 to 2003. As in Maryland no single factor has been labeled as the cause of the crash, rather biologist feel that there has been a wide range of factors coming into play.

## NORTH CAROLINA

In 1994 a mandatory trip ticket was established for reporting. Previous data was collected by port agents. This reporting change may have lead to the spike in harvest in 1994. The declines in 2000 and 2001 are hard to interpret as the state was recovering from hurricane Floyd, and facing a drought in 2001-2002. Also, reduced crab catches in some areas resulted in lower overall effort and landings in the crab pot fishery as fisherman concentrated on other species. Harvest has increased nicely in both 2002 and 2003. It is thought that markets are driving harvest as the "basket trade" has surged as VA and MD wholesalers look to compensate for lower harvest in their states. Fisherman switch between crabbing and other fisheries as markets prices dictate. Traditional crab picking houses have faced hard times and many have closed as they have been unable to compete against foreign imports and the high priced "basket trade". North Carolina may face a decline in harvest when the MD and VA harvest rebound thus eliminating much of the demand for NC crabs.

## SOUTH CAROLINA

SC has one of the most consistent fisheries on the Atlantic coast. There has been a gradual downward trend since 1998 with 2002 landings coming in around 4.3 million pounds. Discussions are ongoing to limit the number of licenses and pots. Current research is focusing on modeling populations, with drought assumed as a strong negative influence in recent years, similar to the situation in Georgia.

**GEORGIA**

Landings where dealer reported prior to 1998, when the state switched over to the trip ticket system. The dealer reporting is thought to have under-reported landings by 36%. The current limited entry system, implemented in 1999, licenses only 159 crabbers.

Harvests have reestablished historic lows every year since 1996 with 2003 coming in at approximately 1.7 million pounds. There has been a shift from full-time to part-time crabbing with bushel trade markets driving effort. Fisheries-independent sampling shows a decline in the population of 90-95%. The recent drought (now over) has been blamed for much of the population crash (see drought section). The drought reduced freshwater input, raised salinities in blue crab habitats and among other things helped proliferate the spread of the parasitic dinoflagellate, *Hematodinium*.

**FLORIDA**

FL is characterized by having the most instability with frequent ups and downs. Prior to 1986 landings where reported through the NMFS general canvas when they switched to a trip ticket system. It is difficult to determine which coast blue crab are caught in Florida as they may be caught closer to one coast then landed on the other because of the relatively short driving distance. However, it is accepted that east coast landings have been down. A blue crab endorsement moratorium went into effect in June of 1998. Fishery independent data collected on the east coast has shown a recent decline in numbers of blue crab, similar to surveys in the other southeast states.

Hard blue crab landings in 2002, on the Florida east coast and inland waters were down 17% and 37%, respectively, from 2001 landings, although the Gulf coast landings increased by 21%. Inland landings had increased during the height of the drought, so it's not surprising to see them decrease from that level.

## Section IV. Recreational Landings

The availability of recreational fishery data is very limited. The magnitude of some of the data that is available suggests that recreational harvests are not insignificant (Table 2). Each state should conduct recreational surveys at least once and then possibly periodically to check percentages of total harvest. If the percentage is low than surveys may not be needed as often as if the percentage is high. It is important for management to at least document the magnitude of recreational landings.

Time and money are key factors limiting the frequency of recreational crabbing surveys Maryland conducts surveys periodically with license funds. Adding a question on crab harvest to the MRFSS survey would be a great aid in assessing the impacts of recreational harvest coast wide.

## Section V. Monitoring Programs

Monitoring programs collect the fisheries-independent data that is critical to the assessment process. The fisheries-independent data becomes more and more valuable as biases increase in fishery-dependent data as a result of increases in restrictions to a crabbers ability to catch what ever is out there.

There is little consistency amongst the monitoring methods of the various states. Sampling conditions and objectives vary by state thus making standardization of methodology an impractical goal. Trawls are often used as they limit sampling bias, are time efficient, mobile, and serve to collect more species than just blue crabs. There is some debate as to the use of traps in monitoring programs. Traps present a variable bias rather than a consistent bias as crabs enter traps under a multitude of conditions, i.e. trap cleanliness, trap fullness, trap inhabitants. Traps can help establish abundance estimates and can be a valuable addition to monitoring programs if data is collected over a long time period. Seining and suction cylinders provide means of monitoring specific sites particularly for juveniles.

Monitoring programs rely on long term data sets for comparison making their continuation a priority to blue crab management. Monitoring programs would benefit from an increase in time and money spent on completing gear efficiency studies. Knowledge of gear efficiencies will enable states to fine tune their monitoring if a gear change is in order.

## Section VI. Aquaculture Initiatives and Issues

Most of the research being conducted on blue crab aquaculture is coming out of the Blue Crab Advanced Research Consortium (BCARC) funded through NOAA. The consortium consists of the following principle investigators:

Yonathan Zohar, Center of Marine Biotechnology,
University of Maryland Biotechnology Institute
Harriet Perry, Gulf Coast Research Laboratory, University of Southern Mississippi
David Eggleston, North Carolina State University
Anson Hines, Smithsonian Envirinmental Research Center
Romuald Lipcius, Virgina Institute of Marine Science

The BCARC successfully induced blue crab reproduction out of season and was able to produce 40,000 juvenile 6-25 mm crabs. Enhancement of wild stocks was successful when tested on small-scale sites (4-9 ha) using hatchery-reared juvenile blue crabs. The introduced crabs adapted rapidly to field conditions. Studies are being completed to identify genetic variations in crab populations that would need to be maintained in hatchery-reared crabs. Additionally, research is being conducted to define the endocrine regulation of reproduction, molting and growth facilitating the manipulation of these processes (Zohar et al. 2003).

The BCARC research is designed to provide biologists with another management tool rather than to substitute for management, as in the case of culturing as a means to establish a put-and-

take fishery. The goal is to provide a means to enhance spawning stocks in recruitment limited fisheries. Enhancement of juvenile crabs needs to be linked to providing corridors for crabs to migrate from the nursery stocking grounds to the spawning sanctuaries.

The BCARC research provides insights into many aspects of blue crab biology and is of great value even if stock enhancement programs are not found to be the best course of action. Future research should continue small scale aquaculture activities, including continuation of ongoing research studies, improve collaborative efforts, and evaluate the feasibility of large scale enhancement as a tool for blue crab management.

## Section VII. Current Statutory Requirements

Sanctuaries are a form of management that has been seen as a great tool by biologists. Virginia makes a spawning sanctuary out of most of the lower Chesapeake Bay during the summer. Maryland has effectively created sanctuaries by creating regulations that reduce fishing in tributaries. Unfortunately, the MD and VA protected waters do not connect or provide any corridors to facilitate a full life cycle sanctuary. North Carolina has protected waters at the mouths of rivers but again fails to protect these crabs as their life history dictates migration to other areas of the bays. Enforcement of sanctuaries has been effective through the use of fly overs to spot the presence of pots in these protected waters.

Reports of large scale abuses of pot limits has generated interest in developing better pot tagging programs. Rather than having crabbers apply their own tags, systems that allocate special state designed tags provide a means of simplifying enforcement. With state designed tags that can not be easily forged, an enforcement officer just has to check for the presence of tags rather than count the total number of pots.

## Section VIII. Stock Assessment and Stock Status Information

Fisheries managers should develop clear management goals and benchmarks to guide the collection of blue crab data and development of assessment models. The data needs and monitoring programs will depend on the type of model being conducted and the benchmarks/goals identified by fisheries managers. The four basic levels are as follows:

1) Production modeling approaches: Requires good catch and effort data to estimate maximum sustainable yield.

2) Non-age-specific models (catch survey analysis): Requires catch data, recruitment indices and adult indices to estimate fishing mortality and abundance, recruitment models to determine spawning stock biomass

3) Stock-Recruitment models: Indices of spawning stock biomass are used to predict levels of future recruitment.

4) Age structured models: Given success with age determination, useful in estimating fishing mortality and spawning stock biomass per recruit.

Much of the assessment calculations depend on the accuracy and availability of the various biological parameters (i.e. max age). In general, more research is needed to better understand biological parameters, such as growth, age, and natural mortality of blue crab over their management range, in order to produce more acceptable stock assessments.

## IX. Socio-eonomic Considerations

Only a few socio-economic studies have been completed for blue crab watermen and most contain little if any time series data. A primary recommendation of study completed for the Chesapeake Bay ( Rhodes et al. 2001) suggests that socio-economic data should be collected as part of each state's regular data collecting processes. Further understanding of the people doing the harvesting can shed new light on means to better manage this complex fishery. The presentation of socio-economic data help produce buy-in to management plans when the industry sees that their needs are being addressed. Creating support from the crab industry is critical to the overall objective of maintaining a healthy fishery as it helps build political support and thus the necessary funding.

In the Chesapeake Bay, 32.4% of Marylanders and 27.1% of Virginian license holders are over the age of 60 (Rhodes et al 2001). Any management program that seeks to reduce fishing effort by retiring licenses can take advantage of this age distribution in a way that will lesson some of the hardship on the participants. This same study found that a majority of Maryland and Virginia crabbers had not received any education beyond high school, suggesting that it would difficult for them to find work in other fields besides crabbing.

As would be expected even less socio-economic data exists for recreational crabbers.

The recent hardships to the blue crab fishery, that helped motivate this status report, have been addressed by the federal government. The NMFS is heading a relief fund of $5,000,000 to be distributed to NJ, DE, MD, VA, NC, SC, and GA (Table 8).

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Table 1. Biological Data for Blue Crab Along the Atlantic Coast (NY - FL)

| | NY | NJ | DE | MD | VA | NC | SC | GA | FL |
|---|---|---|---|---|---|---|---|---|---|
| MAX. AGE | n/a | | 3-4 | | 3-4** | | | | 3-6 |
| WHEN ♀s SPONGE | n/a | | summer | June (southern areas only) | May-Sept | | April/May and July (bimodal) | | March-Oct |
| SPAWNING DATE | n/a | | summer-peak July | n/a | summer peak July-Aug | | | | Feb-Oct |
| SPAWNING TEMP (C) | n/a | | | n/a | | | | | 18-20 |
| LARVAL SUPPLY DATE | n/a | July-Oct | July- Oct | n/a | Jun-Oct | | | | April-Oct |
| LARVAL SUPPLY TEMP (C) | n/a | | | n/a | 19-20 | | | | 20-31 |
| MEGALOPAE INGRESS DATE | n/a | Aug-Nov | Aug-Nov | n/a | June-Aug | | Peak in Oct. smaller peak in March | | July-Sept |
| MEGALOPAE INGRESS TEMP (C) | n/a | | | n/a | | | | | |

*4.5" for non egg-bearing females ** Oldest ever recorded was 7 years old

Table 1. (continued) Biological Data for Blue Crab Along the Atlantic Coast (NY - FL)

| | NY | NJ | DE | MD | VA | NC | SC | GA | FL |
|---|---|---|---|---|---|---|---|---|---|
| GROWTH RATE | n/a | | | | | | | | 25%/molt for crabs 20-132 mm CW (Tagatz [1]1968) |
| TIME TO LEGAL SIZE | n/a | | ~ 1 yr | 14-21 months | 12-18 mnth | | | | ~ 1 yr |
| LEGAL SIZE HARD CRABS FOR SALE (INCHES) | none | 4.75"* | 5” male; mature female any size | 5"-5.25" males | 5" | 5" | | | 5" |
| ♂/♀ RATIO | n/a | | | >1north bay <1south bay | | | | | varied |
| MIGRATION TIMING | n/a | | Sept-Oct | Sept-Nov | | | | | April-Oct |
| NATURAL MORTALITY | n/a | | 0.75-1.0 | | | | | | 0.5-1.0 |
| AGE AT MATURITY | n/a | | ~ 1 yr maturity; 2 year to spawn | 14-21 months | 12-18 mnth | | | | 1 |
| RECRUITMENT INDICES | n/a | | yes | yes | | | | | yes |

*4.5" for non egg-bearing females ** Oldest ever recorded was 7 years old

Table 2. Summary of Recreational Harvest Data Available.

| State | Year | Rec Harvest Estimate | Percent of Commercial Landings | Source |
|---|---|---|---|---|
| Delaware | 1996 | 40,880 lbs | 1.0 | DE DNR Cole et al. 1997 |
| Maryland | 1983 | 18,600,000 kg | 78.6 | MDNR and MRFSS (Stagg et al 1994) |
| Maryland | 1988 | 9,700,000 kg | 49.5 | MDNR and MRFSS (Stagg et al 1994) |
| Maryland | 1990 | 5,200,000 kg | 25.9 | Katherine Chandler Associates Research Inc. (Stagg et al 1994) |
| Potomac River | 2001 | 3,338 lbs | 0.14 | PRFC survey of Potomac River licensed sport crabbers |
| North Carolina | 2000-2001 | 118,050 pounds (only includes data from those holding a Rec. Comm. License) | 0.5 | Vogelsong et al., 2002 |
| South Carolina | 1998 | 857,000 lb (only for SC marine recreational fisheries stamp holders) | | R.A. Low, 1998 |

Table 3. Blue Crab Monitoring Programs from NY-FL

| | NY | NJ | DE | MD | VA | NC | SC | GA | FL |
|---|---|---|---|---|---|---|---|---|---|
| Survey Type | **Hudson River** FI & FD pot survey | FS | FS | FS &SR | FS & R | FS & R | FS | FS | Indian River, Jacksonville, Tequesta- All stratified random plus Indian River had fixed site 1991-1996 |
| Time period | FI & FD June - November (2002-2003) | April-Oct | 1978-present | FS-77-present SR-90-present | FS-95-present R-90-present | FS 78-present R 87-pr | 79-present | 76-present | Indian River 91-03 Tequesta 97-03 Jacksonville 01-03 |
| Periodicity | FI & FD Weekly | monthly | Apr-Oct | FS-May-Oct SR-Dec-Mar | FS montly R-Nov-Apr | FS May +June R June +Sept | monthly bimonthly in sounds | monthly | Indian River: Monthly 91-03 and seasonal 90-96 and 99-03 Tequesta and Jacksonville: Monthly all years |
| Boat size | | 42' | 23' | FS-22' SR-40'-45' | | 42' | 50' | | 22'-24' mullet skiffs |

FI=fishery independent; FD=fishery dependent; FS=fixed station; SR=stratified random; R=random

Table 3. (continued) Blue Crab Monitoring Programs from NY-FL

| | NY | NJ | DE | MD | VA | NC | SC | GA | FL |
|---|---|---|---|---|---|---|---|---|---|
| Gear/ Mesh | FI &FD Standard Crab Pot (2ftX2ftX 1.5 ft) | 16' Otter Trawl, 1/4" liner | 16ft/1.5” body, 0.5” codliner | FS- 16'/1.25 " body/0. 25" codend SR- 6' dredge/ 0.5" liner | FS- 30ft/1.5 body, 0.25 codliner R-6ft dredge | FS- 10.5'/0.75" body, 0.25" tailbag R- 30'/1.5 body,3/4" tailbag | 20' otter trawl, 1" mesh, crab pots | 40', 1.875 | 6.1m Otter Trawl with 38mm stretch mesh, a 3.1 mm mesh liner, and a tickler chain, used by Indian River and Jacksonville<br><br>21.3m Center bag seine, 1.8m deep with 3.2 mm nylon mesh used by Indian River and Jacksonville<br>183m center bag seine, 3.0m deep with 18.8 mm bar mesh used by Indian River, Jacksonville and Tequesta |
| Method changes (date) | none | none | | | | | vessel, number of nets 2002, tow time 1986 | | Indian River: day/night sampling changed to daytime only, seasonal sampling changed to monthly, gears were started and stopped at various points during sampling history more details available upon request<br>Jacksonville and Tequesta: no change |

FI=fishery independent; FD=fishery dependent; FS=fixed station; SR=stratified random; R=random

Table 3. (continued) Blue Crab Monitoring Programs from NY-FL

| | NY | NJ | DE | MD | VA | NC | SC | GA | FL |
|---|---|---|---|---|---|---|---|---|---|
| Tow duration/ distance | | 10 min, mean distance in 2002 = 0.329NM | 10 min | FS- 6 min<br>SR- 1 min | | FS-. 1 minute/ 75yds<br>R- 20 min | 15 minute | | Otter Trawl: river = 5min/0.1nm/1,130$m^2$<br>bay = 10min/0.2nm/2,259$m^2$<br>21.3m seine: bay = 140$m^2$, river = 68$m^2$<br>183m seine: 4,210$m^2$ |
| Samples per month | FI -4<br>FD -4fishers monitored | 11 | 1/station | FS- 37<br>SR- varies 800 total | FS- 120 | FS ~103<br>R ~53 | 7-30 | 36 | Indian River Trawl: inconsistent Indian River 21.3m seine: 38/mnth Indian River 183m seine: 19/mnth Jacksonville Trawl: 32/mnth Jacksonville 21.3m seine: 32/mnth Jacksonville 183m seine: 16/mnth Tequesta 183m seine: 16/mnth |
| Location | FI = Newburgh Bay (RM 57) Kingston Point (RM 91)<br>FD = Tappan Zee Bridge (RM 27) to Poughkeepsie (RM 74) | Delaware Bay | Upper to lower DE Bay | FS 6 tribs<br>SR- statewide | FS- & R- statewide | FS- Statewide<br>R- Pamlico Sound | southern 3/4 of coast | coast wide | Indian River: upper 28deg, 49 min, lower 27 deg 39 min Jacksonville: upper 30 deg 44 min, lower 29 deg 58 min Tequesta: upper 27 deg 38 min, lower 26 deg 57 min |

FI=fishery independent; FD=fishery dependent; FS=fixed station; SR=stratified random; R=random

Table 3. (continued) Blue Crab Monitoring Programs from NY-FL

| | NY | NJ | DE | MD | VA | NC | SC | GA | FL |
|---|---|---|---|---|---|---|---|---|---|
| Depth | FI - 8-12 feet | 2002 = 2.2m | 4-30ft | FS- 2'-15'<br>Sr- 5'-110' | | | 10'-50' | | Trawl: 1.8m min/7.6m max 21.3m seine: max 1.8m<br>183m seine: max 2.5m |
| Salinity range | FI - 0 - 8 ppt<br>FD - 0-15 ppt | 9.1 -30 | 7-30ppt | FS & SR 0-20ppt | FS- 0-35ppt | 0-35ppt | 5-35 ppt | 15-35ppt | Indian River: 0-44ppt<br>Jacksonville: 0-38ppt<br>Tequesta: 0-40ppt |
| Stations | | 11 | 26 | | | | 36 | | |
| Agency contact | Gregg Kenney NYSDEC (845) 256 - 3171 | Jeff Normant | DNREC – Kahn, Coakley | MD DNR G. Davis | FS- VIMS C.Bonzek R-VIMS\ M. Seebo | NCDMF | SCDNR E. Wenner | GADNR P. Geer | FWC/FMRI Debbie Leffler |
| Data collected | FI -Number of crabs, sex, maturity, carapace width, weight, bycatch, water temperature, salinity<br>FD- Total catch and landings, subsample of sex, maturity, carapace width, weight, bycatch, water temperature, salinity | number, size, sex, depth, salinity, DO | total #, size, sex, maturity, sponge stage | FS & SR total #, cw, wt, gender, molt stage, maturity | FS & R total #, size, sex, maturity. sponge stage | #, size, sex, maturity. sponge stage | total #, size, sex, maturity ecdysis stage | total weight and number, size, sex, maturity. , ecdysis stage, sponge stage | gender, number, carapace width, Lat/Long, Temp, Do, Salinity, Conductivity, Depth, bottom type, bottom vegetation, Secchi depth, precipitation, tide |

FI=fishery independent; FD=fishery dependent; FS=fixed station; SR=stratified random; R=random

Table 4. State Comparisons of Blue Crab Management Actions for the Commercial Pot Fishery (Bolded text denotes a change from the 1998 BCFMP) modified from NCDMF table

| | ***Harvest Restrictions*** | | | | | ***Gear Restrictions*** | | ***Size Limits (inches)*** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***State*** | ***Season*** | ***Catch Limits*** | ***Time*** | ***Days*** | ***Pots (max)*** | ***Escape Rings*** | ***Buoys*** | ***Hard*** | ***Soft*** | ***Peeler*** | ***Tolerance*** | ***Sponge Crab Protect.*** | ***Effort Mngt.*** | ***Pot Att.*** |
| NY | none | none | none | none | none | none | none | none | none | none | none | A | Comm. License cap | none |
| NJ | Apr 16-Dec 14 Delaware Bay Mar 15-Nov 30 Other waters | None | 4:00 am-9:00 pm Bay, 24-hrs other waters | None | 600 Delaware Bay, 400 Other waters | None, Terrapin excluder some areas degradeable panel | Reflective I.D. Sink Line | 4.75* 4.5 non egg bearing female | 3.5 | 3 | Zero | A | Yes | 3 days |
| DE | Mar 1-Nov 30 | None | 1 hr before sunrise/sunset | None | 200, 500/vessel | None | I.D. color coded | 5 | 3.5 | 3 | 5% by number | A | Yes | 3 days |
| MD | Apr 1-**Dec 15** | None | **1/2 hr before sunrise-7.5 hrs after sunrise** | Prohibited either Sun. or Mon. | 300 up to 900/vessel w/2crew | 1(2-3/16 in), 1(2-5/16 in) may close for peelers | I.D. | **5**** | **4** | **3.5** separate from catch | 5 hard crabs/ bushel 10 peelers | A | Yes effective 6/98 | None |
| PRFC | Apr 1-Nov 30 | None | 1 hour before sunrise to sunset | None | 270/360/450 per boat | 2(1-2-5/16 & 1-2-3/5) may be closed May & June | All painted alike w/ I.D. | 5”-4/1-7/31 51/4 - 8/1-11/30 | None | 3.25 | 4 hard crabs/ bushel 0 peelers | A | Yes | Non |

* Includes mature female ** Minimum carapace width 5.25 effective August 1, 2002. A^ Prohibit sponge crabs until July 1, 2005 reevaluate at that time A=Unlawful to take, sell or possess sponge crabs; B=Prohibit brown/black sponge with tolerance; C=Crab sanctuary to protect females; D=May sell or possess sponge crabs, if taken legally in another state

Table 4. (continued) State Comparisons of Blue Crab Management Actions for the Commercial Pot Fishery (Bolded text denotes a change from the 1998 BCFMP) modified from NCDMF table

| | ***Harvest Restrictions*** | | | | | ***Gear Restrictions*** | | | | ***Size Limits (inches)*** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***State*** | ***Season*** | ***Catch Limits*** | ***Time*** | ***Days*** | ***Pots (max)*** | ***Escape Rings*** | ***Buoys*** | ***Hard*** | ***Soft*** | ***Peeler*** | ***Tolerance*** | ***Sponge Crab Protect.*** | ***Effort Mngt.*** | ***Pot Att.*** |
| VA | Apr 1-Nov 30 | Apr 1-May 31 51 bushels or 17 barrels/ vessel | **Set pots 1 hr after 6am-2pm/Apr. Sept-Nov 5am-1pm/May-Aug.** | Mon-Sat except peeler pots | 300 peeler 500 hard crab/300 tributaries 500 bay | 1(2-3/16 in), 1(2-5/16 in) may close in some areas | I.D. | 5 | 3.5 | 3 | 10 hard crabs/bushel or 35/barrel **10 peeler no soft** | B and C **baywide sanct. 35 ft contour** | Yes | None |
| NC | None | None | 1 hr before sunrise 1hr after sunset | None | 150 Newport River only | 2(2-5/16 in) may close in one area | I.D. **Sink Line** | 5 | None | None separate from catch | 10% by number/ container | C | **Comm. License cap** | 7 days |
| SC | None | None | 5am-9pm 4/1-9/15 6am-7pm 9/16-3/31 | None | None | 2(2-3/8 in)Jun 1-Mar 14 **Peeler pot may be baited. Bait not to exceed 3" in any meas.** | I.D. with colors | 5* | 5* | None with peeler limit | zero | A **and D** | None | 5 days |
| GA | None | None | None | None | 200/ includes peeler pots | 2(2-3/8 in) | I.D. | 5 | 5 | 3 | Zero | **A^ and D** | Yes | None |
| FL | None | None | 1 hr before sunrise 1hr after sunset | None | None | 3(2-3/8 in) degradeable panel | I.D. | 5* | 5 | None separate from catch | 5% by number/container except bait | A | **none develop by 12/04** | None |

* Includes mature female ** Minimum carapace width 5.25 effective August 1, 2002. A^ Prohibit sponge crabs until July 1, 2005 reevaluate at that time A=Unlawful to take, sell or possess sponge crabs; B=Prohibit brown/black sponge with tolerance; C=Crab sanctuary to protect females; D=May sell or possess sponge crabs, if taken legally in another state

Table 5. State Comparisons of Blue Crab Effort Management Actions for the Commercial Pot Fishery. (Bolded text denotes a change from the 1998 BCFMP) modified from NCDMF table

| ***Crab License*** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***State*** | ***Comm. License Required*** | ***Crew License*** | ***Individual License*** | ***License Cap*** | ***Trap Permit*** | ***Pot Limit (max)*** | ***Transferable*** | ***Use or Lose Provision*** | ***Soft-shell Dealer License*** | ***Soft-shell shedding License*** | ***Apprenticeship Program*** |
| NY | Yes | Endorsement to cover crew | Yes | Yes (need number) | No | none | Yes (Family only) | Yes. Three years. | none | none | none |
| NJ | Yes | None | Yes | Yes (312) | None | 600 Delaware Bay 400 other waters | yes family Only | None | None | None | None |
| DE | Yes | None | Yes 50 Pot Increment | Yes previous license (219) | None | 200 | Yes Family or Designee | None | None | None | None |
| MD | Yes Limited Entry | Fee for Crew | Yes | Yes Tied to comm. Lic. | None | 300 up to 900/vessel with 2 crew | Yes with criteria | None | None | None | Yes with criteria |
| PRFC | Yes Limited Entry | No | Boat License 300/400/500 pots | Yes previous year #525 | Peeler Trap License | 300,400 or 500 per boat | Yes | None | N/A | N/A | None |

* Florida Blue Crab Endorsement extended and scheduled to expire 7/1/05

Table 5. (continued) State Comparisons of Blue Crab Effort Management Actions for the Commercial Pot Fishery. (Bolded text denotes a change from the 1998 BCFMP) modified from NCDMF table

| ***Crab License*** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***State*** | ***Comm. License Required*** | ***Crew License*** | ***Individual License*** | ***License Cap*** | ***Trap Permit*** | ***Pot Limit (max)*** | ***Transferable*** | ***Use or Lose Provision*** | ***Soft-shell Dealer License*** | ***Soft-shell shedding License*** | ***Apprenticeship Program*** |
| VA | Yes 2 year delay | None | Yess 100, 300 or 500 pots | **Morato rium** | Peeler Hard | **300** peeler and 500 hard/300 tributaries 500 bay | Yes **with boat or family** | None | None | Yes | None |
| NC | Yes **License Cap** | None | **None ended Oct 2000** | **N/A Comm. Lic. Cap** | None | 150 only in Newport River | **N/A** | None | None | No **free permit required** | None |
| SC | Yes | None | Yes $25/50 pots $1/pot over 50 pots | None | None | None | No | None | None | Yes | None |
| GA | Yes | Yes | Yes 50 Pot Increments | Yes **(159)** 1998/99 licenses | $2/pot | 200/include s peeler pots | Yes **with boat or family** | 2 years | Yes | None | None |
| FL | Yes | vessel sw products license covers | Yes Income Criteria | none but in moratori um | None | None | Yes Only Family | None | None | None | None |

* Florida Blue Crab Endorsement extended and scheduled to expire 7/1/05

Table 6. State Comparisons of Blue Crab Management Actions for Recreational/ Non-Commercial Pot Fishery. (Bolded text denotes a change from the 1998 BCFMP) modified from NCDMF table

| ***Harvest Restrictions*** | | | | | | | ***Gear Restrictions*** | | | ***Size Limits (inches)*** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***State*** | ***License*** | ***License Exemption*** | ***Season*** | ***Daily Catch Limits*** | ***Time*** | ***Days*** | ***Pots (Max)*** | ***Escape Rings*** | ***Buoys*** | ***Hard*** | ***Soft*** | ***Peeler*** | ***Tolerance*** | ***Effort Manag*** |
| NY | No | No | none | <50 crabs | none | none | none | none | none | none prohibit sponge | none | none | none | none |
| NJ | Yes No Fee | None | None | 1 bushel | 4:00am-9:00pm Bay, 24 hrs other waters | None | 2 | None terrapin excluder some areas | Reflective I.D. sink line | 4.5* prohibit sponge | 3.5 | 3 | Zero | None |
| DE | None | | March 1-Nov. 30 | 1 bushel | None | None | 2 | None terrapin excluder in inland bays | I.D. white | 5 | 3.5 | 3 | 5% by number | None |
| MD*** | None | | Apr. 1-Dec. 15 | 1 bushel 1 dozen peeler/ soft | 1/2 hr before sunrise - 1/2 hr before sunset | None | 2 land owners only | 1 (2-3/16 in) 1 (2-5/16 in) | I.D. | 5** prohibit sponge | 4 | 3.5 | Zero | Tribs Only |
| PRFC | Yes | > 4 doz hard crabs 2 doz soft crabs | Apr. 1 - Nov. 30 | 1 bu. hard & 2 doz. soft | 1 hr before sunrise to sunset | None | 5 | 1 (2-5/16 in) 1 (2-3/8 in) | White w/ I.D. decal | 5” 4/1-7/31 5.25” 8/1-11/30 | None | 3.25 | None | None |

* Includes mature female

** Minimum carapace width 5 1/4 effective Aug. 1, 2002

*** Maryland’s Noncommercial Crabbing License is not required for crab pots unless potter takes more than 2 doz. Hard crabs/ 1 doz. Soft crabs. With License can take 1 bushel hard crabs/ 2 doz. Soft crabs

**** Georgia’s ban on sponge crabs is until July 1, 2005. A reevaluation will be conducted at that time.

Table 6. (continued) State Comparisons of Blue Crab Management Actions for Recreational/ Non-Commercial Pot Fishery. (Bolded text denotes a change from the 1998 BCFMP) modified from NCDMF table

| ***Harvest Restrictions*** | | | | | | | ***Gear Restrictions*** | | | ***Size Limits (inches)*** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***State*** | ***License*** | ***License Exemption*** | ***Season*** | ***Daily Catch Limits*** | ***Time*** | ***Days*** | ***Pots (Max)*** | ***Escape Rings*** | ***Buoys*** | ***Hard*** | ***Soft*** | ***Peeler*** | ***Tolerance*** | ***Effort Manag*** |
| VA | Yes | 2 pots 1 bushel and 24 peelers daily limit | Apr. 1-Nov. 30 | None | 6:00am-2:00pm Apr./Sept - Oct 5:00am-1:00pm May-Aug. | Mon-Sat. with license | 5 | 1 (2-3/16 in) 1 (2-5/16 in) may close in some areas | marked with the letter R | 5 | 3.5 | 3 | 10 crabs/ bushel or 35/barrel 10 peeler/no soft | None |
| NC | Yes | One pot/person along priveatly owned shore or pier | None | 50 crabs 100/vessel after sunset | 1 hr before sunrise 1 hr ___ sunset | None | 5 | 2 (2-5/16 in) may close in one area | I.D. Hot Pink sink line | 5 | None | None | 10% by number/container | None |
| SC | None | | None | None | None | None | 2 | None | I.D. Yellow | 5* | 5* | 5 | Zero | None |
| GA*** | Yes Fishing Lic. | None | None | 1 bushel 2 bushels/ vessel | None | None | 6 | 2 (2-3/8 in) | I.D. Prohibit sponge | 5 | 5 | 3 | Zero | None |
| FL | Yes, if fishing from boat | . | None | 10 gallons/ person | 1 hr before sunrise- 1 hr after sunset | None | None | 3 (2-3/8 in) degradable panel | marked with the letter R | None * prohibit sponge | None | None | 5% by number/ container except bait | None |

* Includes mature female ** Minimum carapace width 5 1/4 effective Aug. 1, 2002 *** Maryland's Noncommercial Crabbing License is not required for crab pots unless potter takes more than 2 doz. Hard crabs/ 1 doz. Soft crabs. With License can take 1 bushel hard crabs/ 2 doz. Soft crabs **** Georgia's ban on sponge crabs is until July 1, 2005. A reevaluation will be conducted at that time.

Table 7. Blue Crab Stock Assessment Statistics NY-FL

| | NY | NJ | DE | MD | VA | NC | SC | GA | FL |
|---|---|---|---|---|---|---|---|---|---|
| Reference/ (website of assessment if available) | | | D. Kahn http://www.dnrec.state.de.us/fw/bca01.pdf | A. Sharov, L. Fegley | CBSAC | D. Eggleston | P. Harris | G. Rogers | M. Murphy et al. www.floridamarine.org/features/category_sub.asp?=4604 |
| Method | none | none | Catch Survey | Catch survey | | Still working on | Schaeffer production model, PCA for env. variables | | Catch survey depletion estimates, ASPIC failed |
| Date | | | 2003 | assessment due in 2004, status of stock annually | | 2003 | 1998,2003 | 1993 | 2000 |
| Abundance trend | | | | stable at low level (62% of highs) since 1998, slight upward tick since 2001 | | | (>75 mm) descending trend | | (>70 mm) varying no trend |
| Recruitment trend | | | | stable at low level (62% of highs) since 1998 | | | (<75 mm) descending trend | | (<65 mm) descending trend |

Table 8. Blue Crab Relief Fund Programs by State

| | **Program Title** | **Funding Provided** | **Principle Investigator** | **Project Description** | **Project Period** |
|---|---|---|---|---|---|
| NJ | *NJ Commercial Blue Crab Fishery Economic Assistance Program* | $218,309 | Paul Scarlett | New Jersey will provide direct personal assistance to commercial blue crab fishermen based on reported commercial landings of blue crab during the years 1999-2001 and currently be active in the 2003 fishery by purchasing a 2003 commercial crab pot or crab dredge license. Fishermen will receive a percentage of the total funds available in proportion to their percent of total harvest. | 7/1/03 - 6/30/06 |
| DE | *Delaware Blue Crab Economic Assistance Program* | $186,743 | Richard Cole | The State of Delaware will distribute ecconomic assistance funds to individuals that qualify based on historical participation in the state's commercial blue crab fishery. Staff will work with the Shellfish Advisory Council to develop a fair and equitable program. Eligibility assistance will be contingent upon indivduals having obtained their 2003 commercial crab pot or crab dredge license. In addition, various allocation programs will be developed for consideration that include, but are not limited to m historical performance over a 1, 2, or 3-year period (1999-2001). | 10/01/03 - 9/30/04 |
| MD | *Maryland Blue Crab Fishery Disaster Program* | $1,193,209 | Lynn Fegley | The State of Maryland proposes to 1) provide direct assistance to blue crab harvesters; 2) develop a work-relief program where watermen are reinmbursed for collecting data on commercial, recreational or ecologically important estuarine species; and 3) develop a crab industry product and process improvement program. | 6/1/03 - 9/30/04 |
| PRFC | | | AC Carpenter | PRFC licensed commercial crabbers were included in “state of residence” program if they met eligibility requirements, as verified by PRFC data. | |

Table 8. (continued) Blue Crab Relief Fund Programs by State

| | Program Title | Funding Provided | Principle Investigator | Project Description | Project Period |
|---|---|---|---|---|---|
| VA | *Virginia Blue Crab Disaster Assistance Program* | $1,210,077 | Jack Travelstead | As a plan for disaster assistance for the blue crab fishery, the Commonwealth of Virgina will provide direct assistance to blue crab fishermen who were active in the fishery from 2000-2002 and are eligible for crabbing license in 2003. Assistance payments will be calculated using a two-tiered approach and will utilize blue crab harvest information from the Marine Resources Commission's Mandatory Harvest Reporting System. | 9/1/03 - 8/31/04 |
| NC | *North Carolina Blue Crab Industry Economic Assistance Program* | $1,847,127 | Maury Wolff | The State of North Carolina will provide direct economic assistance to North Carolina's blue crab industry, including qualified fishermen, dealers, and processors. In addition, the NC Department of Agriculture and Consumer Services, Division of Seafood Marketing, will develop a 36 month blue crab marketing program. | 9/1/03 - 8/31/06 |
| SC | *Economic Assistance to South Carolina's Blue Crab Fishermen* | $255,115 | Dale Theiling | The State of South Carolina will provide direct economic assistance to qualified resident and non-resident blue crab fishermen who landed blue crabs in South Carolina. | 8/1/03 - 7/31/04 |
| GA | *Georgia Blue Crab Industry Economic Assistance Program* | $89,419 | Spud Woodward | The State of Georgia will provide direct economic assistance to blue crab fishers who held a valid GADNR issued Blue Crab Harvesters License as of July 1, 2003 during any of the years 1999 through 2001. | 9/1/03 - 8/31/04 |

Figure 1. New York Commercial Blue Crab Landings 1980-2001.
Personal communication from National Marine Fisheries Service, Fisheries Statistics and Economics Division (11/1/03).

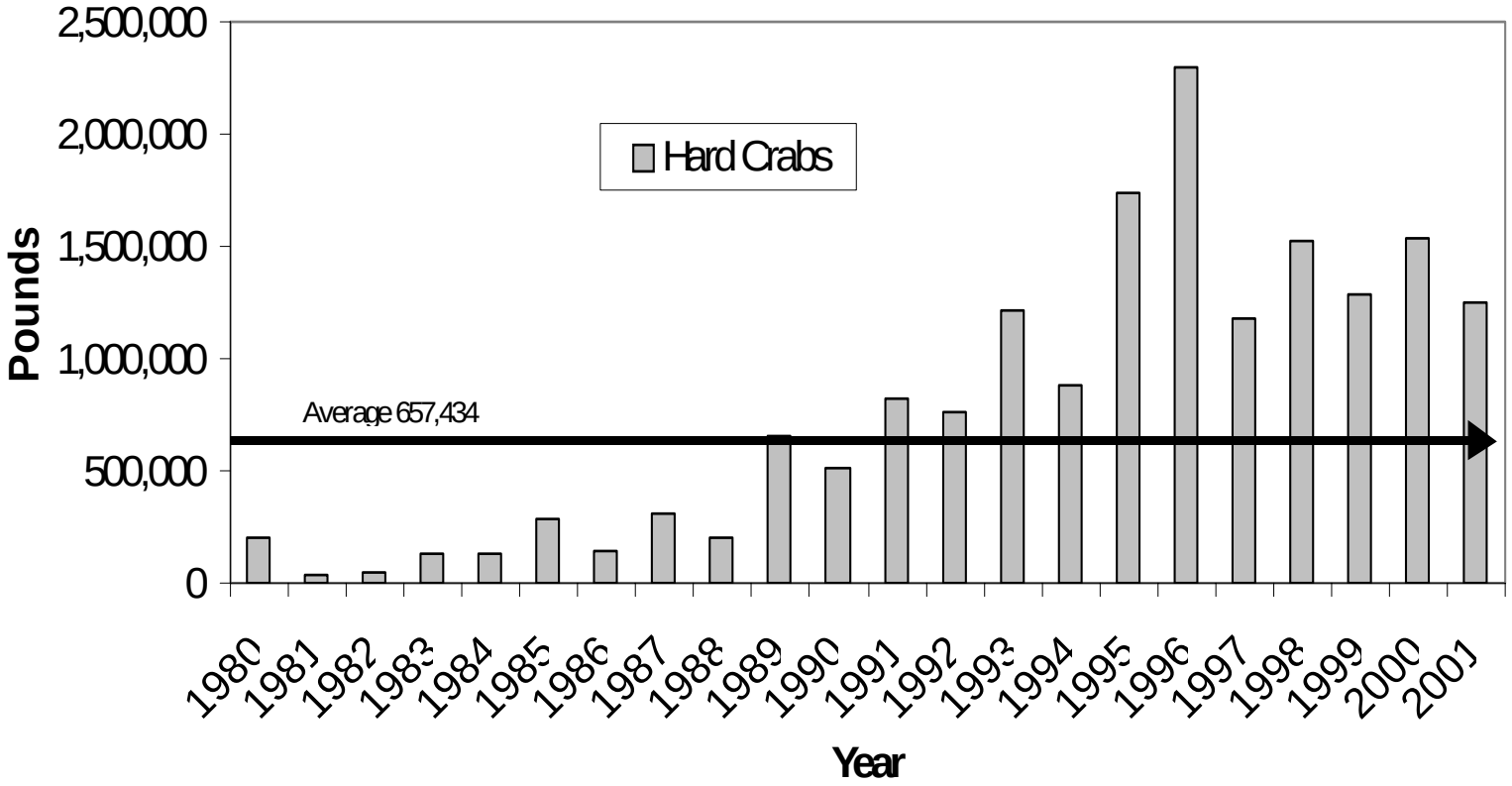

**Figure 2. New Jersey Commercial Blue Crab Landings 1980-2001**
**Personal communication from National Marine Fisheries Serrvice, Fisheries Statistics and Economics Division (11/1/03).**

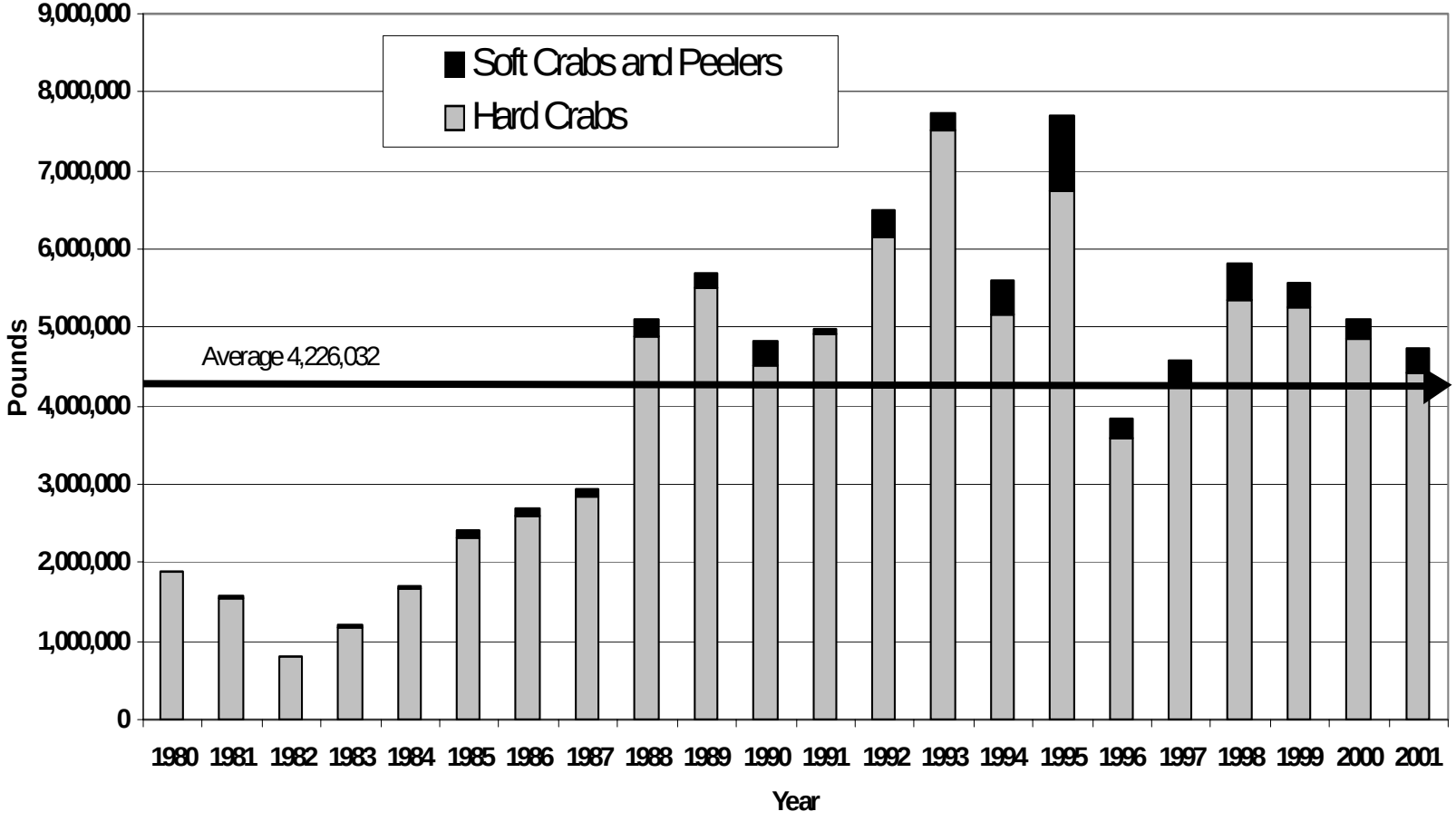

**Figure 3. Delaware Commercial Blue Crab Landings 1980-2001.**
**Personal communication from National Marine Fisheries Serrvice, Fisheries Statistics and Economics Division (11/1/03).**

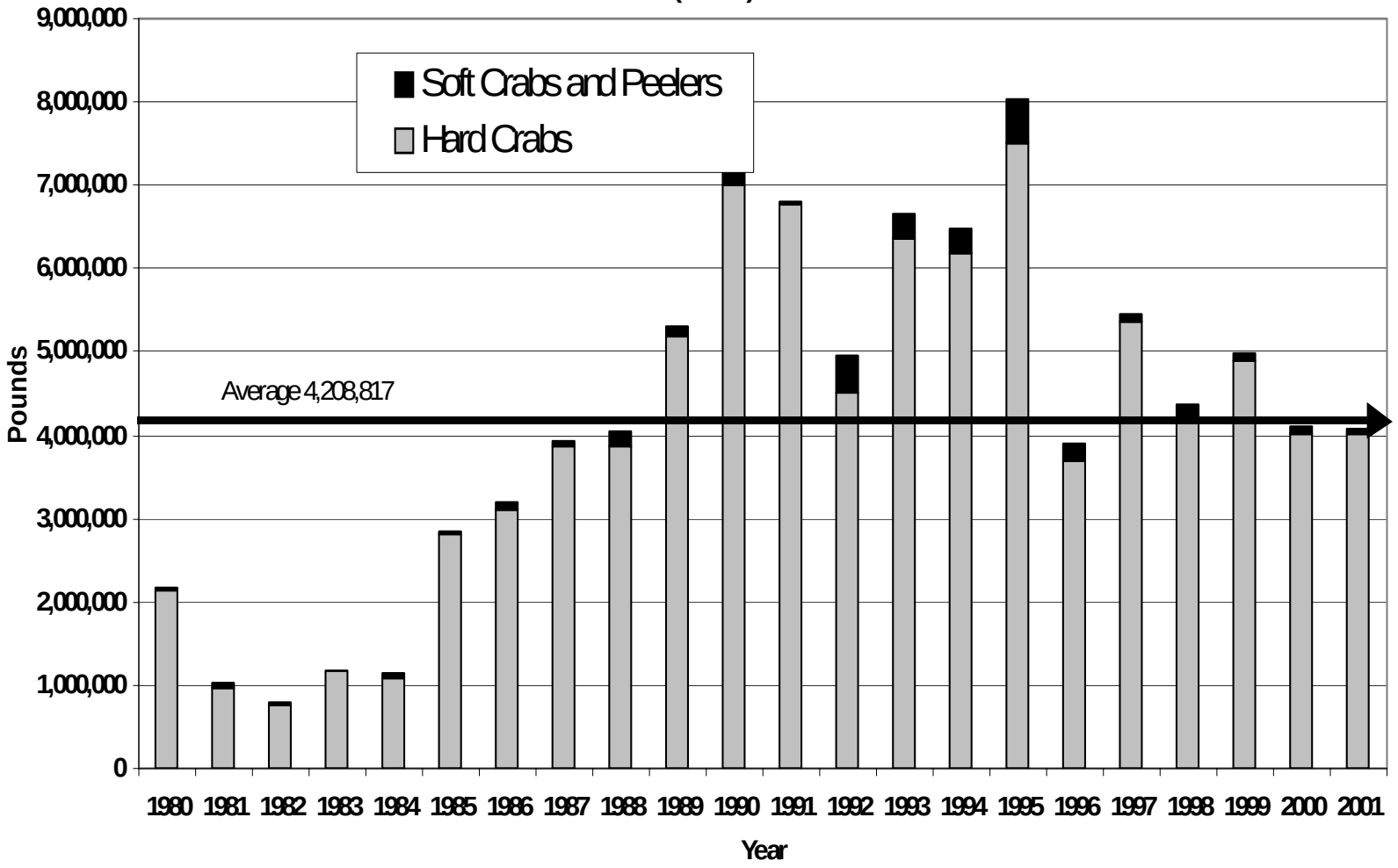

**Figure 4. Maryland Commercial Blue Crab Landings 1980-2001.**
**Personal communication from National Marine Fisheries Serrvice, Fisheries Statistics and Economics Division (11/1/03).**

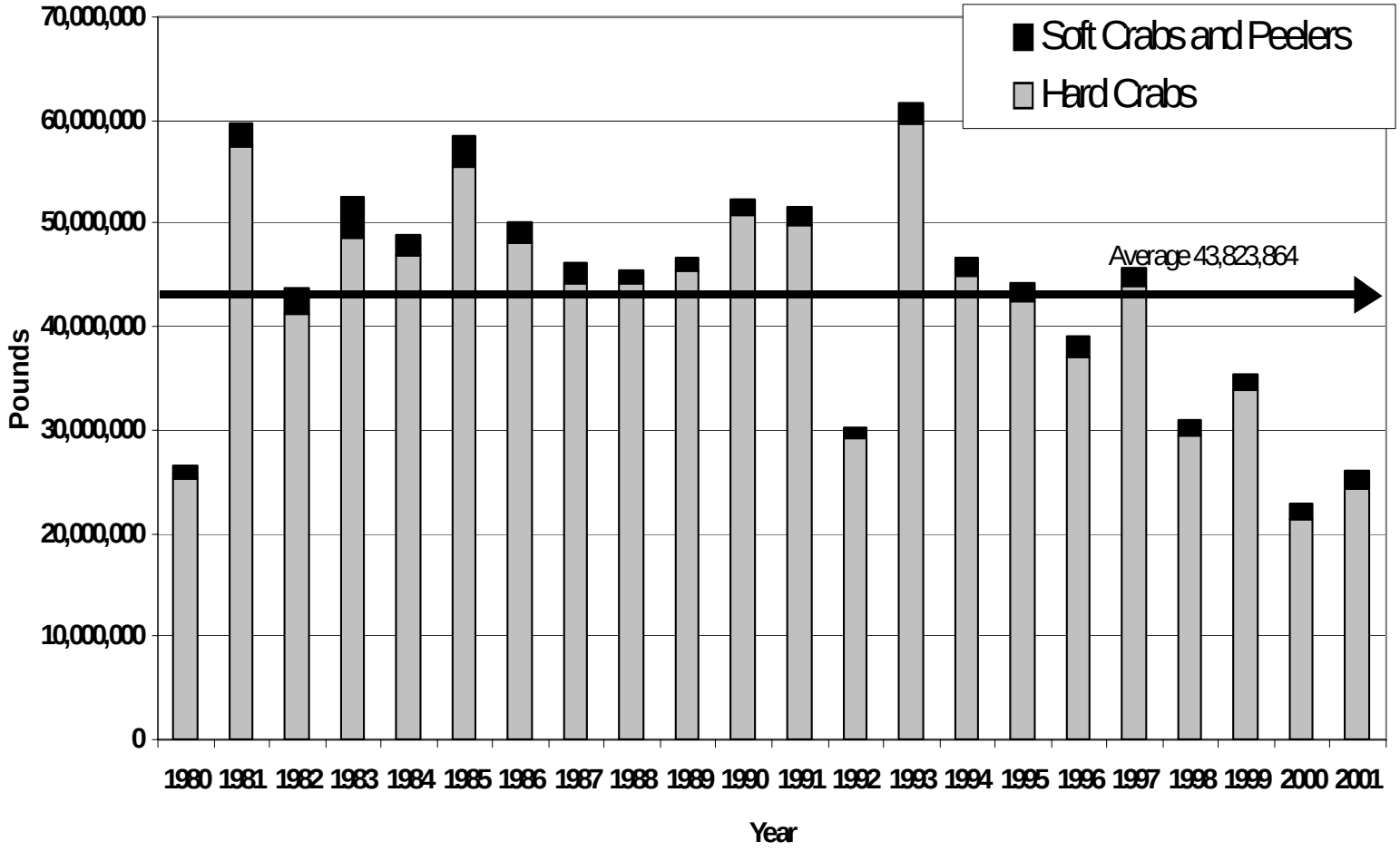

**Figure 5. Potomac River Commercial Blue Crab Harvest 1980-2001**

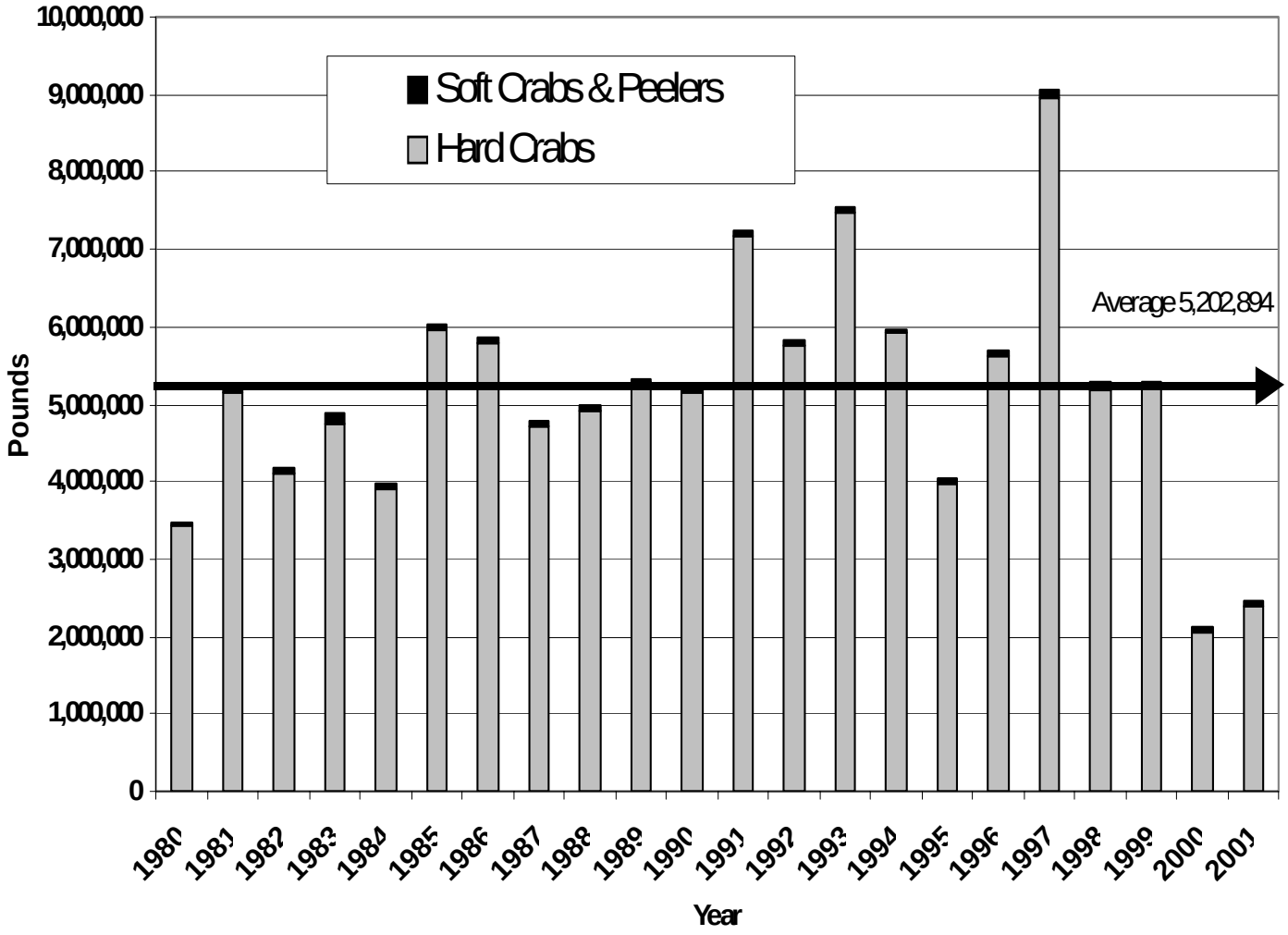

**Figure 6. Virginia Commercial Blue Crab Landings 1980-2001.**
**Personal communication from National Marine Fisheries Service, Fisheries Statistics and Economics Division (11/1/03).**

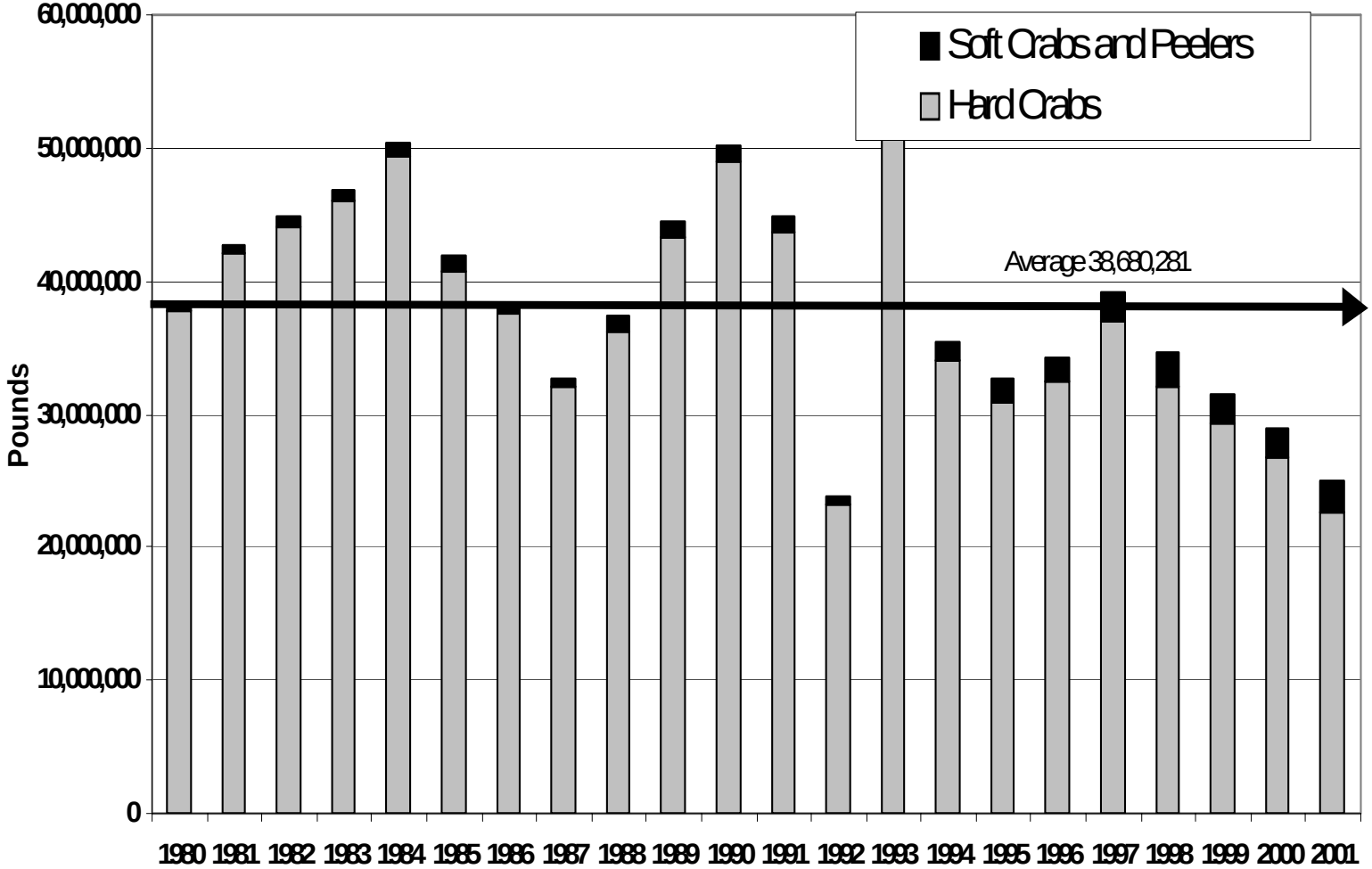

**Figure 7. North Carloina Commercial Blue Crab Landings 1980-2001**
**Personal communication from National Marine Fisheries Serrvice, Fisheries Statistics and Economics Division (11/1/03).**

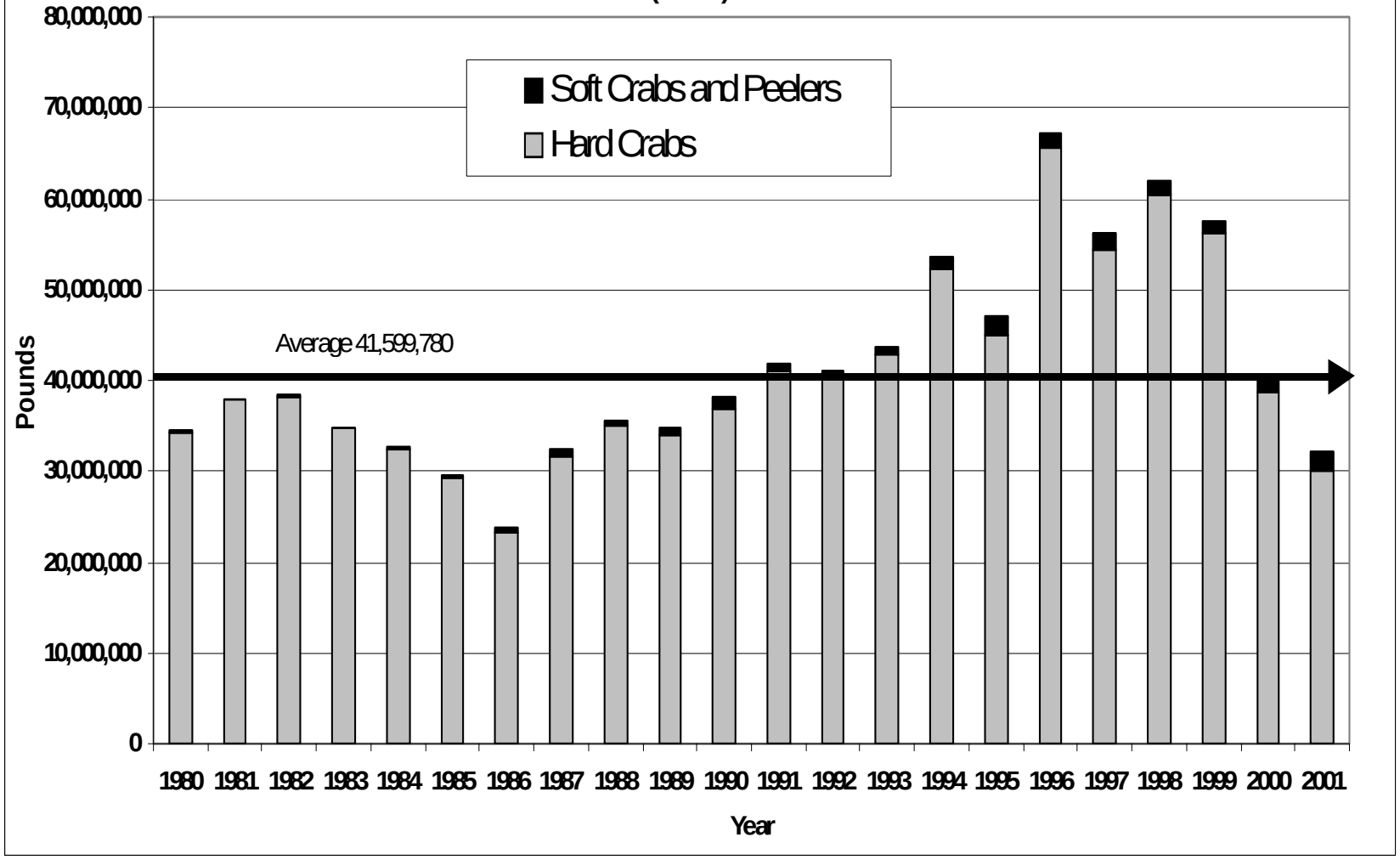

**Figure 8. South Carolina Commercial Blue Crab Landings 1980-2001.**
**Personal communication from National Marine Fisheries Service, Fisheries Statistics and Economics Division (11/1/03).**

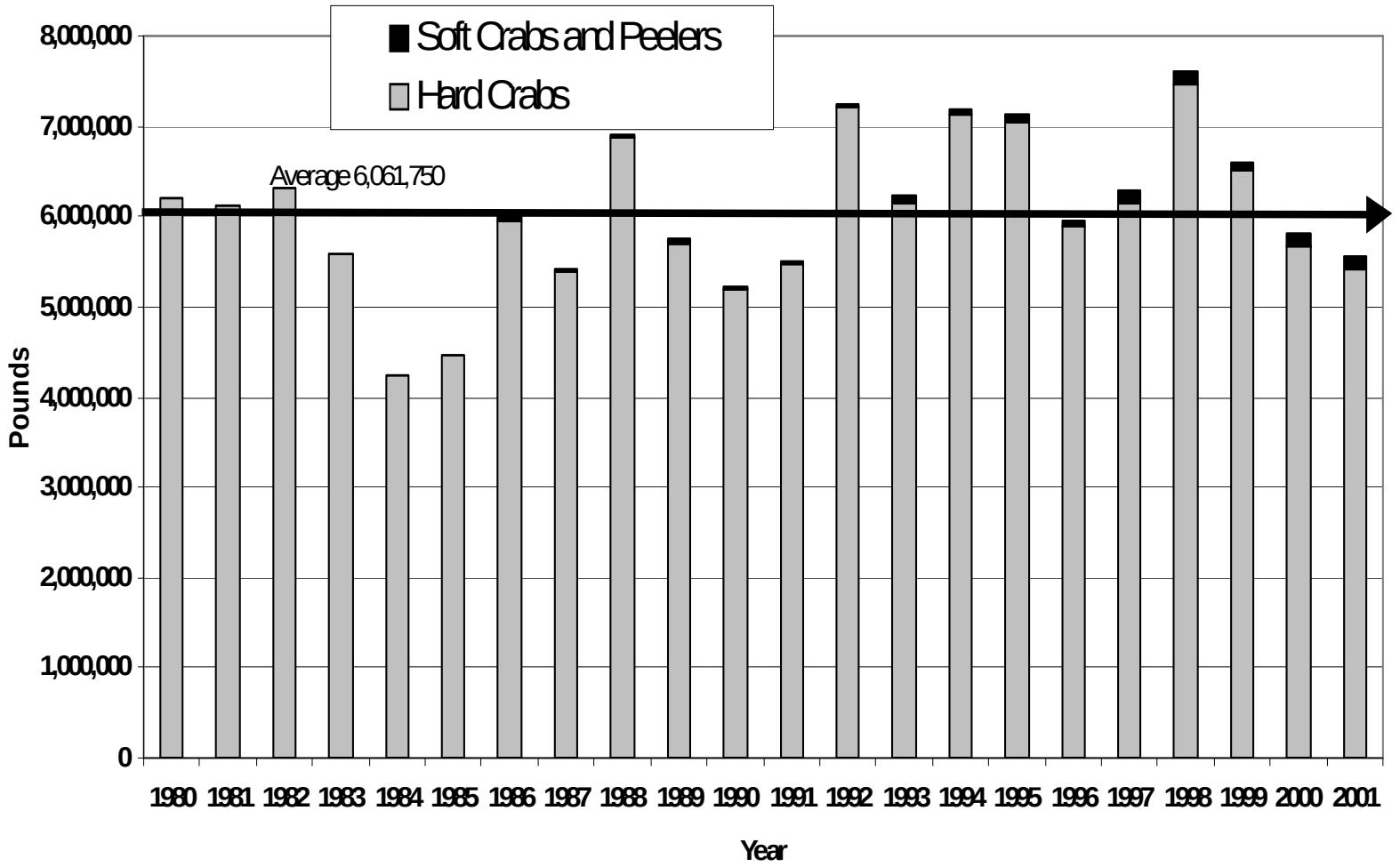

**Figure 9. Georgia Commercial Blue Crab Landings 1980-2001**
**Personal communication from National Marine Fisheries Serrvice, Fisheries Statistics and Economics Division (11/1/03).**

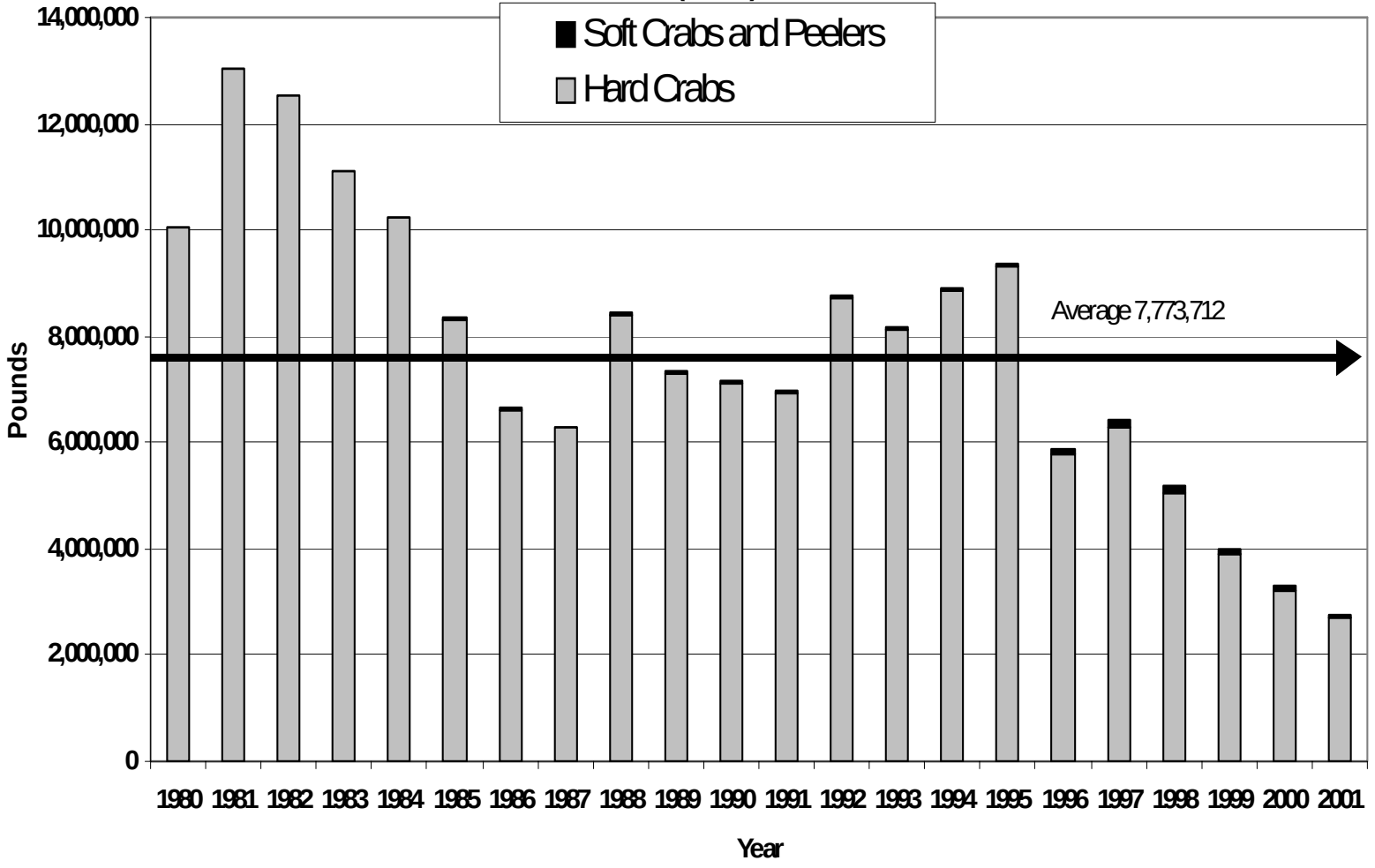

**Figure 10. Florida (E. Coast and Inland Lakes) Commercial Blue Crab Landings 1980-2001**
**Personal communication from National Marine Fisheries Serrvice, Fisheries Statistics and Economics Division (11/1/03).**

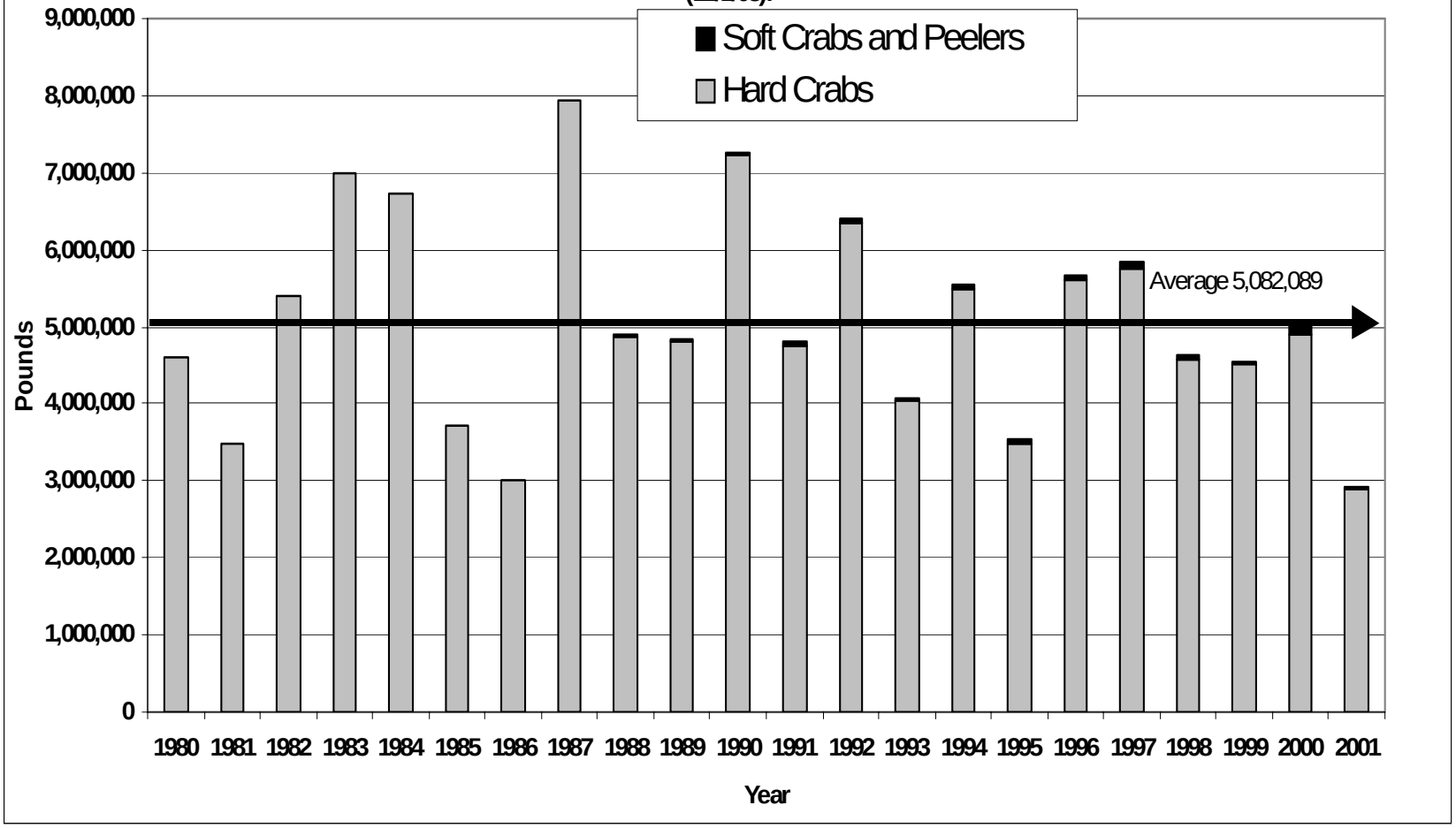

**Figure 11. Total CT-FL Atlantic Commercial Blue Crab Landings 1980-2001**
**Personal communication from National Marine Fisheries Serrvice, Fisheries Statistics and Economics Division (11/1/03).**