

## Overview of Red Drum Tagging Data and Recapture Results by state from Virginia to Florida

### Abstract:

An overview of red drum, *Sciaenops ocellatus*, tagging programs from Virginia through Florida are presented. Program history, tag usage, tagging results, and recapture results are described.

### Tagging Programs Overview and History:

#### Virginia:

The Virginia Game Fish Tagging Program, which relies on annually trained volunteer anglers, provided the Red drum tagging data for Virginia's Chesapeake Bay and coastal waters. The tagging program database includes data from the program's inception (1995) through the present (2009). Funded primarily from Virginia saltwater recreational fishing license funds, the tagging program is run cooperatively by the College of William and Mary's Virginia Institute of Marine Science (VIMS) and the Virginia Marine Resources Commission's (VMRC) Office of the Virginia Saltwater Fishing Tournament (VSFT). The overall objective of the program was to develop trained angler tagging effort on species important to the state's marine recreational fisheries, with a focus on species which had largely been ignored by research-based tagging studies. The lack of tagging data on red drum, a fishery largely targeted only by recreational fishers, primarily inspired development of the Game Fish Tagging Program.

Program participation is limited to approximately 200 taggers. For the period 1995-2003, the number of participants ranged from approximately 64 to 155 anglers. Since 2004, tagger numbers have ranged from approximately 175 to just over 200 individuals annually. Each angler participating in the Game Fish Tagging Program is required to complete a two-hour tagging training workshop before receiving any tagging supplies. The workshop instructs the anglers on data recording, fish handling, hook removal, and fish measurement, and each participant is required to "practice tagging" with freshly iced fish to gain confidence in using program tags.

#### North Carolina:

North Carolina Division of Marine Fisheries (NCDMF) began tagging juvenile and sub-adult red drum (< 685 mm TL) in 1983, and commercial fishermen assisted with this program until 1995. In 1984, NCDMF began a cooperative tagging program with recreational anglers. During the 1980's, volunteer anglers tagged all sizes of red drum encountered. In the early 1990's tagging of juvenile fish by volunteer anglers was phased out, and volunteer anglers were instructed to only tag 'adult' red drum (> 685 mm TL). Since 1986, an approximately 20 active volunteer anglers have tagged red drum each year, and a total of 171 anglers have volunteered since the program began.

Various methods were employed by NCDMF personnel and cooperating commercial fishers to capture sub-adult red drum throughout the project. Between 1986 and 1990, weekly collections from pound nets were made from early summer (June or July) to October near Gum Point (Bath, NC) on the Pamlico River. In years 1987-1990 and 1995-1996, red drum were collected using either run-around or anchored gill nets throughout North Carolina's estuaries from spring (April -May) to fall (August-December). In 1997-1998, red drum were collected using a 200-m trammel net at selected locations along the interior Outer Banks and in Core and Bogue Sounds. In all other years, red drum sampling was conducted on an opportunistic basis. Healthy fish were measured, tagged, and released (Ross and Stevens 1992).

Volunteers caught red drum by hook and line throughout most of North Carolina's marine waters, including ocean beaches, inlets, and western and eastern Pamlico Sound locations. A large portion of volunteer effort was concentrated in the mouth of the Neuse River near Point of Marsh and near Ocracoke Inlet. A tagging kit, which included tags, tagging applicator, data recording cards, tagging instructions, a tape measure and pencil were provided to volunteer taggers. Taggers were asked to record the location tagged fish were released, fork length and tag number.

#### South Carolina:

South Carolina has three red drum tagging programs. These include (i) SC Department of Natural Resources sub-adult tagging program (ii) SC Department of Natural Resources adult tagging program, and (iii) SC Marine Game Fish Tagging Program.

##### (i) SCDNR sub-adult tagging program

The SCDNR sub-adult red drum tagging program began in 1986 and is ongoing. Tags are applied to fish with a total length of 350 mm and greater during routine field sampling work. Since the start of the program, a variety of sampling methods have been used. The main surveys include a non-random stop net program (1986-1994), a randomly stratified trammel net program (1990 – present), a 'MARFIN' trammel program (different gear specifications; 1986-1998) and a randomly stratified electrofishing survey of upper estuary and river areas (2001 – present). Over this period, a total of 53,281 fish have been tagged (Table SC sub-adult 1).

##### (ii) SC Department of Natural Resources adult tagging program

Tagging of adult red drum in SC covers the period 1994-2008. From 1994 through June 2007, 1 mile long-lines were used to sample index stations that were known to give good catches. Since then, 1/3 mile long-lines (same sample hook spacing) have been used in a stratified random sampling design.

##### (iii) SC Marine Game Fish Tagging Program

Since 1974, the South Carolina Marine Resources Division's Office of Fisheries Management has operated a tagging program that utilizes recreational anglers as a means for deploying external tags in marine game fish. The angler-based tagging program has

proven to be a useful tool for promoting the conservation of marine game fish and increasing public resource awareness. In addition, the program has provided biologists with valuable data on movement and migration rates between stocks, growth rates, habitat utilization, and mortality associated with both fishing and natural events. Select marine finfish species are targeted for tag and release based on their importance both recreationally and commercially to the State and South Atlantic region. The list of target species is further narrowed down based on the amount of historical data on that species with regards to seasonal movements, habitat requirements, growth rates and release mortality. Red drum constitutes the majority (47%) of fish tagged and released by recreational anglers participating in this program.

In 1993, anglers tagging red drum were asked to concentrate their efforts on fish over 18 inches, and to not place tags in any fish under that size. In 1997, a cooperative agreement with a fishing club in Merritt Island, Florida provided anglers fishing Mosquito Lagoon and adjacent waters around Cape Canaveral with South Carolina tags. As a result of this effort, information on red drum tagged in Florida was included into the SC tagging program database. These initial tag events and subsequent recaptures are identified in adjacent columns with "FL", and these totals would need to be subtracted from the representative SC totals.

From 1974 to 2004, tag kits were supplied by request to any and all recreational anglers expressing an interest in participating. During this time period, more than 14,000 recreational anglers actively participated by tagging at least one fish. In 2005, in an effort to streamline the program and allow it to operate more efficiently, participation was limited to recreational anglers who completed a training workshop, and the total number of trained taggers was limited to 225 statewide. There are currently 216 trained recreational anglers that participate. However, because there are still thousands of tags still out in circulation, anglers who are not certified continue to tag fish. This information is entered into the database, and participation is included with those anglers that are certified.

#### Georgia:

Since 1987, the Georgia Cooperative Angler Tagging Project has tagged over 1,780 red drum with 54 recaptures. This project allows anglers favoring catch & release to donate some time and effort to data collection. Anglers are given tagging kits that have tags (Hallprint plastic tipped nylon dart tags, PDA) with corresponding cards, tagging applicator, and instructions on tagging technique.

#### Florida:

Red drum were tagged along the Atlantic coast of Florida under a variety of programs mostly during the 1980's and 1990's. These included short-term projects designed to estimate exploitation rates during the mid-1980's, age validation studies targeting large red drum in the Indian River/Mosquito Lagoon area in 1987 and 1988, and longer running, 'tag-when-available' programs conducted by scientists, trained volunteer anglers, and interested anglers. The long-term programs were run under either the Florida Fish and

Wildlife Conservation Commission's (FWC's) Fishery Independent Survey that tagged redfish captured with seines, gill nets and trammel nets during routine monitoring operations, the FWC's trained volunteer angling program, or the National Marine Fisheries Service's Cooperative Tagging System program that provided tagging kits to interested anglers. All of the long-term programs reduced or eliminated tagging efforts by the early 2000's either due to reduced funding and changes in program emphasis (NMFS-CTS moved to strictly large pelagics) or due to program changes (FWC).

Additional information about another tag/recapture program became available through Maumus Claverie, Jr., of the Coastal Conservation Association (CCA) of Louisiana. The tagging database compiled by this organization included tag/recapture information for red drum along the Atlantic coast.

### **Recapture Reporting:**

#### Virginia:

Anglers reporting recaptures of tagged fish are instructed to call the program's office in Virginia Beach, Virginia. The office number is clearly printed on all program tags (Reward-Call 757-491-5160). Rewards offered for reporting tagged fish are merchandise items, i.e., baseball caps, sun visors, quality T-shirts (fish artwork changes annually), Plano tackle box organizers, and pewter fish pins.

#### North Carolina:

Each tag was labeled with the tag number, and a message that read, "REWARD-SEND TAG No. DATE, LOCATION, PHONE No. TO: NCDMF, BOX 769, MOREHEAD CITY, NC". A reward of two dollars was given for returned tags until 1989. In 1990, the reward was increased to five dollars or a baseball cap. Three \$100 prizes were given away in annual drawings from each year's returned tags (Ross and Stevens 1992).

North Carolina Division of Marine Fisheries personnel attempted to contact fishers who returned tags to ask about the fate of the fish. Fates included: returned to water with tag, returned to water without tag, returned to water with a partial tag (tag was clipped off but the anchor was left in the fish), retagged and returned to water, or not returned alive to water. Fishers were also asked about the type of gear used to recapture the fish and to give a detailed description of the location where the fish was captured. The distance of travel for each fish was calculated using shortest in-water route possible.

#### South Carolina:

(i) SC Department of Natural Resources sub-adult tagging program  
 SC sub-adult recaptures come from the SCDNR inshore surveys as well as angler returns. At the time of recapture, information on tag number, date, capture gear, location, total length and fate (harvested, released with tag, released without tag) are recorded. Where possible, ages are assigned either using age-length keys or by analysis of scales or

otoliths. Anglers return their information either by mail (address on tags), by phoning a hotline (since 2008) or by e-mail (some anglers with prior contacts). A t-shirt or hat reward is offered per fish, plus entry into a monthly cash draw of 1 x \$50, 2 x \$20 and 3 x \$10 prizes.

(ii) SC Department of Natural Resources adult tagging program

Nearly all recaptures of SCDNR adult tagged red drum come from SCDNR long lining survey. Information on location, date, specimen total length and weight are recorded.

(iii) SC Marine Game Fish Tagging Program.

When an angler catches a tagged fish, they are instructed to call a 1-800 number provided on the tag to report the catch. The angler receives a t-shirt and/or hat for each reported recapture.

Georgia:

After the fish is tagged, the angler mails in the business reply card. When anglers catch a tagged fish, they are instructed to report back over the phone the tag #, date of recapture, location, length, and fish condition.

Florida:

Because there have been a variety of tagging programs in Florida, recapture reporting protocols have varied as well. For the most part, a phone number is printed on the tag and anglers call in to report recaptures of tag fish. In some cases, rewards have been offered.

**Tag Type History:**

Virginia:

From 1995 to 1997, the program used Floy tags including T-bar anchor tags (Floy-FD-94) with both small and large nylon tips and single barb dart tags (Floy-FT2-94 & FT1-94 tags). Taggers were trained to anchor tags at the base of the dorsal fin with the tag barb passing through the fish's muscle but, more importantly, through the bones supporting the hard spines of the dorsal fin. In 1998, the program switched to Hallprint Ltd. tags (made in Australia) due to problems with the Floy tag barbs breaking off.

From 1998 to 2007, Hallprint small (80 mm streamer) and large (115 mm streamer) single barb dart tags (PDL and PDS tags) were used. Small dart tags were used from 1998 through 1999; however, concerns over dart tags not firmly anchoring in target species lead the program to switch to Hallprint T-bar tags in fish up to 559 mm TL. The T-bar tags were used from 1999 to 2000, when the program switched to stainless steel dart tags for large red drum over 762 mm TL.

In 2001 and 2002, taggers started significantly replacing nylon tip dart tags with SSD tags for tagging adult drum. During 2002 recapture reports for adult drum began to improve,

i.e., reporting rates for tagged adult drum were only 0.8% for fish tagged during 2001 versus 2.8-3% for adults tagged during 2002 and 2003.

The primary tag used for sub-adult drum has been the Hallprint T-bar anchor tag (TBA tag). Used in strips of 50 tags, the tags are cleanly separated one at a time from the strip spine as they tag strip feeds through a “tagging gun”. Major benefits to using T-bar tags and the tagging gun is the tag strips are easy to handle, tagging can be done quickly, and the tags are light weight (causing minimum drag for the fish). Therefore, the tag seems well suited for smaller drum (254-457 mm TL), but also has been found suitable for larger fish (up to about 635 mm TL). However, due to studies in South Carolina (Smith et al. 1997), there are concerns about T-bar tags remaining on the fish for extended periods of time after tagging.

The continuous decrease in recapture numbers of red drum through periods of 60-90 days and 91-120 days post tagging seems to indicate a steady loss of T-bar tags from beyond 30 days post tagging. In Smith et al. (1997) a loss of 16% of T-bar tags was noted at the end of two months (60 days) post tagging. During all but two of the referenced years (2006 and 2007), the program's steep decline in recaptures continued until about 91-120 days post tagging. Then, recapture numbers leveled off at under ten recaptures per period, ultimately dropping to 0-3 per period by 241-270 days post tagging. The overall pattern of the tagging program's decline in sub-adult drum recaptures over time seems largely consistent with the high loss rate of T-bar tags observed by Smith et al. (1997), especially because in the study, the rate of tag loss significantly increased after about 7 months post tagging.

Aware of the referenced studies, the tagging program made limited efforts during 2007 to evaluate T-bar tag-retention in sub-adult drum. A few select taggers double tagged sub-adult fish (fish about 356-508 mm TL) using Hallprint T-bar tags and abdominal internal anchor tags. The recapture results were largely inconclusive due to inconsistencies among anglers regarding clear reporting of the status of both tags in such fish.

#### North Carolina:

Several tag types were used by NCDMF personnel to tag juvenile red drum throughout the study. From 1986 to 2004, Floy ® internal anchor tags with a monofilament streamer core were used. Between 1987 and 1998, Floy ® internal anchor tags with an extra large anchor and a 15 cm streamer (FM-89SL) were administered. Between 1999 and 2007 Floy ® internal anchor tags (FM-95W) with a wire core were used. On healthy robust red drum, scales were scraped away from a small area 0.64 cm (0.25 inches) posterior to the pelvic fin and above the mid-ventral line. An incision was made just large enough to push the internal anchor tag through. The tag was inserted into the incision and twisted 90 degrees. A gentle tug on the streamer tested proper application of internal anchor tags. In 1986 Floy ® Clinch-up tags were inserted dorsally, just posterior to the termination of the dorsal fin, using a Floy ® applicator.

Nylon dart tags were placed on juvenile and sub-adult red drum (<685 mm TL) by volunteers throughout the study and by NCDMF in the first few years. After 1995 volunteers were not given nylon dart tags, due to the perception that they had a lower retention rate than internal anchor tags or steel dart tags. However, 154 nylon dart tags were placed on juvenile red drum after 1995. Nylon dart tags were inserted behind the dorsal fin at an acute angle so that the tag would lie flat along the fish's body. Nylon dart tags were secured behind the pterygiophores and given a slight tug to insure proper placement before fish were released. Fish in poor condition were not tagged and fish were gently returned to the water.

Prior to 1999, adult (> 685 mm TL) red drum were tagged with Floy ® stainless steel dart tags having a monofilament streamer core. After several tags were returned without the outer streamer sheath containing the tag number and other critical text, these tags were replaced with Hallprint ® stainless steel dart tags having a stainless steel wire streamer core. The majority of all steel dart tags were placed by volunteers who were instructed to firmly insert the tag into flesh of healthy adult red drum two or three scale rows under the middle of the first dorsal fin. Taggers were instructed to test for proper application by giving the tag a slight tug to make sure it was secure.

#### South Carolina:

##### (i) SC Department of Natural Resources sub-adult tagging program

Nearly all sub-adult red drum tagged by SCDNR are fitted with either a 3.5" internal anchor tags ("belly disk"; fish with TL = 350-549 mm) or 5.5" steel dart "shoulder" tag (TL > 549 mm). From 1986-1995 tags without reinforcing floy wire were used. During an overlap period in 1995, and all years since, tags with reinforcing floy wire have been used.

##### (ii) SC Department of Natural Resources adult tagging program

From 1994-2001, adult red drum were tagged with a single nylon dart tag. From 2001-2008 each fish was either double tagged with a nylon dart tag + PIT tag, or treble tagged (Charleston Harbor fish only) with a nylon dart tag + steel shoulder tag + PIT tag.

##### (iii) SC Marine Game Fish Tagging Program.

In 1993, anglers tagging red drum were asked to concentrate their efforts on fish over 18 inches, and to not place tags in any fish under that size. In 1996, a larger (14.5 cm) nylon dart tag ("K" prefix) was added to the equipment supplied to anglers, and they were instructed to use this size tag (as opposed to the smaller 9.5 cm tag "E" prefix) on any fish over 27 inches.

From 1974 to 2004, tag kits were supplied by request to any and all recreational anglers expressing an interest in participating. Kits include either 5 or 10 nylon dart tags (Hallprint Pty Ltd.), stainless applicator, and postage paid information cards for recording information on the initial tag event. During this time period more than 14,000 recreational anglers actively participated by tagging at least one fish. Starting in 2000, a database was developed to record issued tags and allowed staff to track tag usage by angler.

Georgia:

Anglers are given tagging kits that have tags (Hallprint plastic tipped nylon dart tags, PDA) with corresponding cards, tagging applicator, and instructions on tagging technique. No tag-type changes have been made since the program's inception.

Florida:

The tag type was not generally available in the original datasets but most tags applied before 1988 were Floy internal anchors and after this were Hallprint dart tags. All of the red drum reported in the CCA program were tagged with external dart tags.

**Red Drum Tagging Activity and Recapture Results:**Virginia:

In the mid 1990's, program participation remained low, with only 58 red drum tagged in Virginia's waters in 1995 and 65 red drum tagged in 1996. Most of the effort was concentrated on adult fish, and there were few recaptures. By the late 1990's, the tagging effort gradually increased to over 1,000 tagged red drum per year (1,065 tagged fish in 1999), and 80 to 95 % of tagged fish were sub-adults ( $\geq 762$  mm TL). Overall recapture rates were around 10% from 1997 to 2000, and recaptures from North Carolina ranged from 8 to 18%. Given that most adult fish were being tagged with nylon tip dart tags, there were only three recaptures of adult drum tagged in Virginia from 1995-2000. Two recaptures were fish at large for only short periods and captured in the area where tagged.

Tagging year 2001 showed a dramatic decrease in sub-adult drum abundance levels. Only 284 fish were tagged—the effort almost equally divided between small and adult fish. With such low numbers of tagged fish during the year, the year's drum recapture rate was only 5%. Tagging numbers were back up in 2002, with 2,657 fish tagged. About 90% of those were sub adult fish. Over 160 red drum were recaptured (recapture rate was 6.1%), and 24% of recaptures occurred in North Carolina waters. During 2003, nearly 2,300 fish were tagged of which 9.3% were adults. Most fish were tagged with SSD tags. Recaptures totaled 260 fish from drum tagged during the year (recapture rate of 12%).

Just under 800 fish were tagged in 2004 and 2005 (46% sub-adults; 54% adults). As expected from low tagged fish numbers, the recapture rate was only just over 2% and 3%, respectively.

For 2006 just over 4,000 drum were tagged in Virginia of which the majority (92%) were young fish (primarily age-2, but a few age-3 drum also were tagged). Recaptures of drum tagged in 2006 totaled 281 fish by the end of the year (a 7% recapture rate). Of these total recaptures, 14% occurred in North Carolina. Recaptures in North Carolina typically occurred during fall months from drum tagged during late spring-summer into early fall. Tagging year 2006 also resulted in an additional 124 recaptures occurring in 2007,



bringing the 2006-2007 recaptures total to 405 (a 10.1% recapture rate). Of the two year total recaptures, 63 (15.5%) occurred in North Carolina waters.

Of the 2,900 fish tagged in 2007, 91% were sub-adults and 9% were adults. Recapture patterns were similar to those of other years when sub-adult drum were abundant. For 2007, a total of 256 drum tagged during the year were recaptured within the year (a 9.8% recapture rate). For the year, 8% of recaptures occurred in North Carolina within 2007.

Rudee Inlet (oceanfront Virginia Beach), Lynnhaven Inlet (just inside the Chesapeake Bay north of Cape Henry), and other lower bay areas were areas of high tagging activity throughout the 12 years of the study. Recaptures of drum associated with the two popular power plant fishing areas primarily documented the fish remaining at the sites over periods of weeks to 40+ days during cold months. Ultimately, some fish from the Elizabeth River site moved back into lower Chesapeake Bay, i.e., to Hampton Roads (Fort Monroe), Little Creek, Mobjack Bay, the Eastern Shore Barrier Islands, etc. The most productive of these areas was the Elizabeth River Hot Ditch area. Rather than migrating out of the Chesapeake Bay during fall to North Carolina waters (considered the usual pattern for sub-adult red drum), fish in this area were observed over-wintering in bay tributaries in the area of power plants. The cycling of river water through the plants resulted in discharges of warmed water sufficient to maintain adjacent areas at temperatures generally suitable for the fish (as well as forage the fish could use--crabs, finger mullet, mummichogs, etc.). Sub-adult drum also concentrated near the Yorktown Power Plant (called the York River Hot Ditch by anglers) during some years.

The study also provided evidence of adult drum moving into Virginia waters from North Carolina in late May and staying in the area during August-September when they ultimately moved during fall months to North Carolina waters where the fish appear to overwinter. This was first observed in 1995 with a fish tagged in October in Virginia, recaptured near Oregon Inlet, North Carolina in November, and was reported again shortly after in South Carolina. Some recaptures document fish tagged in Rudee and Lynnhaven Inlet waters moving out of the bay during fall, often making surprisingly (at the time) rapid transits to North Carolina waters. With large numbers of fish tagged, a distinctive pattern was observed whereby small numbers of sub-adult drum moved quickly out of the inlet area then around Cape Henry and along the Virginia Beach to Sandbridge ocean shoreline to North Carolina waters. Markedly, drum tagged during the last week of August through the first week of September demonstrated simultaneously (1) pulses of fish moving out of the inlet, often over periods of only 5-20 days, to North Carolina recapture sites and (2) a regular rate of recaptures of fish in Lynnhaven waters which had been tagged in the same two week period as the fish migrating to Carolina beaches and sounds.

#### North Carolina:

A total of 48,664 red drum was measured and tagged between 1983-2007. On average, 2,181 (range 725-5068) red drum was tagged each year since 1986 (Table 1, appendix B). Fishers using hook and line gear tagged the majority of adult red drum, while most of the juvenile red drum were captured for tagging by NCDMF using pound net, trammel nets,

and gill nets (Table 2, appendix B). Eleven different tag types were administered. The largest percentage of juveniles (86%) was tagged with internal anchor tags. Most adults (92%) were tagged with stainless steel dart tags.

Tags were distributed throughout North Carolina in estuaries (65%) and ocean waters (35%). Most juvenile (94%) and sub-adult (66%) red drum were tagged in estuaries, but the majority of adult (76%) red drum were tagged in the ocean. The largest percentage (35%) of red drum was tagged in west Pamlico Sound, followed by Ocracoke Inlet (21%) and Roanoke and Croatan Sounds (12%). A total of 75 red drum were tagged in Chesapeake Bay, Virginia. Most estuary-tagged fish were released into west Pamlico Sound (54%), and most ocean-tagged fish were released into Ocracoke Inlet. Since 1983, 5,925 recaptures have occurred (12.2% of those tagged; Table 3, appendix B). Tag return rates were highest for juvenile fish (18.8%) and lowest for adult fish (3.1%). Sub-adults had a tag return rate of 14%. More red drum were recaptured in estuaries (80%) than in the ocean (20%). Most recaptures occurred in west Pamlico Sound (57%).

Recovery matrices for red drum tagged in North Carolina were generated for all red drum tagged across ages and for four age groups (1, 2, 3, 4+). Ages were determined using a 6-month age-length key and were based on a 1 January birthday. Results are presented in Tables 4-8 (appendix B).

North Carolina tagging data have recently been analyzed and the reports in appendix A provide additional detailed information on the NC tagging program.

#### South Carolina:

##### (i) SC Department of Natural Resources sub-adult tagging program

To date, a total of 23,389 recaptures have been reported. The majority of SCDNR returns are from one of three main surveys (stop net survey, SCDNR random trammel survey and 'MARFIN' trammel survey). Recaptures from anglers plus these three SCDNR surveys have provided 20,750 returns on red drum with assigned ages (**Table SC sub-adult 2**).

Of all the fish tagged, the maximum distance between the point of release and point of recapture by an angler was 233 miles (minimum distance by sea). Most fish were recaptured within 30 miles (96.4%), a small number were recaptured between 30 and 100 miles (3.1%), and very few were recaptured at greater distances (0.5%).

The 1991-1999 tagging data was used by Latour et al (2001) to estimate mortality of SC red drum based on various tag reporting rate and immediate survival rate assumptions.

##### (ii) SC Department of Natural Resources adult tagging program

From 1995 onwards, 2,880 red drum were tagged. Of these, 126 were recaptured at least once, 16 recaptured at least twice and 2 recaptured three times (**TABLE SC Adult 1**). Very few recaptured individuals have ages assigned to them because otoliths are not routinely extracted (nearly all fish are released alive).

(iii) SC Marine Game Fish Tagging Program

From 1974 to 2007, 64,310 red drum were tagged and released, and of those, 8,377 were recaptured. The disposition of recaptures is represented as follows: 3,369 were retained; 4,486 were released with same tag; 133 were released with new tag; and 381 were released without a tag. A synopsis of yearly activity since 1974 to current is available in appendix C.

Georgia:

Since 1987, 1,780 fish were tagged with 54 recaptures. Of those recaptures, 3.7 % were in Florida, 11.0 % were in South Carolina, and 85.3 % were recaptured in Georgia.

Florida:

From 1984 through 2003, 10,177 red drum were tagged in Florida with 834 recaptures. Florida tagging data show little difference in overall estimated minimum exploitation or annual survival rates for fish grouped by sizes 301-500 mm TL, 501-800 mm TL, and 801<sup>+</sup> mm TL. Minimum annual exploitation rates varied year-to-year but average about 4% during 1984-2000. Annual survival averaged about 25%-30%.

The CCA data include 1,155 tagged red drum with 201 recaptures from 2001 through 2007. These data show minimum exploitation ( $E_{min}$ ) declined with size, i.e., age:  $\leq 300$ ,  $E_{min}=0.244$ ; 301-500 mmTL,  $E_{min}=0.209$ ; 501-800 mmTL,  $E_{min}=0.184$ ; and 801<sup>+</sup> mm TL,  $E_{min}=0.049$ .

## Appendix A

### Literature Cited:

Smith T, W. Jenkins, and M. Denson. 1997. Overview of an experimental stock enhancement program for red drum in South Carolina. Bull Natl. Res. Inst. Aquacult., Suppl. 3:109-115.

North Carolina tagging data have recently been analyzed and the reports below provide additional detailed information on the NC tagging program:

Bacheler, N. M., L. M. Paramore, S. M. Burdick, J. A. Buckel, and J. E. Hightower. In review. Seasonal variation in age-specific movement patterns of red drum *Sciaenops ocellatus* inferred from conventional tagging and telemetry. Fisheries Bulletin.

Bacheler, N. M., J. E. Hightower, L. M. Paramore, J. A. Buckel, and K. H. Pollock. 2008a. An age-dependent tag return model for estimating mortality and selectivity of an estuarine dependent fish with high rates of catch and release. Trans. Am. Fish. Soc. 137:1422-1432.

Burdick, S. M., J. E. Hightower, J. A. Buckel, K. H. Pollock, and L. M. Paramore. 2007. Movement and selectivity of red drum and survival of adult red drum: an analysis of 20 years of tagging data. North Carolina Division of Marine Fisheries, Morehead City, NC.

Latour, R.L., Pollock, K.H., Wenner, C.A., Hoenig, J.M. 2001. Estimates of fishing and natural mortality for subadult red drum in South Carolina waters. North American Journal of Fisheries Management. 21: 733-744. (S18-RD12).

**Appendix B**

## North Carolina Tagging Data Tables:

Table 1. Number of red drum measured and tagged by year and size class (Juveniles &lt;457 mm TL, Sub-Adults - 457-685 mm TL, and Adults &gt;685 mm TL).

Year	Size Class			Total
	Juvenile	Sub-adult	Adult	
1983	68	7	17	92
1984	14	52	235	301
1985	35	22	242	299
1986	1449	110	161	1720
1987	436	50	239	725
1988	723	102	360	1185
1989	272	117	611	1000
1990	122	135	609	866
1991	2088	280	592	2960
1992	1111	338	472	1921
1993	1255	744	645	2644
1994	3776	271	1021	5068
1995	458	349	688	1495
1996	274	125	713	1112
1997	1933	147	740	2820
1998	2308	635	752	3695
1999	1678	434	1076	3188
2000	939	610	1254	2803
2001	366	347	1028	1741
2002	188	123	1113	1424
2003	105	265	976	1346
2004	260	40	1188	1488
2005	517	363	1250	2130
2006	1697	530	1541	3768
2007	1284	352	1237	2873
<b>Total</b>	<b>23356</b>	<b>6548</b>	<b>18760</b>	<b>48664</b>

Table 2. Gears used to collect red drum for tagging, and the number of fish measured and tagged in each size class (Juveniles <457 mm TL, Sub-Adults 457-685 mm TL, and Adults >685 mm TL).

Gear Type	Size Class			Total
	Juvenile	Sub-adult	Adult	
Pound net	8146	677	14	8837
Gill net	9100	1989	332	11421
Trammel net	2481	252	25	2758
Seines	110	91	9	210
Hook and line	2562	3165	18281	24008
Electric shocker	849	332	14	1195
Long Haul	79	0	31	110
Other	54	29	42	125
<b>Total</b>	<b>23381</b>	<b>6535</b>	<b>18748</b>	<b>48664</b>

Table 3. Total number of red drum recaptured based on year and size class (Juveniles <457 mm TL, Sub-Adults - 457-685 mm TL, and Adults >685 mm TL) when tagged.

Year	Size Class			Total
	Juvenile	Sub-adult	Adult	
1983	16	1		17
1984	3	4	2	9
1985	4	7	4	15
1986	621	14	2	637
1987	117	8	8	133
1988	171	31	11	213
1989	84	13	22	119
1990	27	24	24	75
1991	328	45	13	386
1992	194	49	11	254
1993	151	106	17	274
1994	1116	34	45	1195
1995	48	34	22	104
1996	33	18	17	68
1997	260	23	27	310
1998	221	98	37	356
1999	157	46	25	228
2000	141	103	38	282
2001	55	60	27	142
2002	8	9	41	58
2003	8	21	20	49
2004	27	2	27	56
2005	101	73	57	231
2006	318	101	52	471
2007	185	25	33	243
Total	4394	949	582	5925

Table 4. Recoveries of red drum tagged and either harvested or released across all tag types from 1983 to 2007 in North Carolina. This matrix includes total number tagged for the initial tagging event and all subsequent tag recoveries. For all age groups (1-4+).

Tag Year	Total Tagged	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total Recaps	
1983	92	16	1																								17	
1984	301		9																									9
1985	299			8	5		1	1																				15
1986	1720				548	77	3	1	2	2									4								637	
1987	725					106	22	3	1							1											133	
1988	1185						169	38	3	2		1															213	
1989	1000							105	10	2		1					1										119	
1990	866								57	11	3	1		1								1					75	
1991	2960									285	73	16	4	3	2					1	1					1	386	
1992	1921										125	111	10	4	3										1		254	
1993	2644											199	60	5	4	1	2	1		1					1		274	
1994	5068												966	202	9	2	6	4	2	1	1				1	1	1195	
1995	1495													59	28	5	2	1	2	3	1	1	1	1			104	
1996	1112														28	28	7	2	2					1			68	
1997	2820															185	100	11	6	2			1	2	2	1	310	
1998	3695																227	84	24	4	5	1	3	1	2	5	356	
1999	3188																	124	74	21	6		1			2	228	
2000	2803																		154	102	23			2	1		282	
2001	1741																			92	35	9	2	1	1	2	142	
2002	1424																				21	13	3	6	6	9	58	
2003	1346																					25	11	4	9		49	
2004	1488																						22	18	12	4		56
2005	2130																							102	103	26		231
2006	3768																								354	117	471	
2007	2873																									243	243	
Total	48664	16	10	8	553	183	195	148	73	302	201	329	1040	274	74	224	344	227	269	227	93	49	45	138	492	411	5925	

Table 5. Recoveries of red drum tagged as age-1 and either harvested or released across all tag types from 1983 to 2007 in North Carolina. This matrix includes total number tagged for the initial tagging event and all subsequent tag recoveries.

Tag Year	Total Tagged	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total Recaps	
1983	74	16	1																									17
1984	22		5																									5
1985	42			4	2																							6
1986	1518				545	75	3	1	1	2									4								631	
1987	458					100	19	2	1																		122	
1988	788						162	32	2																		196	
1989	283							79	3																		82	
1990	110								15	4																	19	
1991	2310									279	68	14	3	1													365	
1992	1154										101	92	9	1	2												205	
1993	1424											133	44		3												180	
1994	3778												930	181	7	1			1								1120	
1995	430													27	16	2											45	
1996	289														20	14	3										37	
1997	1966															167	91	6	1								265	
1998	1326																50	52	13	1	2						118	
1999	1128																	28	51	17	2						98	
2000	642																		43	53	10						106	
2001	171																			8	12	3					23	
2002	193																				7	4					11	
2003	47																					4	2				6	
2004	275																						15	11	2		28	
2005	383																							13	45	6	64	
2006	534																								26	40	66	
2007	263																										22	22
Total	19608	16	6	4	547	175	184	114	22	285	169	239	986	210	48	184	144	87	112	79	33	11	17	24	73	68	3837	



Table 6. Recoveries of red drum tagged as age-2 and either harvested or released across all tag types from 1983 to 2007 in North Carolina. This matrix includes total number tagged for the initial tagging event and all subsequent tag recoveries.

Tag Year	Total Tagged	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total Recaps
1983	2																										3
1984	52		3																								3
1985	15			3	1																						4
1986	44				3	1																					4
1987	34					2	1																				3
1988	36						3	3																			6
1989	108							14	1																		15
1990	149								32	1																	33
1991	69									5	2				1												8
1992	311										22	17															39
1993	598											64	13	3					1								81
1994	225												19	7	1											1	28
1995	391													28	7	2											37
1996	132														6	8											14
1997	124															18	2	1									21
1998	1614																172	25	5								202
1999	873																										105
2000	588																										133
2001	198																										64
2002	142																										5
2003	339																										23
2004	30																										1
2005	1686																										354
2006	10352																										186
2007	18205																										1482

Table 7. Recoveries of red drum tagged as age-3 and either harvested or released across all tag types from 1983 to 2007 in North Carolina. This matrix includes total number tagged for the initial tagging event and all subsequent tag recoveries.

Tag Year	Total Tagged	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total Recaps
1983	21																										13
1984	11																										6
1985	13																										7
1986	51																										6
1987	119																										7
1988	34																										1
1989	45																										2
1990	152																										13
1991	204																										3
1992	51																										3
1993	67																										2
1994	34																										2
1995	47																										3
1996	188																										8
1997	234																										8
1998	261																										18
1999	112																										7
2000	146																										7
2001	145																										5
2002	119																										9
2003	332																										20
2004	263																										19
Total	2677			1			6	7		1	1	11	2	3	1	2	8	16	33	6	10	7	5	18	24	162	

Table 8. Recoveries of red drum tagged as age-4+ and either harvested or released across all tag types from 1983 to 2007 in North Carolina. This matrix includes total number tagged for the initial tagging event and all subsequent tag recoveries.

Tag Year	Total Tagged	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total Recaps	
1983	16																										1	
1984	217		1																								4	
1985	224				2		1	1																			4	
1986	137					1			1																		2	
1987	222					4	2	1								1											8	
1988	348						4	3	1	2		1															11	
1989	558							6	6	2		1				1											16	
1990	488								3	6	3	1			1						1						16	
1991	547								1	2	2	1	2	1	1				1	1						1	12	
1992	411									2	1	1	3						1	1						1	8	
1993	470										2	3	2	1	1	2					1			1			13	
1994	861											6	13	1	1	5	3	2	1	1	1	1				1	34	
1995	623													3	4	1	2	1	1	3	1	1	1	1			19	
1996	624														1	5	4	2	2				1	1			15	
1997	696																7	4	5	2				1	2	2	1	24
1998	708																4	6	5	3	3	3	1	3	1	2	5	33
1999	855																	5	3	3	3	3		1		2	17	
2000	1054																		8	8	6			2	1		25	
2001	921																			6	7	3	2	1	1	2	22	
2002	1007																				8	3	3	6	6	9	35	
2003	814																							4	3	8	15	
2004	1038																							1	5	8	4	18
2005	1124																							8	24	17	49	
2006	1216																								10	21	31	
2007	995																									16	16	
Total	16174		1		2	5	7	11	11	11	7	8	11	24	8	11	24	21	27	28	30	8	17	30	64	78	444	

## Appendix C

### South Carolina Summary Data

Note: participating anglers represents only those anglers that tagged at least one fish.

1974:

- 33 red drum were tagged
- 0 recaptures
- (Unavailable) participating anglers this year
- (Unavailable)75 tagging kits issued

1975:

- 65 red drum were tagged
- 5 recaptures
- (Unavailable) participating anglers this year
- (Unavailable)80 tagging kits issued

1976:

- 223 red drum were tagged
- 10 recaptures
- (Unavailable) participating anglers this year
- (Unavailable)62 tagging kits issued

1977:

- 24 red drum were tagged
- 4 recaptures
- (Unavailable) participating anglers this year
- (Unavailable)65 tagging kits issued

1978:

- 2 red drum were tagged (Average length is 9.25")
- 0 recaptures
- 9 participating anglers this year
- 70 tagging kits were issued

1979:

- 57 red drum were tagged
- 9 recaptures
- 11 participating anglers this year
- 74 tagging kits were issued

1980:

- 68 red drum were tagged
- 12 recaptures
- 15 participating anglers this year
- 65 tagging kits were issued

1981:

- 163 fish were tagged and out of these 119 red drum were tagged
- 13 recaptures
- 20 participating anglers this year
- 112 tagging kits issued

1982:

- 205 red drum were tagged
- 39 recaptures
- 28 participating anglers this year
- 120 tagging kits were issued

1983:

- 223 red drum were tagged
- 39 recaptures
- 37 participating anglers this year
- 140 tagging kits issued

1984:

- 211 red drum were tagged
- 40 recaptures
- 65 participating anglers
- 130 tagging kits issued

1985:

- 386 red drum were tagged
- 51 recaptures
- 54 participating anglers
- 150 tagging kits issued

1986:

- 808 red drum were tagged

- 84 recaptures
  - 161 participating anglers
  - 320 tagging kits issued
- 1987:
- 1,836 red drum were tagged
  - 3 recaptures
  - 342 participating anglers
  - 858 tagging kits issued
- 1988
- 1,652 red drum were tagged
  - 8 recaptures
  - 394 participating anglers
  - 990 tagging kits issued
- 1989:
- 2,082 red drum were tagged
  - 209 recaptures
  - 526 participating anglers
  - 1,100 tagging kits issued
- 1990:
- 1,935 red drum were tagged
  - 209 recaptures
  - 576 participating anglers
  - 1000 tagging kits issued
- 1991:
- 2,719 red drum were tagged
  - 372 recaptures
  - 937 participating anglers
  - 1,430 tagging kits issued
- 1992:
- 5,348 red drum were tagged
  - 642 recaptures
  - 1,238 participating anglers
  - 2,020 tagging kits issued
- 1993:
- 4,610 red drum were tagged
  - 729 recaptures
  - 1,192 participating anglers
  - 2,100 tagging kits issued
- 1994:
- 2,493 red drum were tagged
  - 364 recaptures
  - 819 participating anglers
  - 1550 tagging kits issued
- 1995:
- 3,346 red drum were tagged
  - 418 recaptures
  - 677 participating anglers
  - 1,950 tagging kits issued
- 1996:
- 4,638 red drum were tagged
  - 674 recaptures
  - 750 participating anglers
  - 2,170 tagging kits issued
- 1997:
- 4,920 red drum were tagged
  - 728 recaptures
  - 726 participating anglers
  - 1,983 tagging kits issued
- 1998:
- 6,028 red drum were tagged
  - 799 recaptures
  - 850 participating anglers
  - 2,717 tagging kits issued
- 1999
- 3,737 red drum were tagged
  - 615 recaptures
  - 958 participating anglers
  - 3,090 tagging kits issued
- 2000
- 2,958 red drum were tagged
  - 489 recaptures
  - 1,131 participating anglers
  - 1,596 tagging kits issued
- 2001:
- 1,861 red drum were tagged

- 298 recaptures
  - 625 participating anglers
  - 1,011 tagging kits issued
- 2002:
- 2,429 red drum were tagged
  - 274 recaptures
  - 679 participating anglers
  - 874 tagging kits issued
- 2003:
- 2,975 red drum were tagged
  - 412 recaptures
  - 627 participating anglers
  - 796 tagging kits issued
- 2004:
- 2,166 red drum were tagged
  - 356 recaptures
  - 485 participating anglers
  - 386 tagging kits issued
- 2005:
- 1,431 red drum were tagged
  - 216 recaptures
  - 313 participating anglers
  - 237 tagging kits issued
- 2006:
- 1,342 red drum were tagged
  - 263 recaptures
  - 267 participating anglers
  - 309 tagging kits issued
- 2007:
- 1,063 red drum were tagged
  - 195 recaptures
  - 140 participating anglers
  - 369 tagging kits issued

The tagging program database only has entries for fish tagging from 1978 to current. Information provided in this summary prior to 1978 tagging information was retrieved from written annual reports and the recapture entries in the database begin with 1987 and information prior to this date was also retrieved from annual reports.

**Table SC sub-adult 1.** SCDNR sub-adult red drum tagging program. Total number of fish that were tagged by the SCDNR inshore sampling program, by gear type, sample design and tag type. Tag types: 3.0BD = 3" Belly Streamer with disk; 3BDW = 3" Belly/Disk with Floy wire through; 5.5SD = 5.5" Stainless Shoulder Dart; 5.5SDW = 5.5" Stainless Shoulder Dart with wire through; 3.75ND = 3.75" Nylon Dart Tag; 1.5BD = 1.5" Belly Streamer with disk.

GEAR TYPE	SAMPLE TYPE	TAG TYPE						Total
		1.5BD	3.0BD	3.0BDW	3.75ND	5.5SD	5.5SDW	
75' FALCON TRAWL W/OUT TED	Non-Random						1	1
BOTTOM LONG LINE - 1 MILE	Non-Random						1232	1232
BOTTOM LONG LINE - 1/2 J HOOKS & 1/2 CIRCLE HOOKS	Non-Random						82	82
CAST NET	Non-Random	1	1				2	4
DIP NET	Non-Random			185		3	232	420
ELECTROFISHING	Non-Random			162			62	224
ELECTROFISHING	Random			3019			765	3784
GILL NET - MESH F - 2 1/2" STRETCH	Non-Random		19	70			79	168
GILL NET - MESH F - 2 1/2" STRETCH	Random			5				5
GILL NET - MESH G - 3" STRETCH	Non-Random		23					23
GILL NET - MESH H - 3 1/2" STRETCH	Non-Random		1					1
HOOK & LINE	Non-Random		1124	128		111	51	1414
"MARFIN" TRAMMEL NET	Non-Random		130	455		90	674	1349
"MARFIN" TRAMMEL NET	Random		110	1385		74	747	2316
SEMI - BALLOON OTTER TRAWL - 20' C NET	Non-Random			5				5
STOP NET - 366m x 3m x 51 mm stretch mesh	Non-Random	10	3653	114		788	43	4608
TRAMMEL NET - 200 YD X 8 FT - 14 & 2.5 IN STR MESH	Non-Random		1667	1368	6	1492	2769	7302
TRAMMEL NET - 200 YD X 8 FT - 14 & 2.5 IN STR MESH	Random		2566	11157	3	1800	14817	30343
		11	9294	18053	9	4358	21556	53281

**Table SC sub-adult 2.** Number of angler and SCDNR tag returns (including multiple recaptures of the same fish). Only those fish with assigned ages are included and only SCDNR returns from the three primary programs (the stop net survey from 1986-1994, the SCDNR standard trammel net survey from 1990 - present and the 'MARFIN' trammel net survey from 1986-1998).

Source	Fate	All returns	Days-at-large $\leq$ 180 since last release
Angler	Harvested	4,327	2,497
	Release with tag	4,170	2,035
	Released without tag	525	210
SCDNR	Harvested	171	95
	Release with tag	11,546	6,959
	Released without tag	11	3
		20,750	11,799

**TABLE SC Adult 1.** Total number of tagged and recaptured adult red drum from the SC long-lining survey. (Data are filtered to only include recaptures with days-at-large > 7 days).

Year tagged	Number tagged	Number recaptured at least once	Number recaptured at least twice	Number recaptured at least three times
1995	146	2		
1996	131	1	1	
1997	79	2		
1998	195	5		
1999	241	3		
2000	173	13	3	1
2001	199	20	2	
2002	365	37	6	
2003	401	28	1	
2004	224	7	3	1
2005	246	4		
2006	323	3		
2007	138	1		
2008	19			
Total:	2880	126	16	2