State of South Carolina's Coastal Resources

Red drum

The Resource

The red drum, *Sciaenops ocellatus*, is one of the most highly prized inshore fishes by anglers in South Carolina. Depending on the time of year, fishes from 12 to 50 inches are available to the recreational community. This species is a gamefish in our state and can only be harvested by rod and reel and gig. The latter segment of the fishery is closed from December through February.

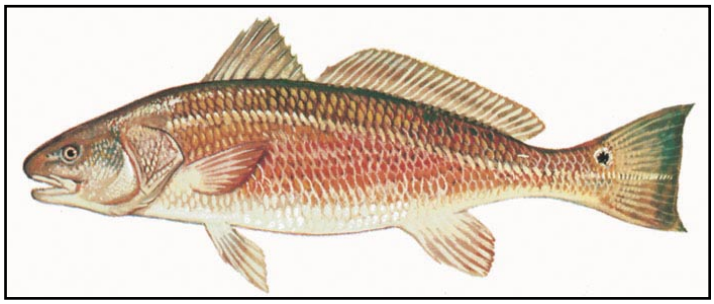

Figure 1. The red drum – an important recreational fish in coastal South Carolina.

Since designation as a gamefish in 1985, the regulations applied to the harvest of this species have been altered eight times by the legislature. The current creel limit of two (2) fish per angler per day and a 15 to 24 inch total length size limits should allow a sufficient number of juveniles and sub-adults to "escape", i.e., survive to maturity (ages 3 to 5) and join the spawning population in nearshore ocean waters.

Red drum are found in nearshore and estuarine waters from Delaware Bay south to southern Florida and throughout the northern Gulf of Mexico. Along the east coast of the United States, its geographical range is divided into two areas: North Carolina and north; South Carolina and south. These are the management units for this species in the Atlantic. In determining the condition of the red drum population along the east coast, the analyses are carried out for the fish in each of these areas.

The rationale for the subdivision into two units is that the northern group has long-range seasonal movements. A portion of the red drum that over-winter off the coast of North Carolina move north and inshore and enter the western part of Chesapeake Bay or along the barrier islands of the eastern shore of Virginia, i.e. Wreck Island, in spring.

The southern unit moves seasonally inshore-offshore with little movement in a north-south direction. Adults are found in nearshore waters from late March-early April through November. They are the fish inhabiting the ocean inlets, nearshore sand bars, and jetties. Divers have also seen them during the warmer months around the artificial reefs that are closest to the coast.

The known spawning locations red drum are near the mouths of inlets and inside the saltier sounds, such as St. Helena Sound in the deeper holes. Spawning occurs over a relatively brief period between late July and early September, with a peak in spawning activity in mid-August. The locations of spawning can be determined by using a hydrophone (an underwater listening device). Male red drum have a large swim bladder (air bladder) with muscles near it. When the muscles contract very rapidly, the fish makes its characteristic drumming sound. Females do not make this drumming sound. During the spawning season, mature male red drum gather at specific locations where they all produce drumming sounds. It is thought that the sounds attract females that are ready to spawn.

The fertilized eggs float and hatch in about 24 to 30 hours. The young larvae feed on microscopic animals in the water. The larvae are transported by tidal currents into the estuary where they arrive in shallow tidal creeks that cut through Spartina marshes. These creeks function as a nursery area, where young red drum feed on opossum shrimp and grass shrimp. As they grow, they feed on mud and fiddler crabs as well as some small fishes.

With the cooling of the creeks in late November and December, young red drum move from these areas and take up residence along the edges of the deeper channels as well as in deep holes inside the estuaries. In the spring, young fish move back into the tidal creeks where they have a wealth of food. From March to August, young red drum increase in size from 1 to 3 inches in total length to 8 to 10 inches. They then move from these creek systems to the larger rivers, creeks and main parts of the estuaries where they form schools of like sized fishes. These red drum are referred to as the subadults.

Subadult red drum remain in estuaries, around inlets and in the surf of ocean beaches for three to five years, at which time they become sexually mature. The adults have a

seasonal inshore-offshore movement (to inshore waters in spring – to offshore waters in fall) whereas the subadults over-winter inside the state's estuaries.

Tagging studies have shown very little movement of red drum between states – indeed, there is limited movement between estuaries. Less than 1% of all fish tagged and recaptured have moved from South Carolina to waters of adjacent states, and most fishes are recaptured with 5 nautical miles of where they were tagged and released.

Although red drum do not roam over wide areas of the coast, they do show limited tidal and seasonal movements. Subadults travel to the flooded marsh at high tide and leave as the tide ebbs. They remain in the shallows while the tide is out. As the tide floods, they begin their movement back onto the surface of the marsh.

When water temperatures are over 55ºF (13ºC), red drum actively feed on the surface of the flooded marsh. They can frequently be seen 'tailing' around high tide. These fishes are trying to root out fiddler crabs, (a major item in their diet) from their burrows. If the water is too cold for the crabs to be active and the red drum to feed, the fish still move with the tides.

During the late fall and winter, bottlenose dolphin are a major predator of subadults. In an attempt to avoid being eaten, the immature red drum stay in the shallows where the dolphin are unable to feed on them. The smaller subadults (13 – 15 inches total length) stay in among subtidal oyster reefs during low tide. They stay as near as possible to the reef. The dolphin will not prey upon them at low tide when the fish are on these shallow water reefs. As the tide floods, these fish also move onto the flooded marsh where the dolphin can not get to them.

Figure 2. A one or two year old red drum (~3 to 5 lbs) in the process of being eaten by a bottlenose dolphin (photo by Eric Zolman of the National Ocean Service, Charleston, SC).

One of the major problems in the management of the red drum fishery is that the harvest is largely confined to immature fish, the subadults. Prior to harvest restrictions, many anglers would catch large numbers of the 12 to 15 inch long fish during each trip. The number of small subadults harvested was considerable. This resulted in a low rate of survival and ultimately a small percentage of the fish attaining sexual maturity and moving into the spawning population.

The Fishery

In presenting the status and trends in the recreational fishery for red drum, Ithe information is organized according to what is considered to be a bass-year rather than a calendar year. A bass-year extends from the 1 of July to the end of the following June. In July, red drum that were spawned the previous year are available both to scientific sampling gears and the recreational fishery. The minimum size limit requires that fish less than 15 inches in total length be released. By partitioning the year in the manner described above, a yearclass can be traced as it progresses through the fishery.

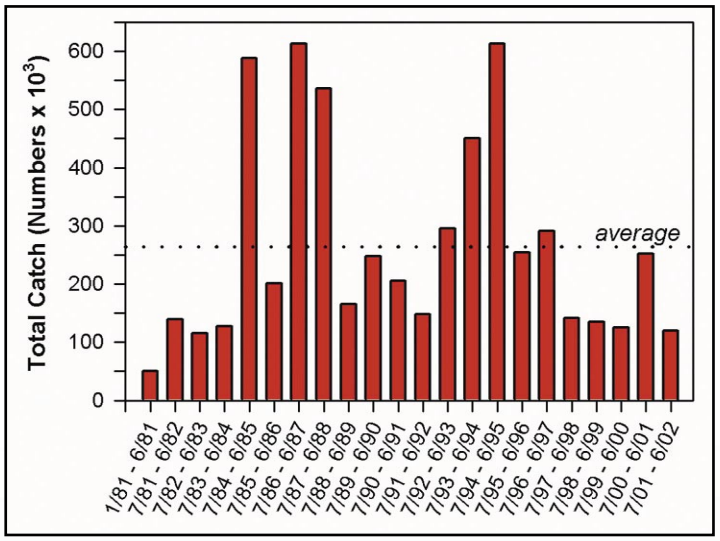

Figure 3. Total catch in number of fish for red drum in the recreational fishery in South Carolina by "bass year". Data are estimated from the MRFSS of the NMFS; dotted line is the estimated long-term average.

The total catch in numbers, as estimated by the Marine Recreational Fishery Statistical Survey (MRFSS) of the National Marine Fisheries Service (NMFS) for South Carolina, has fluctuated around a long-term mean of ~250,000 fish per year (Figure 3).

In recent years, the total catch was greatest in the period between July 1994 and June 1995. In the past 22 years, the estimated catch exceeded the average seven times. Since the recreational catch is largely based on fishes between

the ages of 1 and 2, its magnitude depends on the strength of the most recent yearclasses. If a large number of young are recruited to the nursery areas and there is good survival, that yearclass will be "strong" and the catch will be relatively high one to two years later.

With the advent of bag (creel) and size limits, there has been a gradual increase in the estimated number of red drum caught and released alive in the fishery. *Note: The MRFSS divides the total catch into three categories or types. Type A fish are those caught and landed; type B1 fish are those that are caught and either discarded dead, used as bait, or filleted; type B2 fish are those that are caught and released alive.* There has been a gradual trend over the years covered by the MRFSS from a very few individuals in the early 1980's to over 70% of the total catch being released in recent years (Figure 4). The trend seems to be leveling off between 70 and 80% of the total catch.

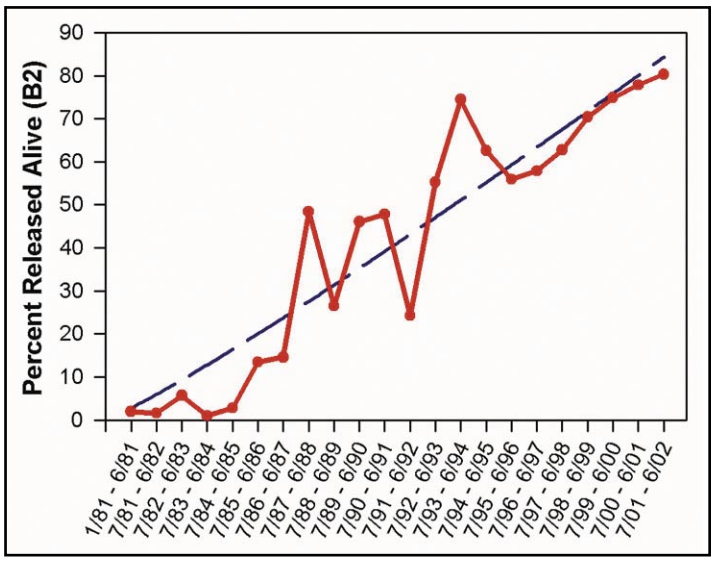

Figure 4. The percentage of red drum caught and released (B2 fish) in the recreational fishery in South Carolina. Dotted line is the long-term trend line. Note that in recent years the trend appears to be leveling off at ~70+%.

The sizes of the red drum in the harvest for the most recent years (July 1999 through June 2002) ranged from 11 to 27 inches total length (Figure 5). Approximately 5.5% of the catch was less than the minimum legal size of 14 inches TL. *Note: The legal minim size was 14 inches TL at that time; the present minimum legal size is 15 inches TL.*

Just slightly less than half of the harvest was between 14 and 17 inches in length. These fishes would be between 1and 2 years old.

Most red drum are caught by small boat anglers fishing in South Carolina's territorial sea during the late summer and early fall. At that time, some of the subadults spawned the previous year have attained the legal minimum size. Based on the MRFSS, there has been a gradual increase in the number of trips by anglers in the state (Figure 6).

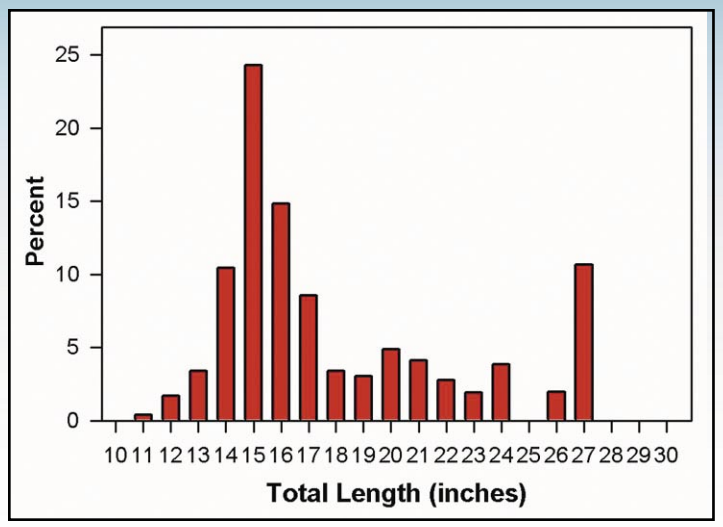

Figure 5. Length frequency of red drum in the recreational harvest as estimated by the MRFSS for 7/99 – 6/02.

The estimated number of trips by small boat anglers is not a perfect measurement of effort since in the survey, the target species was not listed. However, it is a reasonable proxy. Given the number of boats on the state's waters, as well as the increase in the coastal population, it is reasonable that the fishing effort has risen from ~ 200,000 trips annually in the early 1980's to ~800,000 trips in 2002.

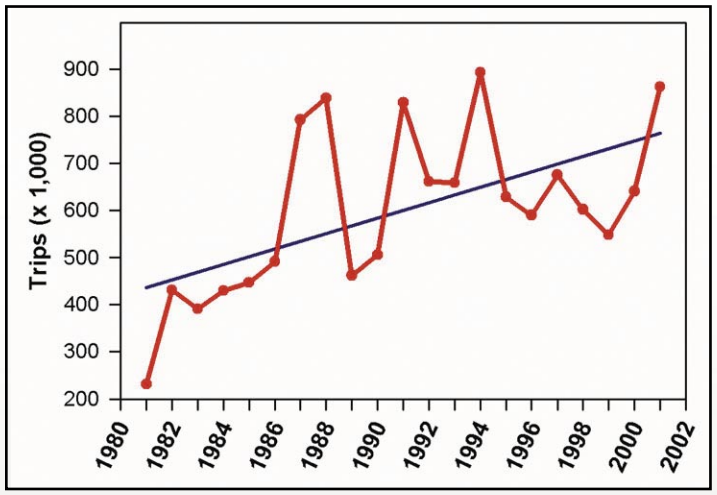

Figure 6. Effort as measured by the number of trips by anglers in small boats in South Carolina by calendar year. Solid line shows the long-term trend for the data. Source is the MRFSS.

Fishery Independent Data

Trammel Net Surveys

In 1991, staff of the Marine Resources Research Institute (MRRI) began a trammel net survey that has expanded to cover various estuaries along the coast from the ACE Basin to Winyah Bay. Each month, stations are selected randomly in each of the seven areas. Sampling begins at early-ebb tide during daylight hours and continues until low tide. The goal is to obtain from 12 to 14 net sets in each of these areas.

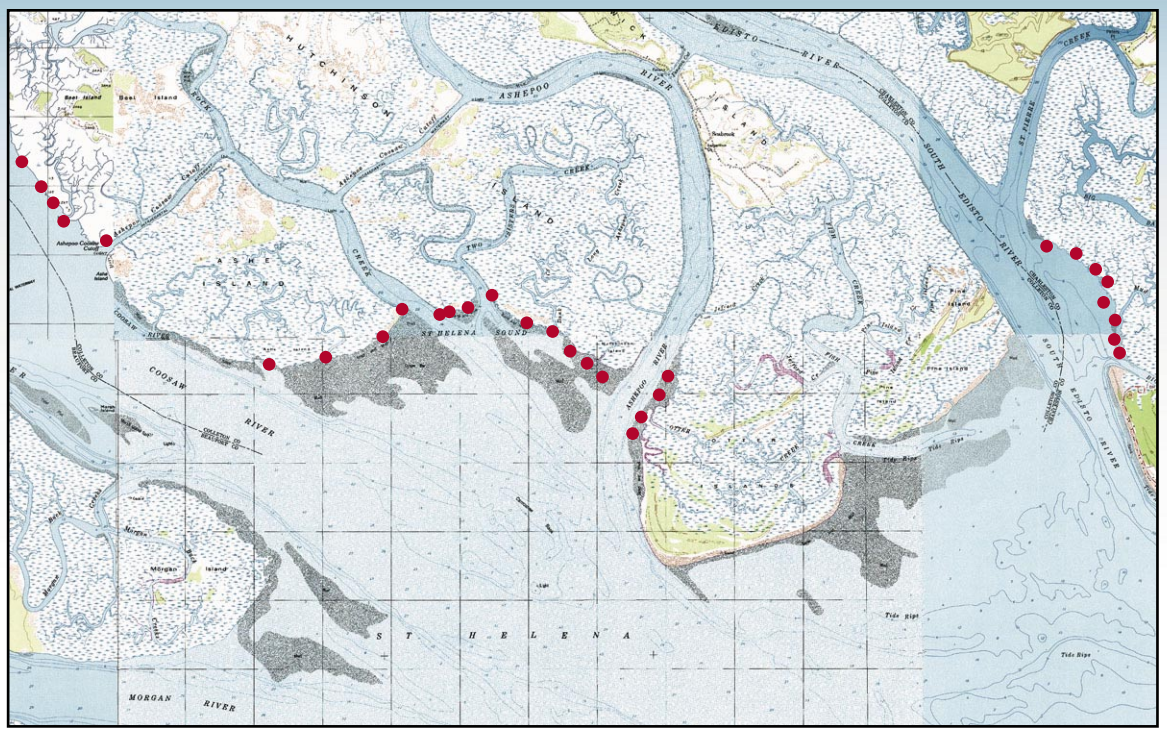

Figure 7. Chart of the ACE Basin to indicate the location of trammel net stations (red dots) from which we select a subset each month.

The sampling gear is a 200 yard long, 8 foot deep, monofilament trammel net with an inner wall of 2.5 inch stretch mesh and an outer wall of 14 inch stretch mesh.

The trammel net is set from the stern of a flat bottom "Florida mullet boat" in an arc against the shore to seal off an area. The net is set at about 10 knots and the set takes only a short time. The area behind the net is disturbed and then the net is hauled. Fishes are removed, placed in a holding tank and processed after the net is cleared and stowed. Fishes are identified to species, counted, measured and the total weight determined. Red drum, black drum and sheepshead are measured, tagged and released. Scales are removed from the midline behind the pectoral fin of each red drum. Ages are legible on the scales for the first 3 to 4 years, after which the age marks get obscured at the edge as the growth rate slows.

To generate a measure of the abundance of red drum, only those stations occupied from mid-ebb to low tide are included. This is because these fish are not available at high tide due to their movement onto the flooded marsh surface. The stratified mean catch per set is calculated for each red drum year (as previously defined) and plotted to show estimates of the trends in the species' abundance.

The long-term mean for the survey is slightly more than five red drum per set (Figure 8). From 1991 through 2000, there was a significant downward trend in the abundance of red drum in the survey. In 2001 to the present, the decrease in abundance has been reversed and most recently, the average catch/set has been greater than the long term mean. The data for the most recent period (04-05) indicate that this is an above average year in terms of average catch per unit effort (CPUE).

As the average catch per unit effort (net set) increased for each recent period, red drum are encountered more

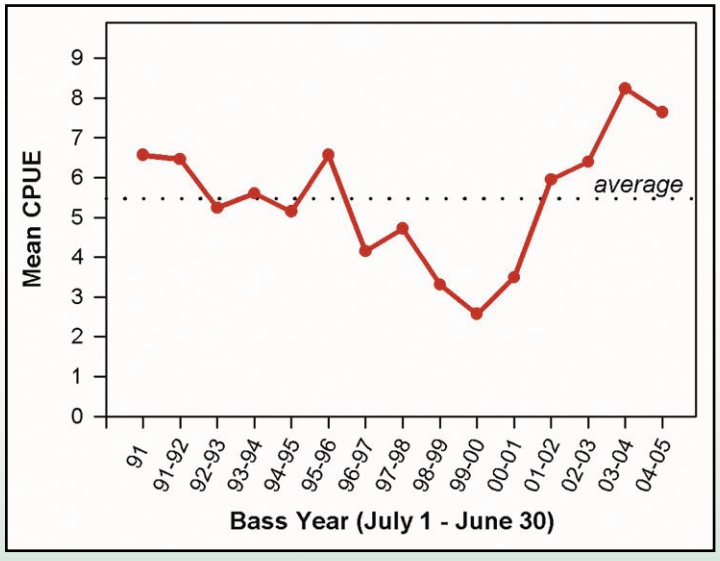

Figure 8. Average number of red drum caught per set for the trammel net survey for each bass year as previously defined. Dashed line is the long-term average.

frequently in our sets also (Figure 9). When a species becomes more abundant, the range, i.e., the locations where it is found, increases. As the abundance declines, the distribution becomes more restricted to the most favorable habitats. When a species is more restricted in its distribution, it becomes more vulnerable to being either caught by an angler or eaten by a predator. To illustrate this point, note that as the average catch per set increased, there was a concomitant increase in the frequency of encounter of red drum in trammel net sets (Figure 9).

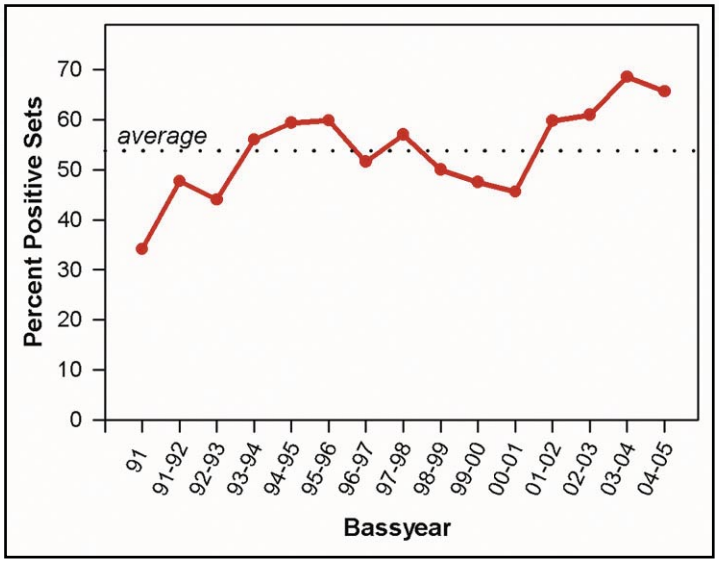

Figure 9. Percent of trammel net sets with red drum in the catch during each bass year (see text for definition of bass year).

In addition to an increased rate of encounter, there are more catches with greater than ten fish. This added more evidence that the abundance of this species inside South Carolina's estuaries was increasing. It is important to note that species like red drum have a long juvenile period (3 to 5 years prior to spawning) and a long life span (40 years),

There are a few reasons why we are seeing the evidence of an increase in the abundance of red drum in state waters. First, we are the beneficiaries of a good yearclass that was spawned in the late summer of 2002. This resulted in an increase in the trammel net catches for the first part of the present period. Second, the recent changes in the size and bag limits have resulted in more fish being returned to the water. Third, in the most current years, we have not had freezes during winter, which forms ice in the shallows, to any great extent.

Longline Sampling for Adults

As part of the sampling of red drum in coastal South Carolina, MRRI staff have been conducting a longline survey of the nearshore waters since 1994. The areas where hool and line gear has been deployed are near the Charleston Harbor Inlet and the old Drill Minefield, south of the "C" buoy.

Catches were measured to the nearest mm TL and tagged with plastic dart tags. More recently, red drum in the catch have been marked with stainless steel dart tags, plastic dart tags and finally PIT tags. *Note: PIT is an abbreviation for Passive Integrated Transponder. This is a metal tag with a code etched on the surface. The tag carries a code that is specific for the fish.* The later carry a code that can be read with an electronic instrument. Examination of fish marked with these PIT tagsallows us to obtain a shedding rate for the various tags used in red drum studies since the PIT tag is essentially a permanent tag.

During the period from 1994 through 2003, 935 sets of bottom longline gear were made. To standardize the calculations between years, only September through December catches were included. Over 78% of all sets were made during these months.

The overall average catch per set was 2.81 adult red drum with a range from 0 to 48. The greatest average annual catch was in 2002 whereas the lowest was in 1997 (Figure 10). Red drum occurred in 62% of the sets (Table 1).

Examination of the annual catch rates does not indicate a trend in the data based on statistical analyses. One problem with using annual data from a relatively short time series is the amount of variation between adjacent years obscures any trends in the data. One method of removing or dampening the effect of this variability is to employ a moving average. When a three-year moving average was applied

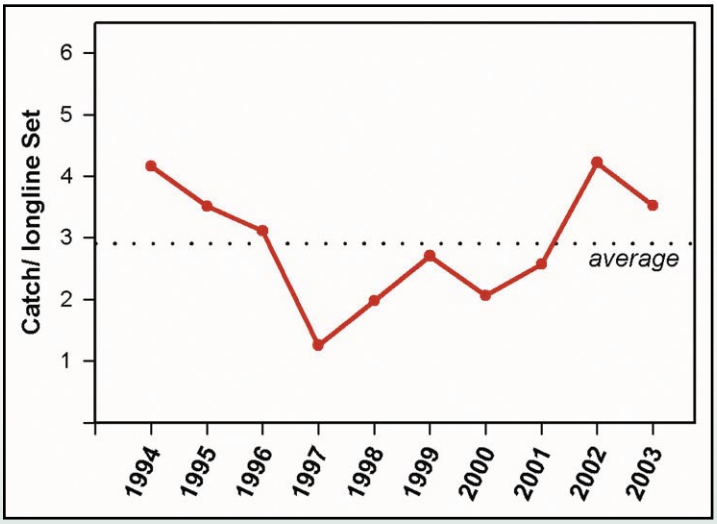

Figure 10. Average catch per set of red drum in longline gear fished in nearshore waters for the months of September through December by year. Solid dots are the average; vertical bars are upper and lower 95% confidence limits.

to the data, the resulting values suggest an increase in the catch per set of the longline survey in recent years (Figure 11 and Table 2).

Table 1. Frequency distribution of the number of red drum taken in longline sets during September through December from 1994 – 2003.

Number of red drum	Frequency	Percent
0	354	37.9
1	168	18.0
2	93	9.9
3	72	7.7
4	56	6.0
5	31	3.3
6	29	3.1
7	24	2.6
8	24	2.6
9	11	1.2
10	16	1.7
11-20	49	5.1
21-30	5	0.5
31-40	2	0.2
41-50	1	0.1

Table 2. Average catch/set of adult red drum in the longline survey along with three year moving average.

Year	Mean CPUE Number	Time Period	3-yr Moving Average
1994	4.16		
1995	3.47	1994-1996	3.59
1996	3.11	1995-1997	2.62
1997	1.25	1996-1998	2.11
1998	1.97	1997-1999	1.97
1999	2.70	1998-2000	2.24
2000	2.06	1999-2001	2.44
2001	2.57	2000-2002	2.95
2002	4.22	2001-2003	3.44
2003	3.52	2002-2004	3.57
2004	2.97		

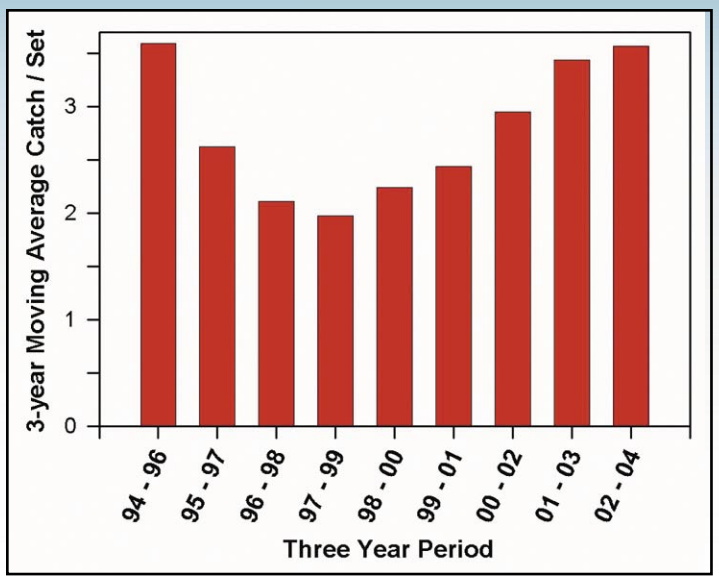

Figure 11. Three-year moving average of the annual mean catch per longline set. X-axis labels indicate three-year time period that comprises the value.

Studies in Georgia and Florida have shown that the number of young fish in the coastal spawning population has increased in recent years. Red drum has a maximum life span of around 40 – 50 years along the southeast coast of the U.S. When the population was overfished, few subadults attained sexual maturity and moved into the spawning group. The abundance of spawners declined because their loss resulting from natural causes and catch and release was not offset by maturing younger fish. Thus "escapement" was too low. *Note: Escapement essentially means the survival of young fish until entrance into the spawning group. The rate is expressed as a percentage. An escapement rate of 4% indicates that 4% of the subadults survive until sexual maturity.* In order to determine if management measures were working, both Georgia and Florida sampled the adults. If management actions were having the desired effect, the number of younger adults should increase. Initial samples prior to restrictions on the harvest found mostly older fishes (20 years+) with very few fish less than age 10. This is expected if the survival of the additions to the spawners were very low. Subsequent samples have shown more younger adult fishes.

One way of estimating the ages of adult red drum is to remove the otoliths (ear bones), section them, and count the number of rings on the section. Each ring corresponds to a year so the age can be determined. This requires killing the fish to obtain the data. A second method, although not as accurate, is based on the size of the fish. As fish age, they grow. After sexual maturity is reached, the rate of increase in size with time is slowed greatly (Figure 12).

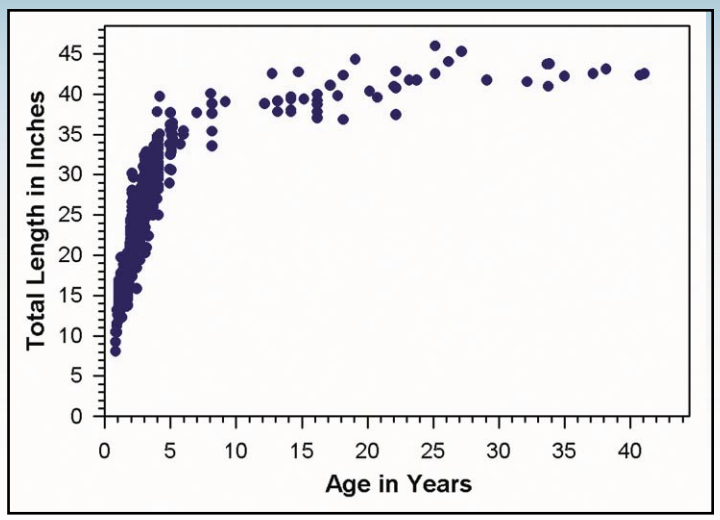

Figure 12. Age length relationship for red drum in South Carolina. Notice how the slope of the curve flattens out at about age 5 between 32 and 35 inches TL.

An examination of the sizes of the fishes in the longline catches should give an approximation of the presence of younger individuals. For this we grouped fish into three inch size categories and considered fish <32 inches TL as recently matured fish. To standardize this between years, we expressed these sizes as a percent of the total catch of red drum.

Table 3 shows the number of red drum captured by longline and grouped by total length in 3-inch intervals. Subadult red drum disappear from the estuarine habitat at a size of ~ 32 inches TL. We assumed this to include those 'young' fish first recruited to the spawning stock.

Table 3. Number of of red drum in longline sets by year in Sept – Dec. Fish lengths are grouped in 3-inch intervals with the mid point of each interval shown at the top of the table.

	25	28	31	34	37	40	43	46	49	Total
1994		1	3	23	61	79	17	1		185
1995		1	5	25	101	138	26			296
1996			3	35	97	133	41	2		311
1997				13	40	57	16	1		127
1998				5	37	70	78	20		210
1999				4	40	100	91	35		270
2000		3	2	23	67	61	24	4		184
2001			5	40	100	53	22	1	1	222
2002		9	34	90	127	91	24	2		377
2003	3	10	28	63	164	100	24	5		397
2004	2	5	19	50	110	61	7	1		255

In the mid-part of the last decade, the smaller size groups, i.e. fishes <33 inches TL, were poorly represented in the catch. Their contribution to the catch remained relatively constant (Figure 13) until the last two years sampled. In 1994, we had a relatively strong yearclass. These fish would have reached sexual maturity between 2000 and 2001. Since some fish that are 32 inches TL can be older than age 5, perhaps these recent up-ticks are the result of a strong yearclass and management measures.

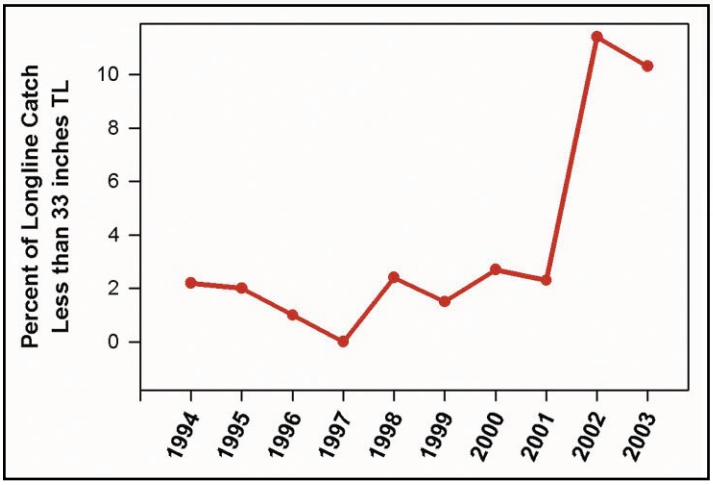

Figure 13. Percent of the longline catch of red drum in the smallest size classes by year.

The trends are encouraging. Catch rates of subadults (ages 1 through 4) have increased in recent years and have remained relatively stable. However, when the catches are broken up in age groups for the last six months of 2004, the contribution of the fish in the 2003 yearclass is below the long term average. Most of these red drum have reached the minimum legal size and can be retained by anglers (Figure 14). This indicates that estuarine abundance as well as the catch will decline in the near future. The three-year moving average of the catch per set of the longline gear also shows a general upward trend in more recent years. The percentage of the fish comprising the smallest, and hence youngest, red drum taken in the longline sets has also shown an increase.

Escapement, or survival until reproduction, is difficult to estimate when only a few yearclasses are available to both the fishery and quantitative sampling. The catches in both the longline and trammel net gear indicate general trends and cannot be related directly to a level of escapement. However, prior to the last assessment, the National Marine Fisheries Service, estimated that escapement was very low, less than 5% for the state. The more recent analysis reported an increasing trend in escapement, in the region of ~10%. Stringent management measures, such as those presently in place, should result in reaching the target level

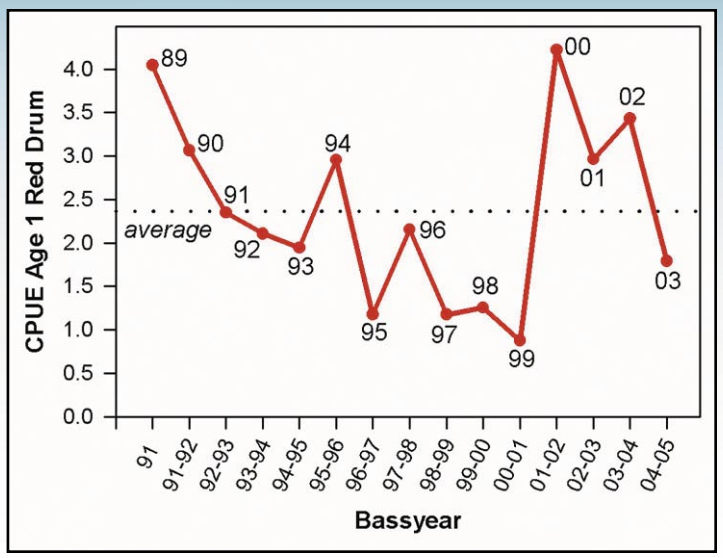

Figure 14. The abundance of one year old red drum in the trammel net catch. Numbers on dotted lines refer to a yearclass, i.e., 99 represents red drum that resulted from the spawning of adults in July-September 1999. Dashed line is the longterm average.

of recruitment of subadults into the spawning stock. *Note: The target is an escapement rate of 40%.*

Based on the available data, there should soon be an increase in the number of "smaller, younger" red drum in the fall longline catches. With the increased abundance of the subadults in the trammel net survey, future catches in the longline survey (three to five years from now, 2008 – 2009) should increase.

With the increased abundance of red drum, there will be pressure exerted to relax the restrictions on the harvest of subadult fish by either enlarging the allowable size range or increasing the bag limit. The SCDNR recommends that no major changes be made in the catch or size limits for another five to ten years to increase the contribution of the various yearclasses to the spawning population. Historically, overfishing on the subadults has reduced the diversity of ages in this population and put all the reproductive "pressure" on the very old fish or those that resulted from very large yearclasses. These are the fish that produce the young that are, in turn, enjoyed by recreational anglers.

It is very difficult to show statistically a spawn-recruit relationship, i.e., the abundance of the adult fish is directly related to the production of young. It is intuitive that if there are no adults, there will be no young, but what is the level of adult abundance that will ensure success of the population? That is not known, but it is wise to increase the probability of enjoying reasonable abundance of age 1 to 4 subadult red drum by having more adults produce more eggs. With more fertilized eggs, there is a greater probability of some of them reaching maturity to reproduce.

Prior to the changes in harvest regulations for red drum, the level of escapement, i.e., survival to reproduction, was insufficient. A return to the excessive harvest levels would more than likely produce the same result in the future. The growth of the coastal population and the increase in the angling population will increase the probability of overfishing without reasonable restrictions.

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