Ultrasonic Biotelemetry Study of Young-Adult Red Drum in Georgia July 1993 - September 1995

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ABSTRACT

INTRODUCTION

The history of red drum legislation in Georgia is relatively recent. Prior to the institution of size and creel limits, over 70% of the red drum being landed in Georgia were less than 14 inches in length with the average weight of approximately 0.75 pounds, and over 60% of the total harvest was landed between June-September (Pafford and Nicholson 1989). In March 1986, a creel size of 14 inches and a possession limit on adult red drum of 2 fish greater than 32 inches was instituted. Implementation of these regulations was designed to improve the yield from the red drum fishery, enhance survival to adulthood, and protect the existing adult stock. This early legislation was a matter of controversy among anglers and marine businesses. Subsequent evaluation of the effect of the size and creel limits established that the average weight of red drum landed had increased to over 3.0 pounds, however, there was no indication that survival to adulthood had increased. Furthermore, the change in size limits had only delayed harvest such that the majority of the catch now occurred in the September-December period.

In September 1989, authority to establish seasons, daily creel limits, and minimum size limits was given to the Georgia Department of Natural Resources (GADNR) Board of Natural Resources through passage of Act 644. Act 644 addresses the need for the State to be more responsive to a comprehensive list of species managed through the various interstate commissions and councils. In respect to red drum, the new law provided for harvesting year round, maintained the minimum size of 14 inches, and established a creel limit of 10 fish per person, of which only 2 could be greater than 32 inches.

On-going fishery independent investigations (Pafford, et.al. 1990), and regional

stock assessments (Vaughan and Helser 1989) determined that red drum stocks were still overfished and that further harvest restrictions were needed to reverse the apparent decline of Georgia's red drum stock. In August 1991, the daily creel limit was reduced to 5 fish per person, and in an effort to provide more protection to adult stocks, only one of which could be greater than 27 inches. In order to close a legal loop hole, a possession limit of 5 was declared in August 1992. Lastly, to be in compliance with Amendment One to the Atlantic States Marine Fisheries Commission's (ASMFC) Fishery Management Plan for Red Drum, the harvest of fish over 27 inches was prohibited in April 1994.

Management of red drum in the South Atlantic Bight is directed by the Red Drum Plan Development Team (RDPDT), an interstate body consisting of the ASMFC and the South Atlantic Fishery Management Council (SAFMC). The various member states provide input into the plan, which includes periodic stock assessments performed by the National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (Vaughan and Helser 1990; Vaughan 1992; Vaughan 1993; and Vaughan 1995).

Recognizing the importance of healthy red drum stocks, states throughout the southeast are conducting both fishery-dependent and -independent studies to provide the best possible information for the stock assessments. One area of concern to the stock assessment scientists is the bias caused by emigration from the inshore fishery.

In Georgia, as red drum mature, they leave the estuary and join the spawning stocks in the nearshore ocean waters. However, this emigration is poorly understood. While some young adults (age 3-5) have been collected in association with older individuals, the possibility exists that these younger fish are temporally and/or spatially segregated from the remainder of the spawning stock. Partial or incomplete recruitment

to the spawning stock could bias ongoing red drum monitoring efforts. Additionally, emigration of red drum from inshore waters may be distorting the results of age-structured assessments.

> Individuals which emigrate (E) are credited as removals from the population, falsely inflating the estimates of both total mortality (Z) and fishing mortality (F). Since red drum are virtually unexploited as adults, it is extremely difficult to measure the effects of emigration on the assessment model. Therefore, the disappearance rate of red drum from the inshore fishery is a function of the additive effects of F + M + E. The effects of emigration, until quantified, will remain a source of bias in the assessment of South Atlantic Bight red drum (Woodward, MARFIN proposal, 1994).

Recent efforts to document the movement and migration of adult red drum in Georgia using ultrasonic biotelemetry provided valuable insight into the life history of this important resource (Nicholson and Jordan 1994). Given the importance of emigration in red drum life history, investigators with the GADNR, Coastal Resources Division, designed a biotelemetry investigation with the following objectives:

- To telemeter sub-adult and young adult red drum captured in both estuarine and/or nearshore ocean waters;
- To determine periodicity of emigration and seasonal distributions; and,
- To determine if young-adult red drum (Age 5-12) are spatially and/or temporally segregated from the rest of the adult population.

METHODS

Description of Study Area

The coastal area of Georgia lies within the western most portion of the Blake Plateau of the North Atlantic Ocean and is approximately 160 km in length (Figure 1). It is composed of a series of bar-built estuaries with a total of 14 major barrier islands. Distance between major tidal inlets ranges from 4-28 km and the barrier islands are separated from the mainland by a 5-10 km band of marsh with a tidal amplitude that ranges from 1.8 to 2.4 m. During spring and fall, astronomical tides, when augmented by easterly winds, may exceed three meters. Monthly mean surface water temperatures vary from 7-33^{o}C annually. Extremely cold winters can result in estuarine water temperatures below 5^{o}C and mortalities of species such as penaeid shrimp and Sciaenids.

The study area centered around the Altamaha estuary and offshore waters within 35 km. The Altamaha estuarine system is located between Glynn and McIntosh counties near the city of Darien. The Altamaha River originates in the piedmont of Georgia and forms a broad delta at the interface with the Atlantic Ocean. This delta is dissected by numerous tidal rivers and creeks which are subject to considerable changes in salinity and temperature due to the influence of the Altamaha River, which has an average annual discharge of 14,000 cfs.

The offshore waters of Georgia consist mainly of gently sloping sand with widely dispersed areas of exposed limestone rock. Particle size of sediments range from clay to fine sand with scattered limestone rock outcroppings occurring offshore primarily beyond 18 km.

Collection Methods

Move

Figure 1. Coastal area of Georgia indicating nine major sound systems.

Red drum implanted with ultrasonic transmitters were collected primarily using conventional hook and line fishing gear from outer shoals and sand bars. Angling was conducted utilizing 9-12' fiberglass fishing rods, either a spinning or bait casting reel, 25 pound test monofilament line, and terminal tackle consisting of a "fish finder" rig (sliding sinker), a short leader (2-3') and a #13 circle hook with closed barb. Circle hooks reduced the number of missed hookups from misjudging when to set the hook and allowed a single angler to fish several rods when used in combination with rod holders (sand spikes). Fresh cut bait consisting of either striped mullet (*Mugil cephalus*) or menhaden (*Brevoortia tyrannus*) was most often used. Red drum were either held in a holding ring or strung through the lower jaw and secured to a stake in ambient water until tagging. All sampling was conducted during daylight hours.

Inshore sampling was conducted using a monofilament trammel net with an inner panel of 7.0 cm stretched mesh and an outer panel of 30.5 cm stretched mesh. A typical trammel net set consisted of setting one end of the net as close to the shore as water depth allowed, and deploying the net perpendicular to the shore for approximately 30 m, then turning upcurrent for the length of the net. The upcurrent area of the net was struck with noise to drive fish into the net. Duration of sets were approximately 30 minutes each. Red drum were placed in a holding ring in ambient water until implant surgery.

Environmental data recorded for each collection included: salinity (ppt); surface water temperature (^{o}C); moon phase; and wind direction and velocity (mph).

Equipment and Tagging Procedure

Biotelemetry equipment consisted of a coded high power ultrasonic transmitter (tag), a directional hydrophone, and a wide band ultrasonic receiver (30-100 kHz)

manufactured by Sonotronics Inc., Tucson, AZ. Each tag had a unique code allowing for the positive identification of an individual fish. The tag measured 18 x 100 mm, weighed 12.0 g, and was neutrally buoyant. The tag, encased in a section of polyvinylchloride (PVC) pipe, was equipped with a magnetic reed on/off switch and had a lithium battery with a two-year life expectancy. To improve transmission range and reduce environmental interference, the tags were set to operate on a frequency of 35 kHz. Information on factors affecting transmission range and reception are discussed in Nicholson and Jordan, 1994.

Red drum are an extremely fast growing species during their first three or four years of life. It is not uncommon for a red drum to average growing 25.0 mm per month during this period (Wenner, 1992). However, once they reach sexual maturity, this growth rate slows considerably. As a result it is extremely difficult to determine a red drum's age by length alone. In order to target young adult red drum (age 4-10) for this study, data by Pafford et. al. (1990) and more recently by Woodward (1994) determined that a size range of 750 mm to 900 mm in combination with a head girth of less than 500 mm would account for 87% of the fish being in the 4-10 year age class. In order to target the lower end of the year class, it was decided to target fish with a head girth of less than 450 mm (head girth was measured from the top of the opercular aperture around the skull with the operculum in a closed position).

Surgical implant procedures were as discussed by Winter (1983), with a modified suturing methodology. Recent advances in biological adhesives suggested experimenting with "bio-glue" for closing the insertion site. Previous experimentation with implant procedures on adult red drum in Georgia (Nicholson and Jordan, 1994) determined that

an unsutured insertion site would close in as little as 48 hours. However, it was not known if the younger, smaller red drum would exhibit the same rapid healing. In checking with local veterinarians, a "super-glue" type product (Vetbond, Animal Care Products - 3M Company) was available and had been used successfully on a variety of animals (Gruber 1995; Kermeen 1995; and Goldstein 1995).

Upon implant of the transmitter, the incision was blotted dry with a clean paper towel. Approximately three drops of bio-glue were then applied to the outer edges of the incision, which was then pinched and held closed for approximately five seconds. This was usually sufficient to close the incision site, however, in some instances (usually when the incision wasn't sufficiently dry) it was necessary to repeat the procedure.

Plastic tipped dart tags (PDB-T) manufactured by Hallprint Ltd. of Australia were used to externally mark red drum. The yellow PDB-T dart tags (125 mm) were constructed from a solid plastic core molded to a plastic barbed head. The streamer or marker portion containing the legend was covered by a fused layer of clear polyethylene. The dart tag included a unique five digit number and the following legend: "$REWARD$-RETURN TO: DEPT. NAT. RES. CRD 1 CONSERVATION WAY, BRUNSWICK, GA 31523". Insertion of the dart tag followed the method of Qualia (1987).

Tracking Methods

A systematic tracking method covering over 400 nm^2 was devised to relocate telemetered red drum. To take advantage of season, personnel availability, climatic conditions and the area believed to have a high probability of locating telemetered red drum, the search area was divided into four distinct zones. The first priority zone (Figure

2) consisted of offshore locations where previous efforts had located telemetered red drum or where fishermen had reported catching or sighting schools of red drum in offshore waters. In most instances these "hot spots" were at or near artificial reefs, natural reefs or in areas where tidal rips set up. As in previous biotelemetry tracking efforts (Nicholson and Jordan 1994), when traveling between designated stations any sign of large fish on the research vessel's fish finder or actively feeding birds was investigated. If an unscheduled stop failed to locate a tagged fish, then the original course was resumed. First priority stations were checked monthly.

At each station, the vessel was brought to a complete stop and the hydrophone was lowered into the water. A full 360^{o} scan was made while listening for coded ultrasonic signals. When conditions were poor for reception of ultrasonic signals, several attempts to listen for signals were made in the vicinity of the site to assure sufficient coverage of the designated site.

The second priority zone (Figure 3) consisted of a single transect adjacent to the beach and outer shoals. This 76 km beach transect ranged from Christmas Creek (between Cumberland and Little Cumberland Islands) in the south to McQueen's Inlet (off St. Catherin's Island) in the north. For long stretches of beach between shoal and channel areas, listening stations were spaced approximately 1.75 km apart. Multiple listening attempts were made around shoal and outer sand bar areas (high energy surf areas) to insure coverage in areas where red drum were known to congregate. Second priority stations were scheduled to be checked upon completion of first priority zone stations.

The third priority zone (Figure 4) covered the major inshore portion of the Altamaha delta. This approximate 60 km area extended from Lewis Creek in the

Fig 2. First priority zone stations.

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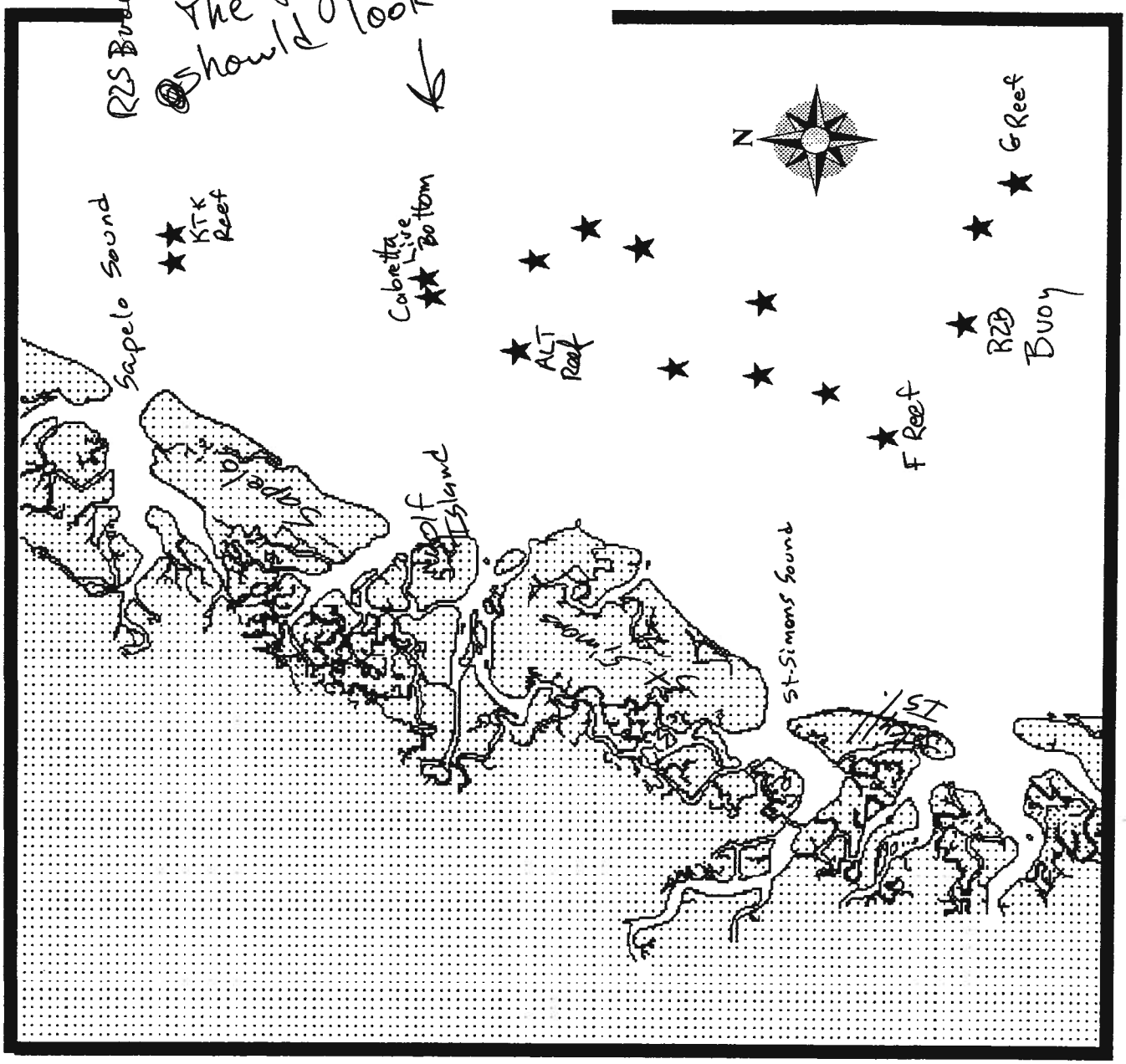

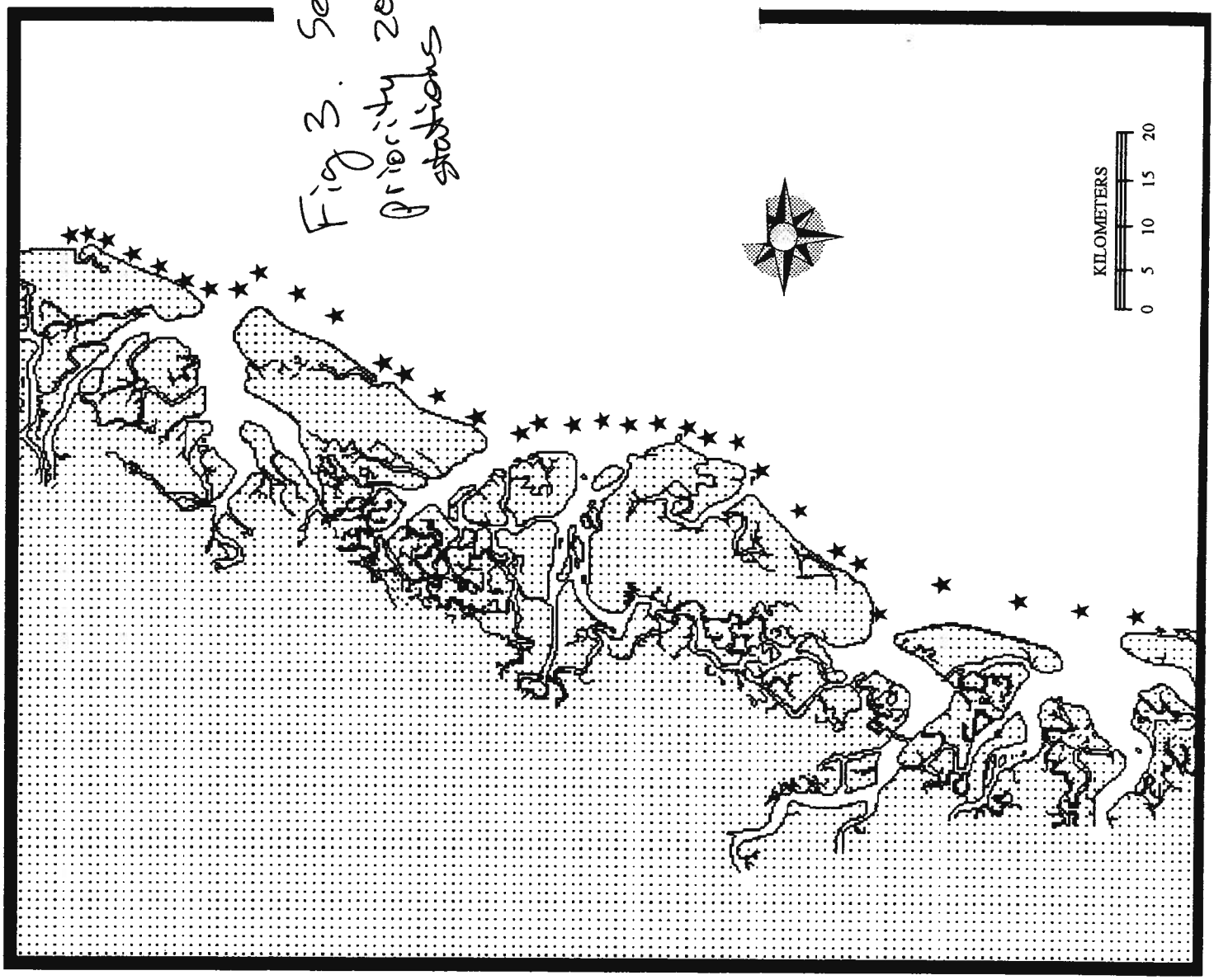

Fig 3. Second priority zone stations

Altamaha River out to the sound/ocean interface in Altamaha channel. Included in this area is the South Altamaha River, portions of the Darien and Butler Rivers, Hammersmith and Dents Creek, and Champney River. Listening stops were much closer in these inshore areas due to limitations in reception of ultrasonic signals (high current velocities, line-of-sight, high volume of particulate matter, etc.). In order to have maximum reception range, this area was tracked only during mean high or low tide. Consequently, it required two days to cover the entire area. Third priority stations were scheduled to be checked upon completion of first and second priority zones, or when conditions were unsuitable for open ocean tracking yet coupled with favorable tidal conditions such that inshore tracking could be effectively performed.

The fourth priority zone (Figure 5) consisted of eight linear transects ranging from St. Simons Sound in the south to Sapelo Sound in the north and east to U.S. Coast Guard navigation buoys "R2B" and "R2S", respectively. Listening stops were approximately 3.5 km apart along each transect line, and as in first priority zone tracking, any indication of fish activity was also investigated. Upon completion of any extra investigation, the original transect course and listening stops was resumed. Fourth priority zone transects were performed on a conditional basis. Once first and second priority zone tracking was completed, and weather conditions permitted offshore tracking activities, fourth priority zone tracking was initiated. In any given month if all eight linear transects were not completed, then in the following month when first and second priority zone tracking was completed, fourth priority tracking was resumed at the last location checked and continued until all eight transects were completed.

RESULTS AND DISCUSSION

A total of 31 red drum were implanted with ultrasonic transmitters from September 1993 through February 1995. A total of 25.8% of the sub- and young adult red drum telemetered were relocated at least once during the study period, as compared to over 66% in the previous telemetry study on adults (Nicholson and Jordan, 1994). One red drum (8.3%) was relocated from the 1993 releases, and that occurred only 8 days following its implant. This individual was relocated a second time 7 days later. Of the 1994 releases, 41.2% were relocated, but again, the majority of relocations were within a month following their implant. As the majority of young adult red drum were implanted during the fall, it is not surprising that 58.3% of the relocations occurred during the September-November period. The one fish tagged in 1995 was a result of a return of a transmitter by an angler that was then implanted in a second young adult red drum at an inshore location. The collection of red drum in association with telemetered fish had limited success. The following provides information on activities and observations that occurred throughout the study period.

Study Year 1993

Twenty young adult red drum were targeted for implant for the first year's telemetry efforts. A total of 12 fish were implanted with ultrasonic transmitters from beach, shoal and offshore areas associated with the Altamaha River delta during 1993 (Figure 6). These fish ranged in size from 798 to 910 mm FL with head girth sizes ranging from 415 to 495 mm (Table 1). Since 1988, only 19.0% of the September-December red drum sampled in Georgia have been in the 750 to 900 mm FL size range. Since 1989, only 5.1% of the September-December red drum sampled in Georgia that

were greater than 750 mm FL have had head girth sizes less than 450 mm. In order to maximize the number of fish implanted, head girth sizes were increased, but kept less than 500 mm. Eight young adult red drum were implanted from the Altamaha delta between September 24 through October 20, while four were implanted in December from locations offshore the Altamaha delta.

Table 1. Meristic, catch information and fish identifier of 1993 telemetered red drum.

DATE	FORK LENGTH/ HEAD GIRTH (mm)	FISH IDENTIFIER	LOCATION CAPTURED
09/24	828 / 435	93-1	Wolf Island Shoal
10/04	848 / 455	93-2	Wolf Island Shoal
10/04	850 / 426	93-3	Wolf Island Shoal
10/04	798 / 415	93-4	Wolf Island Shoal
10/04	866 / 447	93-5	Wolf Island Shoal
10/19	910 / 420	93-6	Pelican Spit
10/19	850 / 435	93-7	Wolf Island Shoal
10/20	790 / 420	93-8	Wolf Island Shoal
12/06	870 / 475	93-9	Artificial Reef ALT
12/06	840 / 445	93-10	Artificial Reef ALT
12/08	860 / 495	93-11	Cabretta Live Bottom
12/08	868 / 480	93-12	Cabretta Live Bottom

July - September 1993

Most of the study activities during this period in 1993 consisted primarily of purchasing equipment and supplies necessary to conduct the study. Field activities were conducted during this period to detect telemetered adults from the previous study and to provide adult-size red drum for other sport fish restoration investigations. In addition, a systematic tracking methodology was devised and tested in anticipation of initiating

tracking in 1994. The first transmitter was implanted in a young adult red drum at Wolf Island Shoal on September 24.

October - December 1993

Four young adult red drum were implanted from Wolf Island Shoal on October 4. On October 19, one was implanted at Pelican Spit and one was implanted at Wolf Island Shoal. On October 20, one fish was implanted from Wolf Island Shoal. There were no fish implanted in November. On December 6, two young adult red drum were implanted at Artificial Reef ALT, approximately 8.8 km east of Altamaha Sound. On December 8, the final two implants of 1993 occurred at Cabretta Bottom, a natural reef located approximately 21.2 km ENE of Altamaha Sound.

Tracking efforts during this period were kept to a minimum in order to maximize field efforts directed at capturing individuals for implant. However, when tide and conditions were suitable, tracking operations were performed enroute to and/or from sampling sites. During October, beach transects were performed from Gould's Inlet to Wolf Island Shoal, and through the inshore area of the Altamaha Sound. In November, tracking was performed in the inshore area of Altamaha Sound as well as spot checks offshore at Artificial Reef ALT. In December, first priority zone stations were performed offshore, as well as third priority zone stations in the lower Altamaha Sound area.

During this period, one telemetered young adult red drum was relocated (Figure 7). On October 27, a telemetered fish was detected at the mouth of the South Altamaha River, 12.4 km upriver from its release location. This fish had been at large for 8 days. It was relocated a second time 7 days later (November 3), only this time to have moved

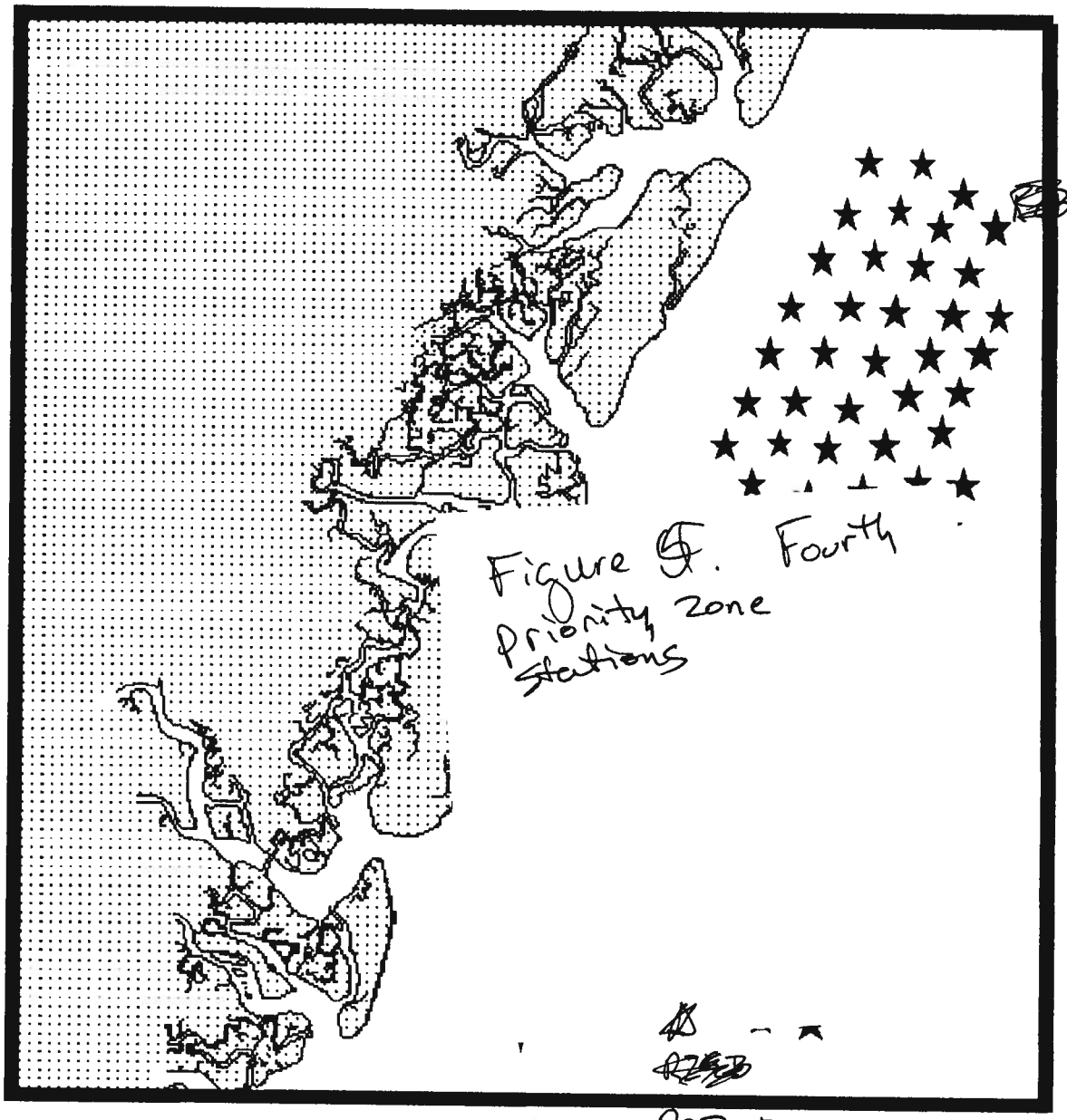

Figure 5. Fourth Priority Zone Stations

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10.6 km downstream to the Altamaha Channel. There were no telemetered red drum located during December.

Study Year 1994

A total of 18 sub- and young adult red drum were implanted with ultrasonic transmitters during 1994 from inshore, beach and shoal, and offshore areas (Figure 8). These fish ranged in size from 594 to 885 mm FL with head girth sizes from 290 to 450 mm (Table 2) and were released from Altamaha and St. Simons Sounds and offshore at Artificial Reef G. Offshore implants in 1994 were a unique opportunity to collect information on the movements of sub-adult red drum utilizing Georgia's offshore waters. One young adult red drum from St. Simons Sound was implanted in February. Five sub-adult red drum were implanted at Artificial Reef G in June. The remaining 12 young adult drum were implanted in September/October from the Altamaha delta area. Five of the 1994 implanted fish were relocated during the course of the year. There were no relocations of 1993 implanted fish.

January - March 1994

There were no relocations of implanted fish in the January-March period. Tracking activities (Figure 9) during this period consisted of checking first priority zone stations offshore, spot checks at Gray's Reef National Marine Sanctuary (GRS) and Navy Tower R5, beach checks from Pelican Spit to St. Simons Sound, inshore runs of fourth

Table 2. Meristic, catch information and fish identifier of 1994 and 1995 telemetered red drum.

DATE	FORK LENGTH / HEAD GIRTH(mm)	FISH IDENTIFIER	LOCATION CAPTURED
02/04/94	752 / 390	94-1	Jekyll Island Flat
06/06/94	675 / 320	94-2	Artificial Reef G
06/06/94	602 / 295	94-3	Artificial Reef G
06/06/94	707 / 315	94-4	Artificial Reef G
06/06/94	700 / 340	94-5	Artificial Reef G
06/14/94	594 / 290	94-6	Artificial Reef G
09/23/94	840 / 430	94-7	Rainbow Shoal
09/23/94	820 / 440	94-8	Rainbow Shoal
09/23/94	840 / 440	94-9	Rainbow Shoal
09/23/94	820 / 430	94-10	Rainbow Shoal
10/14/94	820 / 442	94-11	Rainbow Shoal
10/15/94	805 / 448	94-12	Rainbow Shoal
10/15/94	815 / 450	94-13	Rainbow Shoal
10/15/94	865 / 450	94-14	Wolf Island Shoal
10/17/94	827 / 434	94-15	Wolf Island Shoal
10/18/94	770 / 410	94-16	Wolf Island Shoal
10/28/94	885 / 450	94-17	Rainbow Shoal
02/16/95	825 / 445	95-01	Fog Point

priority zone stations including the Hampton River/Gould's Inlet areas, and spot checks in St. Simons Sound around a large school of red drum in the Jekyll Creek area. Attempts to capture suitable individuals for implant from this large school of red drum produced no appropriate sized individuals.

April - June 1994

There were no relocations of implanted fish during the April-June period. Monthly systematic tracking operations were initiated. All first, second and third priority zone stations were completed in April, including a complete run of all fourth priority zone

transects. In addition, following up on a report from an angler who caught an adult red drum while offshore fishing, a transect was run from GRS to Navy Tower R5, stopping every two nautical miles to listen for telemetered fish between these locations.

First and second priority zone stations were completed in May. Unanticipated personnel assignments resulted in third priority zone stations being performed only in the lower portion of the Altamaha Sound. A portion of the fourth priority zone transects were also completed. On the last day of the month, a power head on the motor of the research vessel went out, requiring extensive down time for repairs.

By mid-June, the research vessel was repaired and tracking operations were resumed. While first priority zone sampling, an angler reported catching red drum at Artificial Reef G. Sampling in the vicinity resulted in the capture of several sub-adult red drum. Recognizing that this was a unique opportunity to document critical life history information that parallels the need for more information on emigration and movement of this life history stage in Georgia's offshore waters, six sub-adult red drum were implanted with ultrasonic transmitters and released. Upon release, one red drum was observed to have been cut in half by a large barracuda before reaching the relative safety of the bottom. The transmitter was observed to have been expelled from the abdominal cavity and settle to the bottom. Attempts to recover this transmitter utilizing SCUBA were unsuccessful.

In addition to the above field activities, interviews were held to hire a marine technician to assist in field operations. Hiring this technician would alleviate logistical problems associated with personnel scheduling.

<u>July - September 1994</u>

The first relocations of 1994 occurred during this sampling period (Figure 10). Tracking operations and relocations were hindered by the record flooding caused by Tropical Storms Alberto and Beryl in July and August, respectively. During the period July 3-7, 1994, Tropical Storm Alberto moved northward from the Gulf of Mexico, across the Florida panhandle, and into parts of southwestern and central Georgia. Parts of central and southwest Georgia received as much as 28 inches of rainfall during the storm. The storm generated 410 billion gallons of runoff in the Ocmulgee River upstream of Lumber City (which feeds into the Altamaha). At a time when the river stage is normally very low, the Altamaha River in the coastal zone remained above a 10 foot river stage throughout the summer and fall (Hippe et.al. 1995).

First and second priority zone stations were completed, as well as the lower sound portion of third priority zone stations in July. In August, all first, second, third and fourth priority stations were completed. In addition to the above, spot checks were performed in the Hampton River from Buttermilk Sound to Pelican Spit; in the Satilla River from the St. Andrew Sound to White Oak Creek; and in St. Catherin's Sound from Yellow Bluff to Shad Island (Figure 11). In September, tracking operations covered all first, second and third priority stations.

The first relocation of a 1994 implanted fish came in September while performing first priority zone tracking operations. One of the sub-adult red drum that had been implanted in June was found to be back at the initial release site (Artificial Reef G). This fish had been at large for 56 days. A possible second fish was heard, however, due to its proximity to the reef structure and confusion due to interference from the transmitter

that wasn't recovered at this site, positive identification of the existance of a second fish could not be determined.

The second relocation of a 1994 implanted fish occurred during third priority zone sampling operations in Altamaha Sound. Three recently implanted young adult red drum were located in a 2.7 km stretch of river in the vicinity of the mouth of the South Altamaha River. All three fish had been implanted on September 23 and released from Rainbow Shoal, then relocated seven days later on September 30, approximately 16 km upriver from their release site. Tide stage was inappropriate for sampling in the vicinity of these relocations.

October - December 1994

All first, second and third priority zone sampling operations as well as a portion of the fourth priority zone transects were completed in October. While performing fourth priority zone transects, one recently implanted red drum was relocated. This fish had been implanted on October 15 at Rainbow Shoal and was relocated offshore nine days later approximately 19.4 km NNE of its release site. This fish was relocated a second time 16 days later (October 31) 12.4 km SSE of its release site and 24.1 km S of its first relocation (Figure 12). Efforts to determine if other red drum were in association with this individual were not successful.

All second and third priority zone stations were completed in November. There were no relocations of telemetered fish. In December all first, second and third priority zone stations were checked. There were no relocations of telemetered fish. As the last known movement from a telemetered red drum had been to the south, it was decided to spot check various locations south of the systematic tracking area. Additional areas

checked included Artificial Reefs A, C and KBY and the St. Mary's Jetties and Channel (Figure 13).

Study Year 1995

One young adult red drum was implanted with an ultrasonic transmitter during 1995 from an inshore area (Figure 14). This fish was 825 mm FL with a head girth of 445 mm and was implanted at an area between St. Simons and Buttermilk Sounds. There were no relocations of 1993 implanted fish. Three of the 1994 telemetered fish were relocated. The 1995 telemetered fish was relocated in the release vicinity for almost two months.

January - March 1995

Information on young adult red drum occurred almost monthly during this sampling period. The first angler return of a telemetered red drum occurred in January. A red drum that had been implanted in October 1994 at Wolf Island Shoal was relocated at Artificial Reef G in February. A red drum implanted at Fog Point (an inshore area between St. Simons and Buttermilk Sounds) in February, was relocated almost weekly at the release site (Figure 15).

Tracking operations in January included all first, second and third priority zone stations. Fourth priority zone transects were conducted and three legs were completed. In addition to systematic tracking, attempts to locate telemetered red drum were continued south of the systematic tracking area. Areas checked included Artificial Reefs A, C, and KBY; and St. Mary's Jetties and Channel (Figure 16). There were no relocations of telemetered fish in January, however, an angler reported recovering a dead red drum while fishing from a bridge in Titusville, FL. He reported that the fish appeared to have been

struck by a boat propeller and was in such a state of decay that when he dipped it up and dropped it on the bridge deck, the abdominal cavity split open, expelling the transmitter. This fish had been tagged at Wolf Island Shoal in October 1994, had been at large for 86 days and was recovered 296.9 km south of Wolf Island. The angler returned the transmitter which was readied for use in another red drum.

Considering the low frequency of relocations associated with this study, this tag return caused considerable speculation on the movement of these young-adult red drum. While the 1994-1995 winter had not produced any sudden, severe freezes, it had been a particularly cold year, generating sustained water temperatures below the 10°C mark. It was theorized that the record flooding in the Altamaha delta, coupled with the cold water temperature might have resulted in movement farther than normal. However, in previous red drum tagging studies in Georgia (Pafford, et.al. 1990 and Woodward, et. al. 1994), a small percentage of all tag returns exhibited movement greater than 30 km. There being no other evidence to support that this movement was typical of large numbers of young-adult red drum, it was assumed that this red drum would be classified as one of the few that do exhibit movement outside its home range.

Systematic tracking in February covered all first, second and third priority zone stations and spot checks south of the systematic tracking area at Artificial Reef A. In the course of regular program activities, spot checks were also performed in the vicinity of the recently implanted fish at Fog Point. Relocation of this recently implanted fish occurred almost weekly in the vicinity of Fog Point throughout the month. In addition to the inshore relocation, a second red drum was relocated during this month. This fish had been tagged at Wolf Island Shoal in October and was relocated at Artificial Reef G.

It had been at large for 123 days and was relocated approximately 44.6 km ESE from its release site. A possible second transmitter was heard, however, due to its proximity to the reef structure and rapidly deteriorating weather conditions, positive confirmation of this signal was not made. The fish that had been positively identified was relocated a second time six days later, still at Artificial Reef G. Efforts to capture other fish in association with this red drum resulted in the capture of three fish whose lengths were between 700-750 mm FL with head girths less than 450 mm. These fish were tagged with external dart tags and released as part of Georgia's Annual Assessment of Red Drum Exploitation and Stock Structure (Study XXII).

All first, second and third priority zone stations were checked in March. The same red drum last located at Artificial Reef G was found there again during this sampling period, 35 days after its previous relocation at that same site. Efforts to sample for other red drum in the vicinity were unsuccessful. In addition, the red drum at Fog Point continued to remain in the vicinity throughout the month. A possible third red drum was heard at Wolf Island Shoal while performing second priority zone operations, however, due to the dynamics of this area, positive identification of this telemetry signal could not be determined.

April - June 1995

Relocations of telemetered fish continued into this sampling quarter with fish being found both offshore and along the beach (Figure 17). The telemetered red drum that had been consistently relocated since implant at the inshore location (Fog Point) moved and was not relocated again. The telemetered red drum found in February and March at Artificial Reef G was again relocated at Artificial Reef G in May. A telemetered red

drum was located along the beach near the south point of Wolf Island in May and June.

Systematic tracking operations covered all first, second and third priority zone stations in April and May. As previous tracking operations indicated adult red drum returned to the beach and shoal areas in spring, additional checks were performed in the vicinity of the Altamaha delta in May and June. Hurricane Allison interrupted systematic sampling in June resulting in missing three stops of the first priority zone stations, however, all second and third priority zone stations were completed. Fourth priority zone stations were not sampled during this period.

There were no relocations of telemetered red drum during April. The first relocation of a red drum in May occurred offshore at Artificial Reef G. The same fish that had been relocated there in February and March was found a third time at Artificial Reef G. Due to the congestion of other boats and anglers utilizing the reef, no effort was made to sample for red drum in association with this fish. It had been 39 days since it was last relocated and had been at large for a total of 203 days since implant.

The second relocation of a telemetered red drum occurred while performing third priority zone transects in the inshore area of the Altamaha delta. The red drum that had been implanted at Rainbow Shoal in October 1994 and relocated twice offshore in October 1994, was relocated a third time on May 16 at the southeastern tip of Wolf Island. It had been 197 days since it was last relocated and had been at large for a total of 213 days since implant. Due to the tide stage, sampling in the vicinity of this relocation was not possible. The following day, while this fish was not relocated, trammel net sampling at this site failed to capture any red drum. Spot checks in this area the following week failed to produce further relocations of this fish. However, on May

30, this signal was again picked up near its the previous relocation (this time beyond the point of an oyster reef and just past a sand bar). Intensive trammel net sampling in the vicinity of this signal failed to produce any red drum. It was curious in that the trammel net sampling and noise associated with the research vessel in the vicinity of this signal did not result in any movement or evasive activity associated with this telemetered red drum.

The only relocation of telemetered red drum in June was the fish at the southeastern tip of Wolf Island. It was found at the exact same spot on June 2, 8, 15 and 18. As a result of the consistency of relocations at the same site and lack of evasive movement associated with this relocation, it was assumed that the telemetered red drum had for some unknown reason died and the transmitter ended up at this site. Conversations with local charter boat captains and fishermen who frequent this fishing drop revealed that some large red drum were caught off the oyster reef in May and released. It was theorized that the red drum in question could have been gut-hooked, and died as a result of attempting to remove the hook. As the fish in question was obviously larger than legal size limits, it was released. In regards to the fish having an external dart tag, it is not uncommon for anglers to not notice tags until filleting the fish.

July - September 1995

The summer of 1995 was a record setting hurricane season being the second most active season in 125 years. While the Georgia coast was spared landfall during the 1995 hurricane season, winds and weather effected systematic tracking operations, particularly in August and September.

Systematic tracking operations in July went smoothly, with all first, second, third and a portion of fourth priority zone stations completed. In August, only third priority zone stations were completed in their entirety. One stop of first priority zone stations was missed (near navigation buoy R2S), and only half of the second priority zone stations were finished (missing coverage from Rainbow Shoal to McQueen's Inlet). There were no fourth priority zone stations sampled. In September, all first, second, and third priority zone stations were completed. Again, there were no fourth priority zone stations sampled. The only relocation for this sampling period was the red drum assumed dead off the southeastern tip of Wolf Island.

Following the significant storm surge created by Hurricane Allison's movement offshore in June, the ultrasonic signal from the southeastern tip of Wolf Island was no longer heard. It was assumed the carcass of the red drum had either decomposed, or been consumed by scavengers and the transmitter was buried in sand and could no longer be heard. However, in early July, weak signals from this transmitter were picked up approximately 0.3 km NE of its previous location. It was assumed that the recent severe weather had moved the transmitter to this new location. No effort was made to sample in the vicinity of this new location and no further effort was made to track this transmitter's movement. There were no relocations of telemetered young-adult or sub-adult red drum in August or September.

CONCLUSIONS AND RECOMMENDATIONS

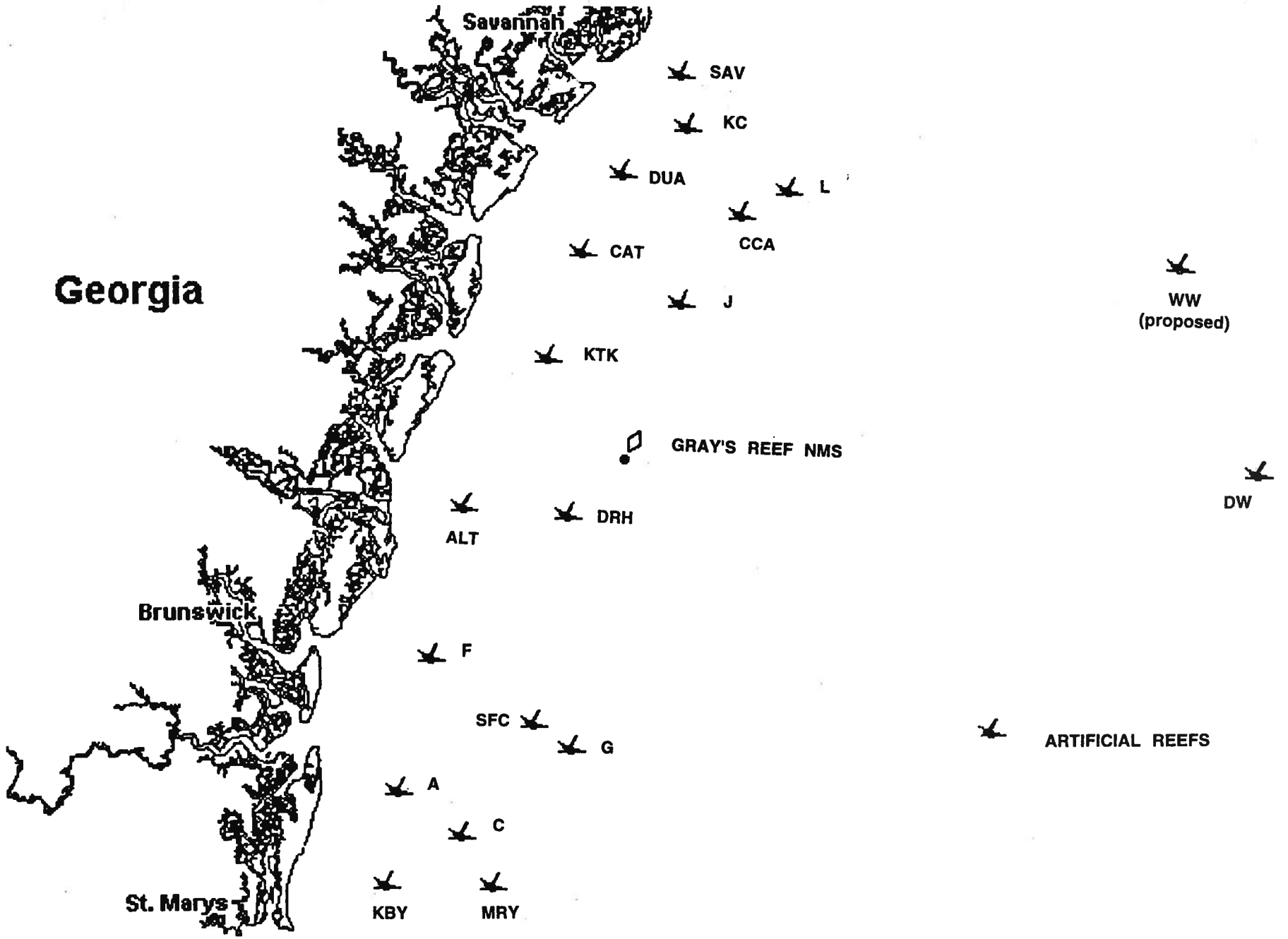
As in the previous telemetry study on adult red drum in Georgia (Nicholson and Jordan 1994), young-adult red drum were found to exhibit similar movement patterns and seasonality of occurrence. Young-adult red drum implanted in the early fall from beach and shoal areas were found utilizing upriver sites in the Altamaha delta in that same season. In winter, young-adult red drum were located offshore, only to return to the beach and shoal areas in the spring. The 297 km movement of one red drum found by an angler off Titusville, FL, is at this time assumed to be a normal occurrence exhibited by a few individuals as found in other red drum tagging studies (Woodward 1994 and Pafford et.al. 1990). The sub-adult red drum tagged at the offshore artificial reef had a similar pattern of use as the young-adult red drum tagged at the inshore site. They both exhibited some fidelity to the release site for a period of several months then moving elsewhere.

The record setting flood and hurricane season of 1994 and 1995, respectively, coupled with the difficulty in obtaining sufficient numbers of individuals for tracking operations had an impact on study results. The 8.3% relocation rate of 1993 implanted young-adult red drum, as compared to the 41.2% relocation rate of 1994 implanted young and sub-adult red drum was probably more influenced by the low number of fish implanted in 1993 than by the climatic factors. In designing this study, an annual sample of 20 implanted fish was targeted. Unfortunately, the fall 1993 sampling season did not yield target numbers of young-adult red drum. Just how much of an effect the flood of 1994 impacted the movement and seasonality of occurrence of 1993 implanted red drum can't be determined.

Insufficient numbers of individuals were captured in association with the telemetered red drum to determine if the young or sub-adult red drum were spatially or temporally segregated from the adult stocks. On several occasions, although reports were received from anglers that red drum were being caught at certain offshore locations, the systematic tracking methodology required checking in other areas. In order to address this and future telemetry studies it is recommended that:

1- a dedicated study of offshore red drum stocks be performed; this study to include an age profile of offshore stocks to be compared with the current age profile of fall run adult stocks from the beach and shoal areas;

2- a telemetry study of spawning adult red drum to determine spawning sites and fidelity to spawning sites.



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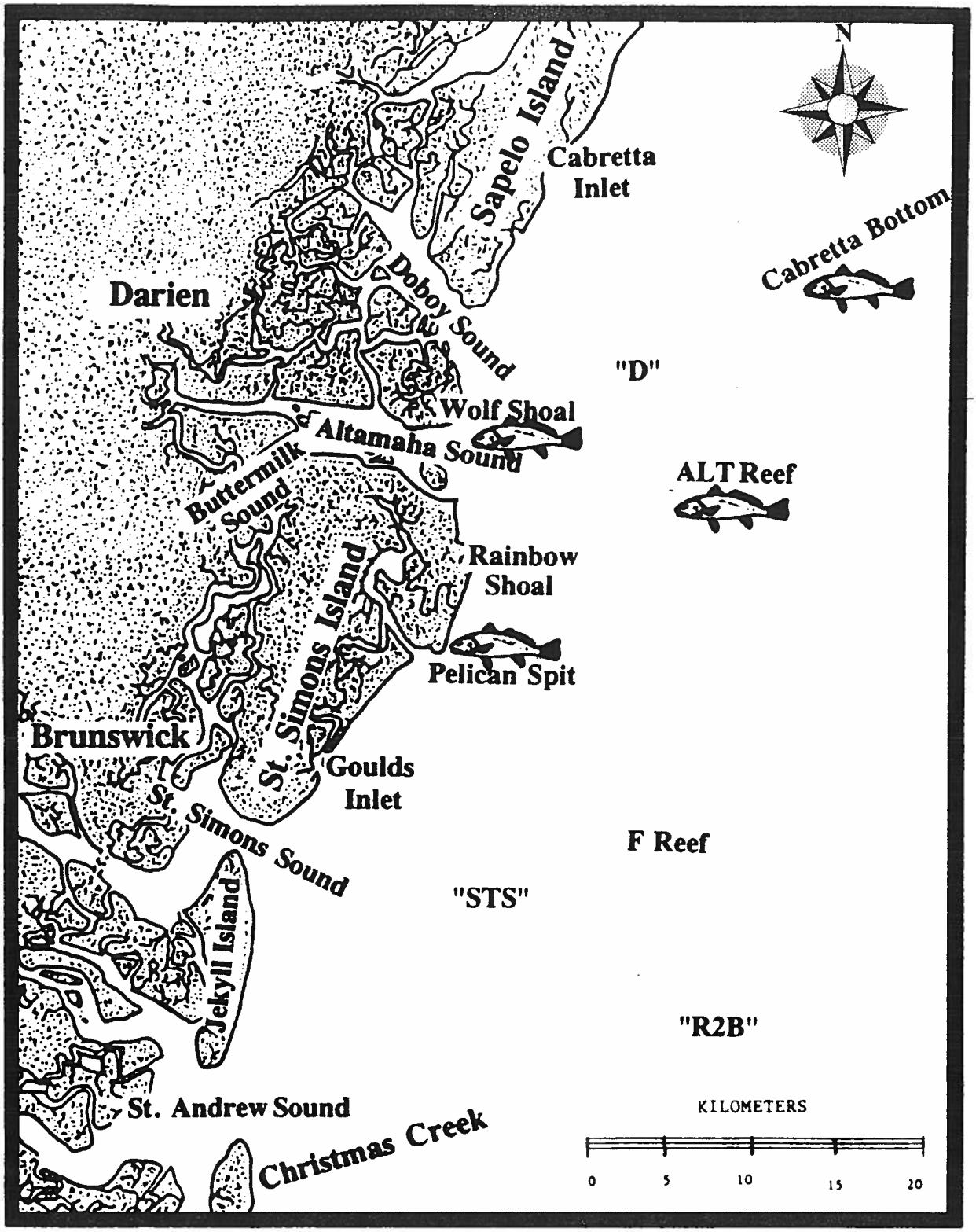

Figure 6. Telemetered sub- and young adult red drum release locations in Georgia during 1993.

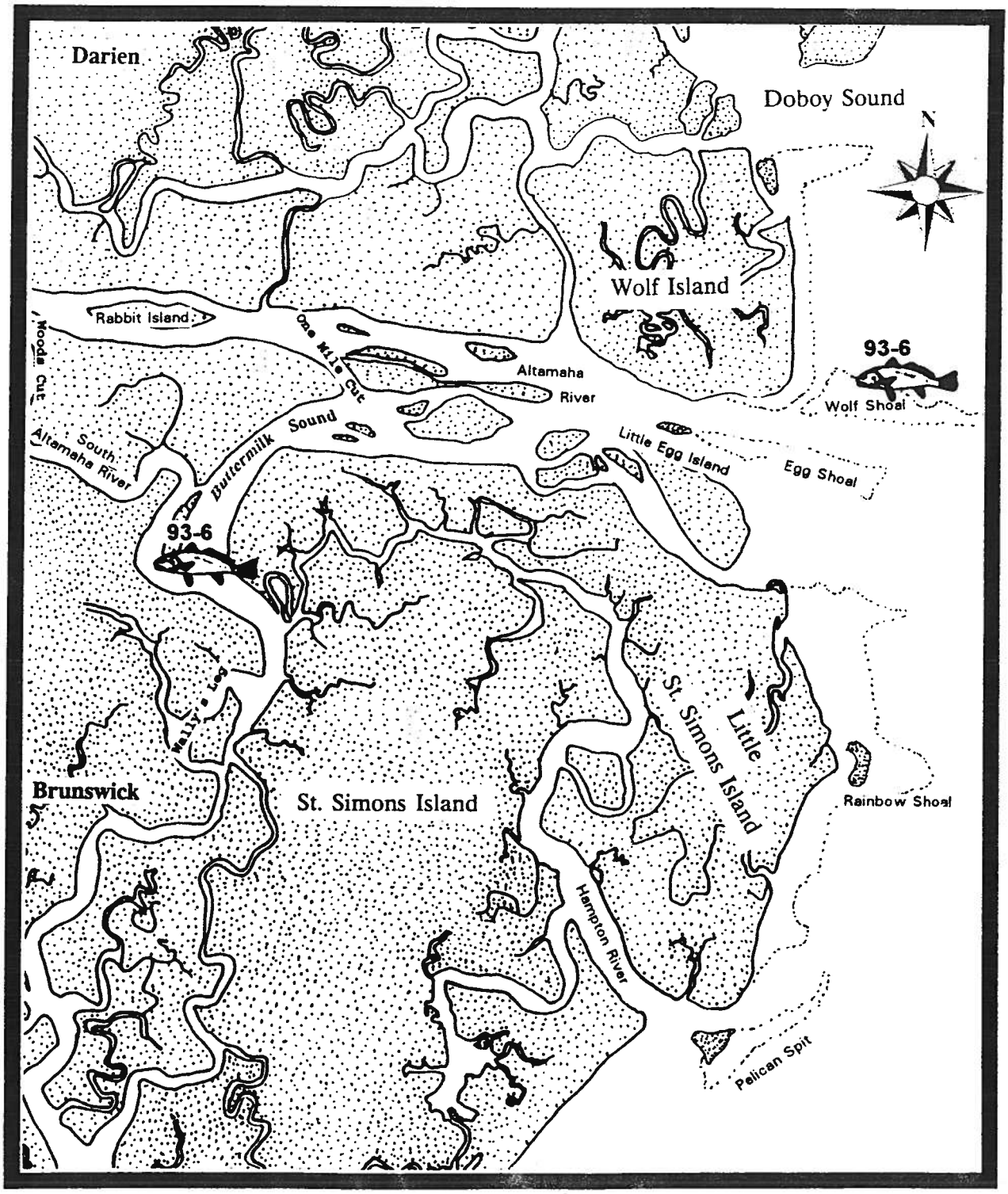

Figure 7. Relocations of telemetered sub- and young adult red drum in Georgia during October - December 1993.

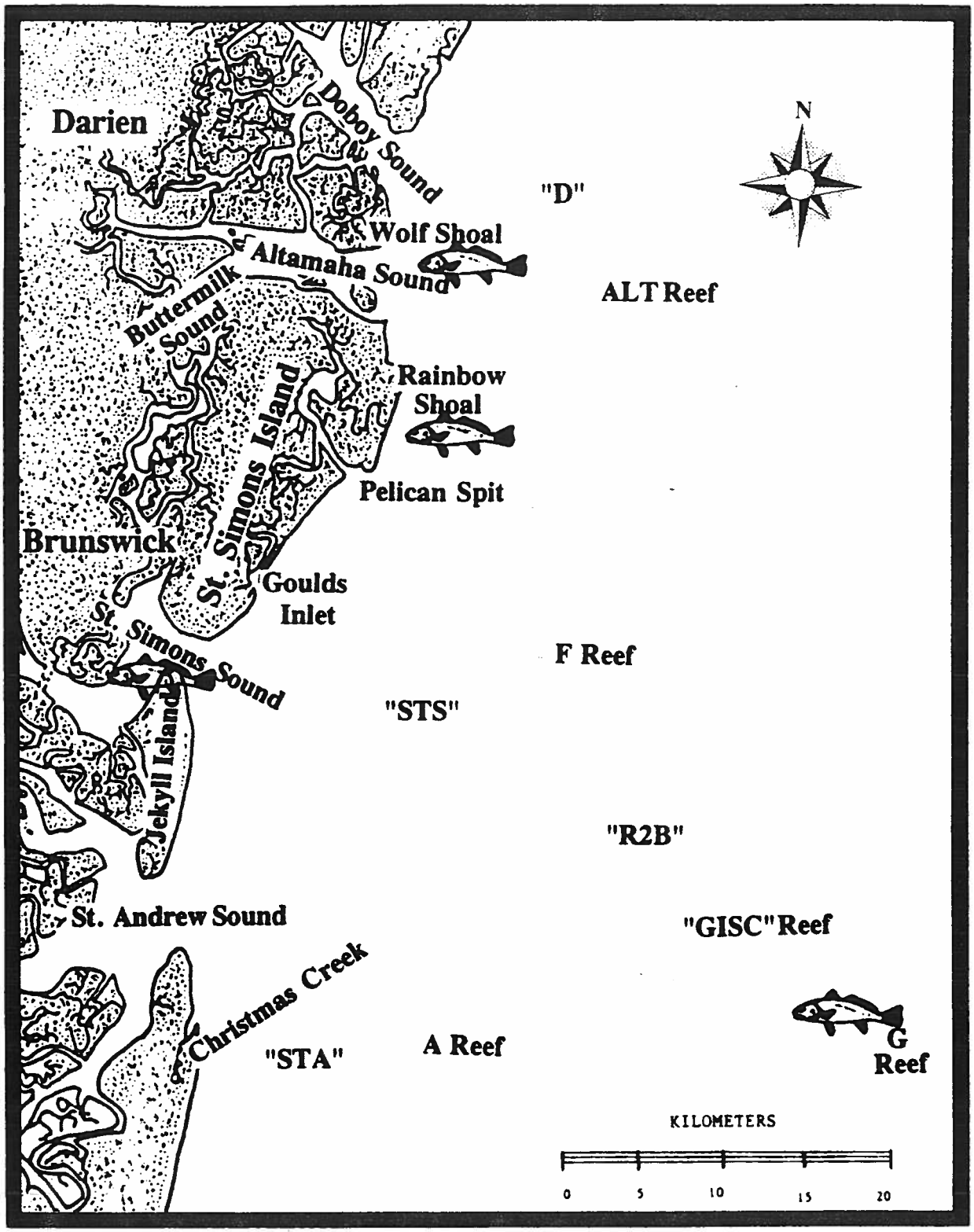

Figure 8. Telemetered sub- and young adult red drum release locations in Georgia during 1994.

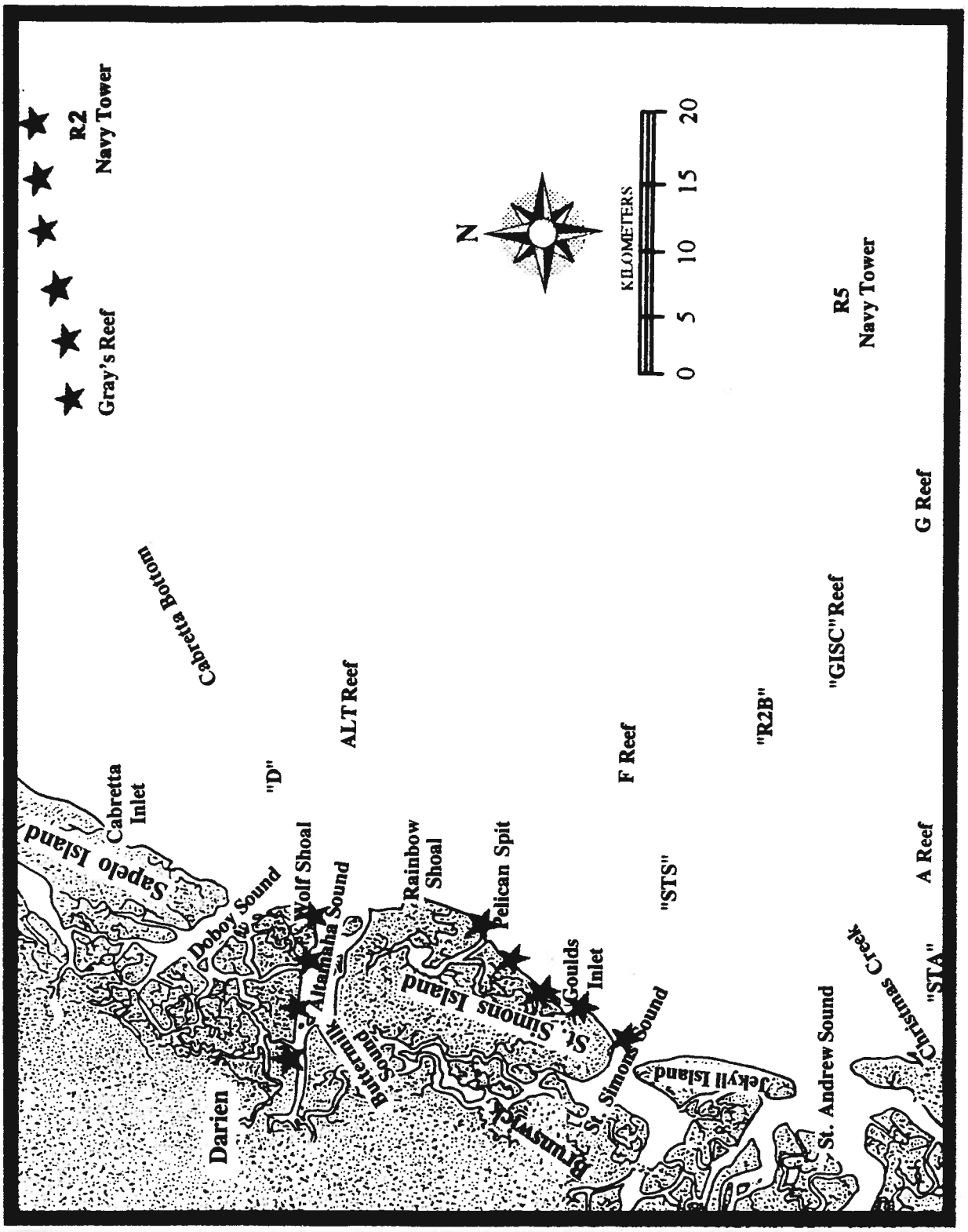

Figure 9. Additional biotelemetry tracking operations (listening stops) performed during the period January - March 1994 in Georgia.

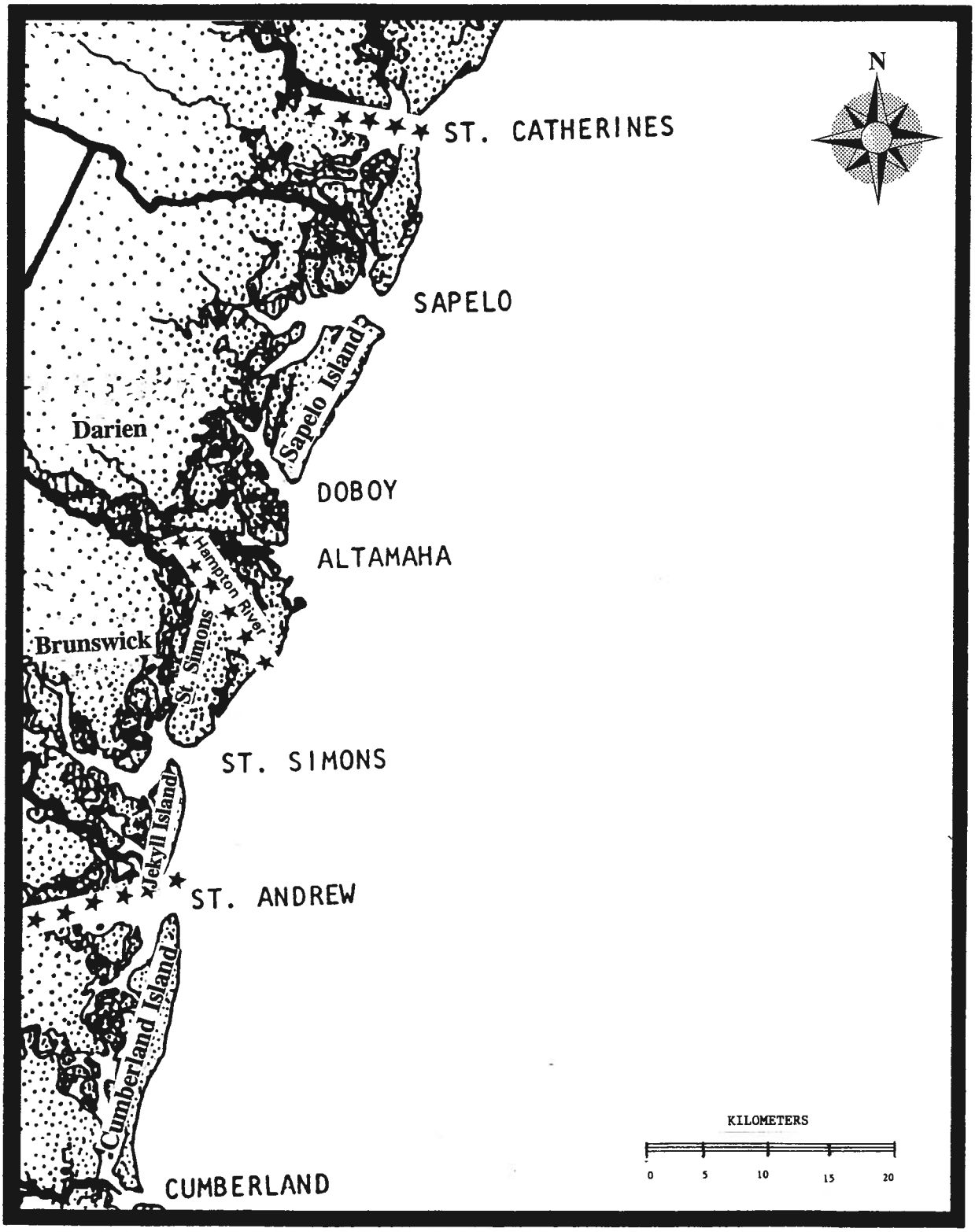

Figure 11. Additional biotelemetry tracking operations (listening stops) performed during the period July - September 1994 in Georgia.

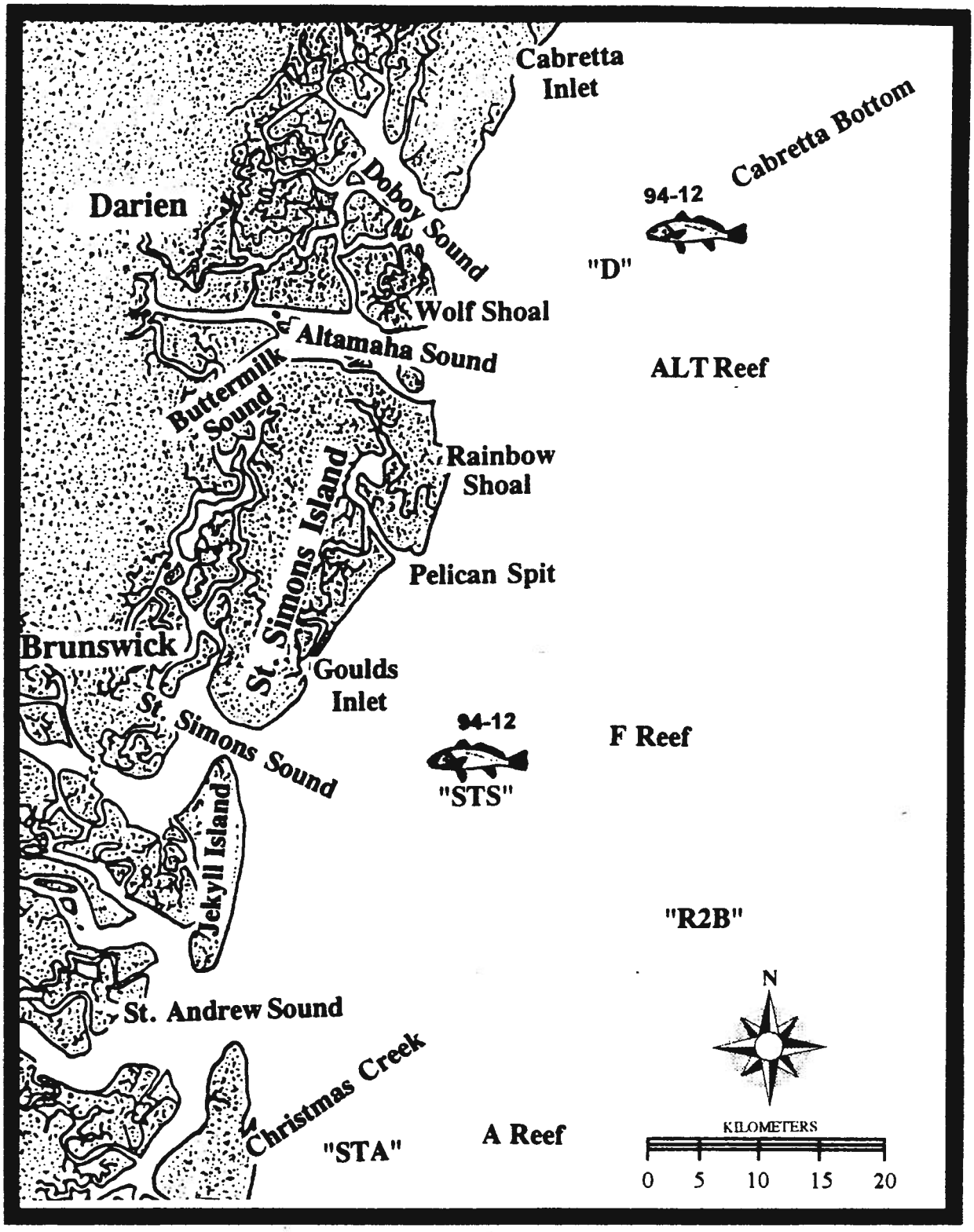

Figure 12. Relocations of telemetered sub- and young adult red drum in Georgia during October - December 1994.

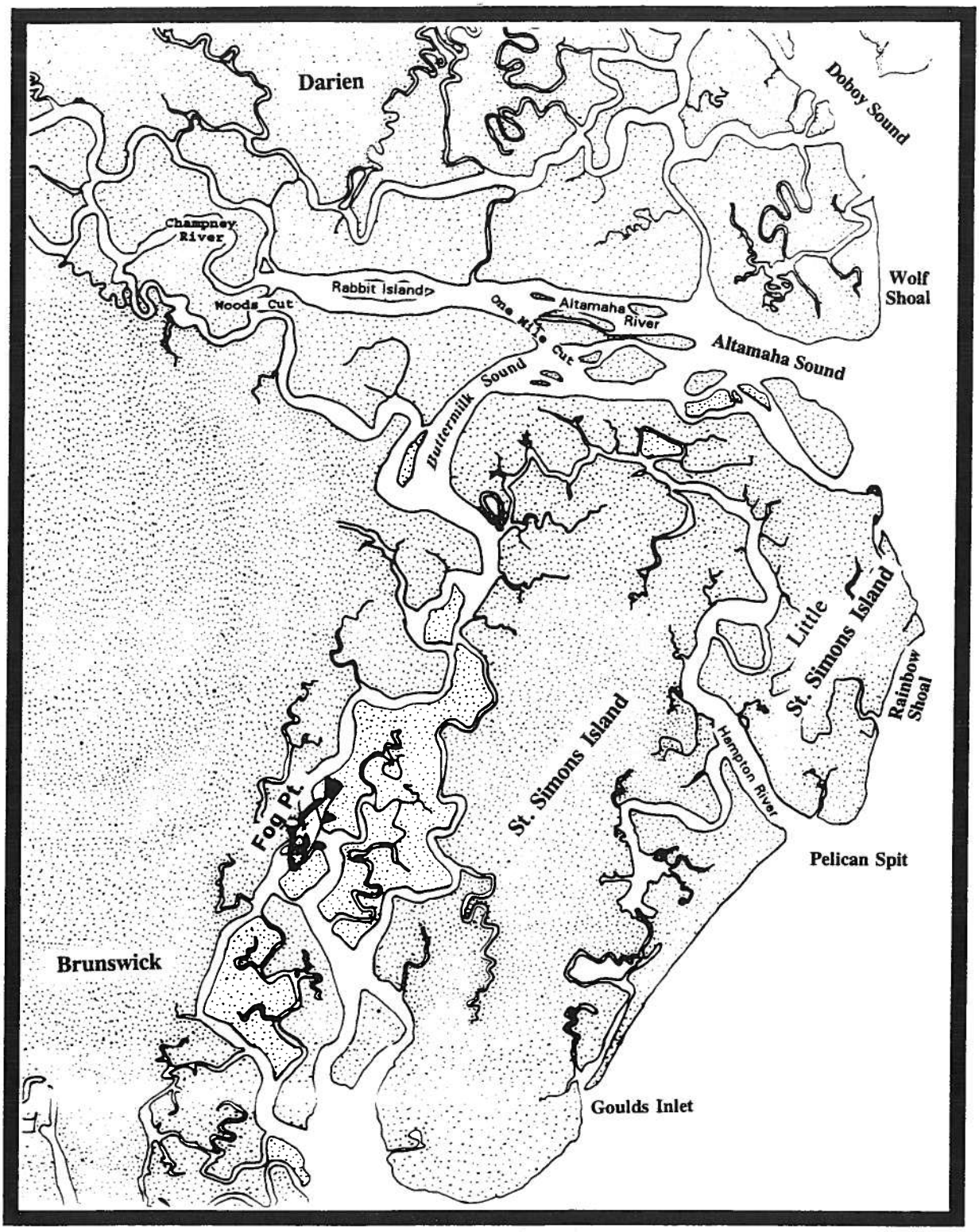

Figure 14. Telemetered young adult red drum release location in Georgia during 1995.

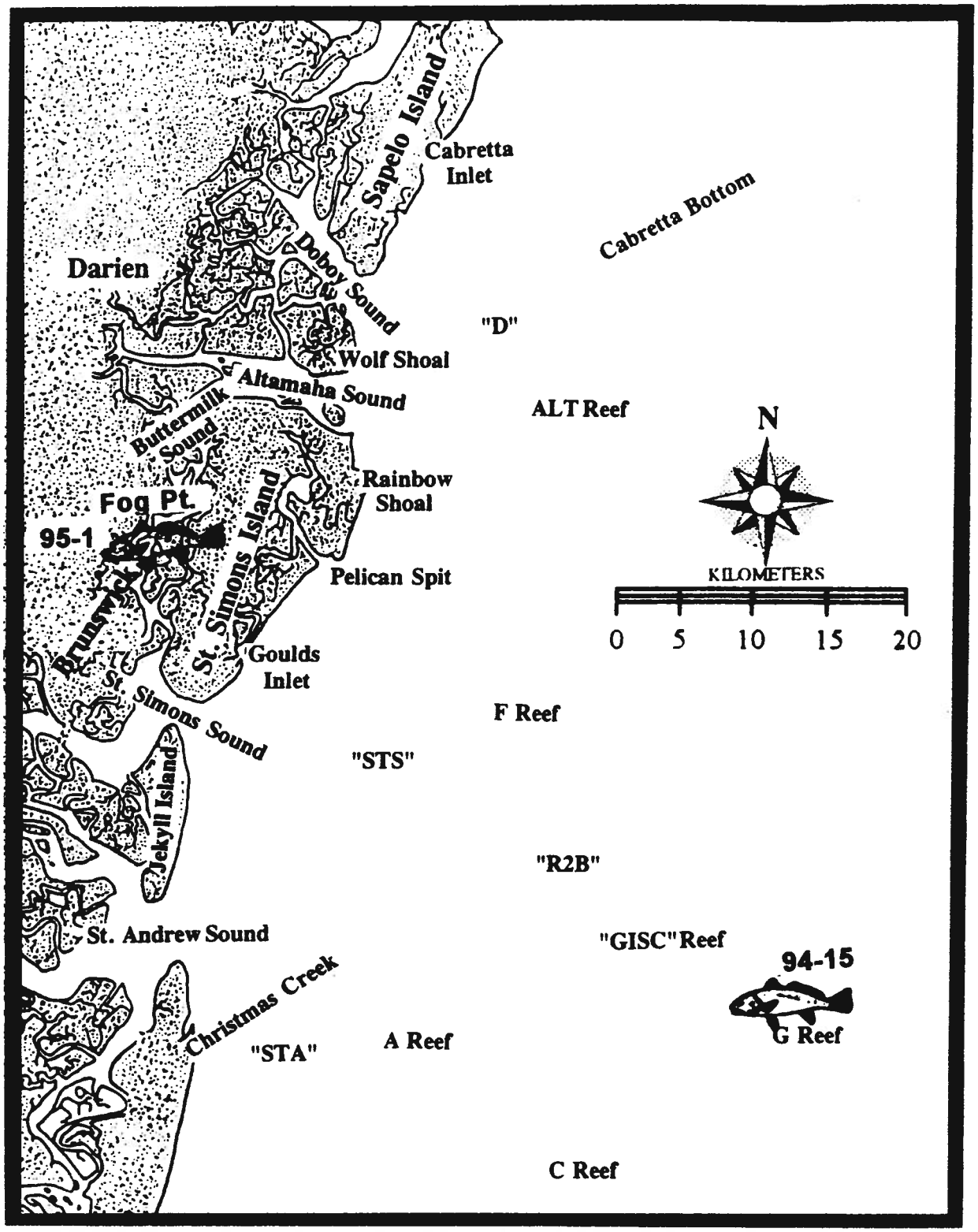

Figure 15. Relocations of telemetered sub- and young adult red drum in Georgia during January - March 1995.

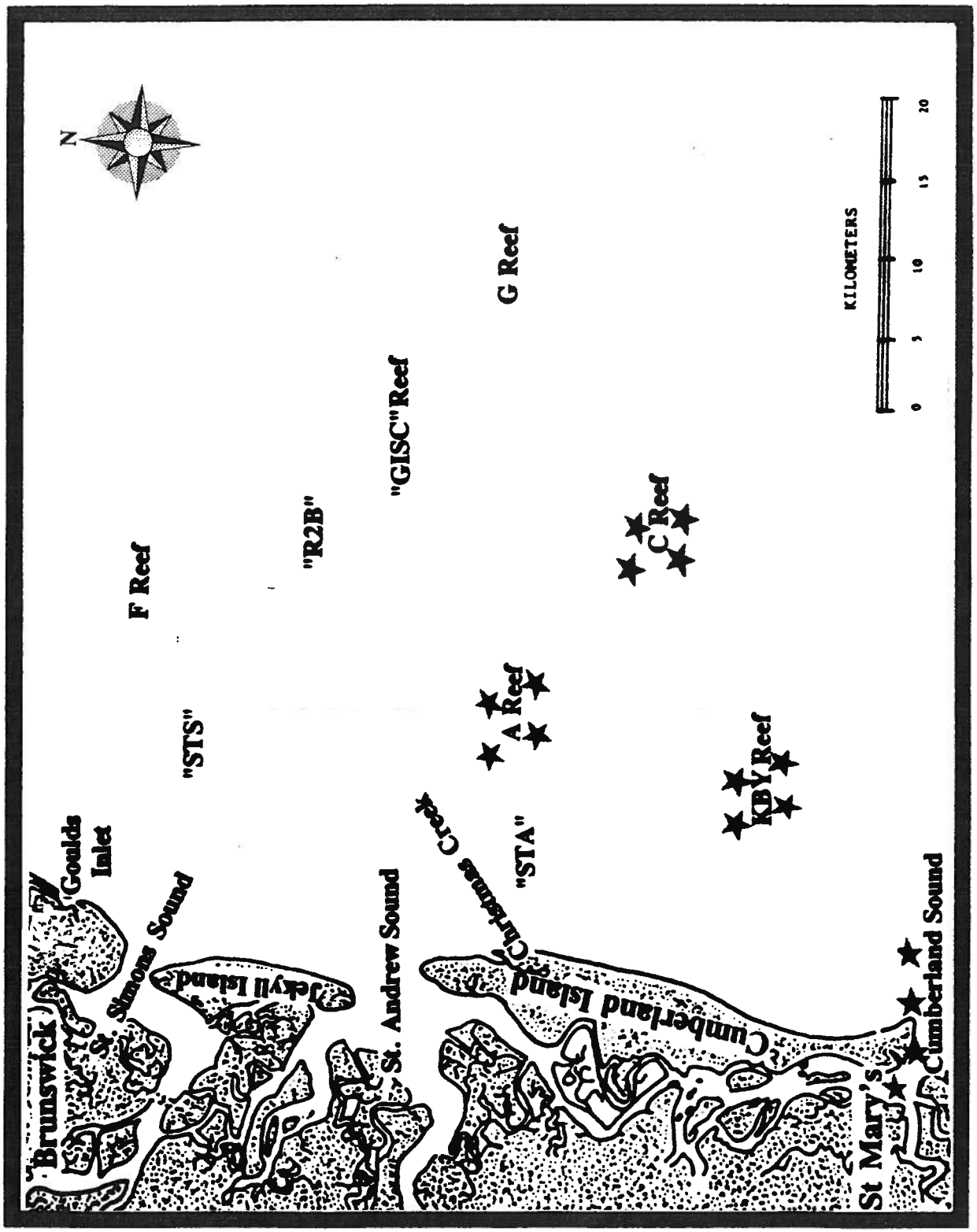

Figure 16. Additional biotelemetry tracking operations (listening stops) performed during the period January - March 1995 in Georgia.