Blue Crab

The Resource

The blue crab, *Callinectes sapidus*, is an estuarine species common in the rivers and tidal creeks of coastal South Carolina (Figure 1). Blue crabs are estuarine dependent, utilizing the tidal creeks and marshes throughout most of their life cycle. Over much of their range, including the entire middle and south Atlantic and Gulf coasts, blue crabs support large commercial trap fisheries. Recently molted blue crabs, called softshell crabs, represent a substantial portion of the fishery in certain locations of the crab's range, but hard crabs make up the vast majority of landings.

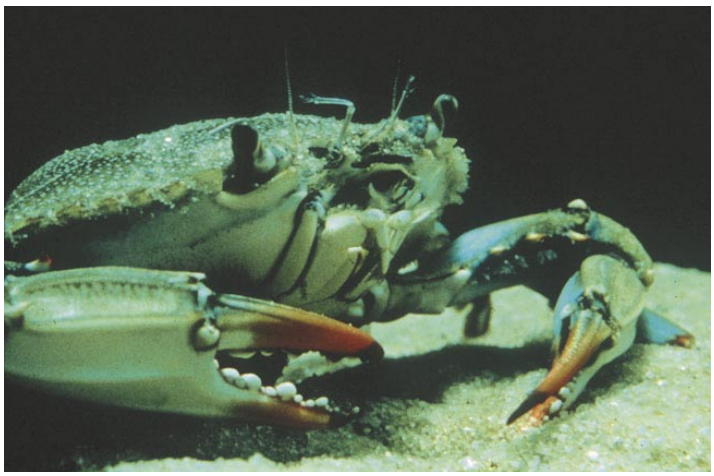


Figure 1. The blue crab, ***Callinectes sapidus****.*

Blue crabs are harvested commercially and recreationally in South Carolina, primarily using crab traps, or pots. Blue crab is one of the primary commercial species statewide, accounting for approximately 10% of the total value of all commercial landings. An average of 6 million pounds are landed each year with an overall value of $3-4 million, depending on market prices. Commercially, blue crabs are also harvested by trawling and as bycatch in the shrimp trawl fishery. Recreational fishermen can use several harvest methods besides crab pots, such as dip nets, drop nets, collapsible baskets, and baited lines.

A small portion of the blue crab fishery in South Carolina targets softshell crabs. Softshell crabs are those which have recently molted and whose shell is still soft. These crabs are sought after by seafood lovers and typically earn fishers a substantially higher price than hard crabs. The shell of the blue crab is only soft for short periods. The outer hard shell of crabs cannot grow larger as the crab grows. Therefore, crabs periodically go through a "softshell" stage by shedding their outer hard shell. Prior to molting, a new shell develops underneath the old shell. It remains soft until the animal crawls out of its old shell. Over a period of a few hours, the premolt or peeler crab molts, and the underlying softshell hardens to become the familiar hard shell. Blue crabs are not attracted to bait during the premolt or peeler softshell stage; thus methods other than bait odor must be employed to attract them.

The status of the blue crab fishery is continuously monitored by the Marine Resources Division (MRD) of the SCDNR, using both fishery-dependent and fishery-independent methods. The goals of SCDNR's monitoring program are:

- To conduct resource monitoring activities and to interact with resource users, managers, and scientists in order to provide recommendations, advice, reports, and supportive data to properly manage the blue crab resource as a sustainable fishery.
- To analyze population trends, life history patterns, and interpret environmental effects on monitored blue crab populations.
- To collect commercial landings data on blue crab populations.

Habitat and Biology

Like many crustaceans, blue crabs have a complex life cycle and occupy several different habitats during their lifetime (Figure 2). Egg bearing females typically migrate to deeper water at the mouth of rivers and bays in order to release their larvae into oceanic currents. The larvae remain in the water column for 4-5 weeks while molting and growing through 7-8 larval molt stages. The final larval stage molts into a free-swimming "megalopa" or postlarva.

Blue crab are recruited as megalopae to estuaries of South Carolina primarily in late summer and early fall. They are transported shoreward by winds and tidal currents until they reach shallow vegetated estuaries where they metamorphose into the first benthic juvenile stage crab. These estuarine saltmarsh habitats serve as the primary nursery grounds for juvenile blue crabs in South Carolina. Follow-

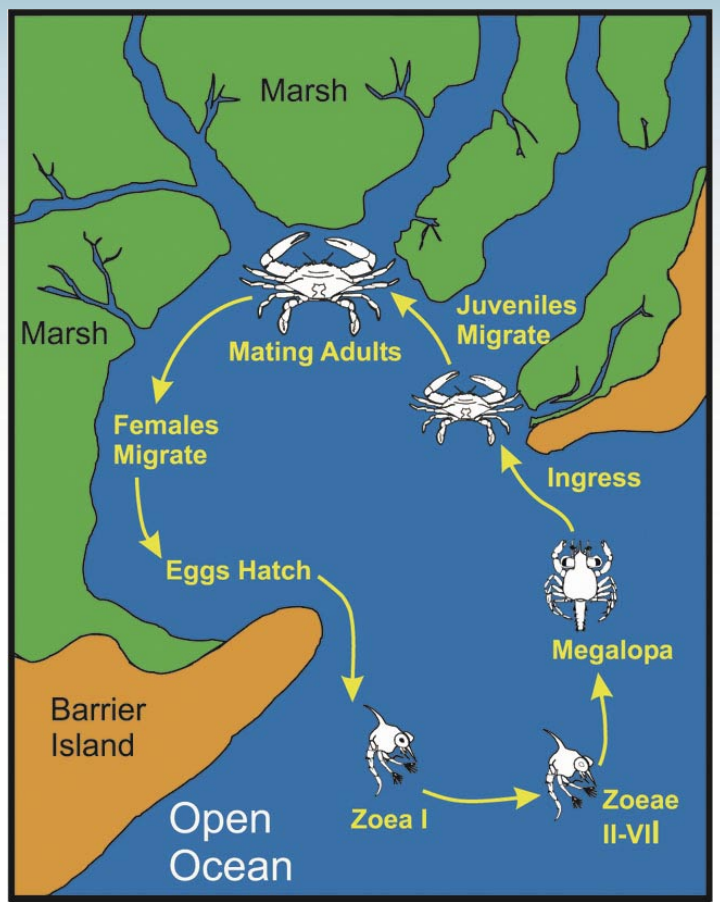


Figure 2. Blue crab life cycle in South Carolina includes several different aquatic habitats from salt marsh tidal creeks to open ocean waters.

ing settlement and molting to the first crab stage, blue crab occupy a variety of estuarine habitats including tidal creeks, marsh rivulets and oyster shell banks. Generally, juveniles and subadults occupy the mid to upper reaches of estuaries. Winter and fall peaks in juvenile blue crab abundance have been reported for coastal South Carolina. Previous studies found that the greatest abundance of juveniles occurred during January and September in the Charleston Harbor system. This winter cohort of juveniles most likely results from a late summer spawn of larvae.

Growth is rapid in estuarine nursery areas, with blue crabs reaching maturity and the five-inch legal harvest size in one to two years. In South Carolina, the mating season extends from February to November. Spawning peaks occur from March to July. Mating takes place in waters of low to moderate salinity. After an elaborate courtship ritual a few days before mating, a male pairs with a female that is about to shed her shell for the last time (pubertal molt). He cradles her and carries her until she molts. Mating takes place while the female is still soft. Sperm that is transferred from the male is stored in receptacles on the female's body and used to fertilize her eggs throughout the following year or two.

After mating, the male continues to carry and protect the female until her shell hardens. Spawning occurs during late spring and summer near inlets and in nearshore ocean waters. As the eggs are extruded, they are fertilized and attached to pleopods, located on the female's abdomen. The female crab carries the eggs under her abdomen in an external mass called a "sponge" until they hatch. Egg-bearing females have been collected in Charleston Harbor from April through October, with a peak in July. Blue crab larvae feed primarily on coastal zooplankton, whereas adults are opportunistic, feeding on fish, other crustaceans (including blue crabs), mollusks and decaying plant and animal matter.

In addition to movements related to the crab's life cycle, weather conditions are known to affect the distribution of crabs. If water conditions become too warm or too cold, crabs move to more favorable areas. Typically, cold water forces crabs, especially mature females, to deep water where they bury themselves in the sediment and become inactive. Crabs have also been known to leave shallow waters because of extreme heat on both a daily and a seasonal basis.

Sampling Methods

Fishery Dependent

The MRD has collected mandatory monthly reports from all licensed wholesale dealers since the late 1970's. These reports provide summary landings for commercial species with some voluntary information on area fished, gear and price included by some dealers.

Beginning in September 2003, the MRD launched a mandatory trip ticket program for all licensed wholesale dealers that not only collects catch but also associated effort. Dealers are now required to complete a ticket for each transaction with a commercial fisherman that details area fished, type and amount of gear fished, hours that gear was deployed, vessel identification, catch and price for each of the fisheries in South Carolina. Tickets are submitted on a monthly basis for the shrimp, crab, inshore finfish, offshore finfish, and shellfish (oyster & clam) fisheries.

Fishery Independent

The SCDNR uses two methods to monitor populations of blue crab. These include sampling with an otter trawl and deploying sets of crab pots. The data have been used historically to respond to issues concerning population conditions of blue crab. The trawl survey include trawling from outboard boats at fixed locations in tidal creeks and by trawling with a larger research vessel at fixed locations in rivers,

sounds, and Charleston Harbor (Figure 3). Creek sampling is conducted during spring and summer, whereas the larger trawl sampling is conducted year round. Information collected by trawl provides size, growth, and abundance data on blue crab in estuarine areas throughout the state. Creek sampling data has proven useful to provide information on juvenile crabs in shallow creek nursery habitats. Crabs are counted, measured and sexed to better understand growth and population structure. Molt stage and maturity are determined for crabs greater than 3 inch carapace width.

Crab potting is another valuable phase of fishery independent monitoring. The data were recently incorporated into a mathematical stock assessment for blue crab in South Carolina. Blue crab are sampled using commercial crab pots bimonthly in the Ashley River, and twice during the fall in Winyah Bay, Bull's Bay, Dawho River, Ashepoo River, and Whale Branch (Figure 3). Three segments of the river are randomly selected out of five possible segments, and five pots are set in each segment. After 4-6 hours, pots are pulled and the crabs are tabulated by category: "Number 1" (≥ 6 inches) male, "Number 2" (≥ 5 inches, < 6 inches) males and females, and sublegal (< 5 inches) carapace widths. Legal sized crab are combined and weighed for each pot.

Equipment Used To Harvest Crabs

Virginian B. F. Lewis' first crab trap, patented in 1928, did not gain widespread popularity because it allegedly allowed crabs to escape too easily. However, his revised trap, patented in 1937, was a big success. During the 1950s, the use of pots (as crab traps came to be known) spread throughout the southeast and Gulf of Mexico fisheries. Prior to the use of traps, blue crabs in South Carolina were caught using trot lines. In general, crab traps consist of a cube of wire mesh with two or four funnel-shaped openings on opposite sides, a bait well located in the center, and a horizontal divider with openings leading to an upper chamber (Figure 4). A horizontal partition bearing two holes separates the trap into an upper and lower chamber. Crabs are attracted into the lower chamber and, once confined, try to escape by swimming upwards. This response causes them to move into the upper chamber, decreasing their chances of escape. Recent innovations include the use of plastic covered wire mesh to retard corrosion, the addition of an iron reinforcing bar at the bottom for stability, and the alternative use of four-funnel traps preferred by some fishermen. Pots are set with floats and lines, and they are fished all year round in estuaries along the coast. Currently, pot fishermen collect the majority of crabs landed on the Atlantic and Gulf coasts.

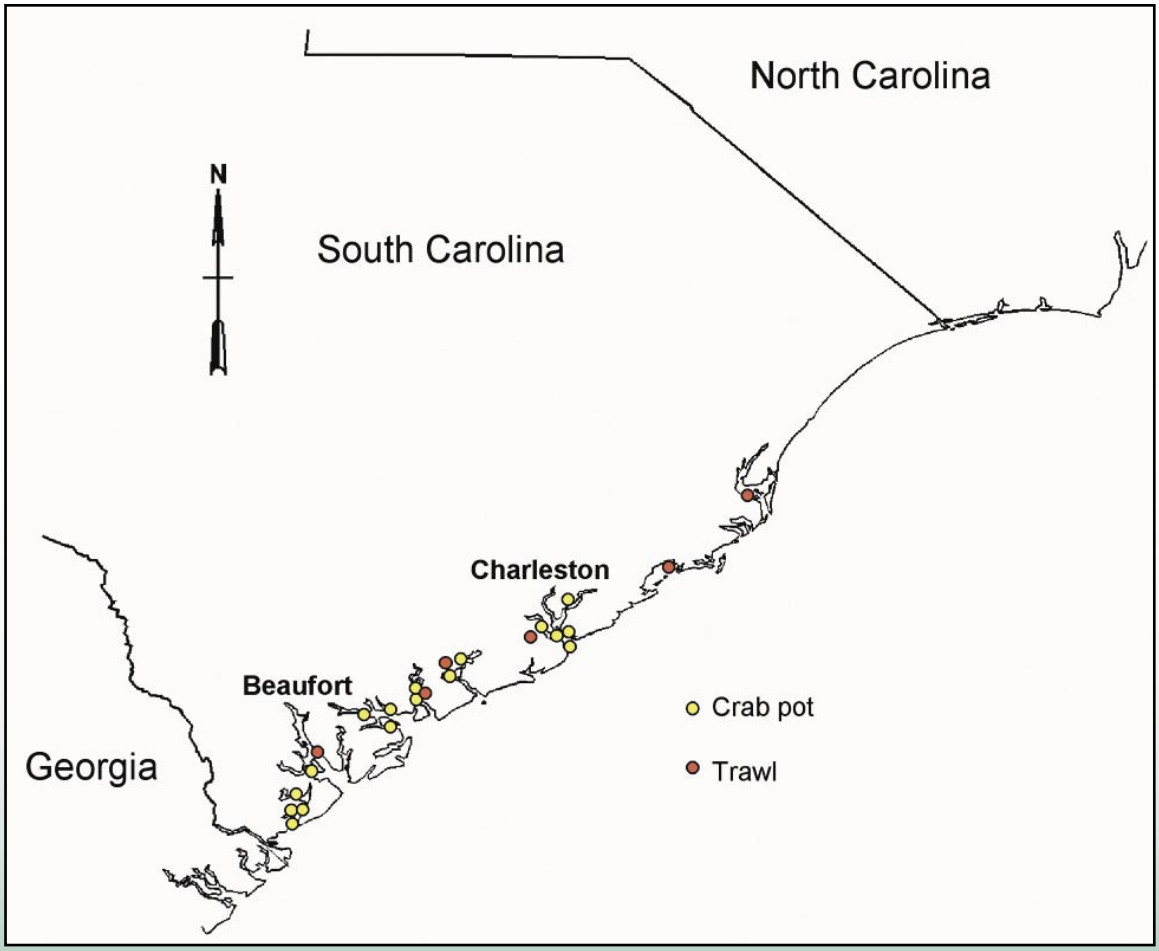


Figure 3. Stations sampled along the SC coast for blue crab.

Figure 4. Commercial hard crab pot used in South Carolina blue crab fishery.

The use of trawl nets pulled by medium-sized boats is another method of harvesting blue crabs. In South Carolina, the crab trawling season may extend from December through March. This is the second most productive method for the commercial harvest of blue crabs, and in some years constitutes an important part of the winter catch in the southern part of the state. Some of the state's blue crab harvest is incidental to the shrimp trawl fishery. Crabs caught in this fashion sometimes have sand grains forced into joints in the legs and claws, and may command lower prices than pot-caught crabs.

Findings

Fishery Dependent Harvest

Hard Crab Fishery

Blue crab landings have historically been the most stable of all the state's commercial fisheries, with long-term landings averaging at about 6 million lbs (Figure 5). In 2002, landings of blue crab in South Carolina were exceptionally low. When compared with the 11-year average, 2002 landings were well below the long-term average for every month except two (Figure 6).

The value of the fishery nationwide has averaged about $180 million (based on an average price of $30 per bushel). Licenses in SC have fluctuated in accordance with prices and crab availability. The lowest number of licenses occurred in mid 1980's, reflecting low price and catch. The rise in 1994 and 1995 was a result of fishermen buying multiple licenses in anticipation of potential law changes involving limited entry. Since 1997, licenses have remained fairly stable with a slight increase in 2000-2001 (Figure 5).

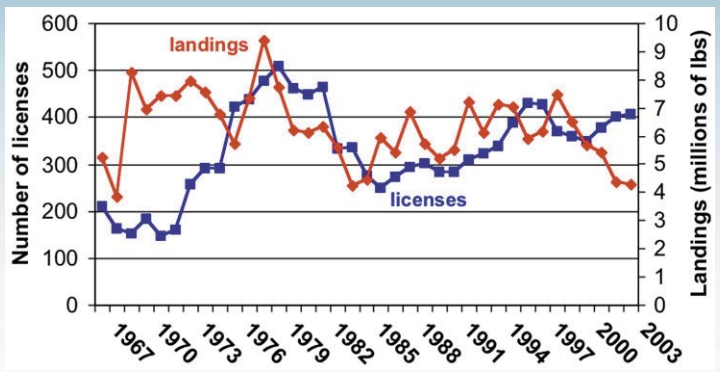


Figure 5. Hard Blue Crab Landings and Licenses in SC.

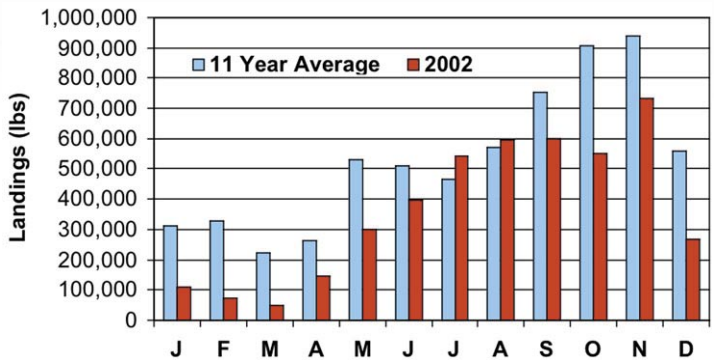


Figure 6. Comparison of 2002 landings of blue crab with previous 11-Year average.

Since 1996-97, a requirement of the license has been to document how many pots each crabber licenses. There has been a major increase in the last couple of years indicating that there are more pots being fished (Figure 7); however, historical effort data remains only an estimate since crabbers have not been required to report the actual number of pots fished. A new reporting system initiated in September 2003 will begin providing actual numbers of pots fished daily. Preliminary data suggest that about 1/3 of the pots licensed are actually fished.

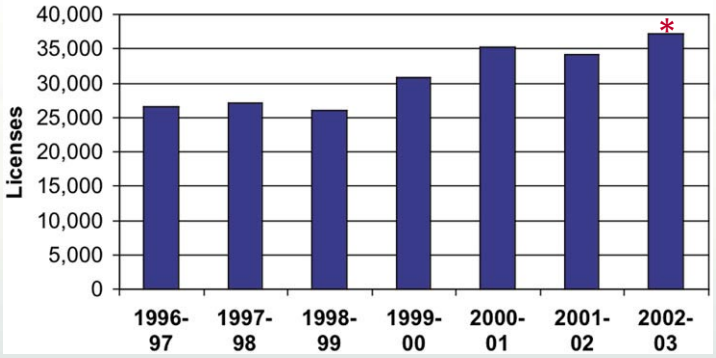


Figure 7. Total number of licensed crab pots in the commercial fishery (indicates data valid through April 2003).*

Commercial landings of exploited species are well known to vary substantially on an annual basis. The variations are often attributed to a variety of climatic conditions such as rainfall and temperature as well as the impacts of human activities including fishing pressure. In the past decade, advanced computer systems and time series models have allowed SCDNR staff to be able to predict blue crab landings 6-18 months into the future with 93-95% accuracy (Figure 8).

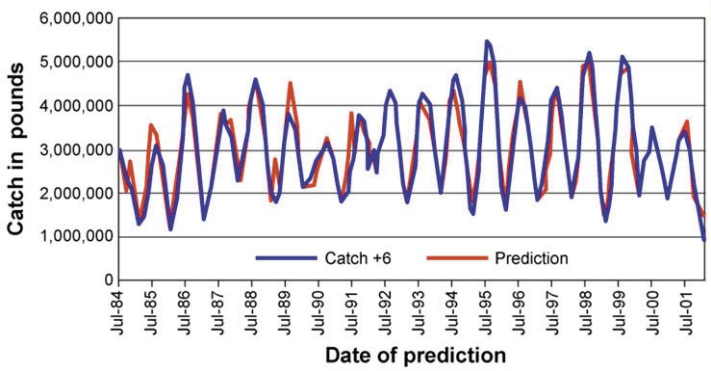


Figure 8. Prediction of crab catch 6 months into the future.

Softshell Crab Fishery

The softshell crab industry of South Carolina remains under-exploited, but it is of significant economic value to certain operators (Figure 9). Softshell crab is a popular menu item and because of the difficulty in collecting crab in the softshell stage and its popularity, command higher prices.

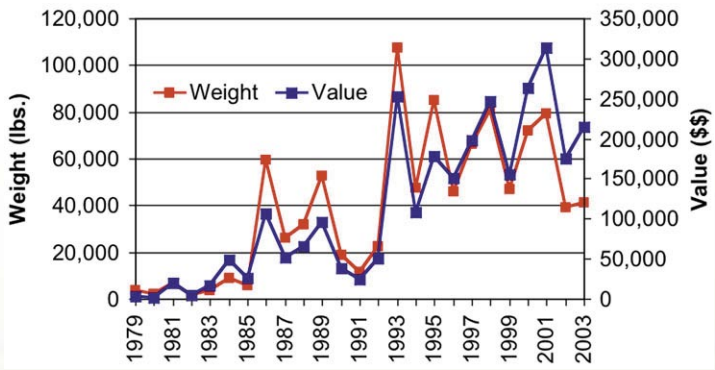


Figure 9. Weight and value of SC peeler crab landings.

Prior to 1975, capture of pre-molt crabs was largely an incidental catch in the hard crab fishery in South Carolina. It constitutes about 5% of the blue crab fishery or less. This fishery has expanded in the last 20 years and the value appears to be increasing over time.

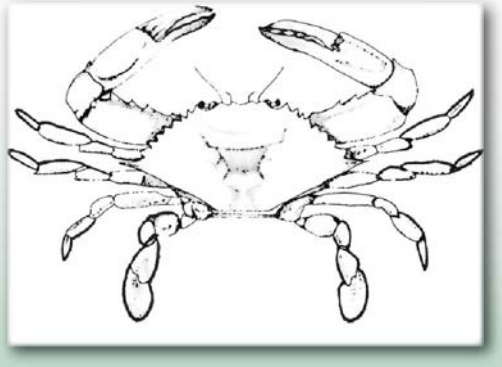
Crabbers separate the peelers, which are largely females, from the rest of their catch and sell them to dealers who keep them in tanks until they have molted. In South Carolina, it is legal to harvest and process softshell crabs measuring less than 5 inches. A permit is required for any individual harvesting, processing, or transporting them.

Certain types of gear are now used to exploit aspects of the crabs' pre-molt behavior. Pots that are baited with mature male crabs attract pubertal-molt females. Habitat traps that offer shelter during the softshell stage have also proven effective. Occurrence of pre-molt crabs may be related to water temperature and lunar phase. Peak capture of soft-shell crab in South Carolina is typically in April and May, with a secondary peak in late September and early October.

Recreational Fishery

Recreational capture of the blue crab is a popular activity along the coast of SC. Fishing for blue crabs can occur year-round, although activity appears to be most intensive during the warmer months (April through November). Crabs may be caught from shore, bridges, piers or boats. Baited hand lines, dip nets, drop nets, and baited crab traps are popular gear used in the recreational fishery. If crab traps are used, no more than two pots per person may be fished without a commercial license. There is no catch limit, but all blue crab retained must meet the minimum legal size of 5 inches, and egg-bearing females must be returned to the water unharmed.

In 1997, a survey of recreational blue crabbing by marine recreational fisheries stamp holders was conducted by the MRD. This survey indicated that 27.4% of the respondents participated in recreational crabbing. Fifty-seven percent of recreational crabbing took place from shore, with crabbing from docks being most popular. Crab pots and handlines were the most popular gear type. The average catch rate for shore crabbers was found to be lower than that indicated by boaters, while the number of trips was greater for the shore crabbers. Recreational crabbers account for approximately 25% of the total crab landings in South Carolina, according to the survey.



Fishery Independent Monitoring

Trawl Survey

Data from SCDNR's long-term trawl survey indicate that annual mean number of blue crabs per tow has been highly variable over time (Figure 10). Exceptionally good catches were experienced through the mid 1990's. However, declines in catches have occurred from 1997 through 2000. In 2002, the worst catches since the survey began occurred (Figure 10). The reasons for these boom and bust years are not well understood, but we suspect that optimum environmental conditions coupled with good spawning success are important in determining size of blue crab stocks. For example, 1995 was a wet year with good conditions for small crabs. Catches of blue crab were very good in the following year (1996). Although 2001 was a good year for blue crab overall, most of the crabs were caught in the first half of the year with catches declining dramatically after July. Unprecedented drought conditions in 2002 appeared to shift the distribution of blue crab up river where freshwater conditions would be found during normal rainfall conditions.

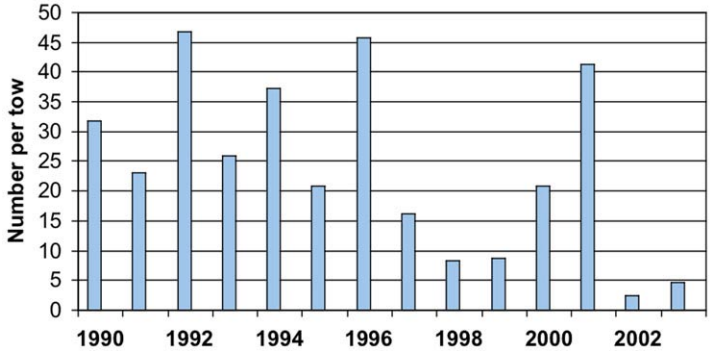


Figure 10. Number of blue crab per tow by 20′ trawl gear in SC.

Compared to the long-term average, our fishery independent data for 2002-03 were below average (Figure 11). For a few months, the 2003 catch per tow exceeded that of 2002, but from August-October, numbers have been very low. During these months, it was warm and fairly dry. In November and December, catches improved a bit with colder temperatures, but catches in our trawl survey are still below the long-term average for adults. However, catch rates of juveniles in January – April 2004 show considerable improvement (above the ten-year mean) suggesting that recruitment to the fishery for summer and fall 2004 should be much improved, despite relatively poor catch rates of spawners in summer 2003.

Trawl data collected in winter and early spring 2004 indicate that juvenile abundance appears to be improving despite several years of much below-average spawner abun-

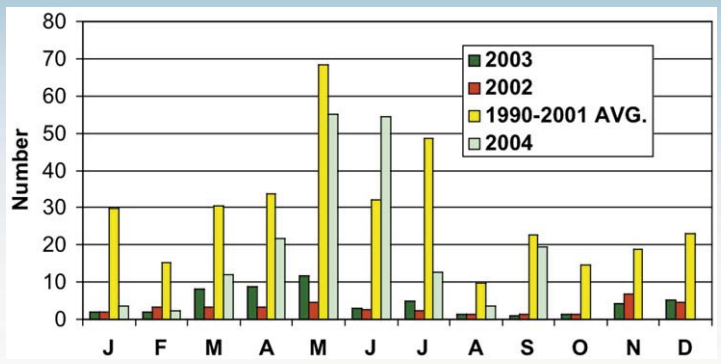


Figure 11. Number of blue crab per 20′ trawl tow by month.

dance. The increased rainfall of fall 2003 probably resulted in good survivorship of the newly recruited larval crabs and helped offset the apparent below-average spawn of summer 2003. Had the drought continued into fall 2003 on the heels of a very poor spawn, the recovery of the stocks could have be set back considerably. As of April 2004, it appears that there could be reasonably good recruitment to the fishery in late summer and fall 2004.

Spawning stock abundance is important as an early indicator of year class strength and fall harvest. When the index of annual sponge crab abundance from the trawl survey is examined over time, there is a general downward trend, especially in recent years (Figure 12). The number of egg bearing females has been extremely low especially in 2002.

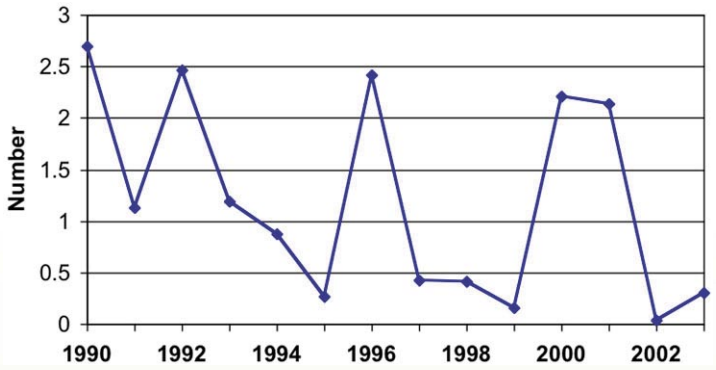


Figure 12. Number of egg-bearing female blue crabs per 20′ trawl tow from January-October.

Another important indicator of year class strength is the abundance of mature females. Based on data from the fishery independent trawl survey, we found that the number of mature females in our survey has experienced a large decline since 1997 (Figure 13). Catches were particularly low in 2002, and no crabs were collected in June or early July, when mature females can be abundant.

Sampling with small trawl in the creeks around Charleston yielded fewer blue crab in 2003 than in 2002 (Figure 14).

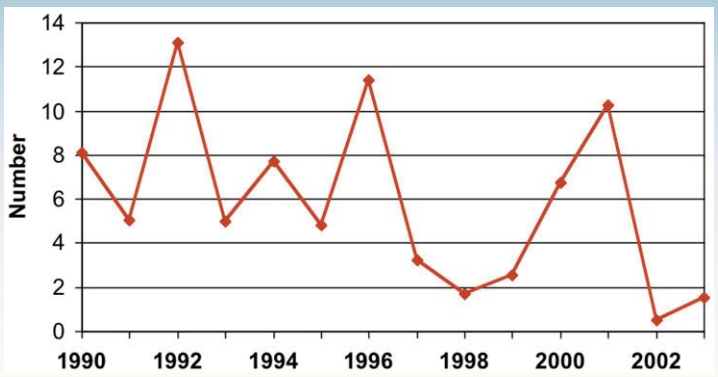


Figure 13. Number of mature female blue crab per 20′ trawl tow from January-December.

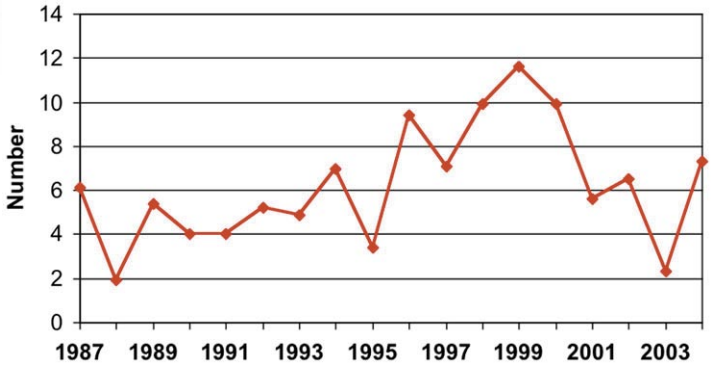


Figure 14. Number of blue crab per tow in trawls made in tidal creeks from May-August.

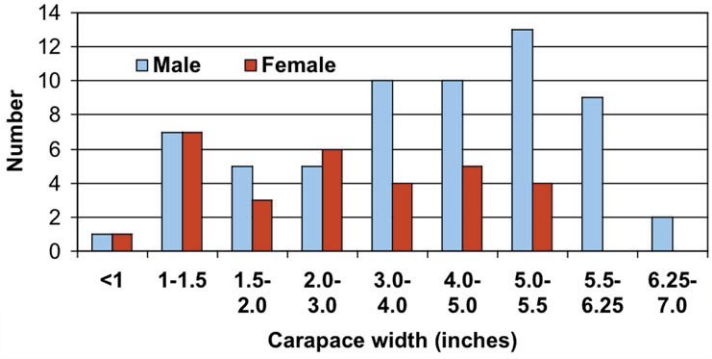


Figure 15. Size of male and female blue crab collected by trawl in tidal creeks.

Catches in the creeks were dominated by male crabs for almost every size class (Figure 15), typical for these areas. In addition, crabs of either sex were generally less numerous in size classes < 3 inches.

The number of small crabs (< 3 inches) also can be used to make predictions about future landings. By using a statistical relationship between the number of small blue crab (< 3 inches) per tow in December and the commercial landings the following year, SCDNR staff have found that the predicted landings for 2004 will be similar to 2000 but still somewhat below the long-term average of 6 million lbs. (Table 1). These combined small and large trawl data suggest that the stocks are still below average and have not fully recovered.

Another fishery independent survey, the Southeast Area Monitoring and Assessment Program (SEAMAP), provides data from the nearshore coastal zone (15-30 ft.) of the South Atlantic Bight. Collections are made by paired 75 foot trawl nets (without TEDS) between Cape Hatteras, North Carolina and Cape Canaveral, Florida. Stations are randomly selected from a pool of trawlable stations within 24 general locations, delineated by the 13 foot depth contour inshore and the 33 foot depth contour offshore.

SEAMAP cruises provide information primarily on the number of mature and egg-bearing females. Males are infrequently collected (<3% of total). The greatest number of egg bearing females is collected in spring, while summer collections generally capture more mature females. Although catches of blue crab are highly variable in SEAMAP collections, the number of blue crab collected off South Carolina in spring and summer has declined significantly over time. Overall density of blue crab peaked in 1999, followed by several years of low abundance.

Table 1. Prediction of landings based on number of small crab caught the previous year in December. The model explains 75% of the variation in landings.

Year	Small Crabs	Landings
1993	9.7	
1994	22.8	7,136,173
1995	8.4	7,044,123
1996	7.2	5,882,133
1997	8.1	6,151,428
1998	4.6	7,460,673
1999	2.5	6,520,561
2000	4.3	5,670,010
2001	0.3	5,430,244
2002	0.74	4,361,888
2003	2.7	4,331,683
2004		5,656,284 Predicted

Crab Pot Survey

Catches in the fall crab pot survey have declined overtime. Catches were especially low over the last three years, with 2001 catches being the lowest since the survey began. CPUE for 2003 has been only slightly better than that for 2002 (Figure 16). When catches are examined by size, we found that the number of legal (>5 inches) crabs have declined since 2000 while sublegal crabs have declined since 2001 (Figure 17). The long-term average for legal crabs in the fall crab pot survey is 3.4 crabs per pot while the average of sublegal crabs is 1.5 crabs per pot. Catches have lagged behind the long-term average for the past several years with no. 1 and no. 2 males. The number of legal female crabs compares well with the average, as does the number of sublegal males and females (Table 2).

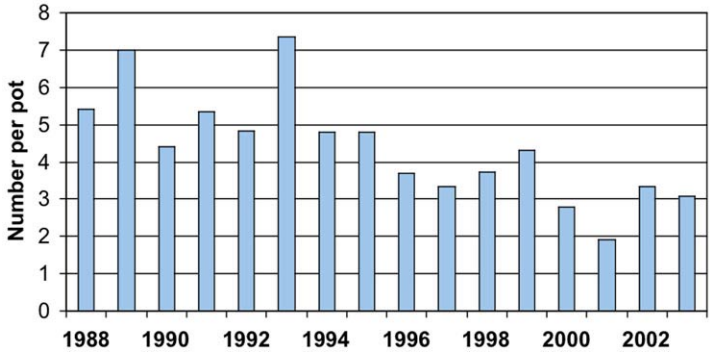


Figure 16. Number of blue crab per pot in fall survey.

Management

The blue crab fishery provides substantial economic benefits to South Carolina, and it must be effectively managed. The agency responsible for this task is the Marine Resources Division of the South Carolina Department of Natural Resources. In South Carolina, it is illegal to take blue crabs whose shell measures less than five inches from tip to tip except for softshell crabs. Pots may only be fished during the day. Under-sized crabs must be returned to the water alive and in good condition. Females with external egg masses cannot be harvested. Other states allow the harvest of females with egg masses and crabs that are less than five inches. These crabs may be imported into South Carolina and processed, provided a permit for this activity has been obtained. Additional details on the regulations of the blue crab fishery can be found in the Code of Laws for SC Marine Fisheries.

Trawling for blue crabs is not allowed during spring months when females migrate to nearshore areas to spawn. This restriction eliminates any conflict with the white shrimp

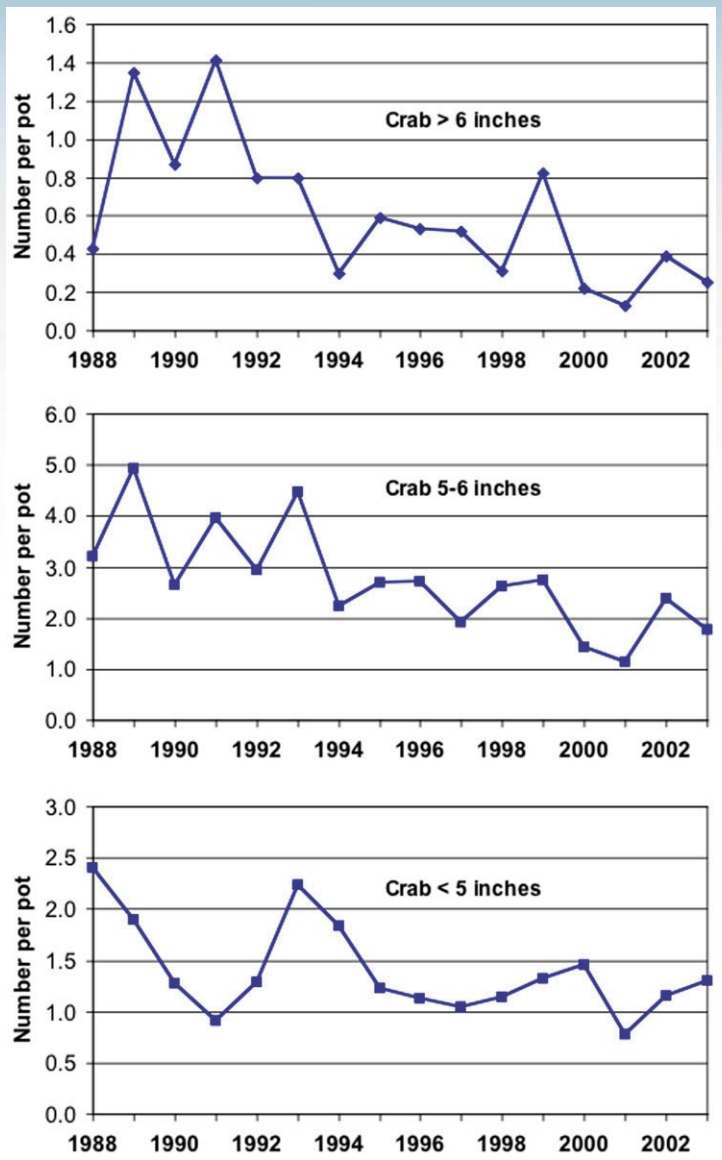


Figure 17. Number of crabs per pot by size in the fall survey. Crabs that are > 6 inches are graded number 1, while crabs that are 5 to 6 inches are number 2's and sublegals are less than 5 inches.

fishery during that time. For trawl harvesting of blue crabs, a fisherman must have a trawling vessel license, a trawler captain's license, and a crab trawl permit (except during open shrimp trawling season).

To catch crabs commercially, a fisherman using three or more traps needs a crabber's license, as well as one for his boat and one for the sale of his catch. For recreational purposes, a person may utilize two traps without the need for a license. As of 1997, it is mandatory that all commercial traps be equipped with escape rings between June 1 and March 14 to allow small crabs to leave the trap. This is to prevent the wasteful killing or injury of animals that have not yet had a chance to reach sexual maturity and reproduce.

Table 2. Number of blue crab per pot in the fall crab pot survey. Crabs that are > 6 inches are graded number 1, while crabs that are 5 to 6 inches are number 2's and sublegals are less than 5 inches.

Year	No. 1's	No. 2 M	No. 2 F	Total Legal	Sublegal M	Sublegal F	Total Sublegal
1988	0.45	1.6	1.3	3.35	1.4	1.1	2.5
1989	1.4	4.2	0.8	6.4	1.6	0.4	2
1990	0.8	2.2	0.5	3.5	1.3	0.4	1.7
1991	1.1	2.8	1.4	5.3	0.76	0.4	1.16
1992	0.8	2.24	0.9	3.94	1.3	0.4	1.7
1993	0.9	3.2	1.45	5.55	2	0.7	2.7
1994	0.35	1.7	0.8	2.85	1.6	0.7	2.3
1995	0.6	2.2	1	3.8	1.1	0.5	1.6
1996	0.5	1.6	1	3.1	0.7	0.4	1.1
1997	0.65	1.55	0.6	2.8	0.8	0.4	1.2
1998	0.31	1.04	1.56	2.91	0.55	0.58	1.13
1999	0.73	2.1	0.94	3.77	1	0.27	1.27
2000	0.2	0.8	0.6	1.6	0.8	0.6	1.4
2001	0.13	0.34	0.81	1.28	0.25	0.52	0.77
2002	0.40	1.20	1.10	2.60	0.70	0.33	1.03
2003	0.25	0.80	0.98	2.03	0.80	0.50	1.3
AVG.	0.64	1.85	0.98	3.42	1.04	0.51	1.55

Issues within the commercial pot fishery include competition over fishing grounds, conflict with other boaters, including shrimp baiters, for space in navigable waters, and intensive potting near private docks. In recent years of drought, crowding of crab pots up to the legal fishing line became a major issue, resulting in pot lines being cut in several areas. Ghost fishing by discarded, cut or lost crab pots is an issue that needs to be resolved. A continuing problem that has plagued commercial crabbers, however, is theft of their catch or their traps. For this reason, the trap fishery has required the attention of law enforcement officials.

A stock assessment done in 2000 indicated that the combination of an annually variable yet relatively constant population size, with increasing landings and increasing fishing mortality over time, suggest that there may also be a trend towards growth overfishing of blue crab. This means that crabbers are harvesting crabs earlier in the recruitment year and catching them at a smaller size and lesser weight. Maximum sustained yield (MSY) was estimated at 6.8 million pounds at an effort level of 500 licenses. While effort has not exceeded MSY, the landings have. This suggests that the fishery may be overcapitalized. Even when there are more people and equipment in the fishery than the fishery can support, fishermen will continue to harvest crabs if the price of crabs remains relatively high.

Concern has also been expressed that targeting of peeler crabs may threaten the hard crab fishery by removing small crabs before they reproduce. Another issue is the targeting of mature females, a high percentage of which are impregnated and, when harvested, are thus removed from the spawning population before they can reproduce.

Each state where the blue crab occurs has its own harvest practices and legislative initiatives. Clearly, laws and regulations are needed to promote the wise use of the resource and to protect it from practices that might lead to its endangerment. In the last few years as harvests have declined, scientists, crabbers, managers, and environmentalists have been working on recommendations for management of the blue crab in SC. With respect to the recent downturn in landings in SC, special committees have been formed to discuss regulatory issues including licensing, quotas, seasons, gear restrictions, fines, as well as size and sex limits. These committees have been very helpful in achieving a mutual understanding of the issues and experiences of all parties concerned in reaching agreement on management policies for the blue crab fishery.

Threats to the Resource

Issues related to blue crabs have been recurrent over the last two years. Resource sustainability or overfishing of spawning stock has historically not been considered to be a serious problem in South Carolina. The concerns expressed by SCDNR biologists and fishermen in 2002 mark the first time that serious concerns about potential overfishing or inadequate spawning stock have arisen. Fluctuations in the blue crab population present a challenge in trying to understand the underlying reasons for such variability.

Economic Factors

Recently, the undependability of harvest levels, rising domestic production costs, significantly increased imports, and the high prices that USA consumers are willing to pay for crab meat have led to increased competition from overseas. This is becoming an economic threat to crabbers and domestic processors. Though historically only a few crab picking houses operated in South Carolina, only one or two have operated in recent years. The high cost of domestic labor needed to provide picked product has been prohibitive in the face of competition from foreign product.

Environmental Factors

A major threat to the future of blue crabs in South Carolina comes from the rapidly changing conditions in their estuarine habitats. We know that system productivity as well as the suitability of nursery habitat is important. Seasonal and annual variations of the geographical distribution of the various life history stages of the blue crab within a region reflect specific environmental characteristics required for reproduction, growth, and survival. The development and relative abundance of a successful year class of crabs can be negatively influenced by a variety of factors such as water pollution, benthic habitat destruction, prolonged drought and periodic tropical storms.

Broad scale meteorological factors within the Southeast such as changes in seawater temperature and salinity have the potential to cause significant decreases in the density of blue crabs. There is also evidence that wind- and tide-generated events that influence the transport of zoeae or megalopae out of or into the estuary are important determinants of year class strength. Having sufficient numbers of mature females and new recruits is very important in maintaining the population.

Lower than usual catches along the entire southeastern US may be related to unfavorable environmental conditions and continuing fishing pressure on an already stressed population. The following are some conditions and diseases that have been found to contribute to decreased viability of blue crab populations.

Drought: Drought conditions from 1998-2001 have been seen as a major factor for the decline of Georgia's blue crab population. The drought in Georgia and South Carolina had dramatic impacts on the salinity of the crab nursery and mating habitat. In many South Carolina estuaries, salinities were much higher than usual at or above the legal fishing line. High salinities had a number of possible effects: 1) contributing to an increase in the parasitic dinoflagellate, *Hematodinium perez* ; 2) pushing crabs out of historic, legal fishing grounds; 3) pushing crabs into unfavorable habitat; 4) possibly interfering with the natural reproduction process; 5) possibly interfering with larval development; and 6) affecting growth and health of marsh grass habitat.

Winter Mortality: Although generally less of a factor in southern states, some blue crab were reported dead in shallow areas in South Carolina during the cold temperatures encountered in 2001 and 2003. Cold temperatures are stressful, and are thought to be a factor in "grey" crab disease in the 1960s (infection by *Paramoeba*).

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. Most low oxygen conditions that occur in South Carolina estuaries are short-lived events and likely do not result in mortality of blue crab, except in impounded wetlands during summer.

Hurricanes: Flooding associated with hurricanes can cause massive relocation of crabs from up-estuary tributaries to central estuarine areas. Tropical storms that occur in South Carolina may crowd crabs into lower estuarine areas where they may be subject to intensified predation and more intense fishing pressure. Hurricane Hugo in 1989 resulted in the loss of many commercial crabbers' pots.

Disease: A protozoan has been reported to cause mortalities of blue crabs in South Carolina. Gray crab disease is caused by an amoeba and causes the viscera and tissues of infected crabs to turn gray in color. *Hematodinium perezi* is an unusual parasitic dinoflagellate that also occurs episodically. Outbreaks reported in some states have been much more severe than those occurring in South Carolina.

Conclusions

Blue crab population abundance fluctuates significantly from year to year or over a period of several years. The blue crab is characterized by production of large numbers of young, rapid growth, early attainment of sexual maturity, high mortality rates, and short life span. Such species may exhibit large year-to-year fluctuations in abundance because physical, chemical, and biological factors can strongly influence abundance. In addition, blue crabs populations are known to be cyclic -- five-year and longer cycles have been identified.

Based on fishery independent sampling, we have found no change in the life history of the blue crab. Mating and spawning are still occurring in association with salinities where they are likely to occur. Severe drought conditions through 2002 throughout the Southeast caused a shift in salinity regimes and the distribution of crabs. In 2002, this was reflected by relocation of blue crab, dominated by males, above the legal fishing line. The fishery independent data indicate an overall decline in the population, especially the spawning stock. Trawling efforts in 2004 indicate that the number of immature females and small crabs has increased, suggesting that fall 2004 catches may approach average if rainfall is adequate. Fishery dependent data indicate a decline in landings since 1997, although number of licenses has been relatively stable. If low spawning stock numbers are combined with poor recruitment, poor environmental conditions, and high fishing mortality rates, then it is almost a certainty that the population will decline. If declines persist for a number of years, it makes it harder for the population to rebound and most likely recruitment won't return to high levels without reductions in fishing and natural mortality along with enhanced environmental conditions.

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