Evaluation of cobia movements and distribution using tagging data from the Gulf of Mexico and South Atlantic coast of the United States

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Appendix A, showing days-at-large and size at tagging tables, was added

Evaluation of Cobia Movements and Distribution Using Tagging Data from the Gulf of Mexico and South Atlantic Coast of the United States.

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Abstract

Cobia movement and distribution in the Southeastern United States and the Gulf of Mexico was evaluated using tag-recapture information provided from recreational anglers, commercial fishermen and charter boat captains. Three data sets were provided by the South Carolina Department of Natural Resources, the Mote Marine Laboratory, and the Gulf Coast Research Laboratory. A fourth data set of tagged cultured fish from the South Carolina Department of Natural Resources was also evaluated. Cobia were tagged over similar periods, with methodologies and tags that were not appreciably different between programs. Tag-recapture in all four studies yielded similar patterns. Only fish at large for greater than 30 days were included in the analysis. Approximately 78% of tagged fish were recaptured in the region in which they were tagged. Only 1% of cobia tagged in the South Atlantic north of Florida were recaptured in the Gulf, and of those tagged in the Gulf only 1% were recaptured in the Atlantic north of Florida. Cobia tagged on the east coast of Florida are caught north of Florida and in the Gulf of Mexico suggesting a mixed stock off of Florida. Datasets were pooled and partitioned by tag recapture location beginning with the Georgia/Florida border and north (GAN), the Georgia/Florida border to the Brevard/Volusia County line (N-BR), Brevard County from the Brevard/Volusia County line to Sebastian Inlet (Brevard/Indian River County line)(BR), Sebastian Inlet to Miami (S-BR), Miami around the tip of Florida to Marco Island on the Gulf side, encompassing all of the Florida Keys (Keys), and the Gulf from Marco Island through the Gulf States to the Texas/Mexico line. The combined data show that cobia tagged north of Brevard County are primarily recaptured north of Brevard County. Of cobia tagged in Brevard County, 25% are recaptured north of Brevard County, 39% in Brevard County and 36% south or west of Brevard County in the Keys or in the Gulf of Mexico. Cobia tagged south or west of Brevard County are much more likely to be recaptured in the Keys or Gulf (93%). These results suggest two stocks of fish that overlap at Brevard County Florida.

Datasets

South Carolina Marine Game Fish Tagging Program

(Introduction and Methods from Wiggers, R. 2010. South Carolina Marine Game Fish Tagging Program 1978-2009). (SEDAR 28 Reference Document 21)

The South Carolina Marine Game Fish Tagging Program (MGFTP) began in 1974. The 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.

For the SCDNR, partnering with the angling community has proven to be an efficient and cost-effective means for researchers to collect data. Anglers are typically able to tag more fish over a larger geographic area than would an agency-based tagging effort, and the opportunity for the public to participate in a research project often creates more of a "buy in" towards fisheries management decisions. Since the program utilizes the public as a means for deploying tags, it is technically referred to as an "angler-based" tagging project. The MGFTP was unique in that it was the first state operated public tagging program on the East Coast. The program has served as a model for other projects that encouraged public fish tagging efforts.

Since its inception, nearly 9,000 participants comprised of South Carolina recreational anglers, charterboat captains, headboat captains, and commercial fishermen have tagged and released over 134,000 marine finfish. Marine finfish species are identified for tag and release based on their importance both recreationally and commercially to the State and South Atlantic region. The program has maintained a list of around 46 target species representing 20 families. The list of target species has been periodically modified throughout the life of the program in order to address data needs related to seasonal movements, habitat requirements, growth rates, and release mortality.

The program has experimented with eight different tag types, with cost, ease of application, and minimal injury to the fish being the major considerations when choosing the best option. Three types of tags met the criteria, all of which were developed and manufactured in Australia by Hallprint Ltd. Polyethylene (non toxic) dart and t-bar tags have proven to have good tag retention and are relatively easy to apply.

From 1986 to 2000, the program grew steadily. Between 1990 and 2000 the program was at its peak in terms of participation, primarily as a result of a more environmentally conscious public and a robust promotional effort put forth by program staff. The establishment of more restrictive size and creel limits, particularly for red drum in the early nineties, resulted in anglers having to release more fish, and thus tag and release provided a satisfying option. Also during this decade, the program was highly publicized in numerous fishing publications and other media outlets, and as a result had more exposure to recreational anglers anxious to get involved. After 2000, changes in the program's operational design, which were aimed at reducing the overall size of the program, resulted in a decline in program participation.

Prior to 2005, any fishermen requesting to participate in the MGFTP were provided with a tag kit consisting of 5 dart tags, an applicator, associated postage paid information cards for recording the initial tag event, and a brief instructional brochure. After the startup kit, anglers were re-supplied with additional tags (in packs of 10) as requested. Each angler is assigned a unique alphanumeric identifier that is used to monitor tagging activity as well as track tag issuance. This information, along with initial tag and recapture data is maintained in a relational database (MS Access).

Because of the relative ease with which dart tags can be applied, most instructions were given to participants verbally, although a brief instructional brochure was developed as a reference tool and to further promote the program.

The brochure gave a brief history of the program, what steps to take if a tagged fish is caught, how to tag large and small fish, as well as the target species to tag (Davy, 1993). Pictures were provided of the target species to aid with identification.
In 2004, a new instructional publication was developed entitled "An Angler's Guide to Tag and Release" (Wiggers, 2005) and was the precursor to training workshops that occurred shortly thereafter. During 2005, the program format changed significantly with the establishment of new guidelines that limited participation to those individuals that could attend a training workshop. Overall participation was also limited to 225 anglers that would now be considered "certified" taggers. The reasoning behind the development of these workshops was twofold. First, it would create a more manageable number of taggers, making it easier to communicate and provide feedback to program participants. Second, the actual training alleviates many problems, such as inaccurate data reporting and improper tagging technique, which are common challenges of angler based programs. The workshops are structured around teaching anglers the proper techniques used in handling, tagging, venting, and releasing marine game fish in addition to providing an overview of the programs' tag and recapture database. The two hour workshop is divided into two parts; a presentation, followed by "hands-on" tagging where participants have the opportunity to practice tagging on dead fish. The practice tagging proves invaluable in helping anglers to hone their tagging technique before placing a tag in a live fish. Through both the instructional guides and training workshops participants are also educated on proper handling and release techniques. Emphasis is put on the healthy release of the fish as the main priority and not necessarily a release where a tag is implanted. Extremely warm water temperatures, swim bladder rupture, or a long fight can all add to a fish becoming overly stressed and in such cases tagging is not advised. When fish are removed from the water to be tagged, anglers are encouraged to place a soft wet towel over the head and eyes of the fish to help keep it calm. It is also suggested that handling be kept to a minimum to avoid removing the fishes' slime layer.

As an incentive to report the recapture of tagged fish, a reward program was initiated in 1991. A white baseball cap with the program logo was the first type of reward provided to individuals who reported a recapture. A fish history report, detailing the date, location and size of the fish from both the initial tag event and recapture event, was also provided to both the angler reporting the recapture and the angler who initially tagged the fish.

The MGFTP has consistently used the color yellow for all tags deployed by recreational participants. Tags are printed with a six digit number in addition to the tag number, the legend printed on the tag streamer reads, "REWARD-MAIL TO: SC MARINE RESOURCES BOX 12559, CHARLESTON, SC 29422, U.S.A. In 2007, the development of a toll free phone number for reporting recaptures resulted in changes to the legend.

Since 1988 the program has used nylon dart tags (K series) measures 14.5 cm (5.75 in.) and is for use on fish over 27 inches. Dart tags are applied with an applicator consisting of a hollow stainless steel tube, the tip of which is cut at a sharp angle, which is then mounted inside a wooden dowel. The tag is inserted just below the spinous first dorsal fin at a 45 degree angle to allow the barb to anchor

between the pterygiophores. On larger fish, where the pterygiophores are spaced farther apart, tags are inserted just below the soft rays of the second dorsal fin. At this location, the barb is more likely to anchor between the pterygiophores, which are naturally spaced closer together. After the tag is in place, anglers are advised to give the tag a firm tug to ensure the tag has locked into place.

Once a fish has been properly tagged and released, anglers are asked to record the date, location, species, length, weight, and name and address on the tag card (see appendix iii). In recording information, anglers are instructed to be as specific as possible. Lengths should be measured as total length, however if the angler is estimating size, this should be indicated as such on the card. Locations should also be specific. Furthermore, anglers are encouraged to mail in tag cards promptly or as soon as possible after tagging.

From 1974-2010 1066 cobia were tagged by recreational anglers along the southeast coast of the United States. Recaptures (n=201) of these tagged fish have occurred throughout the southeast United States and Gulf of Mexico.

Gulf Coast Research Laboratory "SPORT FISH TAG AND RELEASE IN MISSISSIPPI COASTAL WATERS AND THE ADJACENT GULF OF MEXICO
J. Read Hendon & James S. Franks

Introduction and Methods from Hendon and Franks (2010) (SEDAR 28 Reference Document #)
General Tag & Release Methodology

Because the majority of objectives of this research required coordination with volunteer anglers, great efforts were made to recruit local and regional anglers by using newspapers, sport fishing magazines, television media and public workshops held at the Gulf Coast Research Laboratory (GCRL). Throughout the project period, GCRL personnel distributed tagging kits to volunteer anglers in Mississippi and throughout the southeastern U.S. either by mail, at workshops or at fishing tournaments and captain's meetings. Anglers could also pick up kits from GCRL. Tagging kits were comprised of dart tags manufactured by Hallprint Pty Ltd, tagging data cards, a tag applicator, an instruction booklet and a pencil. Each tag was imprinted with the GCRL contact number and address and a unique tag number and prefix. Each tag was attached to a tagging data card that had a corresponding tag number. All materials were placed in a waterproof container before being issued to anglers.

Once an angler tagged a fish, the angler recorded on the data card the tagging date, tagging location, total length (TL) or fork length (FL) of the fish in inches (in), condition of the fish upon release, angler's name and address and any comments. The data card was then to be mailed to GCRL personnel, at which time the data were archived in a database program. When an angler caught a tagged fish (recapture), that angler would notify project personnel and provide them with the species of fish, tag number, date of recapture, location of recapture, length of the fish, whether the fish was released again with the tag intact, recapturing angler's name and address and any comments. Recapture data were then matched with the original tagging data from the database, and time-at-liberty ("Days Out"; number of days from when

the fish was tagged to when it was recaptured) and distance traveled ("Distance"; number of miles from tagging location to recapture location) were calculated. Distance traveled was measured in ArcView 3.2 mapping software. In order to assist in statistical analyses, tagging and recapture locations were assigned to a general zone for each species ("Zone"). A recapture report was then composed and mailed to both the tagging and recapturing anglers.

To alert anglers and the general public to the tagging programs in general and to the potential of catching a tagged fish, informational posters have been placed at most coastal boat landings and bait shops in Mississippi and were mailed to marinas in Louisiana, Alabama and Florida.

Public Workshops

The general format of the workshop remained the same as previous years, with various personnel from GCRL and the Mississippi Department of Marine Resources (MDMR) given the opportunity to present research findings from several different projects during each annual workshop (Appendix I). The second half of each meeting was reserved for public comments and open discussion from attendees.

To alert the public to the date and location of the public workshop each year, project personnel contacted prior workshop attendees and anglers who were currently involved in the tagging programs and provided them with a meeting announcement. Project personnel appeared on the local news and also provided information to local television stations. Press releases and interviews were provided to local newspapers.

COBIA (Rachycentron canadum) AMBERJACK (Seriola dumerili) AND DOLPHIN (Coryphaena hjppurus) MIGRATION AND LIFE HISTORY STUDY OFF THE SOUTHWEST COAST OF FLORIDA

Introduction and Methods from K. Burns and C. Neidig (SEDAR 28 Reference Document 22)

This study was undertaken as part of an attempt to understand the migration and stock identity of cobia, Rachycentron canadum, off the southwest coast of Florida. With MARFIN funding, Mote Marine Laboratory (MML) has been able to tag cobia, to collect length/frequency data and to obtain age and growth information through the collection and analysis of hard parts (otoliths, spines and scales). The Cobia, Amberjack and Dolphin Project (CAD) began in November, 1990, with orders being placed for tagging equipment and supplies. Green, plastic tipped dart tags (1.5 cm head) from Hallprint of Australia and tagging applicators were purchased for use in tagging all three species. Tagging forms were printed and a computer program for data entry was implemented. Volunteer taggers were recruited and trained.

In January 1991, tagging packets were assembled to be given to trained participating anglers to catch and release cobia, amberjack and dolphin. A total of three thousand (3,000) tags were purchased and distributed to participating

anglers. MML tag packets were revised to include tag reporting postcards rather than data sheets. Fish have been tagged by MML personnel and recreational and commercial fishermen.

Most of the cobia, amberjack and dolphin were tagged off the west coast of Florida; however, 42 were tagged off the Florida Keys and 73 were tagged off the east coast of Florida. A total of 1,023 fish (171 cobia, 785 amberjack and 67 dolphin) have been tagged during this project.

Methods

In order to better determine cobia movement and distribution along the east coast of Florida, the three datasets (described above) were compared and determined if suitable for pooling data. Each of the three datasets cover slightly different geographical areas; however the GCRL and Mote datasets overlap more completely. The South Carolina data was collected from 1990 through 2009, the GCRL data from 1989 to 2010 and the Mote data from 1992-2006. Size ranges of tagged fish were essentially the same as were months cobia were tagged and recaptured. Each of the three datasets uses different geographic descriptors such as zones, states or regions. Because we are primarily interested in cobia movements along the east coast of Florida, where it has been proposed by Darden et al. (SEDAR working paper 1) that stock structuring occurs, we have pooled the three datasets and partitioned as follows:

GAN: From the Georgia/Florida line north along the Atlantic Coast. The northernmost sample comes from NJ.

N-BR: From the Brevard/Volusia County line to the Florida/Georgia line.

BR: Brevard County from Brevard/Volusia County line to Sebastian Inlet (Brevard/Indian River County line). Recaptures described as "off Sebastian Inlet" have been classified as BR.

S-BR: Sebastian Inlet to Miami

Keys: From Miami around the tip of Florida to Marco Island on the Gulf side, encompassing all of the Florida Keys.

Gulf: From Marco Island through the Gulf States, to the Texas/Mexico line.

Note that angler recaptures are often generalizations of where a fish was recaptured. Sometimes anglers report a city or "off of a city" making it difficult to determine exact location. In this case we set latitudes and longitudes using the best available information and assigned returns accordingly. Only recaptures of fish at large for longer than 30 days were used.

Tables 1-3 show each programs recaptures sorted by the region where the fish was tagged (column 1) and the region where the fish was subsequently recaptured (row 1). Table 1 shows that from the recaptured cobia, 117 were tagged in waters North of the Florida-Georgia line and 106 were recaptured in the same region. Four of the fish were recaptured North of Brevard county, 6 in Brevard county and 1 was recaptured in the Gulf of Mexico. Tables 1-3 show similar trends.

Table 1. Wild cobia tagged and recaptured by recreational anglers and charter boat captains as part of South Carolina's Marine Gamefish Tagging Program.

	Region Recap	GAN	N-BR	BR	S-BR	Keys	Gulf
Region Tagged	N						
GAN	117	106	4	6	0	0	1
N-BR	0	0	0	0	0	0	0
BR	7	1	0	3	1	0	2
S-BR	1	0	0	0	0	0	1
Keys	0	0	0	0	0	0	0
Gulf	0	0	0	0	0	0	0

Table 2. Wild cobia tagged and recaptured by recreational anglers and charter boat captains as part of the Gulf Coast Research Laboratory's Tagging Program.

	Region Recap	GAN	N-BR	BR	S-BR	Keys	Gulf
Region Tagged	Recaps (n)						
GAN	2	2	0	0	0	0	0
N-BR	0	0	0	0	0	0	0
BR	29	4	4	11	1	4	5
S-BR	5	0	0	0	2	2	1
Keys	147	0	0	1	8	83	55
Gulf	680	4	8	12	23	74	559

Table 3. Wild cobia tagged and recaptured by recreational anglers and charter boat captains as part of the Mote Marine Laboratory's MARFIN Tagging program.

	Region Recap	GAN	N-BR	BR	S-BR	Keys	Gulf
Region Tagged	N						
GAN	2	2	0	0	0	0	0
N-BR	0	0	0	0	0	0	0
BR	0	0	0	0	0	0	0
S-BR	7	2	0	1	3	0	1
Keys	9	0	0	0	0	5	4
Gulf	64	0	0	0	2	4	58

Tables 4-5 consist of the combined results of tables 1-3 expressed as raw data (Table 4) and as percentages (Table 5 and figure 1) of fish tagged within that region that were recaptured in other regions. Table 5 clearly demonstrates that fish tagged in a specific estuary, zone, or region are most likely to be recaptured in those areas. Cobia tagged North of Florida only rarely are recaptured in the Gulf of Mexico (1%), likewise less than 1% of fish tagged in the Gulf of Mexico will be recaptured in the South Atlantic North of Florida. It appears that mixing occurs along the east coast of Florida. Of recaptures from fish tagged in Brevard County, 25% occurred to the north (N-BR and GAN) and 36% in the regions to the south and west (S-BR, KEYS, GAN), with 39% recaptured back in Brevard County.

Fish tagged South of Brevard county were as likely to be recaptured in the Keys and Gulf as where they were initially tagged. A smaller percentage were recaptured North of Brevard county. Lastly, very few fish tagged in the Keys were found north of the Keys although there is movement of fish into the Gulf.

Table 4. Combined table of SC, GCRL and Mote recaptured cobia.

	Region Recap	GAN	N-BR	BR	S-BR	Keys	Gulf
Region Tagged	N						
GAN	121	110	4	6	0	0	1
N-BR	0	0	0	0	0	0	0
BR	36	5	4	14	2	4	7
S-BR	13	2	0	1	5	2	3
Keys	156	0	0	1	8	88	59
Gulf	744	4	8	12	25	78	617

Table 5. Combined table of SC, GCRL and Mote recaptured cobia. Percentages of cobia tagged in a region that are recaptured.

	Region Recap	GAN	N-BR	BR	S-BR	Keys	Gulf
Region Tagged	N						
GAN	121	91%	3%	5%	0%	0%	1%
N-BR	0	0%	0%	0%	0%	0%	0%
BR	36	14%	11%	39%	6%	11%	19%
S-BR	13	15%	0%	8%	38%	15%	23%
Keys	156	0%	0%	1%	5%	56%	38%
Gulf	745	1%	1%	2%	3%	10%	83%

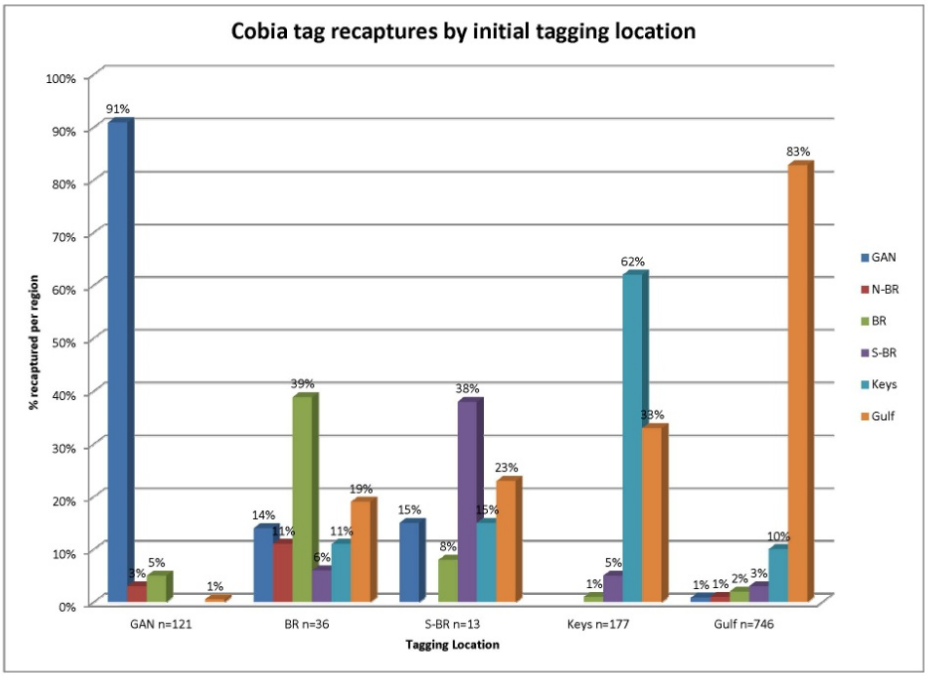


Figure 1. Combined table of SC, GCRL and Mote recaptured cobia. Percentages of cobia tagged in a region that are recaptured.

The tagged cultured fish released as juveniles in the GAN were caught almost exclusively in GAN waters with limited movement to waters North of Brevard County, corroborating the previous wild fish movements.

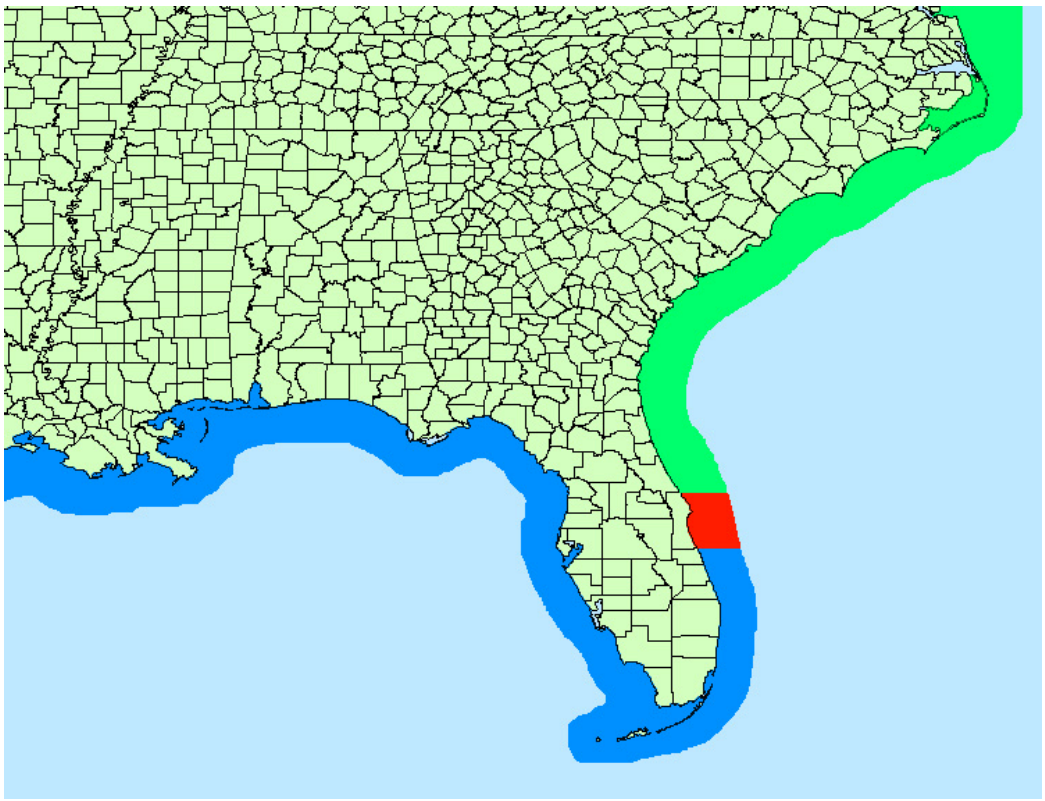
Table 6. Aquaculture-produced tagged cobia released at juvenile sizes in South Carolina.

	Region Recap	GAN	N-BR	BR	S-BR	Keys	Gulf
Region Tagged	N						
GAN	22	20	2	0	0	0	0
N-BR	0	0	0	0	0	0	0
BR	0	0	0	0	0	0	0
S-BR	0	0	0	0	0	0	0
Keys	0	0	0	0	0	0	0
Gulf	0	0	0	0	0	0	0

Recommendations

These data support the genetic findings, which show that cobia collected off St. Lucie, FL. (S-BR) would likely be part of a Gulf stock.

1) Split the landings in Brevard County between the South Atlantic stock and the Gulf stock. Everything south of Brevard County is part of the Gulf stock, and everything North of Brevard County are part of the South Atlantic stock.



Green=South Atlantic stock
Red=mixed stock
Blue=Gulf stock

Figure 2. Visual representation of cobia stock distribution based on tag-recapture data.

Appendix A

Tables 7a and 7b. Days at large at time of recapture by initial tagging region (raw data and percentages).

	Days-at-large	1-6 Months	7-12 Months	13-24 Months	>24 Months
Region Tagged	N				
GAN	121	11	50	35	25
N-BR	0	0	0	0	0
BR	36	11	10	9	6
S-BR	13	5	3	3	2
KEYS	156	46	48	49	12
GULF	182	45	79	44	14

	Days-at-large	1-6 Months	7-12 Months	13-24 Months	>24 Months
Region Tagged	N				
GAN	121	9%	41%	29%	21%
N-BR	0	0%	0%	0%	0%
BR	36	31%	28%	25%	17%
S-BR	13	38%	23%	23%	15%
KEYS	156	29%	31%	31%	8%
GULF	182	25%	43%	24%	8%

Tables 8a and 8b. Days at large at time of recapture by dataset (raw data and percentages).

	Days-at-large	1-6 Months	7-12 Months	13-24 Months	>24 Months
Dataset	N				
SCDNR	125	13	51	35	26
GCRL	304	77	116	86	25
MOTE	79	28	23	19	8

	Days-at-large	1-6 Months	7-12 Months	13-24 Months	>24 Months
Dataset	N				
SCDNR	125	10%	41%	28%	21%
GCRL	304	25%	38%	28%	8%
MOTE	79	35%	29%	24%	3%

Tables 9a and 9b. Fork length (FL) at tagging by location (raw data and percentages). SCDNR dataset excluded because FL/TL are not distinguished.

	FL at Tagging (mm)	300-599	600-799	800-999	1000+
Region Tagged	N				
GAN	2	1	1	0	0
N-BR	0	0	0	0	0
BR	29	0	17	12	0
S-BR	12	1	7	3	1
KEYS	155	9	91	55	0
GULF	179	29	100	36	14

	FL at Tagging (mm)	300-599	600-799	800-999	1000+
Region Tagged	N				
GAN	2	50%	50%	0%	0%
N-BR	0	0%	0%	0%	0%
BR	29	0%	59%	41%	0%
S-BR	12	8%	58%	25%	8%
KEYS	155	6%	59%	35%	0%
GULF	179	16%	56%	20%	8%

Tables 10a and 10b. Fork length (FL) at tagging by dataset (raw data and percentages). SCDNR dataset excluded because FL/TL are not distinguished.

	FL at Tagging (mm)	300-599	600-799	800-999	1000+
Dataset	N				
GCRL	301	25	162	101	13
MOTE	76	15	54	5	2

	FL at Tagging (mm)	300-599	600-799	800-999	1000+
Dataset	N				
GCRL	301	8%	54%	34%	4%
MOTE	76	20%	71%	7%	3%

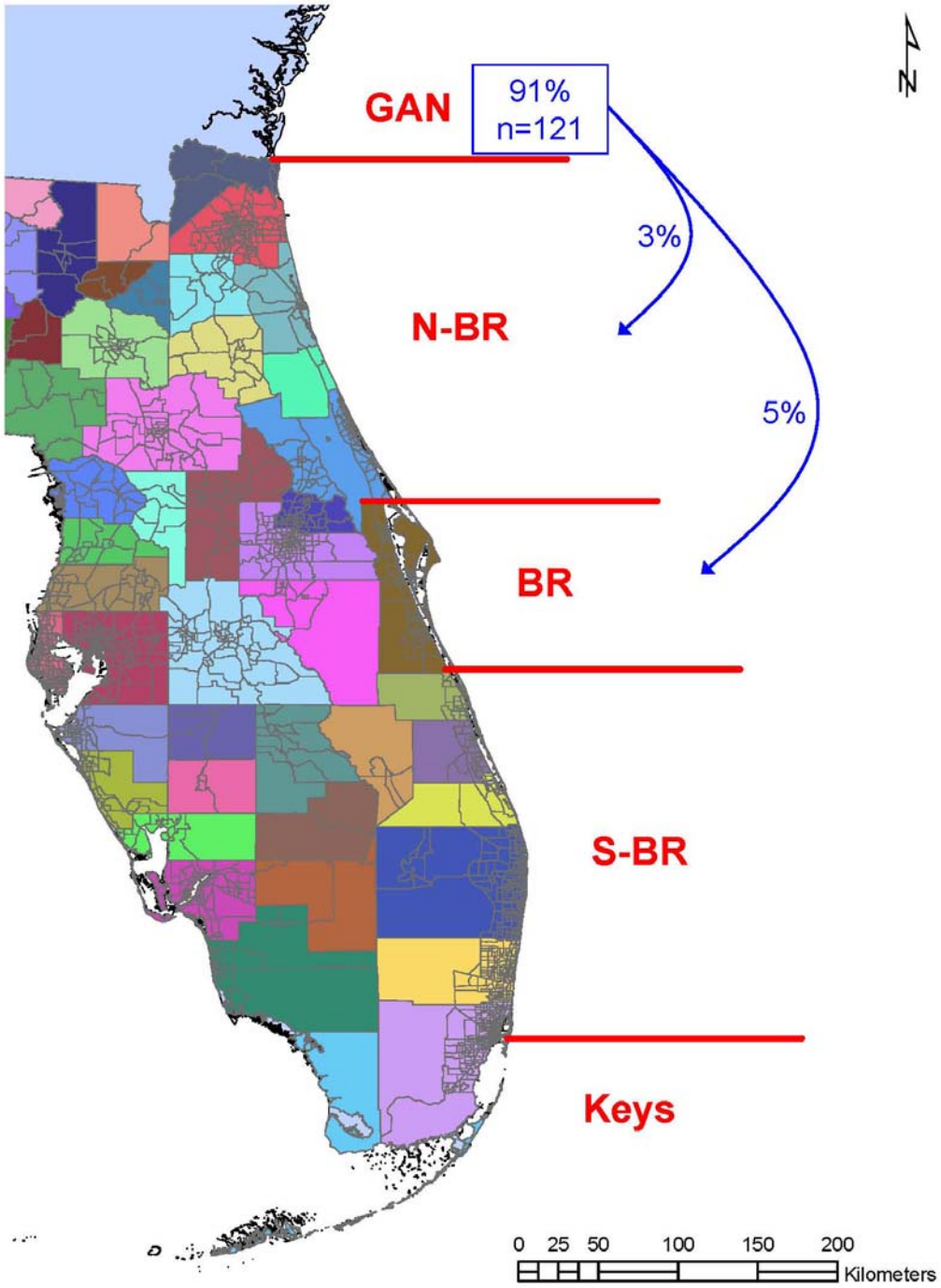


Figure 3. Movement of tagged cobia from north of Florida (GAN) into Florida waters.

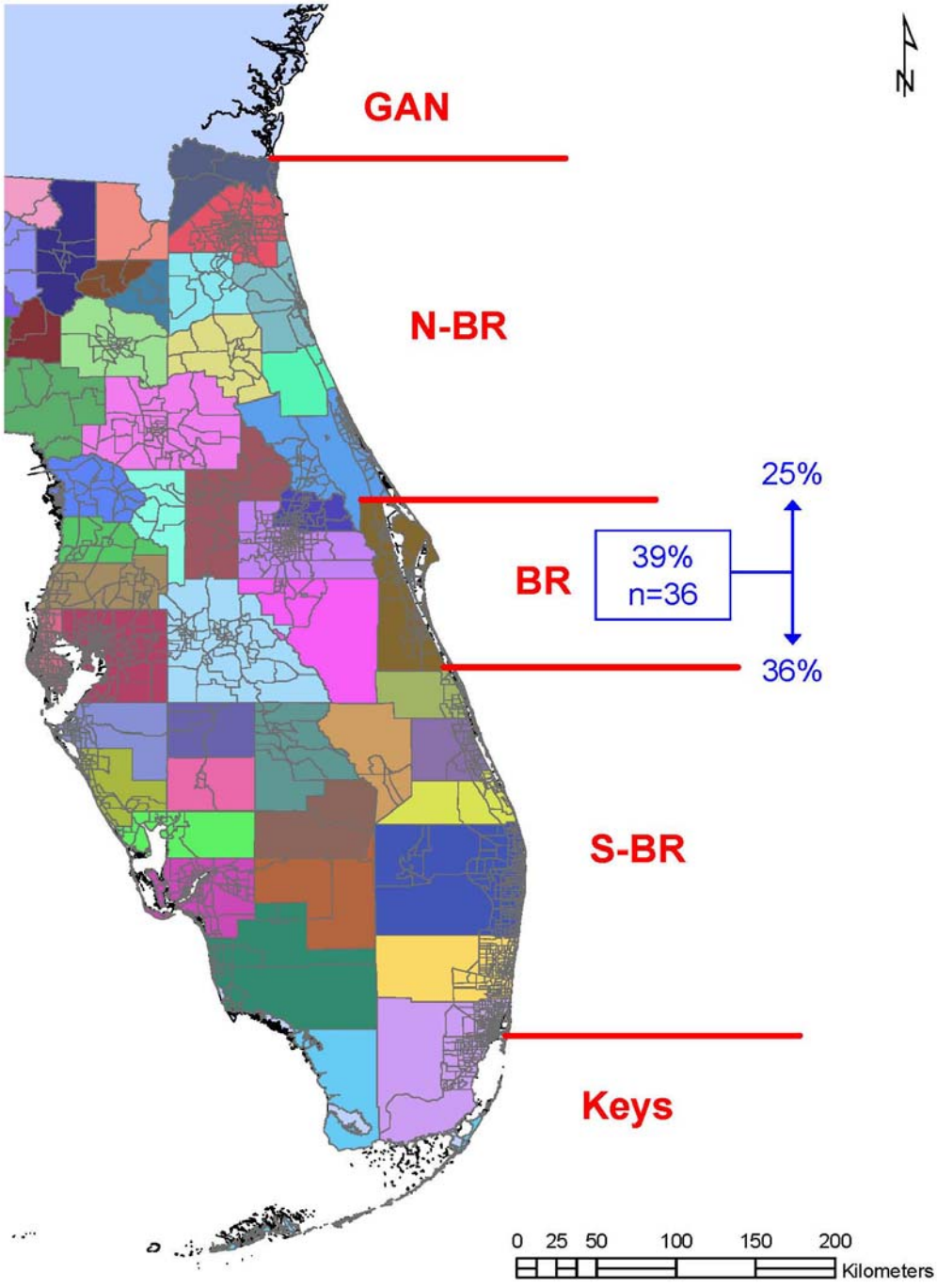


Figure 4. Movement of tagged cobia from Brevard County, FL (BR) to the north and south.

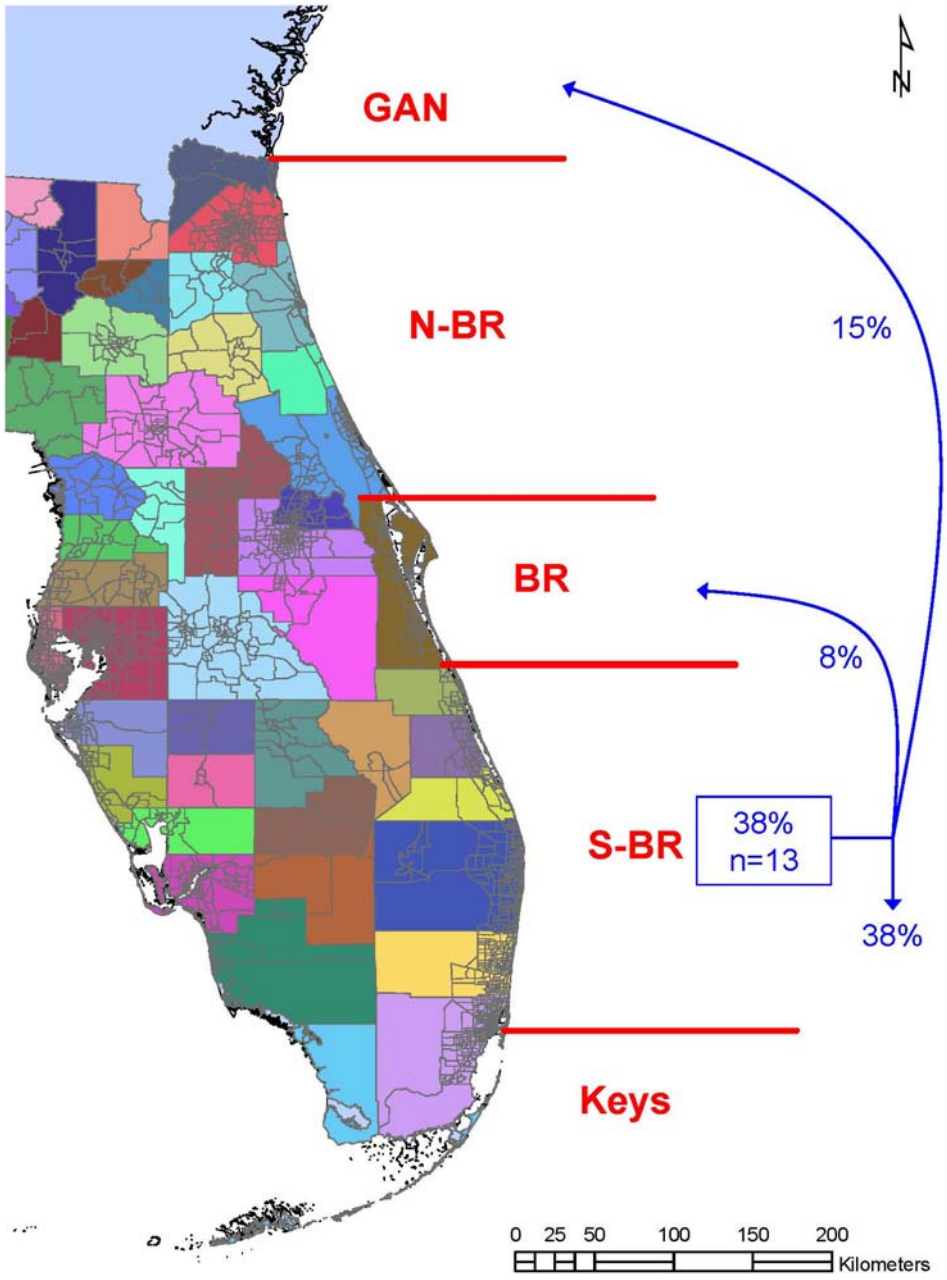


Figure 5. Movement of tagged cobia from south or Brevard County, FL (S-BR) to the north and south.

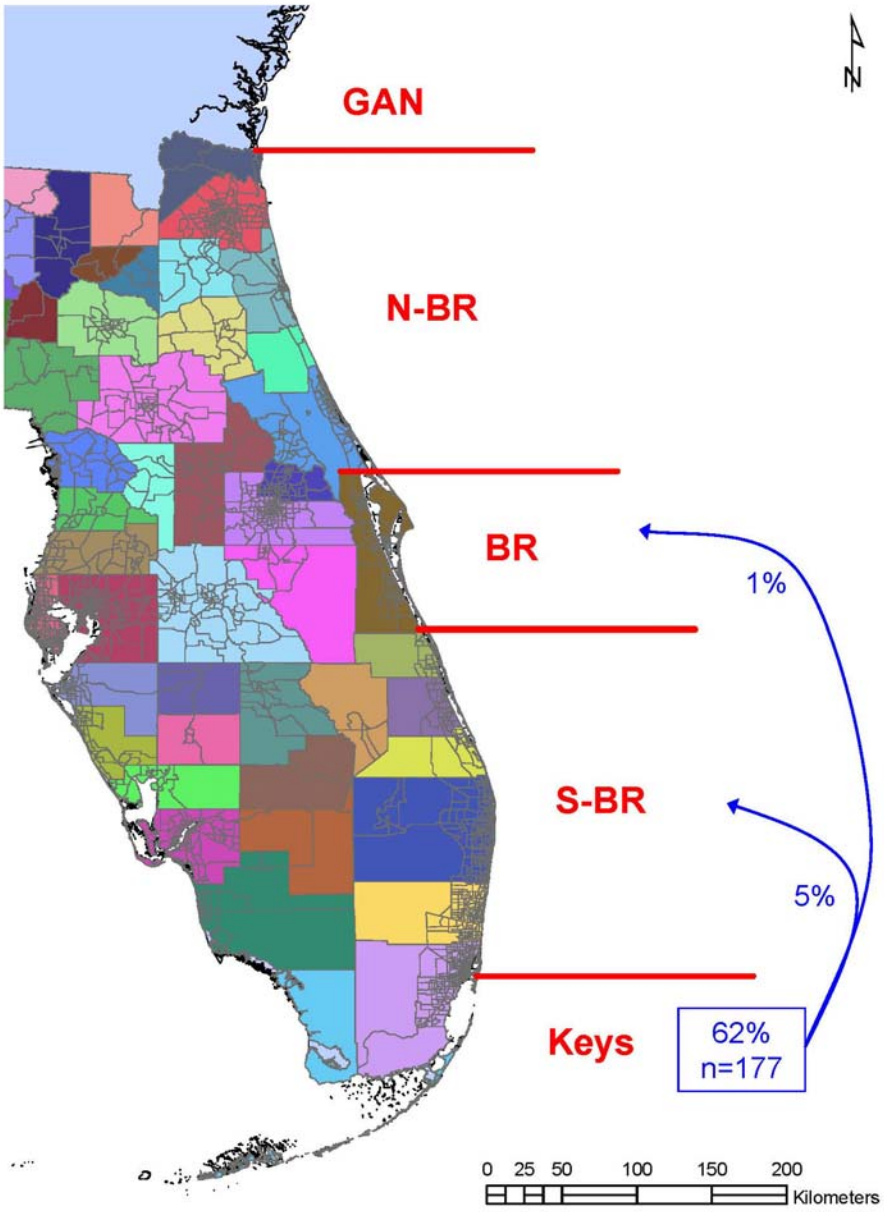


Figure 6. Movement of tagged cobia from the Florida Keys (KEYS) to the north.

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