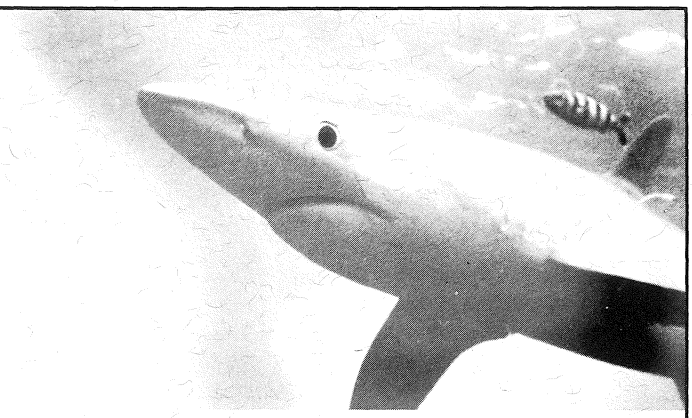
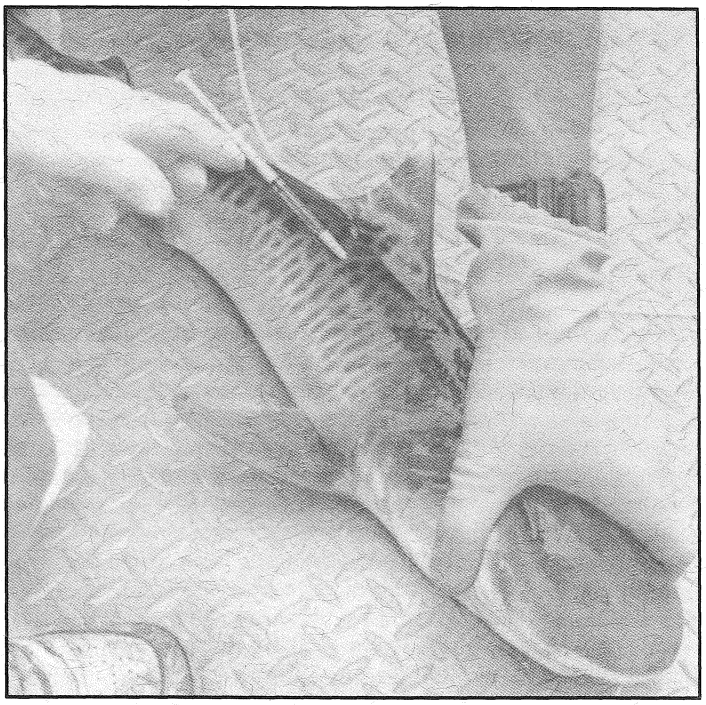
THE SHARK TAGGER 1995 SUMMARY



Newsletter of the Cooperative Shark Tagging Program



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1995 Overview

1995 has been an exciting year for the Apex Predator Investigation (API) in terms of biological studies and in unique and valuable information on shark distributions and migrations. Both our ongoing research and the API's Cooperative Shark Tagging Program (CSTP) have benefited immensely by collaboration and joint research with fishermen and colleagues as individuals and from countless groups and organizations. Without our many friends and associates, a program of this scope would not be possible. We greatly appreciate all of your help with our research efforts and look forward to continued association in the future.

Tags

In 1995, members of the CSTP tagged and released 7,613 fish including 33 species of sharks and rays and 10 species of teleosts (Table 1). The principal shark species tagged were blue (66%), sandbar (8%), tiger (6%), and shortfin mako (3%). Anglers accounted for 74% of the tagging effort, followed by fisheries observers aboard commercial vessels (12%), NMFS and other cooperating biologists (9%), and commercial fisherman (5%). Fish were released by taggers representing seven countries: United States, Canada, Portugal, Great Britain, Italy, France, and Spain. These tags bring the total for the CSTP to over 128,000.

Recaptures

In 1995, cooperators returned information on 534 tagged fish representing 14 species of sharks and 3 species of teleosts (Table 2, Page 5). This brings the Program total to over 6,000 fish recaptured. The majority were blue sharks (304), shortfin makos (53), sandbar sharks (51), and tiger sharks (38). The data were returned primarily from commercial (49%) and sport (45%) fishermen fol-

Continued on Page 2

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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.

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Narragansett, RI 02882

Table 1. Summary of sharks and teleosts tagged, January to December, 1995

Species	Number Tagged by Cooperative Taggers
Sharks	
Blue shark	5,018
Sandbar shark	596
Tiger shark	482
Shortfin mako	235
Blacktip shark	172
Atlantic sharpnose shark	145
Dusky shark	130
Porbeagle	123
Nurse shark	114
Bonnethead	56
Silky shark	52
Sand tiger	48
Bull shark	35
Spinner shark	34
Scalloped hammerhead	27
Blacknose shark	19
Reef shark	16
Lemon shark	13
Bigeye thresher	10
Great hammerhead	8
Oceanic whitetip shark	8
Thresher shark	7
Longfin mako	5
Smooth hammerhead	4
Spiny dogfish	2
Atlantic angel shark	1
Caribbean sharpnose shark	1
Finetooth shark	1
White shark	1
Hammerhead, unspecified	17
Brown/Dusky, unspecified	6
Carcharhinus, unspecified	4
Miscellaneous sharks	25
Miscellaneous rays	12
Total sharks	7,427
Teleosts	
Swordfish	104
Bluefin tuna	22
White marlin	17
Sailfish	14
Blue marlin	10
Yellowfin tuna	8
Bigeye tuna	6
Skipjack tuna	1
Miscellaneous teleosts	4
Total teleosts	186
Grand Total	**7,613**

On the cover: Tagging and injecting a juvenile tiger shark with tetracycline, a vertebral marker for age work, aboard the NOAA R/V *Relentless*. Please measure all recaptured sharks and send us the backbones. *Photo by Mark Ablondi*

lowed by fisheries observers (5%) and biologists (1%). These percentages are similar to the overall percentages of recapture occupations for the CSTP (1962-1993) except for the biologist category (Table 3). Spanish fishermen, through a cooperating biologist, returned 60 tags or 23% of the commercial returns. In the observer category, 21 were from U.S. fishing vessels and 6 were returned from Canadian observers on Canadian and Japanese vessels. Rod and reel, longline, and nets (gill and trawl) were the primary recapture gear along with handline, harpoon, and free swimming. Overall, fishermen representing 17 countries returned information on tagged fish (Table 4).

In contrast, sport fishermen using rod and reel gear and tagging sharks free swimming did the majority (71%) of the original tagging of the recaptured fish, followed by commercial fishermen (13%) using longlines, U.S. and Canadian fisheries observers (10%) on U.S., Canadian, and Japanese longline and gill net vessels, and biologists (6%) using longlines, gill nets, hand lines, and tagging free swimming. Sport fishermen from 6 nations, and commercial fishermen from 3 nations originally tagged these recaptured fish.

Blue Sharks (304 returns)

Blue sharks traveled distances from 1 to 2,704 nautical miles. Ten blue sharks traveled more than 2,000 miles to their recapture location. The 2,704 mile blue shark was tagged free swimming off Martha's Vineyard, MA by a commercial fisherman and recaptured off the Canary Islands after 2.7 years at liberty. Nine of these ten long distance returns were tagged off the Northeast coast of the U.S. and recaptured near the Azores, Madeira Island, Canary Islands, Surinam, Western Sahara, and Venezuela (both in the Atlantic Ocean and Caribbean Sea); the other was tagged off Guyana and recaptured off the Azores. Other long distance recovery locations (> 1,000 miles) were off the Flemish Cap, Puerto Rico, Cuba, Martinique, St. Croix, and the West Indies. Six of these sharks were originally tagged in the Gulf of Maine.

Tagging off the Iberian Peninsula by Portuguese and English sport fishermen produced interesting results. Of the seven recaptured blue sharks tagged off southern Portugal, four traveled due west and were recaptured within 360 miles of their tagging site and within 8 months of the original tagging dates; one traveled 218 miles northwest to northern Portugal; one traveled 935 miles southwest to an area 335 miles south of the Azores; and the other traveled 27 miles to the east. The two smallest fish (approximately 2 ft total length (TL)) traveled the shortest (27 mi.) and the longest distances (935 mi.). Other interesting eastern Atlantic tags include: a 41 in. fork length (FL) blue shark tagged off Rimini, Italy in the Adriatic Sea and recaptured off Croatia after 10.6 months at liberty; another small female (40 in. FL) tagged off England that traveled 934 miles southwest to the Azores in 5.7 months; and a large male tagged off Madeira Island that was recaptured 2.2 years later off Cape Verde Island (768 mi. south).

Ten blue sharks were both tagged and recaptured in an area around the Flemish Cap. All were at liberty for less than 11 months; all except two were small blues (< 5 ft TL) that traveled in a southeasterly direction after tagging for a maximum of 409 miles. The two exceptions were larger fish; one went 130 miles due north and one traveled 1,148 miles west to New York where it was re-tagged and re-released. Seven of the eight small blue sharks were tagged in the same area within two weeks of each other in September of 1994 by a commercial longline fisherman and were recaptured by Spanish longliners after traveling distances of 131 to 409 miles. One of these fish was originally tagged southeast of Nantucket, MA and traveled 1,148 miles to the Flemish Cap after approximately 1 month at liberty. It was subsequently released again to be recaptured 131 miles southeast after another 10 months at liberty. Three other long distance returns were recaptured in this area with origi-

nal tagging locations off Rhode Island, the Tail of the Grand Banks and east of Barbados.

In recent years, increased tagging effort has come from fishermen in the Gulf of Maine, Madeira and Canary Islands, Italy, Spain, Portugal and South America. Information on returns from foreign scientists in Mexico, Spain, the Azores, and Venezuela has also been intensified. Tags and recaptures such as these, outside our typical tagging and fishing areas, are proving critical to further delineate the blue sharks' wide ranging migratory patterns.

Short distance recoveries are also interesting and informative. There are numerous examples of blue sharks returning to within 25 miles of their original tagging location after up to 3.2 years at liberty. In one instance, a blue shark was tagged and released, then recaptured for the first time 19 days later and 19 miles to the north. This 5 ft TL male was re-released and recaptured again after 10.4 months only 5 miles northwest of the second release location and 18 miles west of the original tag location. Another multiple recapture shows a similar tendency to return to the same area after an extended period of time. The first recapture occurred after the blue shark was at liberty for 29 days and had traveled 20 miles east. It was then recaptured 2.9 years later within 19 miles of its second release site and 2 miles of the first.

In summary, blue sharks were at liberty for <1 day to 5.4 years. Thirty percent were at liberty for <1 month, and 81% were at liberty for <1 year. The 5.4 year recapture is under the 8.5 year record time at liberty for blue sharks in the CSTP (Table 5). Overall, 38% of the blue shark recaptures were re-tagged, released with the same tag, or released without a tag.

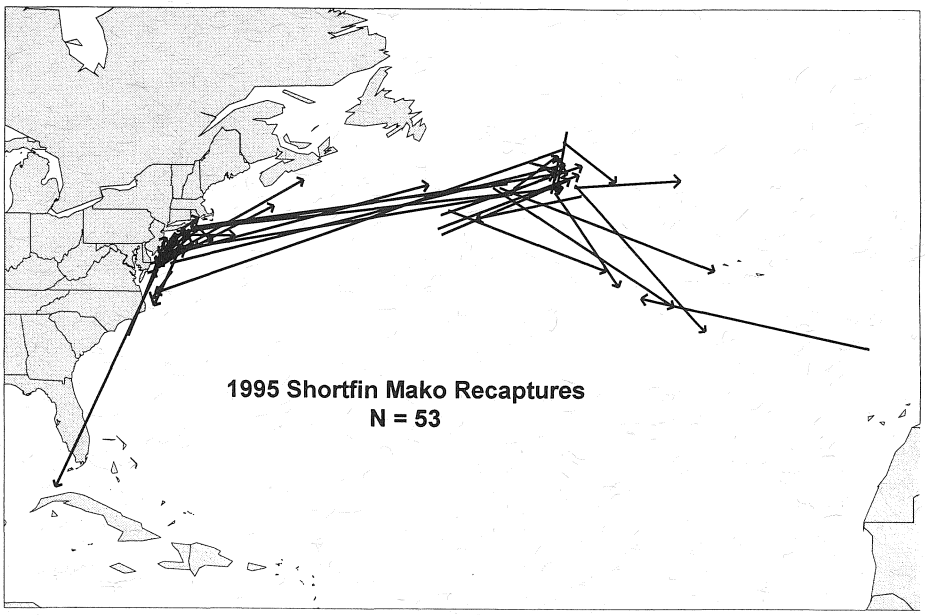

Table 3. Comparison of 1995 tag and recapture data to that of previous years

	1995		1962-1993	
	Tag (%)	Recapture (%)	Tag (%)	Recapture (%)
Occupation:				
Angler	74	45	55	40
Commercial	5	49	8	50
Observer	12	5	12	4
Biologist	9	1	25	6
Method:				
Rod & Reel	71	44	53	43
Longline	23	48	35	44
Free Swimming	3	<1	4	<1
Net	3	5	4	8
Hand Line	<1	2	4	3
Misc.	<1	<1	<1	1

Shortfin Makos (53 Returns)

Mako sharks were at liberty for <1 day to 3.6 years. Many (25) were at liberty for < 1 year and most (41) for < 2 years. Distances traveled ranged from 34 to 1,589 nautical miles (see map). The 1,589 mile return is ninth in terms of maximum distance traveled for a mako shark (Table 5) and was originally tagged east of the Flemish Cap and recaptured off Oregon Inlet, NC after 1.2 years at liberty. A first for the CSTP is a shortfin mako shark tagged off Madeira Island and recaptured southwest of the Azores. A limited number of previous recaptures have shown transatlantic movements from west to east; this is the first evidence from the CSTP data to show movement of makos from east to west. Other long distance recoveries include: a mako shark tagged off Cape May, NJ and recaptured off Newfoundland, Canada (< 5 previously recaptured in this area); makos tagged off the Flemish Cap that traveled west to Rhode Island and New Jersey waters after 1.0 and 3.6 years at liberty; and a fish tagged off Ocean City, MD and recaptured off Cuba (1,028 mi.; 234 days). There are less than 10 makos recaptured in that area to date.

A mako shark was reported as gut hooked at capture and then released with a tag. It was subsequently recaptured 1.2 years later after traveling an overall distance 88 miles. This is not the first reportedly gut hooked fish that has been recaptured after various times at liberty. The survival rate of sharks after different capture times and conditions is still under investigation (see article in this and previous newsletters). Towards this end, please note any information of this kind in the remarks column of your tag cards. Additional interesting returns include: a 2 ft FL mako shark recovered in a gill net off Sakonnet Point, RI and re-released without its tag and two small females tagged on consecutive days southwest of the Tail of the Grand Banks that were both recaptured approximately one year later, 500 miles to the northeast (within 37 miles of each other).

Notable this year is the large number of recaptured (53) makos. This is the highest for any year in the CSTP. In recent years, many sport and commercial fishermen have been more willing to tag and release makos of any size. In addition, fishermen are increasingly cooperative in returning tags and information on recaptured fish.

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Table 4. 1995 recaptures by country of recapture

Country	Number
USA	367
Spain	68
Canada	55
Venezuela	10
Mexico	8
Portugal	6
Cuba	6
Japan	3
Croatia	2
Bahamas	2
Italy	1
Dominican Republic	1
Puerto Rico	1
England	1
Honduras	1
Sri Lanka	1
Dominica, W.I.	1

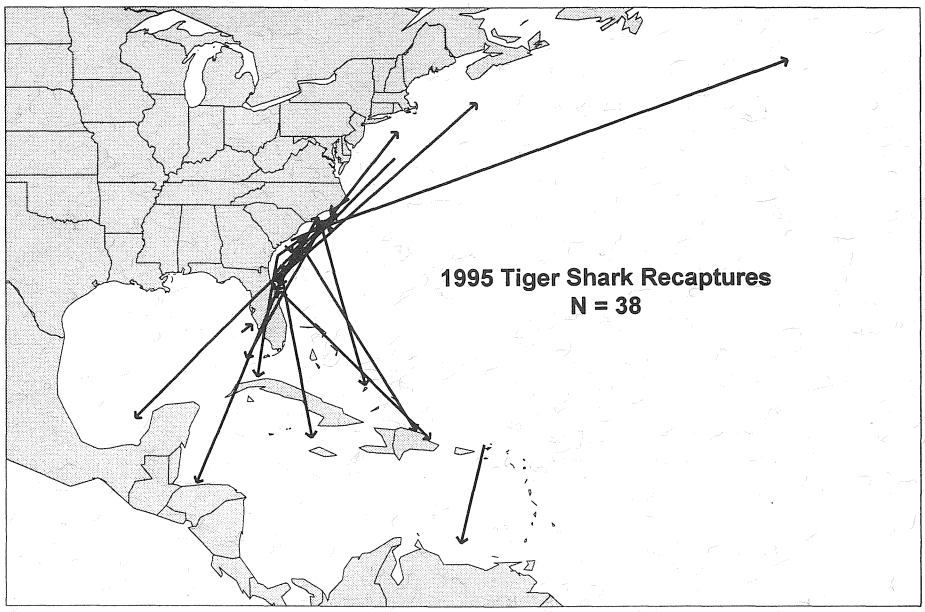

Table 5. Summary of time at liberty, distance traveled, and speed for five species of shark

Species	Time at Liberty (years)		Distance Traveled (nmi)		Speed (nmi/day)	
	1995	All Years	1995	All Years	1995	All Years
Blue Shark	5.4	8.5	2,704	3,740	39	50
Shortfin Mako	3.6	9.5	1,589	2,453	10	36
Sandbar Shark	10.6	27.8	1,966	2,039	6	12
Tiger Shark	3.6	10.9	1,763	1,871	12	33
Porbeagle Shark	8.0	8.6	530	1,005	2	22

Sandbar Sharks (51 Returns)

Sandbar sharks were at liberty from 5 days to 10.6 years and traveled distances from < 1 to 1,966 nautical miles. The longest distance return was tagged off Shinnecock Inlet, NY and recaptured off Port Aransas, TX, 5.4 years later. There are less than 12 sandbar sharks recaptured previously in this area. A total of eight fish were returned after traveling more than 1,000 miles. All were tagged north of Cape Hatteras, NC and recovered in the Gulf of Mexico (seven off the west coast of Florida). As in other years, long distance recaptures (> 300 mi.) primarily exhibited a southwest pattern of movement. The one exception this year was from an interesting multiple recapture. This 7 ft TL female sandbar shark was originally tagged off Long Island, NY in September of 1986 and moved 788 miles in a southwesterly direction to be retagged and re-released off northern Florida 5 years later. The fish was again recaptured 3.5 years later, in May of 1995 off Virginia, after traveling 535 miles to the northeast. At that point, the shark was 254 miles from its original tagging location. Overall, ten of the 42 recaptures (with distance information) were recovered in the Gulf of Mexico; nine off the west coast of Florida and one off Texas.

Tiger Sharks (38 returns)

This has been an impressive year for tiger shark recaptures in terms of recovery locations (see map). Previous returns have shown that tigers tagged off the Atlantic coast of the U.S. have been recaptured off Canada, Mexico, Cuba, Dominican Republic, Puerto Rico, Venezuela, and Central America and show movements into and out of the Gulf of Mexico and into the Caribbean Sea. In many cases, only one or two fish have been recovered in these areas in the 30 years of our program. Recaptures in 1995 have strengthened the validity of these recovery sites with returns off Canada (second tiger to be recaptured there), Mexico (fifth), Cuba (ninth), Dominican Republic (fifth and sixth), Bahamas (first), Venezuela (fifth), and Honduras (second).

In all, three fish traveling distances over 300 miles moved in a northerly or northeasterly direction: two were tagged off northern Florida and recaptured off Montauk, NY (743 mi.; 2.3 yr.) and Nova Scotia, Canada (992 mi.; 1.4 yr.); and the third traveled from North Carolina to the Flemish Cap (1,763 mi.; 1.6 yr.). This recapture location is one of the farthest east for any tagged tiger shark in the CSTP. Another spectacular tiger shark long distance return was a fish tagged off Jacksonville, Florida and recaptured off Africa. This 3 ft FL female was tagged by a commercial fisherman and recaptured by a Spanish longline fisherman after 2.5 years at liberty. The species identification was confirmed at both tag and recapture. We are in the process of verifying the recapture location and if validated, it would be the longest distance traveled by any tagged tiger shark in the CSTP and the first evidence of transatlantic movement for this species. In summary, tiger sharks traveled confirmed distances from 6 to 1,763 nautical miles with 11 traveling more than 500 miles and three > 1,000 miles from their original tagging location.

Other interesting returns include several pairs of tiger sharks tagged in the same location on the same day that were subsequently recaptured. In some cases, the sharks traveled to diverse locations and in others, the tiger sharks seemed to remain together for various periods of time. For example, two 3 ft FL males were released with tags in September of 1994 off northern Florida by a commercial fisherman. One was recaptured southwest of Cuba after 1.3 years at liberty and the other was caught off North Carolina after 0.5 years. Two other

See OVERVIEW, Page 16

Table 2. Tag recoveries: January-December 1995.

	GENERAL LOCATIONS		MONTHS AT LIBERTY	DIST. (MI.) AND DIR.		CAPTURE METHOD		TAGGED BY	
	TAGGED	RECAPTURED				TAG.	REC.	TAGGER	RESIDENCE
Blue shark	E Montauk Pt., NY	E Montauk Pt., NY	<1	9	NE	RR	RR	Lee Pepin	CT
" "	S Montauk Pt., NY	SE Montauk Pt., NY	<1	41	NE	RR	RR	Fred Wedley	NY
" "	S Algarve, Portugal	S Sao Miguel, Azores	30	935	W	RR	LL	Ric Fuller	Portugal
" "	SE Ocean City, MD	W Sao Miguel, Azores	33	1789	E	RR	LL	Mark Sampson	MD
" "	SE Pt. Judith, RI	Dominica Isl., W. Indies	18	1615	S	FS	HL	Rodman Sykes	RI
" "	SW Land's End, England	E Sao Miguel, Azores	6	934	SW	RR	LL	Graeme Pullen	England
" "	S Vilamoura, Portugal	W Cabo Sao Vicente, Portugal	8	276	W	RR	LL	Ric Fuller	Portugal
" "	E Algarve, Portugal	W Lisbon, Portugal	6	360	W	RR	LL	Helder Ferreira	Portugal
" "	E Halifax Hbr., Canada	W Sao Miguel, Azores	18	1040	E	LL	LL	Albert Lawrence	Canada
" "	S Portland, ME	W Sao Miguel, Azores	20	1441	E	RR	LL	Robinson Speirs Jr.	ME
" "	SW Montauk Pt., NY	E Barnegat Inl., NJ	14	64	S	RR	LL	Tom Cashman	NY
" "	SE Fire Island Inl., NY	NE Gibara, Cuba	31	1150	S	RR	LL	William Danisi	NY
" "	SE Barnegat Inl., NJ	E Cape Canaveral, FL	7	707	SE	RR	LL	Greg Thummel	PA
" "	E Cape May, NJ	NW Canary Isl., Spain	17	2645	E	LL	LL	B. Nickerson, NMFS Obs.	MA
" "	E Beach Haven, NJ	E Rudee Inl., VA	30	195	S	RR	LL	David Merrill	NJ
" "	E Barnegat Inl., NJ	E Pt. Judith, RI	8	157	E	LL	LL	K. Cute, NMFS Obs.	MA
" "	SW Montauk Pt., NY	E Cape May, NJ	2	143	SW	RR	LL	Frank J. Braddick	NY
" "	SE Montauk Pt., NY	SW Pt. D'enfer, Martinique	NR	1719	S	HL	LL	Stephen Connett	RI
" "	SE Cape Elizabeth, ME	N Cayenne, French Guiana	7	2289	SE	RR	LL	Ian Bexon	ME
" "	E York Harbor, ME	N Paramaribo, Surinam	6	2164	SE	RR	LL	Bob Puddister	ME
Blue shark	S Martha's Vineyard, MA	N Cayenne, French Guiana	20	2186	SE	RR	LL	Tom Birch	MA
" "	SE Portland Headlights, ME	E Townsends Inl., NJ	2	314	SE	RR	LL	Ian Bexon	ME
" "	SE Montauk Pt., NY	W Sao Miguel, Azores	23	1490	E	LL	LL	B. Bernatonis, NMFS Obs.	RI
" "	SE Pt. Judith, RI	SE Jones Inl., NY	10	98	SW	RR	RR	Keith Silvia	MA
" "	SE Portland Headlights, ME	W Sao Miguel, Azores	7	1793	E	RR	LL	Mark Chase	ME
" "	E Oregon Inl., NC	W Sao Miguel, Azores	8	2085	E	LL	LL	J. Harrington, NMFS Obs.	MA
" "	E Montauk Pt., NY	E Cape May, NJ	10	169	SW	RR	RR	Barry Steinberg	NY
" "	SE Montauk Pt., NY	NE Azores	NR	1979	E	RR	LL	J. Lockshier	CT
" "	E Wachapreague Inl., VA	SW Madeira Isl., Portugal	41	2682	E	LL	LL	Nelson Beideman	NJ
" "	S Martha's Vineyard, MA	SW Canary Isl., Spain	32	2704	E	FS	LL	Rodman Sykes	RI
" "	E Rockport, MA	S Montauk Pt., NY	23	127	SW	RR	RR	Ken Lai	NH
" "	SE Manasquan, NJ	SSE Moriches Inl., NY	<1	62	NE	RR	RR	Frank Mazza	NJ
" "	SW Nantucket Isl., MA	S Freeport, NY	11	151	W	RR	RR	Barry Bordner	MA
" "	E Montauk Pt., NY	E Montauk Pt., NY	10	11	NE	RR	RR	Ed Wills	NY
" "	SE Marblehead, MA	E Gloucester, MA	65	226	NE	LL	LL	W. Quinn, NMFS Obs.	MA
" "	E Manasquan Inl., NJ	S Montauk Pt., NY	<1	66	E	RR	RR	Richard Chisler	NY
" "	E Manasquan Inl., NJ	S Pt. Judith, RI	1	103	NE	RR	RR	Richard Chisler	NY
" "	S Montauk Pt., NY	Isla Dececheo, PR	10	1327	S	RR	HL	Mike Plaia	CT
" "	E Anegada, VI	N Cayenne, French Guiana	1	701	SE	LL	LL	G. Hinteregger, NMFS Obs.	MA
" "	SE Montauk Pt., NY	E Manasquan Inl., NJ	12	94	SW	RR	RR	Harry McAllister	NY
Blue shark	S Montauk Pt., NY	W Sao Miguel, Azores	23	1477	E	RR	LL	Frank Braddick	NY
" "	E Montauk Pt., NY	E Fire Island Inl., NY	1	75	W	RR	RR	Joe McBride	NY
" "	E Montauk Pt., NY	S Portland, ME	9	37	SE	RR	LL	James G. Walsh	CT
" "	Pine Island Sound, FL	W Wiggins Pass, FL	9	16	SE	RR	RR	Leo Dunn	FL
" "	SE Portland, ME	SE Portland, ME	8	202	SE	RR	LL	Ladd Heldenbrand	ME
" "	SE Montauk Pt., NY	E Barnegat Inl., NJ	3	60	S	RR	LL	Frank Braddick	NY
" "	SE Portland Headlights, ME	E Montauk Pt., NY	10	154	S	RR	RR	Ernest H. Johnson	ME
" "	SSE Montauk Pt., NY	S Shinnecock Inl., NY	10	42	SW	RR	RR	Fritz Hubner	NY
" "	SE Pt. Judith, RI	SE Jones Inl., NY	11	106	W	RR	RR	David Blackburn	RI
" "	S Martha's Vineyard, MA	S Pt. Judith, RI	23	40	W	HL	RR	Stephen Connett	RI
" "	S Nantucket Isl., MA	W Lisbon, Portugal	14	2430	E	HL	LL	Stephen Connett	RI
" "	SE Portland Headlights, ME	E Provincetown, MA	14	345	E	RR	LL	Ian Bexon	ME
" "	SE Cape Elizabeth, ME	SE Fire Island Inl., NY	10	234	SW	RR	RR	Jim Hinkley Jr.	ME
" "	E Cape Lookout, NC	E Nantucket Isl., MA	5	528	N	LL	LL	Stephen Connett	RI
" "	SW Shinnecock Inl., NY	S Montauk Pt., NY	1	33	NE	RR	RR	Morton Michaels	NY
" "	E Pt. Pleasant, NJ	SSE Shinnecock Inl., NY	1	59	NE	RR	RR	David Arbeitman	NJ
" "	SE Montauk Pt., NY	SE Montauk Pt., NY	22	10	N	RR	RR	Bill Kovach	NJ
" "	SSE Manasquan Inl., NJ	E Ocean City, MD	1	92	S	RR	RR	Allan Ristori	NJ
" "	E Montauk Pt., NY	E Ocean City, MD	11	229	SW	RR	RR	Dave Preble	RI
" "	SE Moriches Inl., NY	S Montauk Pt., NY	<1	36	NE	RR	RR	John Ficarelli	NY
Blue shark	E Montauk Pt., NY	S Shinnecock Inl., NY	12	65	W	RR	RR	Andy Dangelo	RI
" "	S Montauk Pt., NY	SE Montauk Pt., NY	<1	30	NE	RR	RR	Robert Timson	NY
" "	SE Montauk Pt., NY	S Cape Sable, NS, Canada	2	264	E	RR	LL	Al Woynar	CT
" "	SE Montauk Pt., NY	SW Montauk Pt., NY	10	38	W	RR	RR	Thomas A. Kiernan	NY
" "	SE Beach Haven Inl., NJ	SE Cape May, NJ	<1	34	SW	RR	RR	Richard Janiszewski	NJ
" "	S Shinnecock Inl., NY	E Wachapreague Inl., VA	1	195	SW	RR	LL	Mike Sullivan	NY
" "	S Montauk Pt., NY	E Jones Inl., NY	24	66	W	RR	RR	Albert Phillips Jr.	NY
" "	E Pt. Judith, RI	S Montauk Pt., NY	12	244	W	FS	RR	Rodman Sykes	RI
" "	S Martha's Vineyard, MA	E Block Island, RI	25	47	NW	HL	RR	Stephen Connett	RI
" "	E Rockport, MA	SE Moriches Inl., NY	10	167	SW	RR	RR	John McNamara	MA
" "	SW Pt. Judith, RI	S St. Croix, USVI	22	1571	S	FS	LL	Charlie Donilon	RI
" "	S Newport, RI	NR	NR	NR		RR	LL	Jim Quinn	RI
" "	S Montauk Pt., NY	SE Montauk Pt., NY	12	12	E	RR	RR	Harry McAllister	NY
" "	SW Montauk Pt., NY	SE Shinnecock Inl., NY	<1	27	SE	FS	RR	Bill Williams	NY
" "	SE Portland Headlights, ME	N Cumana, Venezuela	20	1817	S	RR	LL	Albert Pillsbury	ME
" "	E Montauk Pt., NY	E Montauk Pt., NY	1	8	N	FS	RR	Sandy Ballou	RI
" "	E Portland Headlights, ME	E Barnegat Inl., NJ	11	294	SW	RR	RR	Frank Breznyak	ME
" "	SW Jones Inl., NY	S Montauk Pt., NY	<1	106	E	RR	RR	Lawrence J. Festa	NY
" "	E Rudee Inl., VA	SE Montauk Pt., NY	14	298	NE	GN	RR	L. Craig, NMFS Obs.	MA
" "	E Cape May, NJ	SE Ocean City, MD	2	62	SE	RR	RR	Maureen Klause	NJ
Blue shark	SW Jones Inl., NY	SE Fire Island Inl., NY	1	61	E	FS	RR	Lawrence Festa	NY
" "	E Ocean City, MD	S Montauk Pt., NY	1	186	NE	RR	RR	Brion Babbitt	NJ
" "	S Montauk Pt., NY	S Montauk Pt., NY	1	3	N	RR	RR	Bill Ricca	NY
" "	SE Fire Island Inl., NY	SE Jones Inl., NJ	<1	2	SW	RR	RR	Chuck Pleickhardt	NY
" "	E Fire Island Inl., NY	SE Montauk Pt., NY	10	53	E	RR	RR	Tom Cashman	NY
" "	SE Pt.Judith, RI	E Fire Island Inl., NY	12	78	W	RR	RR	James Walsh	CT
" "	SE Montauk Pt., NY	SE Montauk Pt., NY	10	5	NW	RR	RR	Frank Braddick	NY
" "	S Montauk Pt., NY	S Montauk Pt., NY	9	6	SW	RR	RR	C. Michael Brumm	NY
" "	E Montauk Pt., NY	S Pt. Judith, RI	<1	4	SE	RR	RR	James Walsh	CT

Table 2. Tag recoveries: January-December 1995.

	GENERAL LOCATIONS		MONTHS AT	DIST. (MI.) AND DIR.		CAPTURE METHOD		TAGGED BY	
	TAGGED	RECAPTURED	LIBERTY			TAG.	REC.	TAGGER	RESIDENCE
Blue shark	SSW Pt. Judith, RI	SE Shinnecock Inl., NY	<1	14	S	FS	RR	Charlie Donilon	RI
" "	SE Shinnecock Inl., NY	S Shinnecock Inl., NY	<1	8	W	RR	RR	Bill Williams	NY
" "	SE Fire Island Inl., NY	SE Montauk Pt., NY	<1	63	NE	RR	RR	Roger Olsen	NY
" "	SE Montauk Pt., NY	E Montauk Pt., NY	10	8	E	RR	RR	Bill Ricca	NY
" "	E Montauk Pt., NY	S Montauk Pt., NY	12	19	W	RR	RR	Hal Weissman	NY
" "	SE Montauk Pt., NY	SE Jones Inl., NY	<1	78	SW	RR	RR	Frank Braddick	NY
" "	SE Montauk Pt., NY	E Cape May, NJ	12	177	SW	RR	RR	Albert Phillips Jr.	NY
" "	SE Fire Island Inl., NY	SE Fire Island Inl., NY	<1	21	E	RR	RR	Anthony C. Innamorato	NY
" "	SE Fire Island Inl., NY	E Toms River, NJ	1	40	SE	RR	RR	Anthony C. Innamorato	NY
" "	E Montauk Pt., NY	N Venezuela	2	NR		RR	GN	Lee Pepin	CT
" "	Rimini, Italy	Brac Island, Croatia	11	179	E	RR	LL	E. Rossi, BGI	Italy
" "	S Montauk Pt., NY	SE Cape Sable, NS, Canada	1	324	E	RR	LL	Howard Wilder	RI
" "	E Manasquan Inl., NJ	S Jones Inl., NY	8	9	NE	RR	RR	William Fiedler	NJ
" "	S Montauk Pt., NY	E Little Egg Inl., NJ	0	108	S	RR	RR	Ronnie Deluca	NY
" "	S Pt. Judith, RI	S Cape Sable, NS, Canada	2	249	E	RR	LL	Dave Laurie	RI
" "	E Barnegat Inl., NJ	Cape Sable, NS, Canada	1	406	NE	RR	LL	Barry Boyce	NJ
" "	SE Fire Island Inl., NY	SE Fire Island Inl., NY	<1	2	NE	RR	RR	John DiStefano	NY
" "	S Shinnecock Inl., NY	SW Moriches Inl., NY	1	37	W	FS	RR	Lou Pastore	NY
" "	SE Montauk Pt., NY	SE Fire Island Inl., NY	10	77	SW	RR	RR	James Levy	RI
" "	SE Montauk Pt., NY	SE Pt. Judith, RI	<1	25	E	RR	RR	James Ferrone	CT
Blue shark	S Shinnecock Inl., NY	E Manasquan Inl., NJ	25	56	W	RR	RR	Richard Haug	NY
" "	SE Moriches Inl., NY	W Faial, Azores	14	1619	E	RR	LL	Richard Haug	NY
" "	SE Fire Island Inl., NY	S Shinnecock Inl., NY	1	22	E	RR	RR	Peter Geiselman	NY
" "	S Montauk Pt., NY	SE Montauk Pt., NY	1	12	E	RR	RR	Kelly Wright	CT
" "	S Cape Sable, NS, Canada	S Cape Sable, NS, Canada	14	43	NE	RR	LL	J. Symonds, NMFS Obs.	MA
" "	E Manasquan Inl., NJ	S Pt. Judith, RI	3	115	NE	RR	RR	John Aravecz	NJ
" "	SE Pt. Judith, RI	NW Faial, Azores	45	1453	E	RR	LL	Sandy Ballou	RI
" "	SE Pt. Judith, RI	SW Martha's Vineyard, MA	35	19	NW	RR	RR	Ray Chappuis	CT
" "	SW Flemish Cap	SE Jones Inl., NY	8	1148	W	LL	RR	J. Symonds, NMFS Obs.	MA
" "	E Lewes, DE	W Faial, Azores	18	1681	E	LL	LL	P. O'Donnell, NMFS Obs.	MA
" "	E Avalon, NJ	SE Montauk Pt., NY	37	147	NE	RR	RR	Thomas Carrano	NY
" "	E Barnegat Inl., NJ	S Freeport, NY	1	35	N	RR	RR	Kenneth Schott	NJ
" "	S Montauk Pt., NY	E Holquin, Cuba	5	1183	S	RR	HL	Larry Saidel	NY
" "	SE Fire Island Inl., NY	E Manasquan Inl., NJ	1	43	SW	RR	RR	Thomas Kiernan	NY
" "	SE Fire Island Inl., NY	E Cape Sable, NS, Canada	2	671	NE	RR	LL	Bill Ostrower	NY
" "	SSE Montauk Pt., NY	SE Yarmouth, NS, Canada	33	446	E	RR	LL	Harry Clemenz	NY
" "	NE Oregon Inl., NC	Cape Sable, NS, Canada	33	527	NE	LL	LL	J. Harrington, NMFS Obs.	MA
" "	S Martha's Vineyard, MA	S Martha's Vineyard, MA	12	28	NE	RR	RR	Louis Lacagnina	CT
" "	SE Montauk Pt., NY	S Pt. Judith, RI	38	22	N	RR	RR	Gene Artusa	NY
" "	E Montauk Pt., NY	SE Nantucket Isl., MA	12	126	E	RR	LL	Lee Pepin	CT
Blue shark	S Montauk Pt., NY	S Shinnecock Inl., NY	<1	13	SW	RR	RR	Laird Summerlin	MA
" "	SE Montauk Pt., NY	S Montauk Pt., NY	<1	19	SW	RR	FS	Bill Brown	CT
" "	E Rudee Inl., VA	SE Jones Inl., NY	12	238	N	LL	RR	J. Harrington, NMFS Obs.	MA
" "	ESE Townsend Inl., NJ	S Barnegat Inl., NJ	1	65	NE	RR	RR	Pete Roscoe	PA
" "	S Montauk Pt., NY	W Faial, Azores	21	1550	E	RR	LL	Peter Jakits	NY
" "	E Portland Headlights, ME	E Portland Headlights, ME	12	23	E	RR	RR	Frank Breznyak	ME
" "	SE Portland Headlights, ME	SE Fire Island Inl., NY	10	228	SW	RR	RR	Ben Garfield	ME
" "	S Jones Inl., NY	SE Ocean City, MD	1	178	S	RR	LL	John Steiner	NY
" "	SW Shinnecock Inl., NY	S Pt. Judith, RI	2	71	NE	RR	RR	Tom Cashman	NY
" "	SSE Manasquan Inl., NY	SE Montauk Pt., NY	1	113	NE	RR	RR	John Williams	NJ
" "	E Tail of the Banks	SE Flemish Cap	8	241	E	LL	LL	J. Symonds, NMFS Obs.	MA
" "	E Cape May, NJ	S Montauk Pt., NY	1	165	NE	RR	RR	Mike Brocco	NJ
" "	SE Fire Island Inl., NY	S Montauk Pt., NY	1	60	NE	RR	RR	Greg Scala	NY
" "	SE Fire Island Inl., NY	S Shinnecock Inl., NY	1	30	NE	RR	RR	Chuck Pleickhardt	NY
" "	E Montauk Pt., NY	SE Montauk Pt., NY	12	9	S	RR	RR	Mike Brumm	NY
" "	SE Montauk Pt., NY	S Montauk Pt., NY	12	18	W	RR	RR	Frank Braddick	NY
" "	SE Pt. Judith, RI	SE Fire Island Inl., NY	11	116	W	FS	RR	Rodman Sykes	RI
" "	S Martha's Vineyard, MA	SE Pt. Judith, RI	1	76	NW	LL	RR	B. Bernatonis, NMFS Obs.	FL
" "	SE Montauk Pt., NY	S Montauk Pt., NY	<1	13	SW	RR	RR	Jim Bohara	CT
" "	SE Montauk Pt., NY	W Yarmouth, NS, Canada	11	263	NE	RR	LL	Albert Phillips, Jr.	NY
Blue shark	SE Pt. Judith, RI	SE Shinnecock Inl., NY	2	58	SW	RR	RR	Jim Walsh	CT
" "	S Pt. Judith, RI	SE Pt. Judith, RI	<1	21	SE	RR	RR	Robert Sangster	RI
" "	SE Fire Island Inl., NY	SW Montauk Pt., NY	8	28	NE	FS	RR	Tom Boniberger	NY
" "	SE Pt. Judith, RI	S Shinnecock Inl., NY	10	75	W	RR	RR	Tom Mort	RI
" "	SE Montauk Pt., NY	SE Montauk Pt., NY	<1	17	E	FS	RR	Steve Szoke	NY
" "	E Montauk Pt., NY	SE Pt. Judith, RI	1	4	NE	RR	RR	David Cochrane	NY
" "	SE Pt. Judith, RI	SE Moriches Inl., NY	2	60	SW	RR	RR	Joe Pagano	RI
" "	E Montauk Pt., NY	SE Montauk Pt., NY	<1	22	SW	RR	RR	Joe Pagano	RI
" "	S Martha's Vineyard, MA	S Martha's Vineyard, MA	1	11	S	RR	RR	Bruce Gouin	RI
" "	E Cabo de Sao Vinc., Portugal	S Fuzeta, Algarve, Portugal	3	27	E	RR	LL	Graeme Pullen	England
" "	S Jones Inl., NY	SE Manasquan Inl., NJ	<1	31	S	RR	RR	Dennis O'Rourke	NY
" "	SE Jones Inl., NY	SE Pt. Judith, RI	1	95	NE	RR	RR	Matt Richardson	NY
" "	SE Shinnecock Inl., NY	E Barnegat Inl., NJ	<1	58	SW	RR	RR	Gary Blackler	NY
" "	S Montauk Pt., NY	S Montauk Pt., NY	1	12	SW	RR	RR	Otto Haselman	NY
" "	S Fire Island Inl., NY	S Montauk Pt., NY	1	72	NE	RR	RR	Kenneth Schmieder	NY
" "	SE Jones Inl., NY	SE Fire Island Inl., NY	1	11	N	RR	RR	Lawrence Festa	NY
" "	SE Fire Island Inl., NY	E Hampton, NH	3	189	NE	RR	RR	Kenneth Schmieder	NY
" "	SE Montauk Pt., NY	S Fire Island Inl., NY	<1	82	SW	RR	RR	Dana Zewinski	RI
" "	S Montauk Pt., NY	S Portland Headlights, ME	2	170	NE	RR	LL	Nick Millilo	CT
" "	S Montauk Pt., NY	SE Shinnecock Inl., NY	<1	21	W	RR	RR	Mike Brumm	NY
Blue shark	SE Montauk Pt., NY	NE Gloucester, MA	2	130	N	RR	RR	Charles Zboray	NY
" "	S Nantucket Island, MA	SE Montauk Pt., NY	2	65	W	RR	RR	Tom Birch	MA
" "	SE Moriches Inl., NY	SE Jones Inl., NY	<1	30	W	RR	RR	Charlie Johnson	NY
" "	SE Provincetown, MA	SW Cape Sable, NS, Canada	1	109	N	FS	LL	Rodman Sykes	RI
" "	S Pt. Judith, RI	SW Cape Sable, NS, Canada	1	252	NE	RR	LL	Robert Sangster	RI
" "	SE Moriches Inl., NY	SE Jones Inl., NY	2	36	SW	RR	RR	Hugo Kirchner	NY
" "	SE Pt. Judith, RI	SW Buzzards Bay Tower, MA	<1	6	NE	RR	GN	Robert Hogan, Jr.	RI
" "	E Ocean City MD	SE Cape Elizabeth, ME	14	317	N	LL	HL	P. O'Donnell, NMFS Obs.	MA
" "	SE Pt. Judith, RI	NE Cayo Moa, Holquin, Cuba	NR	1219	S	RR	LL	John Salisbury	CT

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	TAGGED	RECAPTURED				TAG.	REC.	TAGGER	RESIDENCE
Blue shark	SE Pt. Judith, RI	SE Pt. Judith, RI	24	20	SE	RR	RR	James Walsh	CT
" "	SE Portland Headlights, ME	SE Fire Island Inl., NY	13	221	SW	RR	RR	Jim Hinkley, Jr.	ME
" "	S Fire Island Inl., NY	S Montauk Pt., NY	1	83	NE	RR	RR	Ray Schmidt	NY
" "	S Shinnecock Inl., NY	SE Pt. Judith, RI	1	64	NE	RR	RR	Ted Bingham	NY
" "	SE Atlantic City, NJ	SE Montauk Pt., NY	4	193	E	RR	LL	Ray Bergman	MD
" "	S Provincetown, MA	S Cape Sable, NS, Canada	6	154	E	LL	LL	K. Cute, NMFS Obs.	MA
" "	SE Manasquan Inl. NJ	S Jones Inl., NY	1	32	N	RR	RR	Harry Thorne	NJ
" "	S Montauk Pt., NY	SE Montauk Pt., NY	3	10	NE	RR	RR	Robert Pintauno	NY
" "	S Fire Island Inl., NY	SE Montauk Pt., NY	3	145	E	RR	LL	Robert Howard	NY
" "	S Martha's Vineyard, MA	S Nantucket Island, MA	NR	86	SE	RR	LL	Lou Lacagnina	CT
" "	SE Montauk Pt., NY	SE Montauk Pt., NY	<1	26	S	RR	RR	Bill Brown	CT
" "	S Montauk Pt., NY	SE Halifax, NS, Canada	2	461	NE	RR	LL	Peter Jakits	NY
" "	SE Montauk Pt., NY	SE Halifax, NS, Canada	NR	512	E	RR	LL	Roderick MacLeod	CT
" "	S Portland Headlights, ME	W Villa Cisneros, Africa	28	2632	E	RR	LL	Ian Bexon	ME
" "	SE Montauk Pt., NY	E Montauk Pt., NY	1	14	NE	RR	RR	Harry McAllister	NY
" "	SW Montauk Pt., NY	SE Montauk Pt., NY	3	119	E	RR	LL	Eugene Crudo	NY
" "	E Portland Headlights, ME	E Cape Sable, NS, Canada	4	312	E	RR	LL	Dave Sinclair	ME
" "	SE Shinnecock Inl., NY	SE Montauk Pt., NY	1	27	NE	RR	RR	Robert Timsen	NY
" "	E Martinique Island	SE Flemish Cap	5	1732	N	LL	LL	G. Hinteregger, NMFS Obs.	MA
" "	N Cayenne, French Guiana	NR	NR	NR		LL	LL	G. Hinteregger, NMFS Obs.	MA
Blue shark	SE Flemish Cap	SE Flemish Cap	11	130	N	LL	LL	Barry Marx	FL
" "	SE Pt. Judith, RI	S Cape Sable, NS, Canada	1	248	E	RR	LL	Barry Bordner	MA
" "	SE Fire Island Inl., NY	SE Jones Inl., NY	<1	5	W	RR	RR	Chuck Pleickhardt	NY
" "	SSE Montauk Pt., NY	S Pt. Judith, RI	<1	12	W	RR	RR	Mike Brumm	NY
" "	SW Montauk Pt., NY	SE Halifax, NS, Canada	3	481	NE	RR	LL	Pat Cutrone	CT
" "	SE Fire Island Inl., NY	SE Fire Island Inl., NY	<1	6	SW	RR	RR	John Jedlicka	NY
" "	SE Pt. Judith, RI	SE Flemish Cap	10	1296	E	FS	LL	Edward Abbenante	RI
" "	SE Fire Island Inl., NY	E Halifax, NS, Canada	4	560	NE	RR	LL	Tom Boniberger	NY
" "	SE Montauk Pt., NY	SE Montauk Pt., NY	3	58	S	RR	LL	Joe McBride	NY
" "	E Faro, Portugal	W Lisbon, Portugal	5	283	W	RR	LL	Helder Ferreira	Portugal
" "	E Faro, Portugal	NW Lisbon, Portugal	7	218	NW	RR	LL	Helder Ferreira	Portugal
" "	SE Montauk Pt., NY	S Long Isl., NY	NR	NR		RR	RR	Ron Bertase	CT
" "	SW Flemish Cap	SE Flemish Cap	11	409	E	LL	LL	Barry Marx	FL
" "	SSE Pt. Judith, RI	S Montauk Pt., NY	1	39	W	FS	RR	Robert Rowan	RI
" "	SE Flemish Cap	SE Flemish Cap	<1	163	SE	LL	LL	J. Symonds, NMFS Obs.	MA
" "	E Beach Haven, NJ	E Pt. Pleasant, NJ	4	182	E	RR	LL	Joe McDonald	NJ
" "	SE Montauk Pt., NY	S Montauk Pt., NY	4	52	S	RR	LL	Bob Weaver	NY
" "	S Fire Island Inl., NY	SE Fire Island Inl., NY	2	23	E	RR	RR	Howard Berman	NY
" "	SE Montauk Pt., NY	E Halifax, NS, Canada	4	505	NE	RR	LL	Dana Zewinski	RI
" "	SE Montauk Pt., NY	S Cape Sable, NS, Canada	1	252	E	RR	LL	Andy Dangelo	RI
Blue shark	S Lagos, Portugal	W Lagos, Portugal	1	277	W	RR	LL	George Burgum	Portugal
" "	SE Montauk Pt., NY	E Cape Sable, NS, Canada	17	692	E	RR	LL	Frank Braddick	NY
" "	SE Portland Headlights, ME	SSE Manasquan Inl., NJ	10	277	SW	RR	RR	Wilbur Bell III	ME
" "	S Vineyard Haven, MA	SE Liverpool, NS, Canada	12	392	E	FS	LL	Stephen Connett	RI
" "	SE Vineyard Haven, MA	SW Montauk Pt., NY	11	108	W	HL	RR	Stephen Connett	RI
" "	S Jones Inl., NY	SE Montauk Pt., NY	NR	NR		RR	RR	Frank Signorelli	NY
" "	E Barnegat Inl., NJ	SE Montauk Pt., NY	1	79	NE	RR	RR	Greg Venturo	NJ
" "	E Cape May, NJ	S Montauk Pt., NY	3	163	NE	RR	RR	Raymond Szulczewsky	NJ
" "	E Beach Haven, NJ	SE Ocean City, NJ	<1	55	S	RR	RR	William Madden	NJ
" "	S Montauk Pt., NY	W Villa Cisneros, Spain	NR	NR		RR	LL	Bruce Robertson	NY
" "	E Beach Haven, NJ	E Beach Haven, NJ	36	40	W	RR	RR	George Lewis	DE
" "	SE Montauk Pt., NY	S Montauk Pt., NY	12	22	NE	RR	RR	Chris Dadiskos	CT
" "	E New Jersey	E Beach Haven, NJ	NR	NR		RR	LL	Stephen Stecki	NJ
" "	E Barnegat Inl., NJ	E Rudee Inl., VA	4	192	S	RR	LL	Kenneth Schott	NJ
" "	S Bayshore, NY	S Sambro, NS, Canada	NR	NR		RR	LL	Dan Azzato	NY
" "	S Montauk Pt., NY	SE Pt. Judith, RI	34	31	NE	RR	RR	Tom Federico	NY
" "	E Manasquan Inl., NJ	SE Moriches Inl., NY	3	57	NE	RR	RR	Dennis O'Keefe	NJ
" "	SE Montauk Pt., NY	Azores	NR	NR		RR	LL	Bill Ricca	NY
" "	NE Georgetown, Guyana	NW Sao Miguel, Azores	NR	2375	NE	LL	LL	Alex Sutton	NY
" "	W Funchal, Portugal	NE Cape Verde, Portugal	27	768	S	RR	LL	Roddy Hays	Portugal
Blue shark	Madeira Island, Portugal	W Villa Cisneros, Spain	NR	NR		RR	LL	Roddy Hays	Portugal
" "	Madeira Island, Portugal	NW Dakar, Senegal	NR	NR		RR	LL	Roddy Hays	Portugal
" "	Madeira Island, Portugal	NW Villa Cisneros, Spain	NR	NR		RR	LL	Roddy Hays	Portugal
" "	E Barnegat Inl., NJ	SE Montauk Pt., NY	8	NR		LL	RR	J. Harrington, NMFS Obs.	MA
" "	S Freeport, NY	SE Fire Island Inl., NY	1	NR		RR	RR	John Genovese	NY
" "	S Long Isl., NY	SE Absecon Inl., NJ	NR	NR		RR	RR	Albert Katz	NY
" "	SE Portland Headlights, ME	Wachapreague Inl., VA	12	381	SW	RR	LL	Ernie Johnson	ME
" "	Madeira Island, Portugal	W Canary Islands, Spain	NR	NR		RR	LL	Roddy Hays	Portugal
" "	E Barbados, N. Antilles	W Spanish Sahara, Africa	18	1606	NE	LL	LL	Daniel Shawhan	FL
" "	S Long Isl., NY	SE Shinnecock Inl., NY	NR	NR		RR	RR	Glen Kaplosuzian	NY
" "	SE Ocean City, MD	SE Ocean City, MD	1	15	NW	RR	RR	Marty Moran	MD
" "	S Fire Island Inl., NY	SE Fire Island Inl., NY	1	25	E	RR	RR	Bruce Hastings	NY
" "	SE Pt. Judith, RI	S Fire Island Inl., NY	1	114	SW	RR	RR	Ken Benson	RI
" "	S Freeport, NY	SE Montauk Pt., NY	NR	114	E	RR	RR	Frank Signorelli	NY
" "	E Montauk Pt., NY	E Cape May, NJ	15	181	SW	RR	RR	Mike Brumm	NY
" "	SE Montauk Pt., NY	S Pt. Judith, RI	12	18	NE	RR	RR	Al Phillips	NY
" "	SE Nantucket Isl., MA	S Flemish Cap	1	1148	E	RR	LL	Bill Tucker	MA
" "	S Martha's Vineyard, MA	S Montauk Pt., NY	12	55	SW	RR	RR	Rick McLaughlin	MA
" "	S Monte Gorda, Portugal	Huelva Andalucia, Spain	2	NR		RR	LL	Helder Ferreira	Portugal
" "	SE Fire Island Inl., NY	SE Fire Island Inl., NY	1	9	SE	RR	RR	Bruce Licata	NY
Blue shark	E Indian River Inl., DE	S Shinnecock Inl., NY	1	140	NE	RR	RR	Hall Jump	MD
" "	E Indian River Inl., DE	S Fire Island Inl., NY	1	81	NE	RR	RR	Hall Jump	MD
" "	S Flemish Cap	SE Flemish Cap	10	207	SE	LL	LL	Barry Marx	FL
" "	S Flemish Cap	SE Flemish Cap	10	141	SE	LL	LL	Barry Marx	FL
" "	S Flemish Cap	SE Flemish Cap	9	172	SE	LL	LL	Barry Marx	FL
" "	S Flemish Cap	SE Flemish Cap	1	1148	E	RR	LL	Barry Marx	FL
" "	S Flemish Cap	SE Flemish Cap	10	131	SE	LL	LL	Barry Marx	FL
" "	S Long Isl., NY	SE Pt. Judith, RI	NR	NR		RR	RR	George Hettesheimer	NY
" "	SW Shinnecock Inl., NY	E Indian River Inl., DE	1	140	SW	RR	RR	Tom Cashman	NY

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	TAGGED	RECAPTURED				TAG.	REC.	TAGGER	RESIDENCE
Blue shark	S Fire Island Inl., NY	E Little Egg Inl., NJ	NR	73	S	RR	LL	Andy Becker	NY
" "	S Fire Island Inl., NY	SW Shinnecock Inl., NY	NR	NR		RR	RR	Andy Becker	NY
" "	S Martha's Vineyard, MA	SE Pt. Judith, RI	1	61	NW	RR	RR	Andy Becker	NY
" "	S Freeport, NY	E Cape May, NJ	NR	NR		RR	RR	Ronnie Bauer	NY
" "	SE Montauk Pt., NY	S Cape Sable, NS, Canada	1	274	E	RR	LL	Joe McBride	NY
" "	SE Montauk Pt., NY	NE Gloucester, MA	2	124	N	RR	HL	Frank Braddick	NY
" "	S Long Isl., NY	SE Wachapreague Inl., VA	NR	NR		RR	RR	David Lee	NY
" "	SW Pt. Judith, RI	S Fire Island Inl., NY	1	74	SW	RR	RR	Charlie Donilon	RI
" "	SE Pt. Judith, RI	SE Pt. Judith, RI	<1	11	SW	FS	RR	Charlie Donilon	RI
" "	SSE Pt. Judith, RI	SE Pt. Judith, RI	<1	1	SW	RR	RR	Charlie Donilon	RI
" "	S Shinnecock Inl., NY	S Fire Island Inl., NY	1	38	SW	RR	RR	Tom Cashman	NY
" "	SW Shinnecock Inl., NY	SE Cape Sable, NS, Canada	NR	421	NE	FS	LL	John Cronley	NY
" "	SW Shinnecock Inl., NY	SW Martha's Vineyard, MA	<1	94	E	RR	RR	John Cronley	NY
" "	SE Jones Inl., NY	SE Cape May, NJ	2	113	S	RR	RR	Larry Festa	NY
" "	Rimini, Italy	W Sibenik, Croatia	NR	NR		RR	TN	E. Rossi, BGI	Italy
Shortfin mako	E Cape Race, NF, Canada	SW Sao Miguel, Azores	9	762	SE	LL	LL	Barry Marx	FL
" "	E Ocean City, MD	NE Oregon Inl., NC	34	132	SW	RR	LL	Bill Verbanas	DE
" "	SE Ocean City, MD	E Townsends Inl., NJ	14	133	NE	RR	LL	Mark Sampson	MD
" "	SE St. John's, NF, Canada	W Sao Miguel, Azores	5	825	SE	LL	LL	J. Symonds, NMFS Obs.	MA
" "	S Jones Inl., NY	NR	NR	NR		RR	LL	Frank Signorelli	NY
" "	S Cape Race, NF, Canada	W Sao Miguel, Azores	10	637	E	LL	LL	Daniel Shawhan	FL
" "	E Sandy Hook, NJ	SSE Cape May, NJ	23	140	SW	RR	RR	Steve Marotta	NY
" "	SE Ocean City, MD	E Ocean City, MD	24	34	N	RR	RR	Mark Sampson	MD
" "	E Flemish Cap	NE Oregon Inl., NC	15	1589	W	LL	LL	J. Harrington, NMFS Obs.	MA
" "	SE Montauk Pt., NY	E Absecon Inl., NJ	12	124	SW	RR	RR	Ed Cacioppo	NY
" "	E Cape May, NJ	SE Fire Island Inl., NY	12	84	NE	RR	RR	Jim Groover	PA
" "	S Flemish Cap	SE Barnegat Inl., NJ	44	1287	W	LL	RR	Scott Drabinowicz	MA
" "	W Funchal, Madeira Isl.,	W Ponta Delgado, Azores	20	934	W	RR	LL	Roddy Hays	Portugal
" "	E Beach Haven, NJ	SE Moriches Inl., NY	24	79	NE	RR	RR	Joe McDonald	NJ
" "	E Barnegat Inl., NJ	SE Beach Haven Inl., NJ	12	46	SW	RR	RR	Paul Regula	NJ
" "	SE Moriches Inl., NY	SE Indian River Inl., DE	11	165	SW	RR	RR	Wain Carlough	NY
" "	E Flemish Cap	SE Flemish Cap	9	240	S	LL	LL	M. Terwilleger, NMFS Obs.	MA
" "	SW Tail of the Banks	SE Flemish Cap	27	537	NE	LL	LL	G. Hinteregger, NMFS Obs.	MA
" "	SE Tail of the Banks	E Tail of the Banks	12	550	NE	LL	LL	Barry Marx	FL
" "	E Cape Fear, NC	SE Ocean City, MD	4	277	N	LL	RR	Steve Branstetter	FL
Shortfin mako	SE Shinnecock Inl., NY	E Townsends Inl., NJ	12	129	SW	RR	RR	Fred Wedley	NY
" "	SE Shinnecock Inl., NY	SE Flemish Cap	NR	1336	E	RR	LL	Bill Williams	NY
" "	SE Flemish Cap	SE Flemish Cap	38	143	N	LL	LL	S. Soares, NMFS Obs.	MA
" "	E Tail of the Banks	SE Flemish Cap	24	166	NE	LL	LL	John Caldwell	FL
" "	E Avalon, NJ	S Cape Sable, NS, Canada	10	378	NE	LL	LL	M. Pol, NMFS Obs.	MA
" "	SE Flemish Cap	W Faial, Azores	22	440	SE	LL	LL	Alex Sutton	NY
" "	SE Ocean City MD	S Fire Island Inl., NY	13	139	NE	RR	RR	Mark Sampson	MD
" "	SE Ocean City MD	SW Key West, FL	8	1028	SW	RR	LL	Mark Sampson	MD
" "	SE Flemish Cap	NW Faial, Azores	14	372	E	LL	LL	Barry Marx	FL
" "	S Tail of the Banks	E Tail of the Banks	13	512	NE	LL	LL	Barry Marx	FL
" "	SE Flemish Cap	SE Cape Race, NF, Canada	3	388	W	LL	LL	Barry Marx	FL
" "	E Ocean City, MD	SE Flemish Cap	12	1462	NE	RR	LL	Mark Schrenk	NJ
" "	SE Montauk Pt., NY	SE Flemish Cap	11	1335	E	RR	LL	Jeff Eckert	CT
" "	S Fire Island Inl., NY	SSE Cape May, NJ	NR	112	SW	RR	RR	Ken Scheben	NY
" "	E Montauk Pt., NY	SE Montauk Pt., NY	15	88	SE	RR	LL	Mike Brumm	NY
" "	E Montauk Pt., NY	E Ocean City, MD	11	222	SW	RR	RR	Joel Studin	NY
" "	E Cape May, NJ	S Cape Race, NF, Canada	NR	1015	NE	RR	LL	Paul Ginnta	NJ
" "	E Wachapreague Inl., VA	E Manasquan Inl., NJ	1	154	N	RR	RR	Keith Patton	MD
" "	S Flemish Cap	SE Flemish Cap	12	140	E	LL	LL	Barry Marx	FL
" "	S Montauk Pt., NY	E Oregon Inl., NC	NR	331	SW	RR	LL	Peter Jakits	NY
Shortfin mako	E Jones Inl., NY	E Absecon Inl., NJ	10	76	SW	RR	LL	Chris Hoppner	NY
" "	E Delaware Coast	E Ocean City, MD	NR	NR		RR	RR	Mark Shepherd	DE
" "	E Ocean City, MD	SE Halifax, NS, Canada	27	628	NE	RR	LL	Paul DiFebo Jr.	DE
" "	E Ocean City, MD	Ocean City, MD	12	0	No	RR	RR	Bill Verbanas	DE
" "	SE Jones Inl., NY	E Sandy Hook, NJ	2	229	E	RR	LL	Joseph Dymarczyk	NJ
" "	S Flemish Cap	SE Faial, Azores	NR	855	E	LL	LL	Daniel Shawhan	FL
" "	E Ocean City, MD	E Beach Haven, NJ	1	476	S	RR	LL	Joe Nibali	MD
" "	S Flemish Cap	SE Flemish Cap	10	200	NE	LL	LL	Barry Marx	FL
" "	SW Shinnecock Inl., NY	S Sakonnet Pt,. RI	2	78	NE	RR	GN	Andy Becker	NY
Sandbar shark	SE Montauk Pt., NY	SE Tavernier, FL	NR	1058	SW	RR	LL	Zac Grossman	FL
" "	E Atlantic City, NJ	N Dry Tortugas, FL	90	1213	SW	RR	LL	Phillip E. Richard	NJ
" "	SSE Montauk Pt., NY	W Key West, FL	128	1250	SW	RR	LL	Warren Hader	NY
" "	E Charleston, SC	W Sanibel Isl., FL	44	450	SW	LL	LL	Biologist (NMFS)	RI
" "	SE Rudee Inl., VA	West Coast, FL	NR	NR		RR	LL	William G. Moffett Jr.	VA
" "	SE Fire Island Inl., NY	West Coast, FL	NR	NR		RR	LL	Carl Safina	NY
" "	E Absecon Inl., NJ	E Vero Beach, FL	102	754	SW	LL	RR	Biologist (NMFS)	RI
" "	E Beach Haven, NJ	E Avon, NC	49	260	S	RR	LL	Greg Thummel	PA
" "	E Cape Henry, VA	E Buxton, NC	41	110	S	LL	LL	Biologist (NMFS)	RI
" "	SW Montauk Pt., NY	E Cape May, NJ	14	128	SW	RR	LL	Tom Cashman	NY
" "	SW Montauk Pt., NY	E Cape May, NJ	14	131	SW	RR	LL	Daniel Azzato	NY
" "	SE Shinnecock Inl., NY	SE Buxton, NC	53	361	SW	RR	LL	Carl Frauenpreis	NJ
" "	Great Bay, NJ	S Cape Hatteras, NC	21	245	S	RR	LL	Philip E. Richard	NJ
" "	E Absecon Inl., NJ	W Dry Tortugas, FL	83	1017	SW	RR	LL	Philip E. Richard	NJ
" "	Quimby Inl., VA	SE Cobb Isl., VA	10	9	S	RR	GN	Chris Harner	VA
" "	E Beach Haven, NJ	NE Charleston, SC	80	0	No	RR	LL	Walter B. Scharff Jr.	NJ
" "	N Ponce Inl., FL	SE Smith Island, VA	42	535	NE	LL	GN	Eric Sander	FL
" "	SE Montauk Pt., NY	NE Cape Lookout, NC	32	413	SW	RR	LL	Tom Federico	NY
" "	BroadKill Bch., DE	BroadKill Bch., DE	<1	0		GN	RR	Biologist (NMFS)	RI
" "	BroadKill Bch., DE	N Cape Henlopen, DE	1	7	NE	GN	RR	Biologist (NMFS)	RI
Sandbar shark	BroadKill Bch., DE	Lewes, DE	<1	2	SE	GN	RR	Biologist (NMFS)	RI
" "	Murder Kill Bch, DE	Delaware Bay, DE	1	3	SW	GN	RR	Biologist (NMFS)	RI
" "	Murder Kill Bch, DE	Delaware Bay, DE	<1	2	SE	GN	RR	Biologist (NMFS)	RI
" "	SE Fire Island Inl., NY	W St. Petersburg, FL	46	1426	SW	RR	LL	Richard E. Ortmann	NY
" "	SW Shinnecock Inl., NY	SE Apalachicola, FL	96	1515	SW	RR	LL	Arthur Raskin	NY

Table 2. Tag recoveries: January-December 1995.

	GENERAL LOCATIONS		MONTHS AT LIBERTY	DIST. (MI.) AND DIR.		CAPTURE METHOD		TAGGED BY	
	TAGGED	RECAPTURED				TAG.	REC.	TAGGER	RESIDENCE
Sandbar shark	E Oregon Inl., NC	NE Ft. Pierce Inl., FL	3	580	SW	LL	RR	NMFS Obs.	MA
" "	Cape Lookout, NC	SE Cape Fear, NC	34	73	SW	RR	LL	Richard Gray	NC
" "	NE Daytona Bch., FL	NW Sarasota, FL	49	773	W	LL	LL	Eric Sander	FL
" "	Delaware Bay, DE	Broadkill Bch, DE	1	1	N	GN	GN	Biologist (NMFS)	RI
" "	BroadKill Bch., DE	Lewes, DE	<1	3	SE	GN	RR	Biologist (NMFS)	RI
" "	BroadKill Bch., DE	Lewes, DE	<1	2	E	GN	RR	Biologist (NMFS)	RI
" "	NW Cape Henry, VA	N Cape Henry, VA	<1	12	E	RR	GN	Tracy Jones	VA
" "	E Southport, NC	W Cedar Key, FL	33	1085	SW	LL	LL	Chris Jensen	NC
" "	Stono Inl., SC	Stono Inl., SC	14	0		RR	RR	Rick Stringer	SC
" "	SE Shinnecock Inl., NY	NW Dry Tortugas, FL	26	1073	SW	RR	LL	Bill Williams	NY
" "	S Montauk Pt., NY	NE Oregon Inl., NC	26	279	SW	RR	LL	Bob Veach	CT
" "	Cape Pt., NC	Cape May, NJ	NR	NR		RR	LL	R. V. Wiseman	VA
" "	SE Shinnecock Inl., NY	SE Port Aransas, TX	65	1966	SW	RR	RR	Robert Bangston	NY
" "	SW Montauk Pt., NY	S Ocean City, MD	NR	191	SW	RR	LL	Dan Azzato	NY
" "	SE St. Augustine FL	E New Jersey Coast	NR	NR		LL	RR	Tris Colket	FL
" "	S Shinnecock Inl., NY	E Barnegat Inl., NJ	NR	39	SW	RR	LL	Robert Tyree	NY
" "	SE Jones Inl., NY	SE Cape Hatteras, NC	NR	325	SW	RR	LL	David Mantovani	NY
" "	S Shinnecock Inl., NY	SE Chincoteague, VA	NR	NR		RR	LL	Ed Hanley	NY
" "	SE Fire Island Inl., NY	SE Pt. Judith, RI	NR	NR		RR	FD	Robert McReynolds	NY
" "	E New Jersey Coast	S Apalachicola, FL	NR	NR		RR	LL	Michael Krokovic	NJ
" "	SE Bayshore, NY	NR	NR	NR		RR	RR	Ed Cacioppo	NY
" "	E. Wachapreague Inl., VA	E Wachapreague Inl., VA	1	0		RR	GN	Pieter Waldenmaier	NJ
" "	E Cape Hatteras, NC	SW Cape Hatteras, NC	8	18	W	LL	LL	Steve Branstetter	FL
Tiger shark	E Fernandina Bch, FL	E Fernandina Inl., FL	3	28	N	LL	LL	Tris Colket	FL
" "	E St. Augustine, FL	E St. Augustine, FL	2	6	N	LL	LL	Tris Colket	FL
" "	E St. Marys, FL	E St. Augustine, FL	17	53	SE	LL	LL	Tris Colket	FL
" "	E Jacksonville, FL	E Crescent City, FL	<1	55	S	LL	LL	Tris Colket	FL
" "	NE Ponce Inl., FL	E Wrightsville Bch, NC	6	286	NE	LL	LL	Tris Colket	FL
" "	SE Southport, NC	Acklins Isl., Bahamas	15	675	S	LL	RR	Chris Jensen	FL
" "	E Fernandina Beach, FL	SE Cape Lookout, NC	6	291	NE	LL	LL	Tris Colket	FL
" "	S Wassaw Sound, GA	SE Cape Lookout, NC	6	285	NE	LL	LL	Chris Jensen	FL
" "	SE Southport, NC	E Cape Fear, NC	12	21	N	LL	LL	Chris Jensen	FL
" "	ESE Jacksonville, FL	E St. Augustine, FL	6	30	SE	LL	LL	Tris Colket	FL
" "	ESE Jacksonville, FL	E St. Augustine, FL	6	30	SE	LL	LL	Tris Colket	FL
" "	SE Charleston, SC	E Cape Fear, NC	6	167	NE	LL	LL	Douglas Oakley	SC
" "	SE Folley Beach, SC	S Folley Beach, SC	NR	28	S	LL	LL	Douglas Oakley	SC
" "	E Ponce Inl., FL	N Miches, DR	43	855	SE	LL	LL	Eric Sander	FL
" "	E Ocean City, MD	NW Campeche, Mexico	13	1623	SW	LL	LL	K. Cute, NMFS Obs.	MA
" "	SE Southport, NC	SE Carolina Bch. Inl., NC	16	11	W	LL	RR	Steve Branstetter	FL
" "	E Wassau Sound, GA	El Porvenir, Honduras	5	1038	SW	LL	RR	Steve Branstetter	FL
" "	E St. Augustine, FL	W Bolama Guinea, Africa	30	3643	E	LL	LL	Tris Colket	FL
" "	E St. Augustine, FL	S Montauk Pt., NY	28	743	NE	LL	LL	Tris Colket	FL
" "	SE Cape Fear, NC	SW Dry Tortugas, FL	NR	621	SW	LL	LL	Steve Branstetter	FL
Tiger shark	S Wassaw Sound, GA	NE Guanabo, Cuba	10	504	S	LL	GN	Steve Branstetter	FL
" "	NE Ponce Inl., FL	E Charleston, SC	11	162	NE	LL	LL	Tris Colket	FL
" "	NE Avon, NC	W Cape Lookout, NC	8	89	SW	LL	LL	Glen Hopkins	NC
" "	SW St. Petersburg, FL	W West Palm Bch., FL	5	51	NE	LL	LL	Basil Arend	FL
" "	NE Ponce Inl., FL	E Daytona Bch., FL	14	42	SW	LL	RR	Tris Colket	FL
" "	NE Ponce Inl., FL	S Cape Sable, NS, Canada	17	992	NE	LL	LL	Tris Colket	FL
" "	E Cape Fear, NC	SE Flemish Cap	19	1763	NE	LL	LL	Steve Branstetter	FL
" "	E Charleston, SC	E Cape Canaveral, FL	17	NR		LL	RR	Glenn Ulrich	SC
" "	SE Ponce Inl., FL	E Ponce Inlet, FL	12	10	N	LL	RR	Tris Colket	FL
" "	E Charleston, SC	N Rio San Juan Sanchez, DR	3	917	SE	LL	LL	Glenn Ulrich	SC
" "	SE Southport, NC	E Southport, NC	19	9	NE	LL	LL	Steve Branstetter	FL
" "	E Southport, NC	E Southport, NC	6	19	SW	LL	LL	Steve Branstetter	FL
" "	E Jacksonville, FL	NR	NR	NR		LL	LL	Tris Colket	FL
" "	NE Jacksonville, FL	NR	NR	NR		LL	LL	Tris Colket	FL
" "	NE Ponce Inl., FL	SW Cabo Cruz Niquero, Cuba	15	662	S	LL	LL	Biologist (NMFS)	RI
" "	E Southport, NC	E Southport, NC	<1	6	NE	LL	LL	Steve Branstetter	FL
" "	E Southport, NC	E Southport, NC	<1	8	SW	LL	LL	Steve Branstetter	FL
Porbeagle shark	E Cape Sable, NS, Canada	E Cape Sable, NS, Canada	9	72	S	LL	LL	Albert Lawrence	Canada
" "	SE Cape Sable, NS, Canada	E Cape Sable, NS, Canada	4	142	NE	LL	LL	Albert Lawrence	Canada
" "	S Cape Sable, NS, Canada	E Cape Sable, NS, Canada	34	198	NE	LL	LL	Nelson Beideman	NJ
" "	S Cape Sable, NS, Canada	E Cape Sable, NS, Canada	1	70	E	LL	LL	Albert Lawrence	Canada
" "	W Cape Sable, NS, Canada	SE Nantucket Island, MA	6	418	SW	LL	LL	Albert Lawrence	Canada
" "	SE Portland Headlight, ME	S Eastport, ME	76	143	NE	LL	LL	M. Kieffer, NMFS Obs.	MA
" "	E Vineyard Haven, MA	SE Portland, ME	88	33	N	LL	LL	D. Kotula, NMFS Obs.	MA
" "	E Nantucket Isl., MA	E Cape Sable, NS, Canada	77	334	NE	LL	LL	L. Craig, NMFS Obs.	MA
" "	S Cape Sable, NS, Canada	E Cape Sable, NS, Canada	12	161	NE	LL	LL	Albert Lawrence	Canada
" "	E Halfway Rock, ME	W Cape Sable, NS, Canada	16	20	E	LL	LL	Stephen Connett	RI
" "	W Cape Race, NF, Canada	SE Halifax, NS, Canada	9	234	SW	LL	LL	Albert Lawrence	Canada
" "	SE Provincetown, MA	SW Cape Race, NF, Canada	90	530	NE	LL	LL	G. Hinteregger, NMFS Obs.	MA
" "	S Cape Sable, NS, Canada	E Cape Sable, NS, Canada	75	252	NE	LL	LL	J. Taylor, NMFS Obs.	MA
" "	E Cape Sable, NS, Canada	E Cape Sable, NS, Canada	16	56	E	LL	LL	Albert Lawrence	Canada
" "	S Portland Headlights, ME	Halls Harbour, NS, Canada	17	362	NE	LL	GN	Steve Athanosios	ME
" "	E Cape Sable, NS, Canada	E Halifax, NS, Canada	24	117	NW	LL	LL	Albert Lawrence	Canada
" "	S Cape Sable, NS, Canada	SE Cape Sable, NS, Canada	96	140	NE	LL	LL	J. Cygler, NMFS Obs.	MA
" "	E Halifax, NS, Canada	E Cape LaHave, NS, Canada	22	116	W	LL	GN	Andy Kingman	PA
Blacktip shark	N Port Aransas, TX	NE Port of Veracruz, Mexico	7	500	S	RR	GN	Frank A. Eicholz III	TX
" "	W N Naples, FL	Naples, FL	NR	NR		RR	FD	John Brossard	FL
	Padre Island, TX	Matamoros Tampico, Mexico	6	103	S	RR	GN	Chris Ruiz	TX
" "	N Port Aransas, TX	NE Cordillera, Mexico	6	390	S	RR	GN	Frank A. Eicholz III	TX
" "	E Miami, FL	NR	NR	NR		RR	RR	Alan G. Summers	FL
" "	Caloosahatchee River, FL	Caloosahatchee River, FL	<1	47	W	RR	RR	Gary Bongers	FL
" "	Pine Island Sound, FL	Sanibel Island, FL	20	35	S	RR	RR	Leo Dunn	FL
" "	Stono Inl., SC	Broad River, SC	11	41	SW	RR	RR	Rick Stringer	SC
" "	Padre Island, TX	ENE Galveston, TX	5	186	NE	RR	RR	Chris Ruiz	TX
" "	Padre Island, TX	E Matamoros, Mexico	1	96	S	RR	HL	Chris Ruiz	TX
Dusky shark	N Oregon Inl., NC	NE Alvarado, Mexico	79	1699	SW	RR	GN	John Thurston, Jr.	VA

Table 2. Tag recoveries: January-December 1995.

	GENERAL LOCATIONS		MONTHS AT LIBERTY	DIST. (MI.) AND DIR.		CAPTURE METHOD		TAGGED BY	
	TAGGED	RECAPTURED				TAG.	REC.	TAGGER	RESIDENCE
Dusky shark	W Cape Lookout, NC	E Oregon Inl., NC	41	119	NE	LL	LL	Biologist (NMFS)	RI
" "	NE Ocean City, MD	S Drumm Inl., NC	81	239	S	RR	LL	Louis Caporaletti	MD
" "	E Manasquan Inl., NJ	E Beaufort Inl., NC	30	456	SW	GN	LL	P. Burns, NMFS Obs.	MA
" "	SE Fire Island Inl., NY	Bahia de Matanzas, Cuba	101	1128	SW	RR	LL	Barry Mack	NY
" "	E Absecon Inl., NJ	S Montauk Pt., NY	97	133	NE	RR	LL	Joe Lucas	PA
" "	E Montauk Pt., NY	West Coast, FL	NR	NR		RR	LL	Hap Evans	CT
" "	E Fernandina Beach, FL	E Fort Lauderdale, FL	6	322	S	LL	RR	Randall Dyal	FL
Nurse shark	Key Vaca, FL	Marathon, FL	23	2	SW	RR	RR	William H. Bollen	FL
" "	Key Colony Beach, FL	Key Colony Beach, FL	7	0		RR	RR	William H. Bollen	FL
" "	John's Pass Inl., FL	W Tarpon Springs, FL	4	39	NW	RR	RR	Steve Grzesik	FL
Atl. sharpnose	E St. Lucie Inl., Stuart, FL	Ft. Pierce Inl., FL	<1	19	N	FS	RR	Robert Pelosi	FL
" "	E St. Lucie Inl., Stuart, FL	E Palm Beach, FL	NR	NR		RR	LL	Robert Pelosi	FL
" "	Padre Island, TX	Magallanes, Mexico	5	560	S	RR	GN	Ernest Morgan	TX
Silky shark	W Dry Tortugas, FL	SE Cape Canaveral, FL	5	301	NE	LL	LL	Baker Dunn	FL
" "	SE C. Palmas, Africa	S Equatorial Guinea	25	517	E	LL	GN	Jaime Mejuto	Spain
Lemon shark	NW Isla Mujeres, Mexico	Vieques Isl., PR	NR	NR		RR	TO	Edmond Meinfelder	PA
Bonnethead	Islamorada, FL	Islamorada, FL	10	0		RR	RR	Graeme Pullen	England
Car. reef shark	Great Inagua, Bahamas	Great Inagua, Bahamas	NR	1		LL	HL	Stephen Connett	RI
Sc. hammerhead	NE Cape Hatteras, NC	S Ocean City, MD	NR	154	N	LL	LL	Biologist (NMFS)	RI
Brown/Dusky shark	E Shark River Inl., NJ	S Drumm Inl., NC	10	367	SW	RR	LL	John J. Ferrera	NY
" "	SW Montauk Pt., NY	SE Cape Fear, NC	92	488	SW	RR	LL	Ronald E. Woodward	NY
" "	E Barnegat Inl., NJ	E Southport, NC	32	387	SW	RR	LL	Jim Lynch	NJ
" "	Oyster, VA	E Smith Island, VA	1	10	SE	RR	LL	Doug Wehner	VA
" "	SE Fire Island Inl., NY	W Cedar Key, FL	88	908	SW	RR	LL	Larry Lund	NY
" "	E Manasquan Inl., NJ	S Apalachicola, FL	109	1469	SW	RR	LL	Gary Williams	NJ
" "	S Fire Island Inl., NY	NW El Cuyo, Yucatan, Mexico	135	1482	SW	RR	HL	John McShane	NY
" "	SE Ocean City, MD	S Sakonnet Pt., RI	51	249	NE	RR	GN	Jeff Kovatch	DE
Carcharhinus	Cape Haze, FL	Charlotte Hbr, FL	1	14	SW	RR	RR	Chuck Gause	FL
" "	SE Moriches Inl., NY	W Crystal River, Tampa, FL	51	1522	SW	RR	RR	Frank Daley	NY
" "	E Manasquan Inl., NJ	E Beaufort Inl., NC	30	456	SW	GN	LL	P. Burns, NMFS Obs.	MA
	E Gt. Machipongo Inl., VA	NE Wachapreague Inl., VA	12	20	N	RR	GN	Charles Hrubes	VA
" "	SE Fire Island Inl., NY	E Miami Beach, FL	132	953	SW	RR	RR	Peter Jakits	NY
Shark	E Seychelles Isl., Africa	E Colombo, Sri Lanka	25	1273	NE	LL	LL	Jaime Mejuto	Spain
" "	SE Pt. Judith, RI	S Cape Sable, NS, Canada	24	NR		FS	LL	Gary Eaton	RI
" "	S Montauk Pt., NY	SE Cape Sable, NS, Canada	2	397	E	RR	LL	Stephen Roland	NY
" "	E Portland Headlights, ME	SE Cape Sable, NS, Canada	5	245	SE	RR	LL	Chuck Baker	ME
" "	NR	S Pascagoula, MS	NR	NR		RR	RR	Ron Cassady	MS
" "	Avalon, NJ	SE Nantucket Island, MA	1	314	E	RR	LL	James Shaw	NJ
" "	E Flemish Cap	W Faial, Azores	12	685	SE	LL	LL	M. Terwilleger, NMFS Obs.	MA
" "	E Cape Sable, NS, Canada	E Cape Sable, NS, Canada	4	112	W	LL	GN	Albert Lawrence	Canada
" "	SE Fire Island Inl., NY	S Barnegat Inl., NJ	73	71	SW	RR	LL	Robert Burgess	NY
Swordfish	S Flemish Cap	NR	NR	NR		LL	LL	Barry Marx	FL
" "	E Pt. Pleasant, NY	S Cape Sable, NS, Canada	44	169	NE	LL	LL	Michael Colledge	NY
" "	E Pt. Pleasant, NY	SW Cape Sable, NS, Canada	47	179	NE	LL	HP	Pete Bilderbeck	NY
" "	SE Provincetown, MA	S Halifax, NS, Canada	79	265	E	LL	LL	F. Turk, NMFS Obs.	MA
" "	E Barnegat Inl., NJ	S Cape Sable, NS, Canada	35	245	NE	LL	LL	Nelson Beideman	NJ
" "	NR	W Oporto, Portugal	NR	NR		RR	LL	Roddy Hays	Portugal
Striped Bass	SE Montauk Pt., NY	ESE Old Orchard Bch, ME	10	162	NE	RR	RR	John Schoen	NY
" "	SE Montauk Pt., NY	SE Sandy Hook, NJ	12	102	W	RR	RR	John Schoen	NY
" "	E Townsends Inl., NJ	N Light Kent Isl., MD	2	84	W	RR	GN	Helen W. Lenzsch	NJ
White Marlin	NE Georgetown, Guyana	Higuey, DR	25	883	NW	LL	RR	Albert (Tim) Johnston	FL

NOTE: FS=Free Swimming; GN=Gillnet; HL=Handline; LL=Longline; RR=Rod&Reel; TN=Trawl Net; BGI=Big Game Italia; FD=Found Dead; HP=Harpoon; TO=Tag Only Found;Obs=Foreign Fisheries Observer; NR=Not Reported

Atlantic Shark Management Plan Update

On March 12, 1996, the Highly Migratory Species Management Division (HMS) announced that the National Marine Fisheries Service (NMFS) has decided to maintain the commercial quota and recreational bag limits for Atlantic sharks at 1995 levels pending further scientific review:

Commercial quotas: 2,570 mt for large coastal sharks and 580 mt for pelagic sharks **and** no commercial quota for small coastal shark species.

Recreational: Bag limit is 4 sharks per vessel per trip for large coastal and pelagic sharks combined **and** 5 sharks per person per day for small coastal sharks

Despite considerable pressure for commercial quota reductions, especially for large coastal sharks, and for reductions in the recreational bag limits, NMFS has maintained these harvest levels because no new stock assessments have been conducted yet to support reductions. Reducing harvest levels at this time, without new data, contradicts the NMFS mandate to manage resources based on the best available scientific information.

A new stock assessment is scheduled to be conducted in early June, 1996 at the NMFS Southeast Fisheries Science Center in Miami, Florida. At that time, the current stock status of large coastal sharks will be evaluated and consequences of commercial and recreational harvest reductions will be examined. Comments are welcomed concerning any management issues. Please contact C. Michael Bailey, NMFS - SSMC3 - F/CM4, 1315 East West Highway, Silver Spring, MD 20910. Telephone (301) 713-2347, FAX (301) 713-0596.

Field Studies

Research Cruises

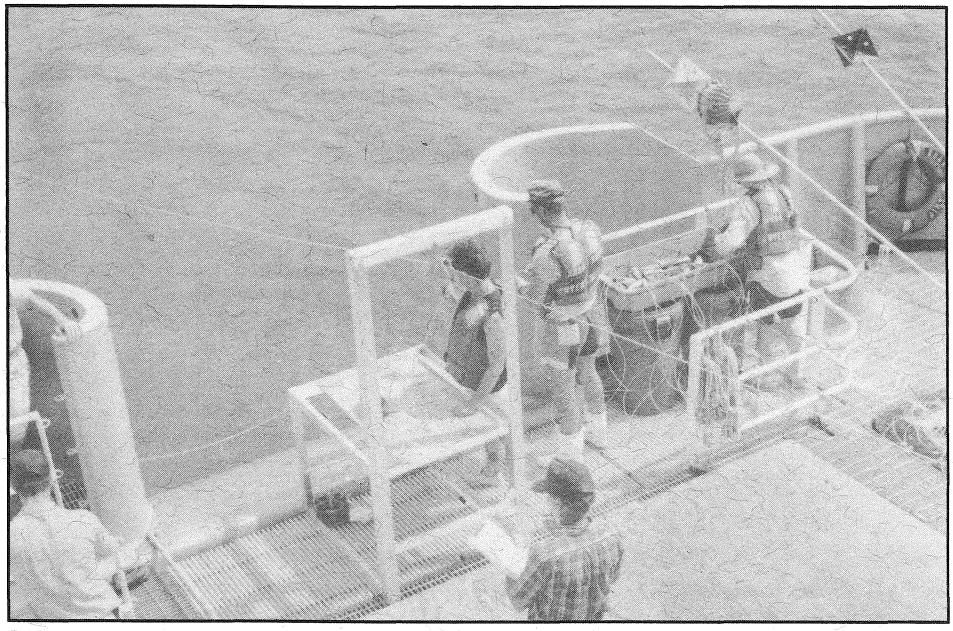
In the summer of 1995, project staff participated in two longline shark survey cruises. These surveys, one in the Gulf of Mexico and one along the Atlantic coast, were spearheaded by personnel from the NMFS Pascagoula, MS Laboratory in cooperation with the NMFS Laboratories in Miami, FL; Woods Hole, MA; Narragansett, RI; and the Highly Migratory Species Management Division in Washington, DC. The primary objectives of the cruises were to 1) conduct pilot studies on the feasibility of using commercial monofilament bottom longline gear to assess the distribution and abundance of large coastal sharks, 2) tag and release live sharks for ongoing migration studies, 3) obtain biological data for ongoing age and growth, reproduction and food habits studies, and 4) collect environmental data at each station. It is hoped that these surveys will provide the basis for conducting comprehensive longline surveys to obtain fishery independent data. These data can then be used in conjunction with fishery dependent catch data to assess the populations of coastal sharks in the Gulf of Mexico and western North Atlantic.

The Atlantic and Gulf surveys were intended to be conducted with identical bottom longline fishing gear and methods. This gear was designed to mimic that currently used by commercial fishermen targeting large coastal sharks. As fished, each standard longline consisted of a 940 lb monofilament mainline, one hundred 12 ft gangions made of 730 lb monofilament line, and bullet floats attached at 33 hook intervals (Atlantic) or one float at midset (Gulf). Each bullet float was directly followed by weights and a staff buoy was attached to each end of the mainline. Hooks were baited with mackerel (1/3 to 1/2 of a whole fish). This "standard gear" was fished for 1 hour at each station. On both surveys, the mean length of the mainline was 1.4 nautical miles (nm).

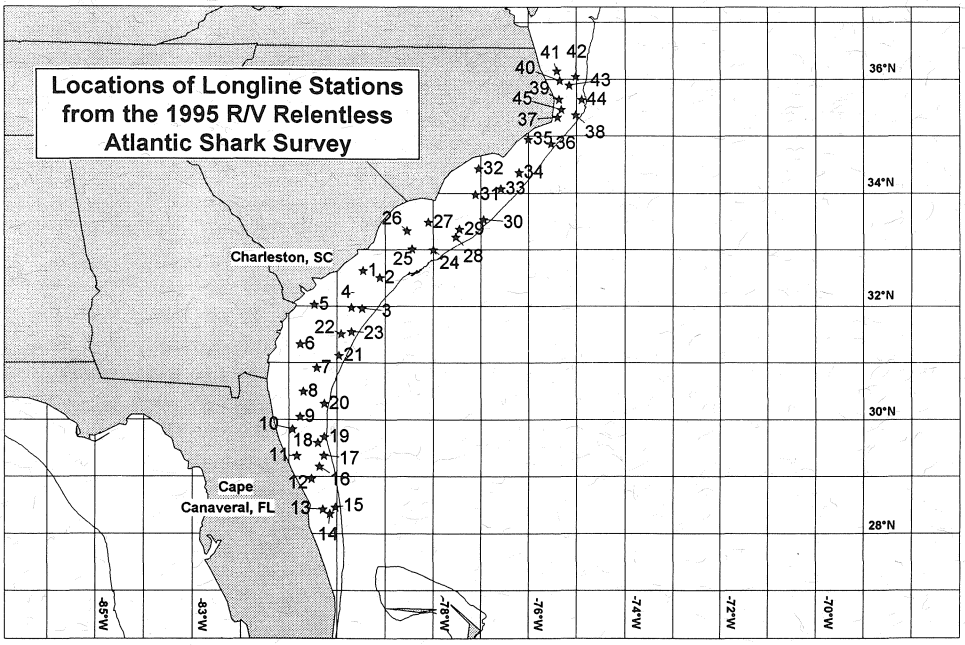
In the Gulf, the survey plan was designed to include three stations per 60 minutes latitude or longitude based on SEAMAP statistical zones (22 zones) and one randomly selected station for each depth strata (10-19, 20-29, and 30-39 fathoms). In the Atlantic, an attempt was made to repeat stations conducted during previous NMFS Narragansett Atlantic shark surveys, while incorporating the depth strata and including three stations per 60 minutes latitude.

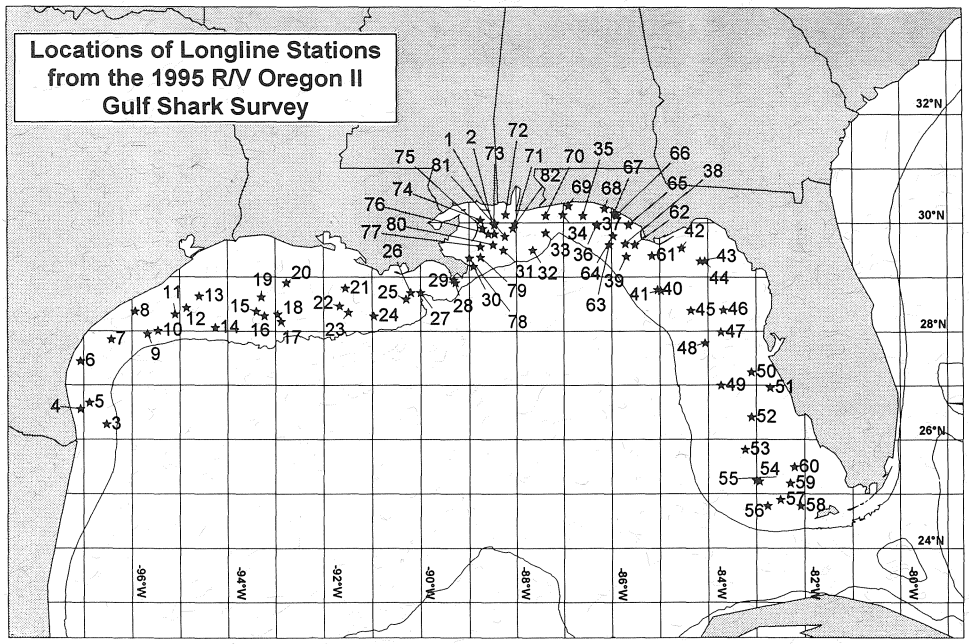
On both surveys, biological samples were taken from landed sharks. Aside from the age and growth, reproduction and food habits data that were collected for our ongoing research, visiting scientists from several universities were on board to sample for their research. These included personnel from: University of Connecticut - internal parasites; Tennessee Aquarium - external parasites; University of Rhode Island - sandbar shark reproductive condition; and University of Alabama, Mississippi Valley College, Texas A & M, and University of Massachusetts - samples for various degree related topics. Personnel from SERO, St. Petersburg, FL, Florida Department of Environmental Protection, the Texas Parks and Wildlife, Mote Marine Laboratory, Louisiana Wildlife and Fisheries, and an observer from the Gulf and Atlantic Fisheries Development Foundation, Inc. also participated. Commercial fisherman Basil Arend, representative of the Southern Offshore Fishing Association, Inc., was a welcome addition to the Gulf cruise where he was integral in assisting the fishing operation. Additionally, several researchers who could not participate in the survey sent protocols for the collection of their samples; e.g. tissue samples for DNA analysis for population genetics studies. (See article, Page 15.)

Continued on Page 12



Setting bottom longline from the NOAA R/V *Relentless.* *Photo by Lisa J. Natanson*





The following is a brief summary of the results of the two surveys.

Atlantic Survey

The Atlantic survey was conducted from 10 - 24 August 1995 on the NOAA Research Vessel *Relentless*. Forty-five stations were completed between Cape Canaveral, FL and Oregon Inlet, NC (see map). Of the total stations, the majority were in the 10-19 fathom depth zone. Twenty-six stations that had been surveyed on the R/V *Wieczno* in the summer of 1986 were repeated. Twenty-seven sets were made during the day and 18 at night. No significant difference was found between day and night catch rates. This result is consistent with the results of our 1989 and 1991 NOAA R/V *Delaware II* shark longline surveys.

Of the 187 sharks caught, 130 were tagged and released, 51 were brought on deck for biological examination and 6 were lost. The majority of sharks caught were Atlantic sharpnose sharks (58%), followed by tiger sharks (27%), and sandbar sharks (8%). All other species represented less than 2% of the shark catch. Catch per 100 hooks was 4.7 for all species and 4.2 for sharks.

Gulf of Mexico Survey

The Gulf survey was conducted from 23 July to 17 August on board the NOAA R/V *Oregon II*. Eighty-two stations were completed in the Gulf from the Mexican border to the Florida Keys (see map). As in the Atlantic, the majority of stations were in the 10-19 fm depth zone and no significant difference was found between day (44 sets) and night (38 sets) catches.

A total of 271 sharks were caught; of these, 133 were tagged and released, 111 were brought on deck and 27 were lost. The majority of sharks caught were Atlantic sharpnose sharks (55%), followed by blacktip sharks (10%), blacknose sharks (7%) and tiger and sandbar sharks (6% each). All other species represented less than 3% of the shark catch. Catch per 100 hooks for all species was 4.1 and 3.3 for sharks.

These surveys were a success largely due to the close cooperation between personnel at the NMFS Labs who planned and conducted them, the outstanding support provided by the commercial fishermen who gave advice on gear, and the volunteers, scientists, and crews on board the NOAA R/Vs *Relentless* and *Oregon II* who worked very hard to complete the surveys in an efficient manner. We hope to continue work with all of these people in the future.

Walker's Cay Sharks

An aggregation of 100-150 blacktip and reef sharks near the Walker's Cay fishing and diving center in the Abaco Islands, Bahamas provides the unique opportunity to study individual sharks on a daily to weekly basis, potentially for many years. These free-living sharks are the mainstay of an ecotourism operation that attracts thousands of divers each year. The director of the dive operation proposed a cooperative tagging study with the API and staff from the Aquarium of the Americas in New Orleans to help define and evaluate the local population. Tagging began in July of 1995. Wes Pratt traveled to Walker's in October to assist with tagging and identification techniques. To date, 38 reef and blacktip sharks have been tagged with M-tag capsules modified to be easily identified by divers at a distance. All of the tagged sharks have remained in the area and are usually seen several times each week by staff and visiting divers. Tagging provides accurate identification of these individuals through visual recaptures and photographic records. Some sharks have been observed in courtship activities and much can be learned about their reproductive behavior using this time series of observations.

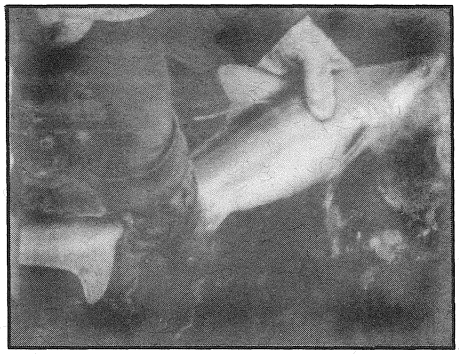
Ongoing Research

These articles update studies that we have reported in previous Shark Tagger newsletters.

Sandbar Shark Nursery Study

The sandbar shark utilizes coastal bays and estuaries along the western North Atlantic for nursery grounds. Little is known about the current extent and ecology of the coastal nursery habitats of the sandbar and other sharks north of Chesapeake Bay. Such information is vital to understanding and managing sharks at this vulnerable stage where they come closest to man's influence. To answer these concerns, API staff conducted a gill net survey of Delaware Bay with four goals in mind: 1) to evaluate the effectiveness of a gill net in catching newborn and juvenile sandbar sharks, 2) to tag newborn and juvenile sandbar sharks on their nursery grounds for delineating short and long term movements, 3) to compile a baseline survey to characterize sandbar shark nursery habitats, and 4) to calculate a preliminary index of abundance for the sandbar shark in Delaware Bay.

Gill net surveys were conducted from 13-17 July and 24 August to 1 September 1995 in Delaware Bay. Gill nets were used because they catch a large fraction of the animals present, whether the fish are feeding or not. To minimize mortality and bycatch and assure survival of tagged animals, the net was continuously hauled over the boat and all animals were removed as the beginning of the net was reset into the water. Twelve stations were chosen on the basis of previous longline captures of sandbar sharks by the staff of the National Aquarium, Baltimore, MD, and by reviewing historical NMFS Cooperative Shark Tagging Program tag and recapture data of ju-



A tagged newborn sandbar shark is released in Delaware Bay.
Photo by H. Wes Pratt

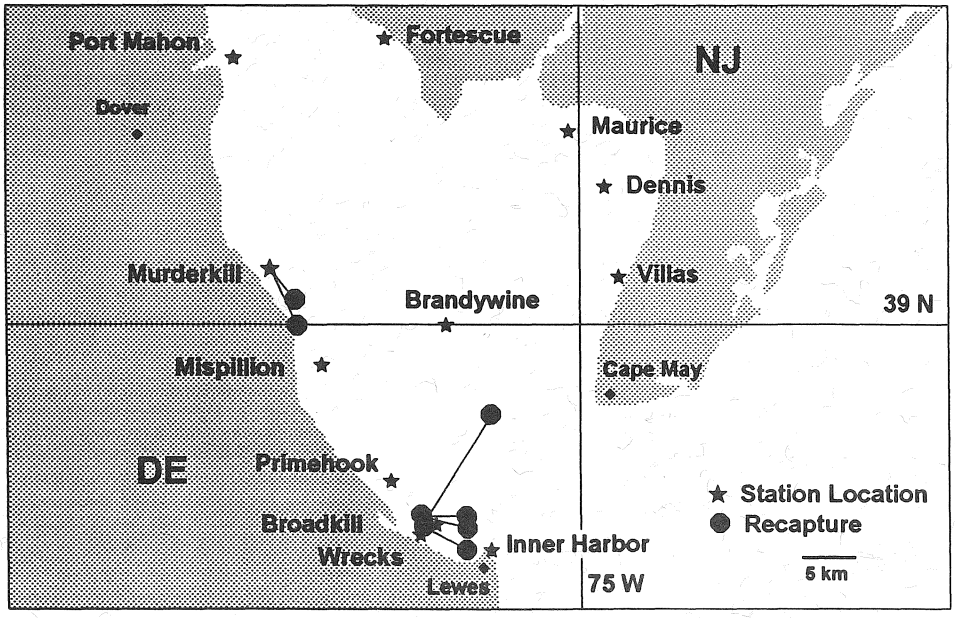
venile sandbar sharks in the Bay. Four of the twelve stations were in New Jersey state waters, seven were in Delaware, and one station was at mid-Bay (see map). Live sharks were tagged with a small plastic dart-tipped NMFS Narragansett tag. Umbilical scar condition and presence and location of external parasites were recorded. Dead sharks were sampled for stomach contents and vertebrae were removed.

The net was set 15 times over a period of 11 days. A total of 199 sandbar sharks were caught; 154 were tagged, one of which was later recaptured and re-released. Overall mortality was 17%. The average catch per unit effort (CPUE) of all sets was 0.4, and 0.7 sharks per 100 m²/hour at stations with sharks. Very small (8-10 in. TL) young of the year smooth dogfish were caught readily in the mesh indicating that even the smallest sandbar sharks were susceptible to this gear. Sandbars approximately 16-24 in. FL were gilled in the net and animals over 24 in. FL were captured by entanglement of the snout and fins.

Sandbar shark distribution in Delaware Bay may be related to salinity and to distribution of forage species. Surface temperatures varied more with weather and cloud cover than with location and did not seem to be a factor in our summer samples. Large shark catches in some areas show that sandbar sharks are primarily distributed in shallow (9-12 ft) near shore waters over sand/mud bottom. Anecdotal evidence from local fishermen suggests that juvenile sandbars move about in groups with the tide. Salinity preferences would help explain their patchy distribution.

Eight of the 154 tagged sandbar sharks (5.1%) have been recaptured to date, four of them in July. Sharks were at liberty between 5 and 40 days and were all recaptured within 7 miles of the original tagging sites (see map). Most show movement to the southeast; one traveled to the center of the Bay where we previously caught and tagged one sandbar shark. These data suggest a very localized nursery ground population.

Figure 1. 1995 Delaware Bay Gill Net Stations and Sandbar Shark Recaptures



1995 Delaware Bay gill net stations with sandbar shark recaptures

Our studies of sandbar nurseries in Delaware Bay and between Virginia and Massachusetts will continue in 1996. API staff, working with University of Rhode Island students, Rebeka Merson and Allison Ferreira and staff from the NMFS Highly Migratory Species Management Division will expand gill net surveys along the Atlantic coast to delineate the range, scope, and extent of the sandbar nursery areas.

Mating Sharks

Our cooperative work in the Dry Tortugas continued with Dr. Jeff Carrier of Albion College to study the reproductive dynamics of a population of seasonally mating nurse sharks. Past results, the first comprehensive investigation of courtship, mating and pupping of free living sharks, were published in the journal Copeia (1994, No. 3) and in National Geographic Magazine (Vol. 187, No. 5, May 1995).

In 1995, emphasis was placed on tagging adult males to study their interaction with other males while mating. Our preliminary work on nurse sharks at Tortugas suggests that multiple males may sometimes be necessary for one successful copulation. We also tagged and injected juveniles with tetracycline for long term age studies. In this unique project using free diving, we have observed the same free-living individuals, day after day, and year after year. Details of reproductive behavior and interactions among sexually active males and females provide new insights into the reproductive biology, including a time-series record of courtship, mating and pupping behavior.

Survivorship Studies: An Update

Gregory B. Skomal and Bradford C. Chase, Massachusetts Division of Marine Fisheries

In the 1994 *Shark Tagger*, we reported on our studies in Massachusetts to assess post-release survivorship of sharks, tunas, and marlin. These efforts to characterize the physiological effects of angling stress and to determine whether or not large pelagic species survive the rigorous fight associated with angling continued in 1995. This article is an update of these efforts.

High muscular activity and stress induced by angling causes changes and disturbances in fish tissues and organs. These changes, manifested in the blood, may be severe enough to alter normal physiology and behavior, and ultimately compromise survivorship. In some cases, fish may die, either on the line or more likely after release. The chemical constituents of the blood can be used to profile the condition of the fish before it is released.

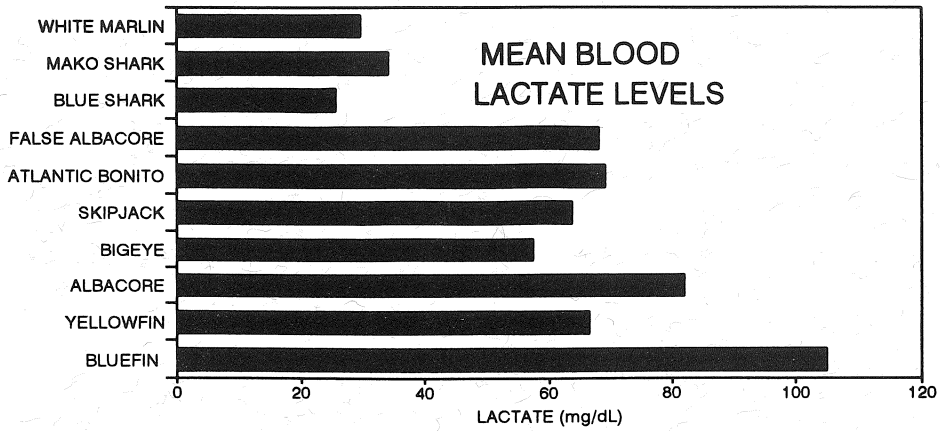
In 1995, 76 fish representing 6 species of tunas and sharks were exposed to varying levels of angling stress; blood was sampled, and the fish were tagged and released. Most of these fish were bluefin tuna(56), although albacore, yellowfin, skip-

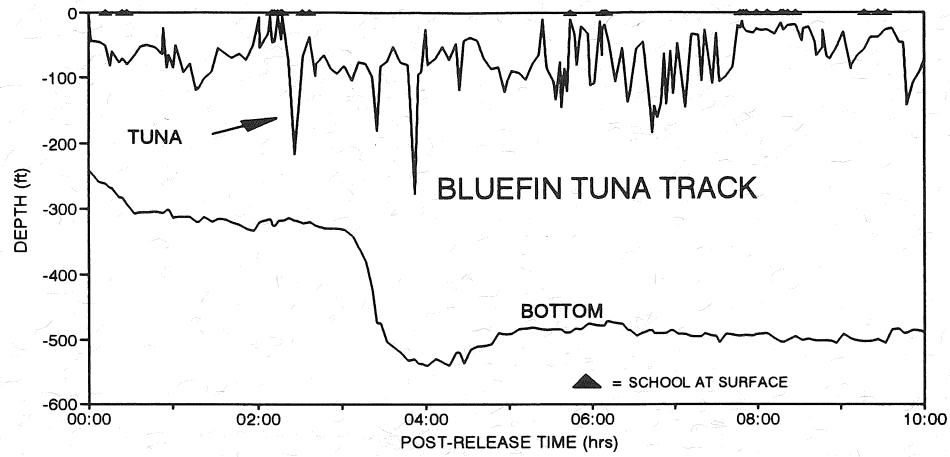
Continued on Page 14

jack, Atlantic bonito, and blue sharks also comprised the catch. Blood samples from these fish bring the number sampled to 279. In 1995, we not only sampled bluefin off the coast of Massachusetts but also during the winter fishery off Hatteras, NC.

Preliminary findings show that large gamefish exhibit fluctuations in blood pH and levels of hormones, electrolytes, and metabolites due to the fight associated with rod and reel angling. The magnitude and nature of these disturbances were found to differ by species. Therefore, each species has a different physiological response to angling. For example, a common metabolite normally associated with fatigue is lactate (lactic acid). Blood lactate levels in angling-stressed tunas were significantly higher than those in sharks and marlin (see Figure.) Moreover, bluefin tuna possessed extremely high levels of blood lactate relative to other species sampled. The amount of lactate in the blood contributes to the acidity of the blood. By measuring the pH of the blood, we can determine the extent of the "acidosis." Extreme acidosis can severely impede normal behavior and may compromise survivorship.

For each species, changes in blood chemistry can be compared to several variables which are associated with the fight such as tackle type, fight time, water temperature, and fish size. Most of the correlations calculated to date are associated with fight time. The following gives a brief preliminary synopsis of what happens physiologically to bluefin tuna, yellowfin tuna, and blue sharks during the fight.





Bluefin Tuna

This species exhibits immediate drops in blood pH due to the buildup of carbon dioxide and metabolic end-products (lactate) in the blood. This acidosis seems to drive the pH to its lowest level in fish that have been fought for 20 to 25 minutes.

Yellowfin Tuna

The blood pH measurements made on yellowfin tuna fought on rod and reel are much lower than those reported as "normal" by other researchers for this species. Although the degree of acidosis fluctuates greatly with fight time, lowest pH levels are reached in as fast as 10 minutes of fighting.

Blue Shark

Blood gas measurements indicate that the blue shark is not hampered by respiratory problems when fought on rod and reel; blood oxygen levels remain relatively high. Blood pH does decrease slowly to a low at a fight time of about 40 minutes. This can probably be attributed to the slow increase in metabolic end-products like lactate. Nonetheless, pH levels remained appreciably higher in this species relative to the tunas fought for similar durations.

Survivorship

Can these species recover from the physiological disturbances outlined earlier? To test hypotheses of release mortality based on blood chemistry data, acoustic telemetry efforts were increased in 1995. A yellowfin tuna, bluefin tuna, and blue shark were fought on rod and reel for the minimum target levels as defined previously, blood was sampled, and the fish were released carrying acoustic transmitters. All were tracked for at least eight hours to determine if they recover from the physiological stress associated with the fight. Although all three fish were determined to be completely exhausted by the event, all survived the duration of the tracks.

Last year, we reported on the track of a blue shark that was fought for one hour; the fish went though a recovery period of about 90 minutes before resuming what we felt was "normal" behavior. Another blue shark was tracked in 1995 after a 35 minute fight. After about two hours of deep prolonged diving excursions(recovery period), this fish resumed normal behavior.

The vertical behavior of a bluefin tuna tracked off Chatham, MA last October is presented in the Figure. This 200 lb fish was tracked for ten hours after being fought for over 30 minutes on heavy tackle. Of particular interest to us was the fact that the tuna not only rejoined, but traveled with the school. Triangles on the graph indicate several instances where the school was observed at the surface. Although the stressed tuna often remained below the surfacing fish, this behavior is indicative that the bluefin was not severely compromised by the fight.

The results presented here are preliminary and many more analyses of the blood chemistry data are still to be conducted. In early 1996, we tracked two large bluefin off Hatteras, NC after prolonged fights. This coming summer, we hope to track additional bluefin, yellowfin, and blue sharks off New England. These results will be presented in a future Shark Tagger. This study is funded in part by NMFS Highly Migratory Species Management Division, Silver Spring, MD. For further information contact Gregg Skomal at P.O. Box 68, Tisbury, MA 02568, (508)693-4372; or e-mail: gskomal@whsun1.wh.whoi.edu.

Shark Genetic Studies

The Fishery Management Plan (FMP) for Atlantic sharks was implemented under the Magnuson Fishery Conservation and Management Act by the National Marine Fisheries Service in 1993 to regulate the harvest of 39 species of sharks. However, many targeted shark species are morphologically similar and difficult to identify accurately to species level for catch statistics and enforcement purposes. This problem is compounded by the dressing of sharks before landing, which removes most morphological identifying characteristics. For the past several years we have cooperated with various researchers concerned with identifying species and stock differences using cellular level genetic markers.

Identification of Shark Carcasses

Laura F. Webster, Jon Ahlquist, R. Martin Ball, and Cheryl M. Woodley
National Marine Fisheries Service, Southeast Fisheries Science Center, Charleston Laboratory, Charleston, SC

The NMFS Charleston Laboratory has been developing a DNA-based method for shark species identification. A standard method exists for identifying sharks from proteins extracted from their muscle, but a method of identifying other parts of the shark such as fins or blood is needed in order to aid law enforcement officials. In this method, DNA is extracted primarily from blood or muscle, but it is also well suited to analysis of other tissue types. A particular portion of the shark DNA is duplicated about a million times (amplified) by a biochemical process known as polymerase chain reaction (PCR). The amplified DNA is then cut into smaller pieces by particular restriction enzymes that recognize a specific DNA sequence. The fragments are separated in a polyacrylamide gel, which is exposed to an electrical current, and visualized with a DNA stain. The fragments can vary in length according to size or in the number of pieces for different shark species producing distinct patterns known as restriction fragment length polymorphisms (RFLPs). Combinations of these DNA banding patterns resulting from different enzymatic digestions can produce diagnostic patterns for each shark species. To date, we have identified 21 species of shark from DNA isolated from muscle and blood (unpublished data). This assay development is intended to expand the Charleston Laboratory's current technical support capabilities for law enforcement in identifing seized property as well as aid in identification requested by management or industry.

We are continuing to add more shark species to our database and to test processed body parts for use with our methods. The Charleston Laboratory would appreciate receiving samples of sharks from those willing to contribute. Please contact Laura Webster at (803) 762-8623; or e-mail Laura_F_Webster@ccgate.ssp.nmfs.gov if interested.

DNA Studies on Sharks

Mahmood Shivji[1], Scott Rogers[2] and Michael Stanhope[3]
[1] Oceanographic Center, Nova Southeastern University, Dania, FL; [2] College of Environmental Science and Forestry, State University of New York, Syracuse, NY; [3] School of Biology and Biochemistry, The Queen's University, Belfast, N. Ireland, UK.

For the past year and a half, we have combined our interests and expertise in different areas of molecular, evolutionary, and population genetics to address issues in the biology, conservation, and management of sharks. With the assistance of the NMFS Narragansett Apex Predator Investigation (API) and Charleston Laboratory, we have initiated several projects, some of which are briefly described here.

To enable accurate, species-level identification of landed shark carcasses, we are developing a community-accessible database of species-diagnostic DNA markers. DNA-based approaches for identifying pathogenic and disease vector organisms are widely used in medicine and agriculture, and are directly applicable to solving fisheries identification problems. We are investigating markers derived from a region of the shark chromosome containing DNA sequences known as ribosomal RNA genes.

Preliminary analysis of our DNA sequence data from several carcharhinid sharks shows clear, species-specific differences. These sequences will provide robust markers for accurate and rapid identification of landed shark carcasses to species-level. Additionally, a major advantage of DNA markers is that they can be used to identify even *pieces* of tissue (e.g., from fins, skin, fillets) that may be too small or degraded for morphological and protein-based, biochemical diagnostic approaches. As such, the availability of species-diagnostic DNA markers for sharks will be of considerable use in forensic and legal applications.

As representatives of one of the oldest vertebrate groups, sharks are of interest from the perspective of the function of their biochemical systems. We are also studying the function and evolution of some nuclear genes in sharks, including the genes that code for ribosomal RNAs and an eye protein called the Interphotoreceptor Retinoid Binding Protein. Our studies have revealed the unexpected presence of a special type of DNA sequence (referred to as introns) located next to the ribosomal RNA genes. Surprisingly, the shark introns have all the characteristics of a specific class of introns (known as Group I introns) that have so far been reported only from some viruses, protozoans, fungi and algae. This class of introns has not previously been found in the nuclear DNA of animals.

In addition to being the first Group I intron reported for any animal, the shark introns are also unusual in their chromosomal location. In sharks, the introns do not occur inside the ribosomal RNA genes as they do in other organisms, but instead are found in the DNA spacer regions that separate the ribosomal RNA genes. To reflect the unusual chromosomal location of the shark introns, we have named them "spintrons", for spacer introns. The discovery of these shark spintrons prompts many questions regarding their acquisition, function, and evolution. We are conducting biochemical studies to determine the function of these spintrons, and exploring the evolutionary basis for the acquisition and distribution of these structures in divergent elasmobranchs. We are also exploring the utility of spintron sequences for the development of genetic markers that can be used for shark species identification (see above).

A recently initiated study in our laboratories involves examining global genetic structure in the blue shark. Blue sharks are a highly migratory species with a circumglobal temperate and tropical distribution. In the North Atlantic, tagging studies conducted by the API indicate that blue shark migrations are extensive and seem to follow current patterns in the Atlantic basin. The full extent of blue shark global migrations, however, is unknown. We are using mitochondrial and nuclear DNA sequences to assess global genetic population structure in blue sharks, and the degree of gene flow within and between oceanic basins. Such studies will, we anticipate, improve our understanding of migratory patterns and reproductive behavior in this species.

Special Request: For the blue shark study, we need to collect small amounts of tissue (muscle and/or liver) for DNA analysis from blue shark specimens caught from around the world. We would greatly appreciate any help from participants in the shark tagging program. To assist, contact Dr. Lisa Natanson at (401)782-3320; or e-mail lnatanso@whsun1.wh.whoi.edu or Dr. Mahmood Shivji at (954) 920-1909; or e-mail mahmood@ocean.nova.edu. We will send you tubes containing a nonhazardous air-transportable preservation solution.

OVERVIEW *(Continued from Page 4)*
small tigers were tagged two days later further north off Georgia; one was recaptured northeast of Cuba after 0.8 years at liberty and the other was recovered off North Carolina after 0.5 years. Two 4 ft FL females were tagged off North Carolina in January of that same year: one traveled 675 miles to the Bahamas and the other 621 miles to the Dry Tortugas, FL. Alternatively, a 3.4 ft FL male and a 3.7 ft female tiger shark tagged off northern Florida on the same day and in the same location were both recaptured within a mile of each other 5.8 months later by a sport fisherman after traveling 30 miles to the northeast.

Overall, tiger sharks were at liberty from 1 day to 3.6 years with 19 out for < 1 year, 33 for < 3 years, and one fish at liberty for over 3 years. A large percentage of the tiger sharks were measured at tagging (84%) and at recapture (34%), providing valuable growth information. Nineteen percent of the tiger shark recaptures were retagged or released with the same tag.

Porbeagles (18 Returns)

Porbeagles were at liberty from 128 days to 8.0 years. This is close to the maximum of 8.6 years previously recorded in the CSTP for a porbeagle shark (Table 5). In fact, six of the 18 porbeagle returns were at liberty for over 6 years with five of the six grouped in the top ten for all years (third, fourth, fifth, seventh, and tenth longest times at liberty). One of these fish at liberty for 7.3 years was recaptured only 33 miles from its original tagging location. Overall, distances traveled ranged from 20 - 530 miles. This long distance recovery was a 6 ft FL male tagged in Nygren Canyon by a foreign fisheries observer on a Japanese longline vessel that was recaptured by a commercial fisherman southwest of Newfoundland, Canada (530 mi.; 7.5 yr.). There are less than 10 porbeagles recovered from this area. Many of both the tagging and recapture locations are primarily along or just outside the 200 meter depth contour.

Data for nine of the original tags and sixteen of the recoveries were collected by Canadian commercial fishermen and observers on Canadian and Japanese vessels outside our U.S. exclusive economic zone. Consequently, one porbeagle that was originally tagged west of Cape Race, NF, Canada and recaptured southeast of Nova Scotia after 0.7 years at liberty, is one of the most easterly tagged fish to date. Also, the recapture of a small female in the Bay of Fundy is the first recovery in this area. We are grateful to have this opportunity to collaborate with the Canadians on the migrations of this important northern shark species.

Other Species (70 Returns)

Recaptures from other species included some long distance and maximum time at liberty records. An Atlantic sharpnose shark surpassed the species maximum distance record by traveling 560 miles from Padre Island, TX to Tabasco, Mexico after 5 months at liberty. This is the second fastest movement to date and the seventh sharpnose to travel from the U.S. to Mexican waters. A bonnethead shark was at liberty for 0.8 years-the maximum for this species in the CSTP. This fish had traveled less than one mile from its original tagging location. The bonnethead is an inshore coastal species located primarily south of Cape Hatteras, NC and into the Gulf of Mexico. Recaptures to date show very local movement except for one fish that moved from Texas to the Mexican border. A dusky shark that was tagged off Oregon Inlet, NC in 1988 was recaptured off Veracruz, Mexico (1,099 mi. southwest) 6.6 years later. A backbone for aging studies was collected from a dusky that was at liberty for 2.5 years and was measured at both release and recapture. Other interesting recoveries include: a silky shark that was tagged southeast of Liberia, Africa that traveled 517 miles to the east after 2.1 years at liberty (fourth in distance traveled and sixth in time at liberty); two nurse sharks recaptured after 1.0 and 1.9 years at liberty that traveled less than 4 miles from their original tagging location; and three blacktip sharks tagged off Texas and recaptured off Mexico.

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Jack Casey Retires

In 1961, John G. Casey had a visionary shark conservation plan centered around tag and release. For years, Jack worked against the tide of myths and misinformation about sharks. He was one of the first to clearly see the value of wild shark populations. After a lifetime of effort and 40 years of government service, Jack Casey retired in April of 1995. It is the end of an era, and we are glad to have been a part of it.

Through Jack's inspiration and hard work, NOAA's Cooperative Shark Tagging Program was created in 1961, at Sandy Hook, NJ, and moved in 1966 to the Narragansett Laboratory. Under his direction, more than 6,500 volunteer fishermen and cooperating scientists have tagged more than 120,000 sharks for research in the past 35 years. The scope of this work is a tribute not only to Jack, but to the thousands of fishermen of all kinds, ages, and nationalities whom he inspired. Jack assembled a team of scientists and support staff to study the confounding and little known lives of sharks. Age, growth, reproduction, and food habits are among the topics of research that he integrated into the Apex Predator Investigation. Jack Casey has touched the lives of thousands of students from school kids on the docks to candidates for advanced degrees. Jack leaves behind not just research papers, but decades of public interface; countless newspaper, magazine, book, radio and television reports that have subtly shaped public opinion about sharks. Jack's legacy is also a strong research program with a huge database promising many fruitful years of research on large Atlantic sharks.

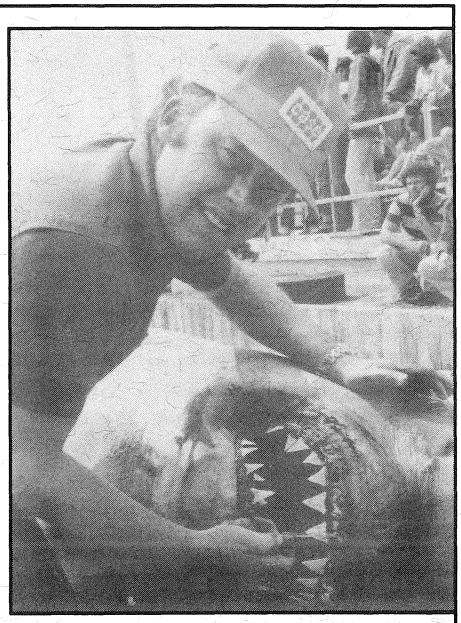

Photo by Alan Lintala