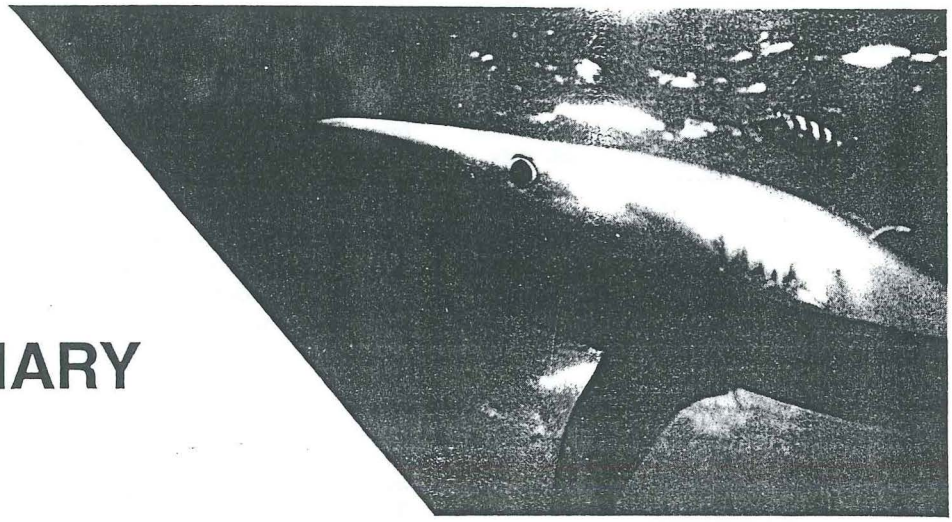
THE SHARK TAGGER 1991 SUMMARY



Newsletter of the Cooperative Shark Tagging Program

Photo by H. W. Pratt

1991 Overview

The year 1991 was the second best on record, with nearly 7,000 fish tagged. The number of fish tagged in 1991 is just 300 fewer than the record number tagged in 1985. At that time, however, the distribution of the tagging effort was very different from this year's results. In contrast to the percentages given below, in 1985, anglers, Fisheries Observers, and biologists (NMFS, and R/V *Geronimo*) each accounted for approximately 33% of the tagging effort with commercial fishermen tagging about 2%. Our sincere thanks to all the anglers and commercial fishermen who are indispensable to the Tagging Program and who made 1991 a very successful year for tagging sharks and furthering the understanding of shark migrations, age and growth, food habits, reproduction and other aspects of shark biology.

A total of 6,902 fish representing 34 species of sharks, 13 species of teleosts, and 7 species of rays were tagged in 1991 (Table 1). The majority were blue sharks (3,818), sandbar sharks (789), tiger sharks (537), dusky sharks (313), and blacktip sharks (213). Anglers accounted for 72% of the total releases followed by commercial fishermen (15%), NMFS and other biologists (7%), R/V *Geronimo* biologists (6%), and NMFS Fisheries Observers (<1%). Fish were released by taggers representing 7 countries: United States, Italy, Portugal, Spain, England, Netherlands, and Ireland.

In this issue

- Near Record Number of Sharks Tagged (6,900) and Record Number Recaptured (413)
- Sandbar Shark Recaptured after 24.9 Years
- Tiger Sharks Travel from U.S. to Dominican Republic and Grenada (750 + MILES)
- Mako Shark Migrations Linked to 18°C (64°F) Water Temperature
- Longline Survey Completed - Shark Catches Down
- Sandbar Shark Tag Returns Show MaturityMay Take up to 30 Years

Recaptures

During 1991, 413 sharks and teleosts were recaptured. Blue sharks (174), tiger sharks (98), and sandbar sharks (78) were the most commonly returned. This is the largest number of fish recaptured since the beginning of the Program in 1962. The returns came from fish tagged by anglers (60%), commercial fishermen (22%), NMFS and other biologists (15%), and Observers (3%). Recaptured fish were originally caught on rod-and-reel, longline, handline, trawl net, gill net or tagged free-swimming. The sources of the recaptures were primarily commercial fishermen (63%) and recreational anglers (35%). Returns came from vessels from the following 16 countries and island territories: U.S. (362), Canada (18), Mexico (10), Spain (7), Japan (3), Italy (2), Venezuela (2), and 1 each from Barbados, Cuba, Ivory Coast, Portugal, Trinidad, Bermuda, Faroe Islands, Yugoslavia, and the Dominican Republic.

Blue Sharks (174 Returns)

Blue sharks were at liberty from 0 to 1,642 days (4.5 years). Although there were more blue sharks returned this year than in most previous years, the majority were short-term recaptures (35% at liberty for less than 1 month, 85% less

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
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Table 1. Summary of sharks and teleosts tagged, January-December 1991

Species	Tagged by		
	Cooperative Taggers	Narragansett Biologists	Total
Blue shark	3,713	105	3,818
Sandbar shark	701	88	789
Tiger shark	516	21	537
Dusky shark	308	5	313
Blacktip shark	204	9	213
Shortfin mako	156	3	159
Atlantic sharpnose shark	111	4	115
Scalloped hammerhead	58	37	95
Sand tiger	58	11	69
Lemon shark	57	0	57
Nurse shark	50	1	51
Bull shark	49	0	49
Porbeagle	32	0	32
Galapagos shark	31	0	31
Bonnethead	24	0	24
Blacknose shark	22	0	22
Silky shark	14	3	17
Smooth hammerhead	15	0	15
Spinner shark	15	0	15
Reef shark	14	0	14
Smooth dogfish	7	4	11
Atlantic angel shark	10	0	10
Sand *unspecified*	10	0	10
Common thresher shark	9	0	9
Bigeye thresher shark	6	1	7
Caribbean sharpnose shark	6	0	6
Oceanic whitetip	6	0	6
Finetooth shark	5	0	5
Great hammerhead	5	0	5
Crocodile shark	4	0	4
Bignose shark	2	0	2
Longfin mako	2	0	2
White shark	2	0	2
Basking shark	1	0	1
Spiny dogfish	1	0	1
Hammerhead *unspecified*	45	0	45
Brown/Dusky *unspecified*	12	0	12
Thresher *unspecified*	5	0	5
Carcharhinus unspecified	4	0	4
Miscellaneous sharks and rays	38	11	49
Total sharks	**6,328**	**303**	**6,631**
Swordfish	100	0	100
Bluefin tuna	42	0	42
White marlin	41	0	41
Albacore tuna	14	0	14
Yellowfin tuna	13	0	13
Blue marlin	12	0	12
Atlantic sailfish	8	0	8
Bigeye tuna	6	0	6
Miscellaneous teleosts	35	0	35
Total teleosts	**271**	**0**	**271**
Total	**6,599**	**303**	**6,902**

than 1 year, 99% less than 3 years). This year's maximum time at liberty of 4.5 years is not a record, but it does add to our understanding of the age and growth of this species. The 4.5 year shark was a male, tagged at an estimated 7 ft and measured 9.2 ft at recapture. Based on results from our studies, this fish was approximately 7 years old at tagging and 12 years old at recapture after 4.5 years at liberty. Unlike sandbar sharks, which may live for more than 50 years (see article this newsletter), blue sharks may live for less than 20 years. This shark was re-released with the tag in place, we hope to be recaptured again.

Distances traveled by individual blue sharks ranged from 1 to 3,188 nautical miles. Many (86) were returned within 100 miles of their tagging location and most (138) within 300 miles. Eleven blue sharks traveled more than 1,000 miles. These included both males and females ranging in size from approximately 5 to 7.5 ft at tagging. Four were tagged between June 15-30 in 1990 and were subsequently recaptured southeast of the Grand Banks (1,200 miles), off Portugal (2,472 miles), off Grenada (1,851 miles) and northeast of Brazil near the equator (3,188 miles). The 3,188 mile recapture is the fourth longest distance traveled for any blue tagged in our Program. Two others returned this year were tagged in the Gulf of Maine in July and August of 1990 and were returned southeast of the Grand Banks and off Cuba. The remaining five long-distance returns were recaptured east of the Grand Banks, off Morocco, Venezuela and the Azores (2). These wide-ranging returns from 1991 are further examples of the complex migrations of the blue shark that encompass the entire North Atlantic. Additional tagging off the European, African, and South American coasts would certainly bring a clearer understanding of these movements.

Five small blue sharks (30 inches or less) were tagged and recaptured in the Eastern Atlantic and adjoining seas. Three were tagged by Italian sport fishermen off the northeast coast of Italy in the Adriatic Sea. They were at liberty from 11 to 13 months and were recaptured in the Adriatic Sea (2) and the Gulf of Taranto (distances of 30 to 300 miles). Two were tagged off southern Portugal and traveled 163 and 398 miles north after 57 and 286 days at liberty.

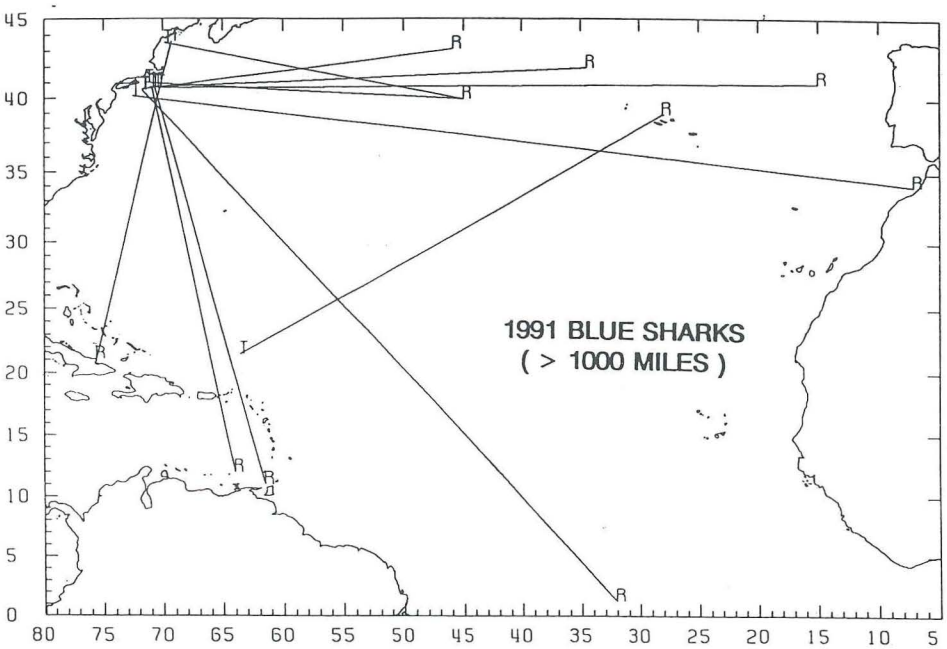
Long-distance movements by tagged fish are interesting, but returns that show little movement can be equally significant. Two fish that were tagged close together on the same day in July of 1990 were both recaptured approximately 1 year later within 43 miles of their tagging location. Both were retagged and released. Another blue shark was recovered only 17 miles from where it was tagged after 2.3 years at liberty. Alternatively, a tagged blue shark at liberty for one day was recaptured 48 miles away.

One unusual return was a tag found in the remains of a blue shark that was inside of a tiger shark stomach. The tiger was caught 9 days later, approximately 134 miles away from where the blue was tagged.

Fifty-eight tagged blues were released unharmed after the tag had been recovered; many with the same or a new tag in place. Six backbones were obtained from recaptured blue sharks for age and growth studies.

Sandbar Sharks (78 Returns)

The longest time at liberty for a sandbar shark recaptured in 1991 was 24.9 years. This is just 48 days short of the record for any fish tagged in the Cooperative Tagging Program. This male sandbar shark was tagged in Great Machipongo Sound, Va. by a Narragansett biologist on June 17, 1966 and was recaptured by a commercial longline fisherman on May 14, 1991 in the Gulf of Mexico. Fortunately, an observer from Louisiana State University was onboard and measured the length at recapture. Growth over this time period averaged an inch per year. This slow growth agrees well with information from other recaptures and with



results of our age studies on sandbar sharks (see article in this newsletter). Overall, 66 sandbar sharks were at liberty for more than 1 year, 27 for more than 5 years, and 4 for more than 10 years. The latter returns include fish at liberty for 11.1, 15.6 and 17.5 years.

Distances traveled ranged from 4 to 2,019 miles. Most of the sandbar recaptures were long-distance returns: 58 traveled more than 100 miles, 47 more than 500 miles, and 43 more than 1,000 miles. The maximum distance (2,019 miles), from a fish tagged south of Pt. Judith, R.I. that traveled to Mexico, is the third longest reported to date for any sandbar shark.

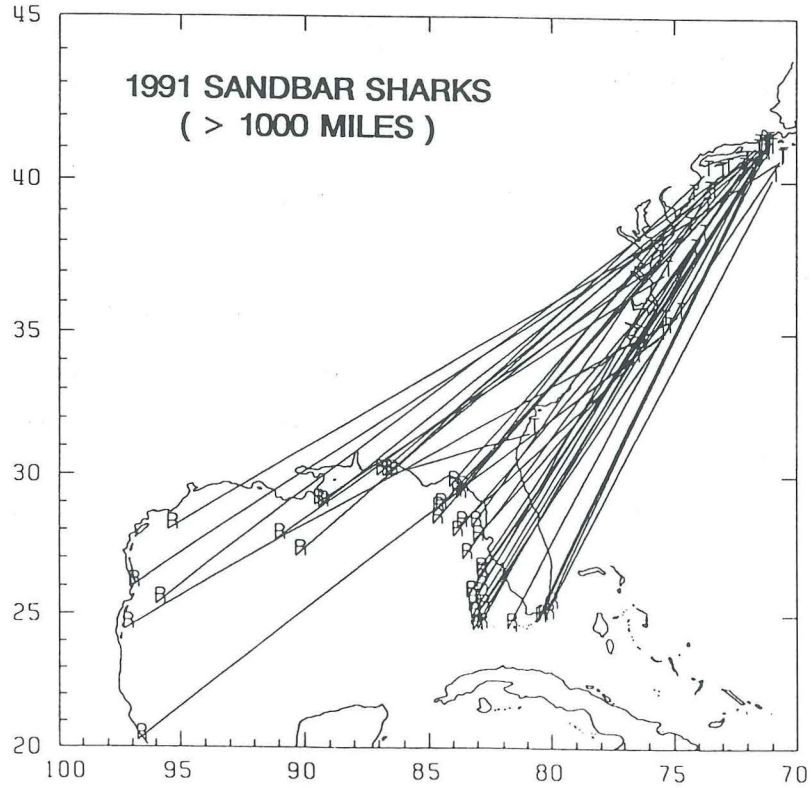
The predominant pattern of movement for sandbars returned this year (and previous years) is in a north-south direction. Thirty-nine of the sandbar sharks that were tagged in the Atlantic were recaptured in the Gulf of Mexico. An additional four were recaptured off the Florida Keys. All were north-south migrations exceeding 1,000 miles. To date, only two sandbar sharks that have been tagged in the Gulf of Mexico have shown movements outside the Gulf. These results can be partially explained by the fact that a large percentage of the tagging effort is off the Atlantic coast of the U.S. Every year a small number of new fishermen (both recreational and commercial) from the Florida west coast and Gulf of Mexico join the Tagging Program. We welcome anyone in those areas who would be willing to tag sharks.

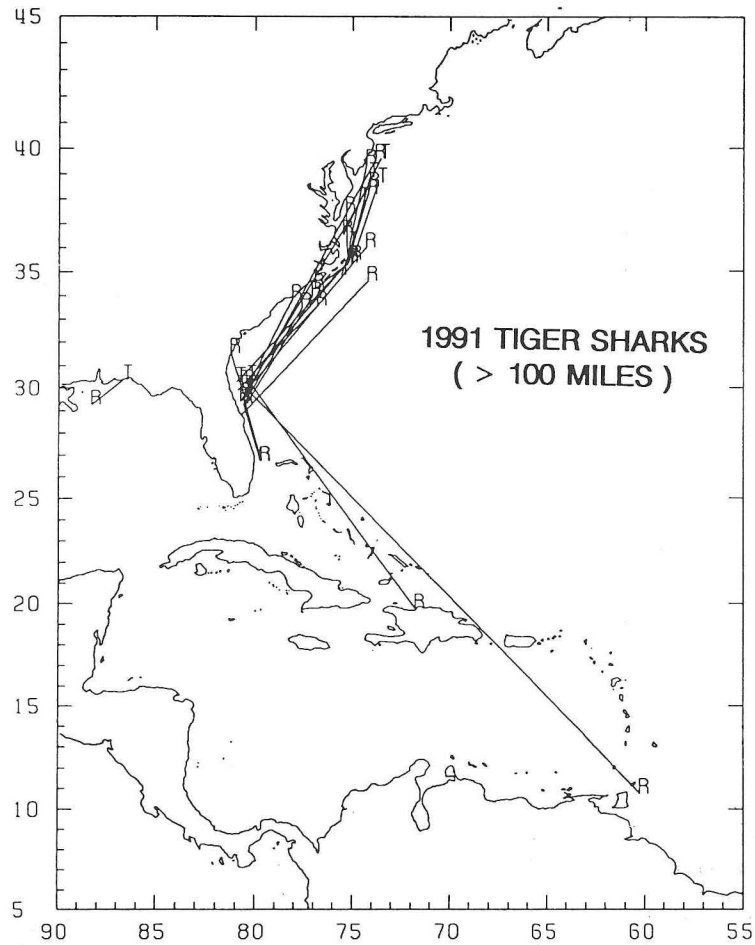
Only 12 fish did not fit into the directional pattern described. Nine of these were returned less than 100 miles from their tagging locations; some after many years at liberty. Fish recaptured after 3.1, 4.0, and 4.8 years were returned within 12, 30, and 4 miles, respectively.

The complexity of the migration patterns for the sandbar shark is illustrated by the following returns. Three fish (all juveniles) were tagged by NMFS biologists between May 22-25, 1989 off North Carolina. Two were recaptured after 2.3 years; one 97 miles to the north (off Virginia) and the other 1,168 miles to the southwest (in the Gulf of Mexico). The third shark was at liberty for 1.9 years and traveled 73 miles to the southeast. Two other fish tagged at the same time and place in 1986 off Virginia were recaptured 4.8 and 4.9 years later, one off New Jersey (110 miles northeast), and one off St. Petersburg, Fla. (1,266 miles southwest). Sandbar sharks segregate by size and sex. Moreover, the different segments of the population (*i.e.* adult males and females, and juveniles of both sexes) all have different migration patterns that apparently change with growth and maturity. The Tagging Program continues to clarify the complicated movements of this species.

Tiger Sharks (98 Returns)

The majority (69) of tigers traveled less than 100 miles from their point of tagging off the northeast coast of Florida. (*e.g.* 13 miles in 10.2 months, 59 miles in 14.6 months). Four tiger sharks





showed long range movements exceeding 500 miles. One was tagged off Ocean City, Md. by a sport fisherman and recovered 592 miles away off Florida by a commercial fisherman. The other three, tagged off northern Florida by the same commercial fisherman, were recovered off New Jersey (686 miles), the Dominican Republic (788 miles) and Trinidad (1,626 miles). The Trinidad recapture is the second longest distance for this species and the first tiger shark recovery from that area. The Dominican Republic recapture is only the second tiger shark returned from that area.

One tiger, tagged off Destin, Fla., was recaptured south of Mobile, Ala. Although this fish did not travel far (108 miles), it is still a valuable recovery. Less than 10 tiger shark returns have been tagged and/or recaptured in the Gulf of Mexico.

Tiger sharks were at liberty from 2 to 2,222 days (6.1 years). The majority (81) were out for less than 1 year. The 6.1 year recapture is not a record, but is approaching the maximum time at liberty for tiger sharks of 8.0 years.

This is by far the largest number of tiger shark returns ever received. Credit for this effort goes to commercial shark fishermen who tagged and recaptured approximately 85% of all the returns. Thirty-seven were released again with a new tag or with the same tag. Backbones were collected from 14 fish for age studies.

Multiple tiger shark recaptures, from 1991 and previous years, provide a unique data set to assess the early growth of this species in the wild. This year, nine tiger sharks were recaptured more than once; four were re-released with the same tag or with a new tag in place. Many of these fish were measured at both the tagging and recapture points by the same commercial fishermen and provide accurate growth information on individual fish.

Shortfin Mako Sharks (20 Returns)

Tags were returned from makos at liberty for a maximum of 6.4 years. Eleven fish were out less than 1 year and 18 less than 5 years. The remaining 2 were free for 6.3 and 6.4 years and are the second and third longest time at liberty for any mako shark. The current record is 8.2 years. Both fish were tagged by Foreign Fisheries Observers in Hydrographer and Lydonia Canyon (off Georges Bank) and recaptured off the New Jersey Coast (a distance of 206 and 273 miles west, respectively).

Overall, 5 makos were recaptured within 100 miles of their tagging location and 19 within 1,000 miles. The furthest distance traveled was 1,726 miles by a mako tagged near Veatch Canyon by a Foreign Fisheries Observer and recaptured on Laguiara Bank off Venezuela by a sport fisherman after 4.0 years at liberty. This is a valuable recapture as it is the fourth longest distance and only the third mako recaptured in the Caribbean. The mako was caught with a flying gaff while feeding on a white marlin that was hooked at the boat's transom.

A rate of travel of 18.6 miles per day was reported for a mako tagged off Montauk Pt., N.Y. and recaptured east of Little Egg Inlet, N.J (74 miles in 4 days). This is the second fastest rate reported for this species (maximum of 35.7 miles per day). For a more comprehensive analysis of mako shark tagging, see the article on mako tagging below.

Other Species (43 Returns)

Recaptures from other species provided valuable information including some long distance and maximum time at liberty records. A **nurse shark**, tagged in the Florida Keys and recaptured 145 miles away off Riviera Beach, Fla. represented the longest time at liberty and third largest distance for this species. A **bonnethead shark** set a distance record by traveling 141 miles from Texas to Mexico. A **yellowfin tuna** was tagged in Wilmington Canyon and recaptured south of the equator off Liberia (4,047 miles). Although this is the longest distance traveled for a yellowfin tuna in our Program, these findings are consistent with results from the SEFC Miami tuna tagging program. Other interesting recaptures included: two **dusky sharks** tagged off North Carolina by National Marine Fisheries Service biologists in October of 1985 that were recaptured off Mexico; a **scalloped hammerhead shark** recaptured after 5.9 years and a **sand tiger shark** after 2.4 years (both third longest times at liberty for those species); four **blacktip sharks** tagged and recaptured in the Gulf of Mexico with a maximum distance of 292 miles; and a **porbeagle shark** that traveled 404 miles in 50 days (8 miles per day).

Table 2. Tag recoveries: January-December 1991.

	GENERAL LOCATIONS		MONTHS AT LIBERTY	DIST. (MI) AND DIR.		CAPTURE METHOD TAG REC.		TAGGED BY	
	TAGGED	RECAPTURED						TAGGER	RESIDENCE
Blue shark	SE Pt Judith, RI	S Block Is, RI	11	41	W	RR	RR	Bob Rowan	RI
" "	E Montauk Pt, NY	S Pt Judith, RI	2	7	NW	RR	RR	Francis Powers	MA
" "	E Montauk Pt, NY	E Cape Henry, VA	9	270	SW	RR	LL	Craig Hutnick	NY
" "	SE Ocean City, MD	SE Montauk Pt, NY	12	209	NE	RR	RR	Mark Sampson	MD
" "	S Pt Judith, RI	SE Powell Canyon	12	213	E	RR	LL	George Hehner	RI
" "	SE Montauk Pt, NY	E Cape Henlopen, DE	<1	134	SW	RR	LL	Ronnie DeLuca	NY
" "	SE Fire Is Inlet, NY	SE Cabo de Sao Vicente, Portugal	32	3,081	E	RR	HL	Ted Bingham	NY
" "	E Barnegat Inlet, NJ	E Cape Hatteras, NC	1	303	SW	RR	LL	Larry Gorman	NY
" "	S Nantucket Is, MA	E Wassaw Sound, GA	53	660	SW	LL	LL	Stephen Connett	RI
" "	S Pt Judith, RI	SE Shinnecock Inlet, NY	11	38	SW	RR	RR	Kelly Smith	CT
" "	S Montauk Pt, NY	S Montauk Pt, NY	<1	4	SE	RR	RR	Gene Blau	NY
" "	SE Montauk Pt, NY	SE Pt Judith, RI	3	61	E	RR	HL	Walter Kaprielian	NY
" "	SE Shinnecock Inlet, NY	SE Montauk Pt, NY	12	13	NE	RR	RR	Bill Imperiale	NY
" "	Poormans Canyon	S Montauk Pt, NY	<1	204	NE	RR	RR	James Daniel	MD
" "	E Ocean City, MD	SE Pt Judith, RI	1	227	NE	RR	HL	Dale Hoover	PA
" "	SE Pt Judith, RI	NR	NR	NR		LL	LL	Stephen Connett	RI
" "	Montauk Pt, NY	SE Cabo Sao Vicente, Portugal	NR	NR		RR	LL	Steve DeMarco	CT
" "	E Montauk Pt, NY	N Cumana, Venezuela	11	1,763	S	RR	LL	Vincent Insinga	CT
" "	S Shinnecock Inlet, NY	SE Oceanographer Canyon	4	202	E	RR	LL	Ken Burkhard	NY
Blue shark	E Ocean City, MD	E Ocean City, MD	<1	20	SE	RR	RR	Dennis Senk	NJ
" "	SE Manasquan Inlet, NJ	SW Oceanographer Canyon	3	174	E	RR	LL	Carmine Vastola	NJ
" "	SE Cape Porpoise, ME	E Wachapreague Inlet, VA	10	389	SW	RR	LL	James Hinkley	ME
" "	SE Shinnecock Inlet, NY	S Montauk Pt, NY	5	68	S	RR	RR	Bob Cicerani	NY
" "	SE Pt Judith, RI	SW Pt Judith, RI	25	54	W	RR	RR	Frank Mather	MA
" "	SE Pt Judith, RI	Wilmington Canyon	9	188	SW	RR	RR	Andy Dangelo	RI
" "	E Cape Elizabeth, ME	Punta Lucrecia, Holguin, Cuba	9	1,389	S	RR	LL	David Sinclair	ME
" "	SE Montauk Pt, NY	SE Powell Canyon	12	208	E	RR	LL	Bill Ricca	NY
" "	SE Pt Judith, RI	SE Montauk Pt, NY	28	17	SW	RR	RR	Gerald Ruest	RI
" "	SSW Pt Judith, RI	SSE Fire Is Inlet, NY	12	64	SW	RR	RR	Charlie Donilon	RI
" "	SSE Pt Judith, RI	SE Block Is, RI	2	21	SE	RR	HL	Charlie Donilon	RI
" "	E Beach Haven, NJ	SE Montauk Pt, NY	29	82	NE	LL	RR	Biologist (NMFS)	RI
" "	E Cape May, NJ	SE Pt Judith, RI	3	187	E	RR	LL	Joe Lucas	PA
" "	S Martha's Vineyard, MA	Georges Bank	24	NR		HL	RR	Stephen Connett	RI
" "	S Montauk Pt, NY	SW Cape Sable, NS Canada	1	254	E	FS	LL	Carl Safina	NY
" "	E Pesaro, Italy	SE Pesaro, Italy	13	99	SE	RR	HP	Agostini Luca	Italy
" "	S Montauk Pt, NY	Georges Bank	NR	NR		RR	LL	Ray Hendrickson	NY
" "	SE Jones Inlet, NY	E Manasquan Inlet, NJ	<1	18	NW	RR	RR	Stephen Roland	NY
" "	S Shinnecock Inlet, NY	SE Moriches Inlet, NY	<1	5	N	RR	RR	Tom Cashman	NY
" "	SW Montauk Pt, NY	E Manasquan Inlet, NJ	<1	35	SW	RR	RR	Tom Cashman	NY
Blue shark	E Barnegat Inlet, NJ	SE Montauk Pt, NY	3	83	NE	RR	RR	Dean Wright	PA
" "	E Ocean City, MD	E Ocean City, MD	<1	26	W	LL	RR	Stephen Connett	RI
" "	SE Pt Judith, RI	W Cabo Finisterre, Spain	16	2,472	E	HL	LL	Stephen Connett	RI
" "	SE Pt Judith, RI	SE Hydrographer Canyon	3	83	SE	HL	LL	Stephen Connett	RI
" "	S Martha's Vineyard, MA	SE of Grenada	6	1,851	S	HL	HL	Stephen Connett	RI
" "	SE Pt Judith, RI	SE Shinnecock Inlet, NY	12	86	W	HL	RR	Stephen Connett	RI
" "	SE Pt Judith, RI	E Veatch Canyon	2	60	SE	HL	LL	Stephen Connett	RI
" "	Montauk Pt, NY	SE Pt Judith, RI	NR	NR		RR	RR	Tom Federico	NY
" "	Montauk Pt, NY	SE Pt Judith, RI	NR	NR		RR	LL	Tom Federico	NY
" "	SW Montauk Pt, NY	S Pt Judith, RI	21	59	E	RR	RR	John Kudrick	NY
" "	SE Pt Judith, RI	S Pt Judith, RI	<1	30	SW	RR	RR	Lee Pepin	CT
" "	E Cape May, NJ	S Cape Sable, NS Canada	2	429	NE	RR	TN	Bill Kleimenhagen	PA
" "	E Cape Henlopen, DE	E Ocean City, MD	14	53	SW	RR	RR	Bill Kleimenhagen	PA
" "	Montauk Pt, NY	Wilmington Canyon	NR	NR		RR	LL	Wayne King	NY
" "	S Montauk Pt, NY	Georges Bank	NR	NR		RR	LL	Joe Panas	NY
" "	SE Pt Judith, RI	S Pt Judith, RI	11	15	W	RR	RR	Al Anderson	RI
" "	Montauk Pt, NY	S Montauk Pt, NY	NR	NR		RR	RR	Greg Dubrule	CT
" "	S Montauk Pt, NY	E Ocean City, MD	NR	148	SW	RR	RR	Bob Raimondi	MA
" "	SE Pt Judith, RI	SW Tail of the Grand Banks	3	815	E	HL	LL	Stephen Connett	RI
" "	SE Pt Judith, RI	SE Oceanographer Canyon	3	101	E	HL	LL	Stephen Connett	RI
Blue shark	SE Pt Judith, RI	Hudson Canyon	11	110	SW	LL	RR	Stephen Connett	RI
" "	SE Montauk Pt, NY	SE Montauk Pt, NY	NR	NR		RR	RR	Frank Mundus	NY
" "	SE Portland, ME	S Flemish Cap	3	1,128	E	RR	LL	Mark Chase	ME
" "	SE Portland, ME	SE Hydrographer Canyon	15	222	S	RR	LL	Ben Garfield	ME
" "	E Plum Island, MA	Light Buoy, Portland, ME	11	40	N	RR	RR	Richard Jennings	MA
" "	E Saco River, ME	SE Hydrographer Canyon	16	220	S	RR	LL	Bob Puddister	ME
" "	SE Montauk Pt, NY	E Cape Henlopen, DE	1	134	SW	RR	LL	Robert Sherwood	NY
" "	S Shinnecock Inlet, NY	SE Cape Sable, NS Canada	5	452	E	FS	RR	George Kazdin	NY
" "	SW Montauk Pt, NY	S Pt Judith, RI	<1	56	E	FS	RR	George Kazdin	NY
" "	S Montauk Pt, NY	SE Fire Is Inlet, NY	<1	54	W	RR	RR	Conrad Szemreylo	CT
" "	S Montauk Pt, NY	SE Montauk Pt, NY	<1	20	NE	RR	RR	Jim Bohara	CT
" "	Veatch Canyon	E Manasquan Inlet, NJ	11	152	W	RR	RR	Fred Iasiello	CT
" "	E Rimini, Italy	Gulf of Taranto, Italy	11	300	SE	RR	LL	Argangyeli Mattias	Italy
" "	E Fano, Italy	E Ancona, Italy	1	30	SE	RR	RR	Mario Cardinali	Italy
" "	SE Pt Judith, RI	SE Montauk Pt, NY	<1	12	SW	RR	RR	Al Anderson	RI
" "	S Montauk Pt, NY	SE Montauk Pt, NY	<1	40	NE	RR	RR	Bob Genereau	CT
" "	SE Shinnecock Inlet, NY	E Veatch Canyon	3	144	E	RR	LL	Bill Williams	NY
" "	SE Shinnecock Inlet, NY	SE Pt Judith, RI	3	80	NE	RR	RR	Bill Williams	NY
" "	S Shinnecock Inlet, NY	S Montauk Pt, NY	<1	36	E	FS	RR	Floyd Carrington	NY
" "	E Ocean City, MD	Hudson Canyon	4	102	NE	RR	LL	Doug Krisher	PA
Blue shark	S Montauk Pt, NY	Georges Bank	NR	NR		RR	LL	Fred Wedley	NY
" "	S Montauk Pt, NY	E Oceanographer Canyon	4	177	E	RR	LL	Pete Kazura	NY
" "	S Montauk Pt, NY	Nygren Canyon	<1	230	E	RR	GN	Mike Plaia	CT
" "	S Montauk Pt, NY	S Cape Sable, NS Canada	2	268	E	RR	LL	Mike Plaia	CT
" "	SE Montauk Pt, NY	SE Montauk Pt, NY	<1	0		RR	RR	Peter Hines	NY
" "	S Montauk Pt, NY	SE Cape Sable, NS Canada	13	340	E	RR	LL	Peter Hines	NY
" "	S Montauk Pt, NY	SE Montauk Pt, NY	<1	48	NE	RR	RR	Ben Franford	CT
" "	E Montauk Pt, NY	S Flemish Cap	5	1,200	E	RR	LL	Ben Franford	CT
" "	Montauk Pt, NY	SE Montauk Pt, NY	NR	NR		RR	RR	Skip Gula	NY
" "	SE Shinnecock Inlet, NY	SE Montauk Pt, NY	<1	42	NE	RR	RR	Fred Wedley	NY
" "	Montauk Pt, NY	S Montauk Pt, NY	NR	NR		RR	RR	Robert Nankervis	NY
" "	S Shinnecock Inlet, NY	SSE Cape May, NJ	4	177	SW	RR	LL	Jack Patotine	NY
" "	S Montauk Pt, NY	E Tail of Grand Banks	4	1,161	E	RR	LL	David Cochran	FL
" "	S Montauk Pt, NY	SW Dakar, Senegal	8	3,188	SE	RR	LL	Frank Braddick	NY
" "	Jupiter, FL	E Townsends Inlet, NJ	NR	NR		RR	RR	John Watche	FL
" "	S Montauk Pt, NY	SE Oregon Inlet, NC	8	321	SW	RR	LL	Pete Kazura	NY
" "	SE Pt Judith, RI	SW Martha's Vineyard, MA	2	17	N	RR	RR	Tom Birch	MA
" "	E Montauk Pt, NY	SE Montauk Pt, NY	14	33	SW	RR	RR	Kelly Smith	CT

Table 2 continued.

	GENERAL LOCATIONS TAGGED	RECAPTURED	MONTHS AT LIBERTY	DIST. (MI) AND DIR.		CAPTURE METHOD TAG	REC.	TAGGED BY TAGGER	RESIDENCE
Blue shark	S Montauk Pt, NY	SE Montauk Pt, NY	36	28	NE	RR	RR	A. Christopher Varone	RI
" "	SE Fire Is Inlet, NY	S Pt Judith, RI	1	71	NE	RR	RR	Ed Unkel	NY
" "	S Montauk Pt, NY	S Montauk Pt, NY	24	29	SW	RR	RR	Bill HoJohn	NY
" "	E Cape May, NJ	SE Cape May, NJ	<1	27	S	RR	LL	Richard Humphreys	NJ
" "	SE Montauk Pt, NY	Georges Bank	NR	NR		RR	LL	Jack Lemmons	NY
" "	S Montauk Pt, NY	SW Munson Canyon	2	206	E	RR	LL	Ben Franford	CT
" "	SE Montauk Pt, NY	SE Montauk Pt, NY	11	36	W	RR	RR	Frank Braddick	NY
" "	SE Montauk Pt, NY	SE Pt Judith, RI	13	42	E	RR	HL	Frank Braddick	NY
" "	Montauk Pt, NY	SW Montauk Pt, NY	NR	NR		RR	RR	Cliff Heaton	CT
" "	SE Montauk Pt, NY	S Pt Judith, RI	<1	20	NE	RR	RR	Bill Brown	CT
" "	S Pt Judith, RI	E Montauk Pt, NY	1	24	NE	FS	RR	Lee Pepin	CT
" "	S Pt Judith, RI	S Montauk Pt, NY	<1	12	S	RR	RR	Lee Pepin	CT
" "	S Montauk Pt, NY	S Montauk Pt, NY	<1	1	E	RR	RR	Lou Pastore	NY
" "	S Pt Judith, RI	SE Fire Is Inlet, NY	3	71	SW	RR	RR	Charlie Donilon	RI
" "	S Pt Judith, RI	S Pt Judith, RI	<1	4	SW	RR	RR	Bill Brown	CT
" "	S Montauk Pt, NY	S Pt Judith, RI	1	63	SE	RR	RR	Gloria Hayn	NY
" "	SE Montauk Pt, NY	NW Faial Azores	8	1,637	E	RR	LL	Howard Kiedaisch	NY
" "	SW Montauk Pt, NY	SE Montauk Pt, NY	<1	45	NE	RR	RR	John Fields	NY
" "	E Beach Haven, NJ	W Atlantis Canyon	1	110	E	FS	LL	Greg Venturo	NJ
" "	SE Pt Judith, RI	SE Block Is, RI	13	21	W	RR	HL	Michael Woodley	MA
Blue shark	SE Pt Judith, RI	SE Pt Judith, RI	12	51	W	HL	RR	Stephen Connett	RI
" "	E Rudee Inlet, VA	E Townsends Inlet, NJ	1	166	NE	FS	RR	Stephen Connett	RI
" "	SE Pt Judith, RI	S Shinnecock Inlet, NY	3	83	W	HL	HL	Stephen Connett	RI
" "	SE Pt Judith, RI	SE Cape Sable, NS Canada	1	344	E	HL	LL	Stephen Connett	RI
" "	SE Pt Judith, RI	SE Pt Judith, RI	1	21	E	HL	RR	Stephen Connett	RI
" "	SE Pt Judith, RI	SE Ocean City, MD	2	224	SW	HL	RR	Stephen Connett	RI
" "	SE Pt Judith, RI	SW Cape Sable Is, NS Canada	2	186	E	HL	LL	Stephen Connett	RI
" "	SE Pt Judith, RI	Hudson Canyon	2	128	SW	RR	LL	Ben Tribken	MA
" "	S Montauk Pt, NY	SE Pt Judith, RI	<1	40	NE	RR	RR	Gene Blau	NY
" "	SE Fire Is Inlet, NY	SW Montauk Pt, NY	<1	16	NE	RR	RR	Edward Unkel	NY
" "	S Montauk Pt, NY	S Montauk Pt, NY	<1	11	N	RR	RR	Peter Jakits	NY
" "	E Barnegat Inlet, NJ	E Barnegat Inlet, NJ	<1	1	SE	RR	RR	Scott Martindell	PA
" "	S Pt Judith, RI	SE Cape Sable, NS Canada	4	442	E	RR	RR	Bob Rowan	RI
" "	S Vila Moura, Portugal	NE Cabo Finisterre, Spain	9	398	N	RR	LL	Graeme Pullen	England
" "	S Pt Judith, RI	Block Canyon	10	51	S	FS	RR	Rodman Sykes	RI
" "	SE Pt Judith, RI	S Montauk Pt, NY	2	46	W	FS	RR	Stephen Connett	RI
" "	E York Harbor, ME	SE Pt Judith, RI	1	186	S	LL	LL	Stephen Connett	RI
" "	SE Pt Judith, RI	SE Montauk Pt, NY	1	69	W	HL	RR	Stephen Connett	RI
" "	SE Pt Judith, RI	SE Montauk Pt, NY	<1	74	W	HL	RR	Stephen Connett	RI
" "	SE Pt Judith, RI	S Montauk Pt, NY	<1	84	W	HL	RR	Stephen Connett	RI
Blue shark	SE Pt Judith, RI	SE Montauk Pt, NY	<1	89	SW	HL	LL	Stephen Connett	RI
" "	Portland, ME	E York Harbor, ME	NR	NR		RR	RR	Dave Sinclair	ME
" "	E Ocean City, MD	E Indian River Inlet, DE	<1	27	E	RR	RR	Mark Sampson	MD
" "	E Ocean City, MD	SE Montauk Pt, NY	4	186	NE	RR	RR	Billy Verbanas	DE
" "	S Montauk Pt, NY	SE Montauk Pt, NY	<1	33	E	RR	RR	Michael Hurney	NY
" "	E Ocean City, MD	Veatch Canyon	6	219	NE	RR	RR	Billy Verbanas	DE
" "	NE San Juan, PR	Azores	8	2,103	NE	RR	LL	Scott Drabinowicz	MA
" "	SE Pt Judith, RI	SW Cape Sable Is, NS Canada	2	204	E	RR	LL	Robert Reichenberger	NY
" "	SE Fire Is Inlet, NY	S Moriches Inlet, NY	<1	13	N	RR	RR	Anthony Innamorato	NY
" "	SE Moriches Inlet, NY	Hydrographer Canyon	4	147	E	RR	LL	Jim Haney	NY
" "	SE Shinnecock Inlet, NY	SW Pt Judith, RI	<1	24	NE	RR	RR	Bill Williams	NY
" "	E Barnegat Inlet, NJ	SSE Cape May, NJ	4	127	S	RR	LL	Dean Wright	PA
" "	S Montauk Pt, NY	Hydrographer Canyon	4	144	E	RR	LL	Ray Hendrickson	NY
" "	SE Fire Is Inlet, NY	SE Fire Is Inlet, NY	<1	7	N	RR	RR	Sal DiMarco	NY
" "	SE Montauk Pt, NY	SE Shinnecock Inlet, NY	<1	49	SW	RR	RR	Dennis Vlahakis	CT
" "	S Pt Judith, RI	SE Pt Judith, RI	2	46	NE	RR	RR	Bob Weaver	NY
" "	S Montauk Pt, NY	SE Pt Judith, RI	<1	39	NE	RR	RR	Frank Braddick	NY
" "	Montauk Pt, NY	SE Shinnecock Inlet, NY	NR	NR		RR	RR	Tom Federico	NY
" "	Montauk Pt, NY	SE Shinnecock Inlet, NY	NR	NR		RR	RR	Tom Federico	NY
" "	SE Montauk Pt, NY	SE Pt Judith, RI	<1	33	NE	RR	RR	Paul White	NY
Blue shark	S Montauk Pt, NY	W Atlantis Canyon	1	74	E	RR	LL	Terrence Stoner	NY
" "	S Montauk Pt, NY	S Pt Judith, RI	NR	NR		RR	RR	Frank Braddick	NY
" "	SE Pt Judith, RI	SE Pt Judith, RI	1	36	SE	RR	RR	Al Anderson	RI
" "	SE Montauk Pt, NY	SE Pt Judith, RI	1	26	NE	RR	RR	Robert Reichenberger	NY
" "	Pt Judith, RI	Tobago, West Indies	NR	NR		RR	HL	Lee Pepin	CT
" "	SE Pt Judith, RI	Georges Bank	NR	NR		RR	LL	Robert Reichenberger	NY
" "	SE Pt Judith, RI	SW Munson Canyon	2	150	E	RR	LL	Robert Reichenberger	NY
" "	SE Montauk Pt, NY	S Pt Judith, RI	<1	21	W	RR	HL	Frank Braddick	NY
" "	E Cape Henlopen, DE	SE Cape Elizabeth, ME	2	304	NE	LL	HL	Biologist (NMFS)	RI
" "	SE Montauk Pt, NY	S Pt Judith, RI	<1	19	E	LL	RR	Biologist (NMFS)	RI
" "	SE Montauk Pt, NY	SE Montauk Pt, NY	<1	25	W	LL	RR	Biologist (NMFS)	RI
" "	SE Pt Judith, RI	Atlantis Canyon	<1	66	SW	RR	LL	Dan Tortora	MA
" "	SE Montauk Pt, NY	Hudson Canyon	<1	87	SW	RR	LL	Joe McBride	NY
" "	E Saco River, ME	SE Saco River, ME	<1	16	W	RR	RR	Andy Tartre	ME
" "	E Saco River, ME	S Cape Elizabeth, ME	1	16	W	RR	RR	Andy Tartre	ME
" "	S Vila Moura, Portugal	SW Nazare, Portugal	1	163	NW	RR	LL	Graeme Pullen	England
" "	SE Pt Judith, RI	S Cape Sable, NS Canada	1	226	E	RR	LL	Al Conti	RI
Sandbar shark	Great Machipongo Snd, VA	SE Galveston, TX	298	1,463	SW	GN	LL	Biologist (NMFS)	RI
" "	SE Manasquan Inlet, NJ	E Ponce Inlet, FL	90	721	SW	RR	LL	Ralph Roth	NJ
" "	SE Montauk Pt, NY	E Matecumbe Harbor, FL	82	1,063	SW	RR	LL	Joe McBride	NY
" "	SE Montauk Pt, NY	W Naples, FL	93	1,357	SW	RR	LL	Warren Hader	NY
" "	E Ocean City, MD	SSW Mobile, AL	80	1,475	SW	RR	LL	Ed Haney	MD
" "	SW Montauk Pt, NY	E Ocean City, MD	36	169	SW	RR	LL	Shaler Carrington	NY
" "	E Oregon Inlet, NC	E Barra Jesus Maria, Tamp, Mexico	85	1,668	SW	LL	RR	Stephen Connett	RI
" "	Great Bay, NJ	NW St Petersburg, FL	210	1,460	SW	RR	LL	Bob Mangold	FL
" "	SE Montauk Pt, NY	SW St Petersburg, FL	187	1,409	SW	RR	LL	Steve Locke	NY
" "	SE Block Is, RI	W Naples, FL	47	1,414	SW	RR	LL	Howard Wilder	NY
" "	S Fire Is Inlet, NY	Jacksonville, FL	NR	NR		RR	LL	Roy Carpenter	NY
" "	SE Pt Judith, RI	NW St Petersburg, FL	106	1,599	SW	RR	LL	Charlie Donilon	RI
" "	E Barnegat Inlet, NJ	SE Apalachicola, FL	133	1,466	SW	RR	LL	Pete Barrett	NJ
" "	ESE Montauk Pt, NY	W Naples, FL	116	1,370	SW	RR	LL	Dave Willis	CT
" "	NE Manasquan Inlet, NJ	S Destin, FL	108	1,585	SW	RR	LL	Frank Freer	NJ
" "	SE Manasquan Inlet, NJ	NW Dry Tortugas, FL	105	1,146	SW	RR	LL	Pete Barrett	NJ
" "	Montauk Pt, NY	NW Dry Tortugas, FL	NR	NR		RR	LL	Philip Schaffer	NY
" "	Cape Hatteras, NC	E Key Largo, FL	97	650	S	RR	LL	Bill Moffett	VA
" "	E Beach Haven, NJ	E Cape May, NJ	49	53	SW	RR	LL	Bill Darney	NJ
" "	NW Baltimore Canyon	SW Key West, FL	55	1,105	SW	TN	LL	Jay Loubris, NMFS Obs	MA

Table 2 continued.

	GENERAL LOCATIONS TAGGED	RECAPTURED	MONTHS AT LIBERTY	DIST. (MI) AND DIR.		CAPTURE METHOD TAG	REC.	TAGGED BY TAGGER	RESIDENCE
Sandbar shark	SE Pt Judith, RI	SE Metamoros, Tamp., Mexico	82	2,019	SW	LL	LL	Stephen Connett	RI
" "	S Pt Judith, RI	Block Is, RI	62	NR		RR	RR	Al Anderson	RI
" "	S Pt Judith, RI	S Pensacola, FL	83	1,670	SW	RR	LL	David Pagano	RI
" "	E Wachapreague Inlet, VA	NE Cape Hatteras, NC	82	141	S	LL	LL	Biologist (NMFS)	RI
" "	SW Moriches Inlet, NY	SE Ormand Bch, FL	79	799	SW	RR	LL	Ted Bingham	NY
" "	E Wachapreague Inlet, VA	W St Petersburg, FL	59	1,266	SW	TN	LL	Roger Dow, NMFS Obs	MA
" "	E Wachapreague Inlet, VA	SE Barnegat Inlet, NJ	58	110	NE	TN	LL	Roger Dow, NMFS Obs	MA
" "	Avon, NC	W St Petersburg, FL	19	1,101	SW	RR	LL	Arnold Farber	VA
" "	SE Cape May, NJ	NE Ponce Inlet, FL	55	720	SW	RR	LL	Bob Vichko	NJ
" "	E Barnegat Inlet, NJ	E Cape Henlopen, DE	11	70	SW	RR	LL	Murray LaBarr	NJ
" "	SE Manasquan Inlet, NJ	NE Ponce Inlet, FL	55	720	SW	RR	LL	Jim Lynch	NJ
" "	S Moriches Inlet, NY	SE Port Brownsville, TX	61	1,892	SW	RR	LL	Ted Bingham	NY
" "	E Montauk Pt, NY	S Leeville, LA	31	1,686	SW	RR	LL	Mike Bentinegna	NY
" "	E Morehead City, NC	Nautla, Ver. Mexico	75	1,627	SW	LL	LL	Biologist (NMFS)	RI
" "	Montauk Pt, NY	E Port Orange, FL	NR	NR		RR	LL	Ken Darnay	NY
" "	S Fire Is Inlet, NY	NW St Petersburg, FL	45	1,531	SW	RR	LL	Ken Schmieder	NY
" "	E Cape May, NJ	E Beach Haven, NJ	48	30	N	RR	GN	David Krypel	NJ
" "	SW Montauk Pt, NY	W Tarpon Springs, FL	59	1,498	SW	RR	LL	Al Ristori	NJ
" "	SW Wachapreague Inlet, VA	W Tarpon Springs, FL	27	1,253	SW	RR	LL	Jeffrey Pitts	VA
" "	E Little Egg Inlet, NJ	SE Barnegat Inlet, NJ	37	12	E	RR	LL	Phillip Richard	NJ
Sandbar shark	S Montauk Pt, NY	W Dry Torgugas, FL	49	1,279	SW	RR	LL	Ralph Miano	CT
" "	SE Little Egg Inlet, NJ	S Freeport, TX	62	1,811	SW	RR	LL	John Capuano	NJ
" "	S Montauk Pt, NY	W Key West, FL	45	1,266	SW	RR	LL	Bill Haga	NY
" "	S Pt Judith, RI	SE New Orleans, LA	58	1,708	SW	RR	LL	Fred Gallagher	RI
" "	S Cape Lookout, NC	W Tarpon Springs, FL	60	1,042	SW	LL	LL	Biologist (NMFS)	RI
" "	E Ponce Inlet, FL	E Ponce Inlet, FL	58	4	NE	LL	LL	Biologist (NMFS)	RI
" "	E Savannah, GA	NE Ponce Inlet, FL	57	130	S	LL	LL	Biologist (NMFS)	RI
" "	NE Cape Hatteras, NC	E Fernandina, FL	57	406	SW	LL	RR	Biologist (NMFS)	RI
" "	S Moriches Inlet, NY	N Ponce Inlet, FL	62	788	SW	LL	LL	Biologist (NMFS)	RI
" "	NNE Barnegat Inlet, NJ	NE Cape Henry, VA	48	163	SW	RR	LL	Nels Peterson	PA
" "	E Cape Henry, VA	S New Orleans, LA	36	1.420	SW	RR	LL	Bill Moffett	VA
" "	SE Fire Is Inlet, NY	W Naples, FL	51	1,318	SW	RR	LL	Phil Bruckner	NY
" "	E Rudee Inlet, VA	E Barnegat Inlet, NJ	22	212	NE	RR	LL	Richard Dusch	VA
" "	E Ocean City, NJ	E Barnegat Light, NJ	9	27	N	RR	GN	Bob Beideman	PA
" "	ESE Block Is, RI	E Mule Key, FL	118	1,087	SW	RR	LL	Andy Dangelo	RI
" "	E Little Egg Inlet, NJ	SE Cape Canaveral, FL	29	741	SW	RR	LL	Al Ristori	NJ
" "	E Cape May, NJ	E Cape Fear, NC	7	353	SW	RR	LL	Jack Kline	NJ
" "	S Pt Judith, RI	SE Apalachicola, FL	22	1,559	SW	RR	LL	Andy Dangelo	RI
" "	S Wassaw Sound, GA	S Destin, FL	14	1,014	SW	LL	LL	Biologist (NMFS)	RI
" "	SE Cape Hatteras, NC	W Tarpon Springs, FL	27	1,168	SW	LL	LL	Biologist (NMFS)	RI
Sandbar shark	SE Oregon Inlet, NC	NE Cape Henry, VA	28	97	N	LL	LL	Biologist (NMFS)	RI
" "	N Oregon Inlet, NC	E Avon, NC	22	73	SE	LL	LL	Biologist (NMFS)	RI
" "	Delaware Bay, NJ	Ocean City, NJ	12	32	NE	LL	RR	Bruce Hecker	MD
" "	E Moriches Inlet, NY	E Charleston, SC	18	479	SW	RR	LL	Robert Sassok	NY
" "	S Montauk Pt, NY	S Shinnecock Inlet, NY	27	30	W	RR	RR	Tom Federico	NY
" "	S Pt Judith, RI	S Key West, FL	23	1,116	SW	RR	LL	Andy Dangelo	RI
" "	S Pt Judith, RI	S Elliot Key, FL	22	1,045	SW	RR	LL	Fred Gallagher	RI
" "	E Beach Haven, NJ	E Cape May, NJ	2	38	SW	RR	LL	Jim Morrison	NJ
" "	S Pt Judith, RI	SE Tavernier, FL	28	1,025	SW	RR	LL	Ed Correia	RI
" "	S Pt Judith, RI	E Drum Inlet, NC	8	417	SW	TN	RR	Rodman Sykes	RI
" "	Sand Bridge Pier, VA	Chesapeake Bay, VA	9	20	NW	RR	RR	Albert Norwood	VA
" "	E Ponce Inlet, FL	SE Ponce Inlet, FL	1	5	S	LL	LL	Eric Sander	FL
" "	E Rudee Inlet, VA	E Brant Beach, NJ	<1	180	N	LL	GN	Biologist (NMFS)	RI
" "	E Manasquan Inlet, NJ	S Fire Is Inlet, NY	13	16	NE	RR	LL	Rich Schneider	NJ
" "	SE Moriches Inlet, NY	S Alligator Light, FL	55	1,271	SW	RR	LL	Dan Azzato	NY
" "	N Cape Henlopen, DE	E Port Orange, FL	NR	NR		LL	LL	Bruce Hecker	MD
" "	SSE Block Is, RI	W Sarasota, FL	28	1,449	SW	RR	LL	Andy Dangelo	RI
" "	SE Pt Judith, RI	NW Key West, FL	77	1,338	SW	LL	LL	Stephen Connett	RI
" "	S Martha's Vineyard, MA	Gulf of Mexico	80	NR		LL	LL	Stephen Connett	RI
Tiger shark	E Beach Haven, NJ	SE Rudee Inlet, VA	1	206	SW	RR	RR	Michael Ianniello	NJ
" "	E Beaufort Inlet, NC	SE Ocean City, MD	73	210	N	LL	RR	Biologist (NMFS)	RI
" "	NE Ponce Inlet, FL	S Long Beach, NC	48	273	NE	LL	RR	Tris Colket	FL
" "	E Ocean City, MD	NE Cape Hatteras, NC	8	200	S	RR	LL	John Draper	NJ
" "	SE Ocean City, MD	NE Ponce Inlet, FL	40	592	SW	RR	LL	Dick Arnold	MD
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	NR	NR		LL	LL	Eric Sander	FL
" "	E Cape May, NJ	NE Cape Hatteras, NC	9	217	S	RR	LL	Joe Lucas	PA
" "	E Beach Haven, NJ	SE Barnegat Inlet, NJ	<1	3	NW	RR	GN	Alan Thomas	NJ
" "	NE Ponce Inlet, FL	NE Cape Hatteras, NC	20	424	NE	LL	LL	Tris Colket	FL
" "	S Destin, FL	S Mobile, AL	19	108	SW	RR	LL	Charles Dawsey	FL
" "	NE Ponce Inlet, FL	E Jacksonville Beach, FL	7	55	N	LL	RR	Tris Colket	FL
" "	NE Ponce Inlet, FL	E Jacksonville, FL	14	59	N	LL	LL	Tris Colket	FL
" "	E Jacksonville, FL	SE Oregon Inlet, NC	9	402	NE	LL	LL	Tris Colket	FL
" "	E Ponce Inlet, FL	SE Topsail Inlet, NC	14	323	NE	LL	RR	Tris Colket	FL
" "	E Ponce Inlet, FL	E Port Orange, FL	NR	NR		LL	LL	Tris Colket	FL
" "	SE Ponce Inlet, FL	E Morehead City, NC	23	479	NE	LL	LL	Tris Colket	FL
" "	NE Ponce Inlet, FL	Sapelo Sound, GA	12	124	N	LL	RR	Eric Sander	FL
" "	E St. Augustine, FL	E Oregon Inlet, NC	8	477	NE	LL	LL	Tris Colket	FL
" "	NE Ponce Inlet, FL	NE Jacksonville, FL	7	53	N	LL	LL	Tris Colket	FL
" "	E Daytona, FL	E Jacksonville Beach, FL	9	73	N	LL	LL	Tris Colket	FL
Tiger shark	E Avon, NC	E Wrightsville Beach, NC	NR	107	SW	LL	LL	Tom Spencer	VA
" "	E Wilmington, NC	SE Wilmington, NC	8	33	SW	LL	LL	Chris Jensen	NC
" "	E Daytona, FL	E Ponce Inlet, FL	2	17	E	LL	LL	Tris Colket	FL
" "	E Daytona, FL	SE Ponce Inlet, FL	2	28	SE	LL	LL	Tris Colket	FL
" "	E Daytona, FL	E Ponce Inlet, FL	2	17	E	LL	LL	Tris Colket	FL
" "	E Daytona, FL	E Ponce Inlet, FL	2	17	E	LL	LL	Tris Colket	FL
" "	NE Oregon Inlet, NC	E Atlantic City, NJ	12	204	N	LL	GN	Biologist (NMFS)	RI
" "	NE Ponce Inlet, FL	E Port Orange, FL	NR	NR		LL	LL	Tris Colket	FL
" "	S Tavernier, FL	S Tavernier, FL	2	4	N	LL	LL	Don Young	FL
" "	NE Ponce Inlet, FL	E Ponce Inlet, FL	5	38	S	LL	LL	Tris Colket	FL
" "	E Jacksonville Beach, FL	Manzanillo Bay, Dom. Rep.	10	788	SE	LL	RR	Tris Colket	FL
" "	NE Ponce Inlet, FL	E Ponce Inlet, FL	10	13	SE	LL	LL	Eric Sander	FL
" "	E Ponce Inlet, FL	N Cape Canaveral, FL	<1	22	SW	LL	LL	Eric Sander	FL
" "	E Ponce Inlet, FL	N Cape Canaveral, FL	3	44	S	LL	RR	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	1	12	SW	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	E Port Orange, FL	NR	NR		LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	2	6	NW	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	2	18	N	LL	LL	Eric Sander	FL

Table 2 continued.

	GENERAL LOCATIONS		MONTHS AT LIBERTY	DIST. (MI) AND DIR.		CAPTURE METHOD		TAGGED BY	
	TAGGED	RECAPTURED				TAG	REC.	TAGGER	RESIDENCE
Tiger shark	NE Ponce Inlet, FL	NE Ponce Inlet, FL	<1	26	S	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	E Ponce Inlet, FL	<1	43	S	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	<1	15	SW	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Jacksonville, FL	3	70	N	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	2	13	S	LL	LL	Eric Sander	FL
" "	E Ponce Inlet, FL	NE Ponce Inlet, FL	10	14	S	LL	LL	Tris Colket	FL
" "	E Ponce Inlet, FL	SE Barnegat Inlet, NJ	9	686	NE	LL	GN	Tris Colket	FL
" "	E Ponce Inlet, FL	E New Smyrna Beach, FL	5	22	S	LL	LL	Tris Colket	FL
" "	SE St Augustine, FL	S Cape Lookout, NC	11	283	NE	LL	RR	Tris Colket	FL
" "	SE St Augustine, FL	E Trinidad	12	1,626	SE	LL	LL	Tris Colket	FL
" "	E Ponce Inlet, FL	E Ponce Inlet, FL	1	14	S	LL	LL	Tris Colket	FL
" "	E Ponce Inlet, FL	E Ponce Inlet, FL	5	5	SE	LL	LL	John Fraser	FL
" "	NE Ponce Inlet, FL	N Cape Canaveral, FL	8	21	S	LL	LL	Tris Colket	FL
" "	N Cape Canaveral, FL	SE Ponce Inlet, FL	3	15	N	LL	LL	Grant Gilmore	FL
" "	E Ponce Inlet, FL	NE Ponce Inlet, FL	1	7	SE	LL	LL	Tris Colket	FL
" "	NE Ponce Inlet, FL	E Ponce Inlet, FL	5	18	SE	LL	LL	Eric Sander	FL
" "	E Ponce Inlet, FL	NE Ponce Inlet, FL	5	43	NW	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	6	8	NE	LL	LL	Tris Colket	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	6	20	NE	LL	LL	Tris Colket	FL
" "	NE Ponce Inlet, FL	E St Augustine, FL	7	22	NE	LL	LL	Tris Colket	FL
Tiger shark	E Cape Hatteras, NC	SE Cape May, NJ	6	201	N	LL	RR	Tom Spencer	VA
" "	E Cape Hatteras, NC	SE Wachapreague Inlet, VA	6	134	N	LL	LL	Tom Spencer	VA
" "	NE Ponce Inlet, FL	NE Cape Hatteras, NC	4	439	NE	LL	LL	Tris Colket	FL
" "	E St Augustine, FL	N Ponce Inlet, FL	8	20	SE	LL	LL	Tris Colket	FL
" "	E St Augustine, FL	E Ponce Inlet, FL	7	65	SE	LL	LL	Tris Colket	FL
" "	E St Augustine, FL	E Ponce Inlet, FL	NR	67	SE	LL	LL	Tris Colket	FL
" "	NE Ponce Inlet, FL	NE Jacksonville Beach, FL	8	48	N	LL	LL	Tris Colket	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	5	7	SE	LL	LL	Tris Colket	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	5	4	E	LL	LL	Tris Colket	FL
" "	NE St Augustine, FL	NE Ponce Inlet, FL	11	50	S	LL	LL	Tris Colket	FL
" "	E Ponce Inlet, FL	E Jacksonville Beach, FL	2	92	N	LL	LL	Tris Colket	FL
" "	SE Rudee Inlet, VA	SE Oregon Inlet, NC	3	64	S	RR	LL	R. V. Wiseman, Jr.	VA
" "	E Cape Henry, VA	SE Rudee Inlet, VA	<1	4	E	LL	RR	Steve Branstetter	VA
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	1	13	S	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	SE Ponce Inlet, FL	1	38	S	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	E St Augustine, FL	1	23	N	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	<1	9	SE	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	E Ponce Inlet, FL	3	24	S	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	N New Smyrna Beach, FL	5	47	NW	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	E West Palm Beach, FL	6	176	S	LL	LL	Eric Sander	FL
Tiger shark	NE Ponce Inlet, FL	N New Smyrna Beach, FL	5	46	NW	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	SE Ponce Inlet, FL	5	34	S	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	3	33	N	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	E Ponce Inlet, FL	3	15	SE	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	N New Smyrna Beach, FL	5	45	N	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	E West Palm Beach, FL	5	161	S	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	SE Cape Fear, NC	5	294	NE	LL	RR	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Ponce Inlet, FL	<1	12	E	LL	LL	Eric Sander	FL
" "	E Ponce Inlet, FL	NE Ponce Inlet, FL	1	31	N	LL	LL	Eric Sander	FL
" "	E Ponce Inlet, FL	SE Ponce Inlet, FL	1	4	SE	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Jacksonville, FL	1	67	N	LL	LL	Eric Sander	FL
" "	E Ponce Inlet, FL	NE Ponce Inlet, FL	<1	29	NW	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	N New Smyrna Beach, FL	3	51	N	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	E Ponce Inlet, FL	2	23	S	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	E St Augustine, FL	1	28	N	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	NE Jacksonville, FL	1	71	N	LL	LL	Eric Sander	FL
" "	NE Ponce Inlet, FL	SE Ponce Inlet, FL	3	14	SW	LL	LL	Eric Sander	FL
" "	SE Ocean City, MD	E Cape May, NJ	1	73	NE	RR	LL	Mark Sampson	MD
" "	SW Charleston, SC	Broad River, SC	1	32	W	LL	RR	Biologist (NMFS)	RI
" "	SE Ponce Inlet, FL	NE Ponce Inlet, FL	1	42	NW	LL	LL	Tris Colket	FL
Mako sharks	S Montauk Pt, NY	E Ocean City, MD	<1	180	SW	RR	RR	James Frost	NY
" "	SE Lydonia Canyon	SE Manasquan Inlet, NJ	77	273	W	LL	RR	Brad Chase, NMFS Obs	MA
" "	SE Hydrographer Canyon	E Cape May, NJ	75	206	W	LL	RR	Arv Poshkus, NMFS Obs	MA
" "	S Pt Judith, RI	Corsair Canyon	24	273	E	RR	LL	Richard Kreager	CT
" "	S Veatch Canyon	Laguiara Bank, Venezuela	48	1,726	S	LL	FG	Jerzy Cygler, NMFS Obs	MA
" "	S Veatch Canyon	E Townsends Inlet, NJ	43	144	W	LL	RR	Georg Hinteregger, NMFS Obs	MA
" "	S Atlantis Canyon	E Cape Henry, VA	18	221	SW	LL	LL	Georg Hinteregger, NMFS Obs	MA
" "	SE Fire Is Inlet, NY	E Ocean City, MD	23	129	SW	RR	RR	Eugene Villante	NY
" "	SE Shinnecock, Inlet, NY	E Morehead City, NC	9	399	S	RR	LL	Larry Luce	NY
" "	SW Shinnecock Inlet, NY	E Oregon Inlet, NC	5	290	S	RR	LL	Robert Scattergood	NY
" "	SE Manasquan Inlet, NJ	SE Ocean City, MD	22	123	SW	RR	RR	Joseph Rodrigues	NJ
" "	SE Manasquan Inlet, NJ	SW Pt Judith, RI	12	89	NE	RR	RR	David Foley	NY
" "	E Ocean City, MD	SSE Fire Is Inlet, NY	1	147	NE	RR	RR	Steve Jones	MD
" "	SE Montauk Pt, NY	SE Cape Hatteras, NC	6	379	SW	RR	LL	Howard Kiedalsch	NY
" "	Hudson Canyon	Lydonia Canyon	<1	218	E	RR	LL	Bill Heller	NJ
" "	SE Pt Judith, RI	S Pt Judith, RI	<1	47	W	RR	RR	Bob Bernstein	MA
" "	SE Pt Judith, RI	S Pt Judith, RI	1	41	SW	RR	RR	F. David Jones	MA
" "	E Ocean City, MD	Hudson Canyon	3	125	NE	RR	LL	Billy Verbanas	DE
" "	SW Montauk Pt, NY	E Little Egg Inlet, NJ	<1	74	S	RR	LL	Ray Hendrickson	NY
" "	E Manasquan Inlet, NJ	S Montauk Pt, NY	11	84	E	RR	RR	Frank Lawton	NJ
Dusky shark	E Manasquan Inlet, NJ	E Little Egg Inlet, NJ	NR	44	S	RR	RR	Scott Belm	NJ
" "	NE Manasquan Inlet, NJ	S Freeport, TX	121	1,881	SW	RR	LL	Philip Meyer	NJ
" "	SE Pt Judith, RI	S Rio Grande River, TX	58	2,015	SW	LL	GN	Brian Crabtree	MA
" "	SE Jones Inlet, NY	SE Apalachicola, FL	93	1,521	SW	RR	LL	Lawrence Festa	NY
" "	E Oregon Inlet, NC	NE Progreso, Mexico	69	1,173	SW	LL	LL	Biologist (NMFS)	RI
" "	SE Oregon Inlet, NC	E Chachalaces, Mexico	64	NR		LL	LL	Biologist (NMFS)	RI
" "	SE Shinnecock Inlet, NY	E Soto La Marina, Mexico	51	2,017	SW	RR	LL	Bill Williams	NY
" "	SE Pt Judith, RI	S Pt Judith, RI	13	26	SW	RR	TN	Lionel LeVallee	MA
" "	SE Ocean City, MD	E Rehobeth Beach, DE	9	31	N	RR	LL	Mark Sampson	MD
" "	E Manasquan Inlet, NY	S Fire Is Inlet, NY	<1	13	N	RR	LL	Rich Schneider	NJ
Blacktip shark	N Key West, FL	W St Petersburg, FL	7	124	NW	RR	LL	Thomas Vicher	FL
" "	Pine Is Sound, FL	Pine Is Sound, FL	<1	1	SW	RR	RR	Leo Dunn	FL
" "	Matagorda Is, TX	Matamoras, Mexico	5	153	S	RR	LL	Andrew Jenkins	TX
" "	NE Miami, FL	E Key Biscayne, FL	1	8	S	RR	RR	Mark Quartiano	FL
" "	Padre Is, TX	Aldama, Mexico	<1	292	S	RR	GN	Joe Hinojosa	TX

Table 2 continued.

	GENERAL LOCATIONS		MONTHS AT LIBERTY	DIST. (MI) AND DIR.		CAPTURE METHOD		TAGGED BY	
	TAGGED	RECAPTURED				TAG REC.		TAGGER	RESIDENCE
Porbeagle shark	SE Munson Canyon	SW Cape Sable, NS, Canada	29	141	N	LL	LL	Frank Turk, NMFS Obs	MA
" "	S Munson Canyon	S Flemish Cap	34	1,005	E	LL	LL	Georg Hinteregger, NMFS Obs	MA
" "	NE Powell Canyon	E Cape Sable, NS, Canada	30	233	NE	LL	LL	Georg Hinteregger, NMFS Obs	MA
" "	SW Munson Canyon	W Cape Sable, NS, Canada	44	182	N	LL	PS	Linda Craig, NMFS Obs	MA
" "	SW Flemish Cap	SE Cape Sable, NS, Canada	1	404	W	LL	LL	Nelson Beideman	NJ
Nurse shark	Melbourne Beach, FL	Patrick AFB, FL	31	NR		RR	FOB	Woody Woodrum	FL
" "	Big Pine Key, FL	Port of Palm Beach, FL	62	145	NE	RR	RR	William Botten	FL
" "	Boot Key, FL	Boot Key, FL	20	0		RR	RR	William Botten	FL
" "	NW Naples, FL	NW Naples, FL	1	0		RR	RR	John Brossard	FL
Sand tiger shark	SW Cape Fear, NC	Portsmouth Is, NC	28	146	NE	LL	RR	Biologist (NMFS)	RI
" " "	NE Cape Hatteras, NC	Delaware Bay, DE	NR	226	N	LL	RR	Biologist (NMFS)	RI
" " "	N Cape Henry, VA	E Lewes, DE	9	114	NE	LL	RR	Steve Branstetter	VA
Atl. sharpnose	Port Royal Sound, SC	Broad River, Paris Is, SC	1	3	NW	RR	RR	Al Kolberg	SC
" "	SE Charleston, SC	SE Charleston, SC	14	1	SE	RR	RR	Ivan Schultz	SC
Sc. Hammerhead	E Oregon Inlet, NC	Norfolk Canyon	71	73	N	LL	GN	Biologist (NMFS)	RI
"	E Melbourne, FL	NR	NR	NR		LL	LL	Jack Morton	FL
Silky shark	NE Ponce Inlet, FL	E St Augustine, FL	8	149	E	LL	LL	Eric Sander	FL
Bonnethead	Matagorda Is, TX	Matamoras, Mexico	4	141	S	RR	LL	Mark Kelley	TX
Bull shark	Myakka River, FL	Charlotte Harbor, FL	2	10	S	RR	RR	Charles Gause	FL
Galapagos	NE of Bermuda	Argus Bank, Bermuda	12	40	SW	LL	RR	Stephen Connett	RI
Hammerhead	E Cape Hatteras, NC	SE Cape Fear, NC	41	176	SW	RR	LL	Phil Tokazowski	NC
Shark	Fire Is Inlet, NY	SW Mobile, AL	NR	NR		RR	LL	David Hescheles	NY
"	SW Powell Canyon	SE Oregon Inlet, NC	43	424	SW	LL	LL	Steven Slota, NMFS Obs.	MA
Bluefin Tuna	SE Manasquan Inlet, NJ	SE Montauk Pt, NY	1	112	NE	RR	HL	David Foley	NY
Yellowfin Tuna	Wilmington Canyon	SW Monrovia, Liberia	38	4,047	SE	RR	PS	Frank Lawton	NJ
Amberjack	Miami, FL	E Juno Beach, FL	NR	NR		RR	RR	Bruce Brownson	FL
Striped Bass	New Rochelle Harbor, NY	Hudson River, NY	11	NR		RR	RR	Joseph Ferrara	NY
Snook	NR	Ft Myers, FL	NR	NR		RR	RR	NR	FL

NOTE: FG=Flying Gaff; FOB=Found on Beach; FS=Free Swimming; GN=Gillnet; HL=Handline; HP=Harpoon; LL=Longline; PS=Purse Seine; RR=Rod & Reel; TN=Trawl Net; Obs=Foreign Fisheries Observer; NR=Not Reported

Shark Fisheries Management Plan Update

The revised draft of the Secretarial Shark FMP for the Atlantic Ocean has been extensively rewritten. The FMP is expected to be implemented during the summer of 1992, after the regulations have been finalized.

For additional details contact:
NMFS
Office of Fisheries Conservation and Management
1333 East-West Highway, Silver Springs, MD 20910.

Revised Draft of the Secretarial Shark FMP for the Atlantic Ocean

Most significant proposed measures:

- Segregation of sharks into three biological/managerial species groupings
  - (1) large coastal
  - (2) small coastal
  - (3) pelagic sharks
- Quotas and bag limits tailored to species grouping
- Minimum size on mako sharks
- No sale of recreational catch
- Prohibition on landing fins at a ratio of not greater than 5 per carcass
- 50% reduction in commercial landings from (estimated) 1990 levels
- Recreational bag limits for large coastal, small coastal, and pelagic species

Tagging Studies on the Shortfin Mako Shark *(Isurus oxyrinchus)* in the Western North Atlantic

The following article is taken from a paper by Jack Casey and Nancy Kohler that was presented at the **Sharks Down Under** Conference (Australia) in 1991. The complete paper will be published in the *Australian Journal of Marine and Freshwater Research.*

The shortfin mako shark *(Isurus oxyrinchus)* is distributed throughout the temperate and tropical zones of the world's oceans. Females reach a known maximum size of 394 cm (12.9 ft) total length (TL), and mature at about 280 cm (9.2 ft) TL. Males mature at 195 cm (6.4 ft) TL and reach a maximum length of 284 cm (9.3 ft) TL. Makos are ovoviviparous producing 4 to 18 pups per litter. Pups are approximately 70 cm (2.3 ft) TL at birth with a probable gestation period of 8 to 12 months. The less abundant longfin mako *Isurus paucus* is poorly known and not considered in this report.

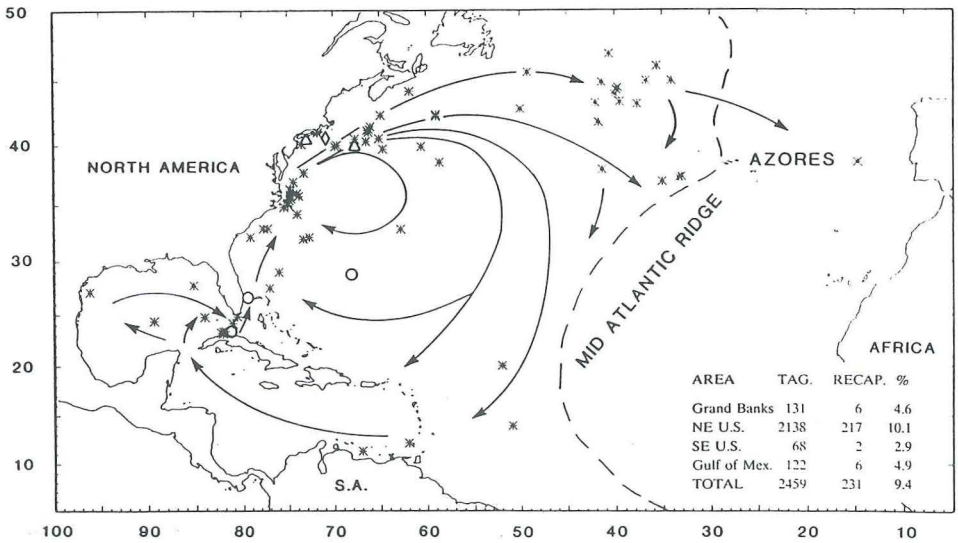
From 1962 through 1989, a total of 2,459 mako sharks were tagged under the NMFS Cooperative Shark Tagging Program. Most sharks (91%) were tagged during the last 13 years. Recreational fishermen and NMFS biologists accounted for nearly all of the tagging on the continental shelf within 100 nautical miles from shore. U.S. commercial longliners, Foreign Fisheries Observers on Japanese longline vessels, and NMFS biologists on research vessels accounted for most of the offshore tagging effort. U.S. swordfish longline fishermen accounted for 97% of the releases in the Grand Banks area. Foreign Fisheries Observers (38%) and anglers (35%) accounted for most of the releases off the northeastern U.S. In the southeastern U.S., the tagging effort was divided mainly between Observers (38%), anglers (21%), and NMFS biologists (18%). In the Gulf of Mexico, Foreign Fisheries Observers accounted for 80% of all releases.

RECAPTURES

A total of 231 tags (9.4%) have been returned by fishermen from 16 countries, 92% of which are from the following four countries: U.S., Spain, Japan, and Canada.

MAKO SHARK (Isurus oxyrinchus)

LONG DISTANCE (>300 miles) TAG RETURNS FROM THE NORTH ATLANTIC



TAGGING AREA- * NORTHEASTERN U.S., Δ GRAND BANKS, o GULF OF MEXICO, ◊ SOUTHEASTERN U.S.

Time at Liberty

The time at liberty ranged from 1 day to a maximum of 8.2 years with 59% of all recaptures taken within the first year and 95% within 4 years. Age and growth studies of mako sharks in the western North Atlantic show males and females grow at the same rate until they are about 4.5 years old and 230 cm (7.6 ft) FL (Fork length is approximately 93% of total length). Females reach a larger size than males and we have estimated the life span of the species to be about 11.5 years. Tag and recapture data support the estimates of more rapid growth in mako sharks compared to many other species of sharks. This, in part, may explain the lack of long-term recaptures. Another consideration is that so few very large makos (>300 cm (9.8 ft) FL) are taken anywhere that there is only a remote chance that a large tagged specimen will be recaptured.

Rate of Travel

The maximum rate of travel by a tagged mako was 35.7 miles per day. This individual, tagged off Georges Bank, was recaptured 37 days later off the Grand Banks, a straight-line distance of 1,321 miles between tag and recapture locations (see map). The rates of travel for the next five fastest tagged makos were between 12.3 and 15.5 miles per day.

Distance Traveled

Sixty-one (24%) of the recaptures were caught within 100 miles of the tagging location, and 148 (64%) were caught within 300 miles. The remaining 83 recaptures were long-distance returns that exceeded 300 miles and are shown in the figure. The long-distance recaptures include 77 returns from makos released off the Northeastern U.S. that were recaptured over an extensive area of the Atlantic, including the Caribbean and Gulf of Mexico. Three returns from makos tagged in the Gulf of Mexico showed movements exceeding 300 miles to Cuba, eastern Florida, and the Sargasso Sea. The two long-distance returns from releases on the Grand Banks and the single long-distance return released from the southeastern U.S. were recaptured off the northeastern U.S. The maximum straight-line distance traveled by a tagged mako shark was 2,452 miles between the northeastern U.S. and Spain.

Relationship to Water Temperatures

In the North Atlantic the preferred water temperature of the mako shark appears to be a rather narrow range between 17° and 22°C (63°to 72 °F). Analysis of surface temperature data from 2,766 sets of swordfish longline gear between the Gulf of Mexico and

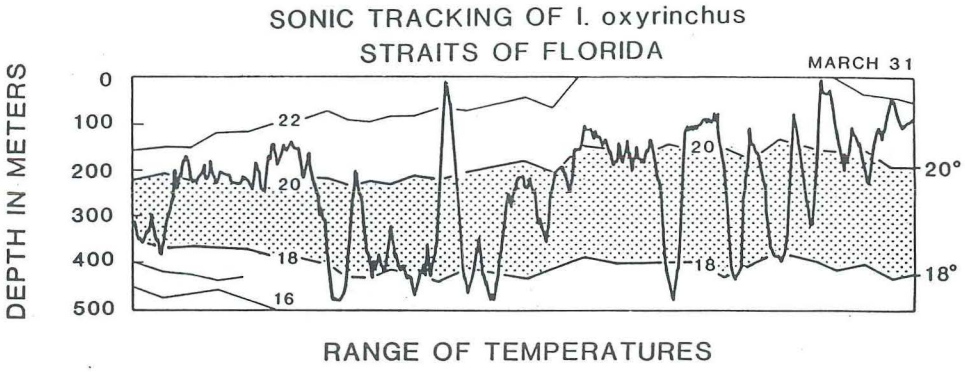
the Grand Banks showed that mean minimum and maximum temperatures in which makos were caught fell between 18.5° and 20.5°C (65.3° and 68.9°F), respectively. The Spanish longline fishery for swordfish, which covers an extensive area between Spain and the Grand Banks, also shows highest catch rates for mako sharks in surface temperatures of 18°C (64°F).

Recreational catches of mako sharks off the U.S. middle Atlantic states also show that makos do not move inshore onto the continental shelf in spring until surface temperatures reach about 17°C. The oldest continuous mako shark fishing tournament in this region has been held at Bay Shore, N.Y., since 1965. The trend in species composition data from this tournament, which is held in late June, shows the blue shark dominated catches when surface temperatures were below 18°C but that mako sharks were common, and in some years dominant, when water temperatures reached 18°C.

Other evidence on water temperatures preferred by mako sharks is provided by sonic tagging experiments. In one experiment, a temperature-monitoring radio tag was attached to an approximately 180 kg (375 lb) mako shark that we followed with Frank Carey for four days. The track, from Florida across the Gulf Stream and into the Sargasso Sea, showed the shark swam from the surface to 500 m but spent most of its time at depths where the temperature range was between 17° and 22°C (see figure).

Since the mako shark is warm bodied and widely distributed throughout the world oceans, individuals are probably able to withstand temperatures well outside the "normal range" suggested here. Nevertheless, the evidence that makos occupy a depth range from the surface to at least 500 m and prefer water temperatures near 18°C, allows us to consider some basic ideas to explain the pattern of tag returns from the western North Atlantic.

The source of 18°C water in the Sargasso Sea is the northern edge of the Gulf Stream, which in winter cools from 20°C and sinks to form an isothermal layer that flows off to the south, at about the 300 m level, beneath the warmer surface waters of the Sargasso Sea. The 18°C-layer is described as a wedge 250-m thick, extending 12,000 km (7,457 mi) along the margin of the Gulf Stream (roughly between 75°W and 45°W) and extending 1,500 km (932 mi) into the Sargasso Sea. The eastern edge of the 18°C water is not well defined but is approximately over the Mid-Atlantic Ridge. Because of its temperature and salinity characteristics (18°C and 36.5 ppt salinity), this water forms a distinct layer between deep, cold water and warm surface water, and is distributed over much of the Atlantic, west of the Mid-Atlantic Ridge. Some of this 18°C water flows into the Caribbean Sea, probably through the Windward Passage. If the depth of the preferred temperature of 18°C defines the distribution of the mako shark in the western North Atlantic, it would help to explain why only one tagged mako was recovered from the Eastern Atlantic. In some areas over the Mid-Atlantic Ridge, the 18°C layer becomes so shallow that it essentially disappears.



A HYPOTHESIS OF MAKO MIGRATIONS IN THE WESTERN NORTH ATLANTIC

Mako sharks are widely distributed throughout the western North Atlantic in a preferred temperature range of 17° to 22°C. A seasonal cycle of abundance off the Northeastern U.S. beginning in January shows makos to be common along the western margin of the Gulf Stream with at least one area of high abundance off Cape Hatteras, N.C., where the Gulf Stream flows near the continental shelf. Beginning in April and May, as inshore shelf waters warm, and the axis of the Gulf Stream moves farther north, mako sharks begin moving northward onto the continental shelf between Cape Hatteras and the southern part of Georges Bank. Usually, makos are caught off southern New Jersey in early June and off New York and Southern New England by late June. The movement inshore and northward occurs simultaneously along the Gulf Stream from Cape Hatteras to the Grand Banks.

From June through October, makos are taken by anglers on the continental shelf between Cape Hatteras, N.C., and Cape Cod, Mass., and in recent years in southern parts of the Gulf of Maine. During this season, swordfish and tuna longline fishermen also catch makos between the continental shelf and the Gulf Stream from Cape Hatteras, N.C., to the southern tip of the Grand Banks. This entire area, particularly on the continental shelf south of Cape Cod, may be the primary feeding grounds for a large part of the juvenile and subadult mako population in the western North Atlantic. Off the northeastern United States, 33 different food items were found in mako stomachs, with bluefish representing 78% of the prey by volume. The amount of food in mako shark caught inshore between Cape Hatteras and Cape Cod was significantly higher than the amount found in makos taken offshore beyond the continental shelf.

During November-December, makos move from the area between Cape Hatteras and the Grand Banks to offshore wintering grounds in the Gulf Stream and Sargasso Sea. If we assume that 18°C Sargasso Sea water represents preferred habitat for makos, then their core distribution in the western North Atlantic covers a latitudinal range between 20°N to 40°N, bordered by the Mid-Atlantic Ridge on the east and the Gulf Stream on the west. Certainly mako sharks occur outside these boundaries at different seasons and they can make transatlantic crossings as evidenced by the single recapture from the coast of Spain. However, most of the recaptures can be explained on the basis of a "Sargasso Sea" hypothesis including those returns from the Caribbean Sea.

See Makos, page 13

Field Studies 1991

Field studies this year included a seven week longline cruise and attendance at shark fishing tournaments from New Jersey to Massachusetts.

TOURNAMENTS

Information was obtained from 15 shark tournaments, between Marthas Vineyard, Mass., to southern New Jersey. Ten of the tournaments were attended by staff biologists, and five by volunteers. Measurements and biological examinations were made on 432 sharks of 7 species. Blue sharks were the most common (239) followed by makos (121), common thresher sharks (18), sandbar sharks (17), tiger sharks (15), dusky sharks (13), and hammerheads (9).

Over the past 26 years, shark fishing tournaments have been vital to NMFS shark research. For example, of the 13 blue sharks landed at the Montauk Captains Association Tournament in 1991 (in N.Y.,) 4 were recaptures. All of them were tagged and recovered 30 to 40 miles southeast of Montauk. Three were at liberty for less than a month and provided information on local movements and one was free for over three years. At the Hudson Anglers Tournament, also in NY, a female blue shark in the first stages of pregnancy was landed. This shark was of interest because she was out of phase with the majority of the mature females in the blue shark population. Most pregnant females give birth in the Eastern Atlantic. This is only the second of the thousands of blue sharks we have examined in 20 years that was in the early stages of pregnancy.

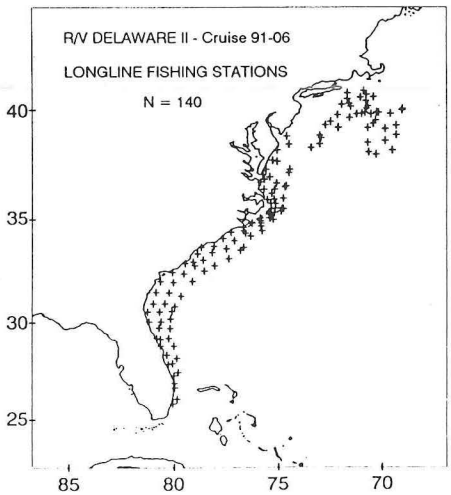
Although we would like to attend every tournament, we are unable to do so, however we appreciate hearing from directors regarding dates and plans for their tournaments. Please continue to send us summaries of your results.

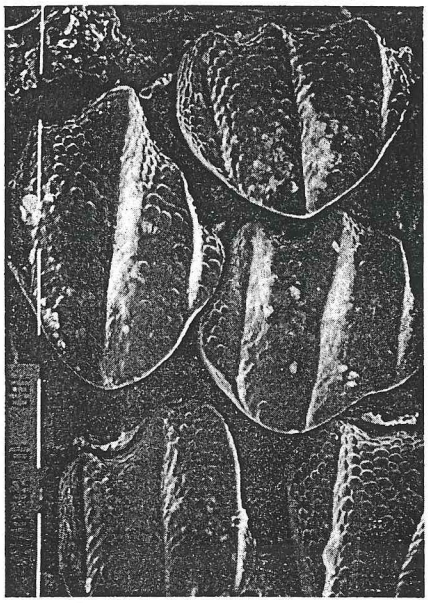
RESEARCH CRUISE

From April 23 to June 7, 1991 project staff conducted a longline survey aboard the R/V *Delaware II* along the Atlantic coast between Miami, Fla., and southern New England. This cruise repeated a 1989 survey in the same region, during the same season, using the same fishing methods. The objectives of the cruise were to (1) survey the distribution, abundance, and species composition of sharks and other apex predators; (2) collect baseline catch per effort data in shelf, slope, and Gulf Stream waters, (3) tag sharks and large teleosts for migration studies; (4) collect food and feeding information from sharks, tunas, and swordfish; (5) collect biological samples for age, growth and reproductive studies on sharks; (6) obtain data on dressed and total weights, fin weights, and morphometric measurements relative to the commercial handling of sharks; and (7) provide a platform of opportunity for visiting scientists conducting research on sharks.

A total of 539 fish, representing 31 species, were caught on 140 longline sets. Eighteen species were sharks and 13 species were boney fishes or rays. Sharks represented 82% of the catch. Three hundred and three fish (56%) were tagged and released. The most common species tagged were blue, sandbar, scalloped hammerhead, and tiger sharks. Biological samples for reproductive studies were collected from 89 sharks of 21 species. Samples of vertebrae for our age and growth work were obtained from 142 sharks. Examinations of 78 stomachs from 15 species of sharks were made for ongoing studies of food habits.

The ratio of dressed weight to total weight was determined for 56 sharks of 11 species, including sandbar, scalloped hammerhead, tiger, bigeye thresher, blue, silky, and night sharks.





Scanning electron micrograph of denticles (scales) of the blue shark

The sharks were dressed by a Florida commercial fisherman using the method employed for large coastal sharks. The dressed weight represented 49% of the total weight for all species combined. The highest yield was 62% of the total weight for hammerhead sharks, and the lowest yield was 36% of the total weight for tiger sharks. In conjunction with the dressing process, fin weights for each carcass were also obtained. The proportional weight of the fins was highest in sandbar sharks (2.3% of total weight). The average yield of fins for 7 species of sharks was 1.6% of the total weight and 3.1% of their dressed weight.

Visiting scientists from five institutions participated in the cruise to assist us and to further their research. Dr. Janine Caira of University of Connecticut made the first comprehensive collection of tapeworms from pelagic sharks in the western North Atlantic. Dr. Sho Tanaka of Tokai University, collected tissue samples used to describe and quantify sperm storage in male sharks. Dr. Jeff Carrier of Albion College took samples of denticles (scales) from body and fin locations to compare species differences using scanning electron microscopy. Chris Jensen of the University of North Carolina compared blood hematocrits among different sharks to provide an index of their physiological condition. Dr. Gavin Naylor of the American Museum of Natural History collected teeth and jaws to compare evolutionary changes re-

flected in the fossil record of sharks' teeth. Eileen Grogan of Virginia Institute of Marine Science investigated blood and the tissues that comprise the shark immune system. Other materials obtained during the cruise included muscle samples for biochemical tests to identify the meat of different sharks that are sold for human consumption. The samples were sent to the NMFS Fisheries Technology Laboratory in Charleston, S.C.

One objective on the cruise was to obtain baseline catch data from an area of expected high blue shark abundance, offshore between Georges Bank and the Gulf Stream. Although satellite data showed ideal surface water temperatures during early June these offshore fishing stations failed to produce sharks. The absence of sharks indicates the difficulty of attempting to survey highly pelagic species in a limited area where they are "here today; gone tomorrow". In this case the blue sharks had apparently moved to continental shelf waters and were generally confined to a shallow surface layer above that fished by the longline hooks. Evidence for this possibility was provided by recreational fisherman who began catching blue sharks on the continental shelf near the surface during the first week in June. The volunteer tagging effort for June showed that 1,980 blue sharks were tagged in 1991, a record number for that month. The uneven distribution of large pelagic sharks will be a major consideration in planning future surveys.

Despite shortcomings in attempts to survey a variety of different sharks using one standard fishing method, there was a definite decline in the catch per 100 hooks (c/100 hks) for several species of large coastal sharks. The principal differences in the c/100 hks between the 1989 and 1991 surveys were decreases of 67% in sandbar sharks, 55% in scalloped hammerhead, 43% in dusky sharks, and 29% in sand tigers. The c/100 hks increased for Atlantic sharpnose, blacktip, and silky sharks, but fewer than ten individuals of each of these species were caught. The average c/100 hks of sharks in the region between Miami and Delaware bay declined from 5.96 in 1989 to 2.97 in 1991 (an overall decrease of 50%).

The Effect of Temperature on Band Deposition in the Little Skate, *Raja erinacea*

The following article is taken from a paper by Lisa Natanson that will be published later this year in *Copeia*.

Scientists have attempted to use bands in the vertebrae of sharks as a clue to their growth rates and age. Several studies have documented annual bands (rings) in the vertebral centra of various species of elasmobranch fishes. However, studies on the basking shark and the shortfin mako shark have indicated that two bands could be formed per year, and a study on the Pacific angel shark showed vertebral bands were related to growth rate (size) rather than time. The fact that some sharks do not show annual vertebral rings reinforces the need for validation (the confirmation that the ring is a yearmark for each species being aged). Why bands form is unknown. In this study, laboratory experiments were conducted to determine the effects of temperature on vertebral band (ring) deposition in the little skate, *Raja erinacea*. Skates injected with the antibiotic tetracycline, used as a biological marker, were maintained in aquaria for one year. Band deposition patterns from skates kept under fluctuating environmental temperature conditions were compared to deposition patterns of skates kept under constant temperature conditions, all other factors being the same.

If seasonal fluctuation of temperature was a cue for the deposition of bands, then it would be expected that skates in the experimental (constant temperature) tank would not show a band past the tetracycline mark. All but two skates in this tank did show a distinct band past the mark, indicating that for this species, temperature is probably not a primary cue for band deposition. More studies using manipulations of photoperiod, feeding and other environmental parameters to try to affect band deposition need to be undertaken to determine species specific cues.

Makos *Continued from Page 11*

Northern 18°C Sargasso Sea water enters the Caribbean and forms a distinct layer between 125 and 300 m. The route that makos might travel from the Sargasso in this water into the Caribbean then into the Gulf of Mexico and the Florida Straits is consistent with the tag returns from those areas. However, the distribution of recaptures suggests the principal wintering grounds of juvenile makos is the western margin of the Gulf Stream and the northern part of the Sargasso Sea.

This hypothesis offers a partial explanation for the pattern of tag returns for the mako shark in the western North Atlantic. However, the picture is far from complete. Attempts to understand the life history of the shortfin mako cannot truly advance until more is known about its reproductive biology and the distribution of large adults. Only four pregnant makos have been reported from the western North Atlantic. All were taken in southern areas off Florida and in the Gulf of Mexico. On the other hand, very small makos, considered to be recently born, have been reported during the summer months in an area extending from the Gulf of Mexico to the Grand Banks. One explanation for this distribution of young is that most of the adult females remain far offshore and are widely distributed in tropical waters. If so, newborn makos may be dispersed over a broad geographical area by the Gulf Stream. A reproductive strategy that ensures widely separated, pregnant females and the dispersal of young over a broad area would offer some protection for the young from predation by large oceanic predators, including other mako sharks.

Additional studies are needed to significantly advance our knowledge of mako biology and to provide information for future management of the stocks. New initiatives are being directed to: (1) collection of fisheries data by countries that use or incidently catch makos, (2) research on the reproductive biology of the mako shark, (3) defining stocks through genetic research, and (4) encouraging tagging in the eastern Atlantic. The importance of the mako shark in U.S. fisheries is recognized in the *Fishery Management Plan for Atlantic Sharks*. The mako is the only species in this plan, covering 39 shark species, for which minimum size regulations have been proposed.

Sandbar Shark Age Estimates Revised

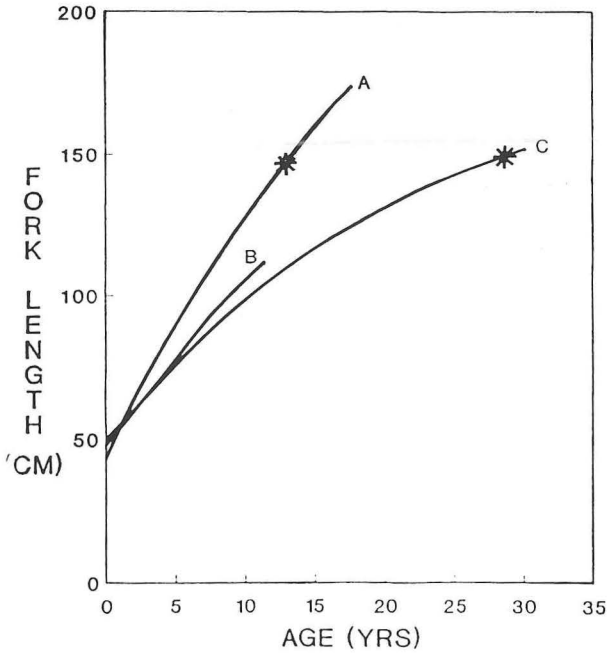
The following article is taken from a paper "Revised estimates of age and growth of the sandbar shark *(Carcharhinus plumbeus)* from the Western North Atlantic" by J. Casey and L. Natanson. The complete paper will be published later this year in the *Canadian Journal of Fisheries and Aquatic Sciences.*

We decided to reexamine age and growth data for the sandbar shark in light of: (1) studies that questioned the accuracy of conventional ageing methods, (2) the need for accurate age data for management plans that are imminent for Atlantic sharks, and (3) the additional growth information from tagged sharks that have been recaptured since 1983.

In our study of age and growth of the sandbar shark published in 1985, age estimates were based on vertebral rings with additional evidence provided by tag and recapture data, length-frequency distributions, and sharks maintained in aquaria. Despite attempts to support vertebral ring interpretation by these methods, tag recoveries in subsequent years provided evidence that our age determination from vertebrae were underestimated. Recent long-term tag returns suggest the sandbar shark grows much slower than we proposed and may take nearly 30 yr to reach maturity.

New growth information on recaptured sandbar sharks obtained between 1983 and 1990 was combined with data from earlier long-term recaptures. Three long-term recaptures provide examples of the longevity of this species (all lengths are fork lengths): (1) In 1985 a female sandbar shark that was at liberty for 17 years was shipped to the Narragansett Laboratory. This shark was estimated to be 102 cm (3.3 ft) in length at tagging and measured 155 cm (5.0 ft) at recapture. We determine her to be 5 years old at tagging, and at least 22 years old at recapture. Examination of the reproductive organs revealed that she was still immature. (2) In 1990 a female sandbar shark was recaptured after 25 years at liberty. This individual was 112 cm (3.7 ft) in length when tagged in 1965, and measured 157 cm (5.1 ft) at recapture. The estimated age at tagging (7 years) gives this shark an age of 32 years at recapture; and (3) a male measuring 178 cm (5.8 ft) at tagging, had not grown measurably when it was recaptured after 10 years. Since length at first maturity for males is about 150 cm, (4.9 ft) it is reasonable to assume that this shark was over 30 years old at tagging and over 40 years at recapture. (A total of 33 long-term recaptures are included in the publication.)

Reexamination of age in the sandbar shark again brings up the need for validation of all age classes using tagging data, vertebral marking and other methods. In our first study, the emphasis on vertebral rings which are extremely difficult to interpret in adult sandbar sharks, underestimated the size at maturity by at least 8 years and possibly 16 years. In a large, slow-growing species with low fecundity and alternate-year pupping, this will make a substantial difference in calculating the theoretical maximum output of young, which is a major consideration in any attempt to manage the species.



Estimated growth for the sandbar shark based on (A) 1985 back-calculated size at age from rings in vertebrae, (B) growth-per-year based on tag-recapture data as of 1985 and (C) growth based on all tag-recapture data as of 1990. * denotes size and age at maturity.

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Distribution of this newsletter is limited to active participants in the NMFS Cooperative Shark Tagging Program. This Information is preliminary and subject to revision.

JACK CASEY NAMED A.E.S *DISTINGUISHED FELLOW*

The AMERICAN ELASMOBRANCH SOCIETY Board of Directors named John G. "Jack" Casey as the Society's fourth Distinguished Fellow at the June summer meetings in New York. According to the proclamation, the Society's highest recognition was awarded to Casey:

"For pioneering work in tag-recapture studies of elasmobranchs...

For substantial and significant contributions to studies of life history, age, and growth of elasmobranchs...

For efforts to establish and promote public awareness and public involvement in the studies of elasmobranch biology and for the promotion of graduate and professional research programs...

For decades of work elucidating the patterns of migration, distribution, and abundance of large Atlantic sharks...

And for a life of dedication to the cause of elasmobranch conservation..."

Jack Casey after keynote address during 1991 meetings.