NMFS Cooperative Shark Tagging Program, 1962–93: An Atlas of Shark Tag and Recapture Data

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Introduction

The National Marine Fisheries Service (NMFS) Cooperative Shark Tagging Program (CSTP) is part of continuing research directed to the study of the biology of large Atlantic sharks. The CSTP was initiated in 1962 at the Sandy Hook Laboratory in New Jersey under the Department of Interior's U.S. Fish and Wildlife Service (USFWS). During the late 1950's and early 1960's, sharks were considered a liability to the economy of resort communities, of little or no commercial value, and a detriment to fishermen in areas where sharks might damage expensive fishing gear or reduce catches of more commercially valuable species.

Several shark attacks along the New Jersey coast at that time gave rise to public concern about a perceived shark menace. In response to that concern, a shark longline survey was conducted in 1961 from Jones Inlet, N.Y., to Cape Henlopen, Del., by laboratory staff. The objectives of that study were to determine the species composition, distribution, abundance, food habits, seasonal occurrence, and other aspects of the biology of large sharks off the middle Atlantic states. The survey resulted in the capture of over 300 sharks, including white sharks, *Carcharodon carcharias*; and tiger sharks, *Galeocerdo cuvier*, considered to be among the most dangerous species.

When the details of the survey were made public, hundreds of recreational fishermen interested in fishing for sharks as "big game" in the rapidly expanding offshore recreational fisheries offered to assist USFWS biologists in their research on sharks. This was the genesis of the CSTP. Volunteer participation began with an initial group of less than 100 fishermen involved in tagging feasibility studies in 1963. The program expanded in subsequent years, coming under the auspices of the U.S. Department of Commerce's National Marine Fisheries Service, NOAA, in 1970. It currently includes over 6,500 volunteers distributed along the Atlantic and Gulf coasts of North America and Europe. An overview of the early history of the CSTP is included in Casey (1985).

This paper broadly summarizes the tagging and recapture (T/R) information from the CSTP for 1962 through 1993. T/R data are presented in an atlas format to provide an overview of the 32-year database and show the extent of the tagging effort, areas of release and recapture, sources of recaptures, and movements of tagged sharks with respect to state boundaries, the 200-mile U.S. Exclusive Economic Zone (EEZ), and international and territorial waters of other countries.

Materials and Methods

The tagging methods used in the CSTP have been essentially unchanged during the past 30 years. The two principal tags in use are a fin tag (Jumbo Rototag) and a dart tag ("M" tag) (Fig. 1). The Rototag is a two-piece, plastic cattle ear tag that is inserted through the first dorsal fin. These tags were primarily used by USFWS biologists on small sharks during the first few years of the CSTP. As the program expanded to include thousands of volunteer fishermen, the dart tag was developed to be easily and safely applied to sharks in the water. The "M" tag is composed of a stainless steel dart head, monofilament line, and a Plexiglas capsule containing a vinyl plastic legend with return instructions printed in English, Spanish, French, Japanese, and Norwegian. These dart tags, in use since 1965, are implanted in the musculature near the base of the first dorsal fin. Numbered dart tags are sent to volunteer participants on self-addressed return post cards for recording tagging information (species, size, and sex of shark, and date, location, and gear).

In addition, first time taggers are sent a tagging needle, tagging instructions, a copy of the "Anglers Guide to Sharks of the Northeastern United States" (Casey, 1964), and a current *Shark Tagger* newsletter. This newsletter is an annual summary of the previous year's T/R data and biological studies on

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Figure 1.—The two principal tags, Jumbo Rototag (left) and "M" dart tag (right), used in the NMFS Cooperative Shark Tagging Program from 1962 to 1993.

sharks that is sent to all participants in the CSTP. Tagging studies have been mostly single-release events in which recoveries are made opportunistically by recreational and commercial fishermen. When a tagged shark is recaught, information similar to that obtained at tagging is requested from the recapturer. Initially, a $1.00 reward was sent as an incentive for returning tags; after a few years, the reward was increased to $5.00. Since 1988, a hat with an embroidered logo has been used.

Throughout the program, special care has been taken with respect to identification of species. It was apparent in the first few years that fishermen were having difficulty identifying sharks. Sharks in the genus *Carcharhinus* were (and remain) the most difficult to identify. Difficulties were also apparent in separating the mackerel sharks (i.e. shortfin mako, *Isurus oxyrinchus*; porbeagle, *Lamna nasus*; and white shark) and smooth, *Sphyrna zygaena*; and scalloped, *S. lewini*, hammerheads. In addition, taggers sometimes simply reported "shark," "sand shark," "dogfish," or "gray shark," names that can refer to any of several species. Over the course of the CSTP, there has been a continuing effort to provide shark identification materials to participants, many of whom have become experts in identifying sharks in their areas. The cadre of sport and commercial fishermen, scientists, fish dealers, and foreign fisheries observers send measurements, photographs, teeth, skin, and other materials to verify species identification.

For this paper, the combined 32-year database was further refined by plotting T/R locations by species and verifying observations that fell outside expected distributions. Tag and recapture data were evaluated to provide an overview of the range of some of the more important species of sharks and to show the extent of their migrations. Any data judged to be important with respect to long-distance movements, extended times at liberty, or unusual locations were considered valid only if they were tagged by NMFS biologists, other scientists, experienced foreign fisheries observers, or knowledgeable/experienced shark fishermen. Additionally, fishermen were contacted by telephone or letter to confirm details when the information was judged to be particularly relevant. If the data could not be verified, it was deleted or assigned to a nonspecific category such as "unidentified *Carcharhinus*."

During the course of the program, fishermen have become more experienced in identifying sharks, navigational systems and the accuracy of tagging data have improved, and questionable information from early years have become more obvious. Moreover, the additive effect of recaptures from sharks tagged by NMFS and other biologists have helped to confirm overall movement patterns of many species. Concerted attempts have also been made to critically and conservatively evaluate T/R information with respect to times at liberty, distances traveled, rates of travel and movements of sharks in relation to national and international boundaries.

This paper summarizes tagging and recapture data for 33 species of sharks taken in the CSTP, together with ancillary information, e.g. type of gear used and occupation of participants. Standard sets of figures (maps and graphs) are included for each species. Maps are displayed in a longitude/latitude projection with the U.S. EEZ boundary represented by a dotted-dashed line. Species sections appear in taxonomic order. Figures for each species include the following:

1) Atlantic distribution—Tagging and recapture locations are plotted on a standard Atlantic Ocean map. Summary information includes number of males and females tagged and recaptured, overall recapture rate, and maximum observed speed, distance traveled, and time at liberty. Note that maps show a general distribution of tagging and recapture locations, but because of scale, do not readily reflect tagging density.

2) Tagging distribution—The initial map represents an overview of the total tagging data with distinct symbols for males, females, and unknowns. These data are further broken down by area on subsequent maps where appropriate. Numbers of each sex and the 200 m depth contour are marked on each figure.

3) Recapture distribution—All of the recapture information for each species is displayed on a single map with arrows depicting the point of tagging (origin of arrow), and point of recapture (arrowhead). In some instances, an enlargement of a particular area is included on the same page (denoted as A and B) to improve clarity. An additional map denoting long-distance movements is included for some species.

4) Yearly summaries—Number of sharks tagged and recaptured by year are plotted on two distinct line graphs with the same year scale for comparison.

The blue shark, *Prionace glauca*, presented us with unique problems in portraying the tagging data. The substantial tagging effort off the northeastern coast of the United States made it difficult to definitively display sex ratios and tagging effort. For example, 22,500 blue sharks were tagged within a 60-mile radius of Montauk Point, Long Island, N.Y., during the study period. The blue shark data were therefore divided into eight regions, and sex ratios (males to females) were determined for each region. These regions were based on general distribution of the data and geographic areas (e.g. Grand Banks). The three regions off the U.S. coast have the EEZ as their eastern boundary.

Results and Discussion

The CSTP, between 1962 and 1993, has resulted in 106,449 tagged sharks of 33 species and 4,598 recaptures of 29 species. Ninety-one percent of the tags are accounted for by eight species: blue shark (57%); sandbar shark, *Carcharhinus plumbeus* (15%); dusky shark, *C. obscurus* (6%); tiger shark (4%); shortfin mako (3%); blacktip shark, *C. limbatus* (2%); scalloped hammerhead (2%); and Atlantic sharpnose shark, *Rhizoprionodon terrraenovae* (2%) (Table 1). The number of sharks tagged varies from 22 for the Greenland shark, *Somniosus microcephalus*, to 60,856 for the blue shark. Most species (27) have more than 100 sharks tagged.

Numbers of recaptures by species range from 0 to 2,339. Ninety-two percent of the recaptures are accounted for by seven species: blue shark (51%); sandbar shark (16%); tiger shark (10%); shortfin mako (7%); lemon shark, *Negaprion brevirostris* (3%); dusky shark (3%); and nurse shark, *Ginglymostoma cirratum* (2%). For most species (26), less than 100 fish were recaptured. No returns to date have been reported for the basking shark, *Cetorhinus maximus*; finetooth shark, *Carcharhinus isodon*; smalltail shark, *C. porosus*; and Atlantic angel shark, *Squatina dumeril*. The rate of recapture ranges from 0.0 to 10.9% (for the nurse shark).

The number of fish tagged and recaptured is influenced by a variety of factors, and the apparent abundance of a species, as reflected in the T/R data, can be misleading. The blue shark, for example, is an abundant species, and because of its low economic value, many are released. On the other hand, the shortfin mako is prized by both recreational and commercial fishermen, and this is reflected in the relatively low numbers of makos tagged and released and high recapture rate (third highest). The tiger shark is an example of a species where an intensive age and growth study, in recent years, has increased the numbers tagged and recaptured. Life history characteristics may also influence tagging and recapture success (e.g. a species that stays in an area for extensive periods of time, like the nurse shark, is more subject to capture and

Table 1.—Summary of tag and recapture data for 33 species of sharks from the NMFS Cooperative Shark Tagging Program during 1962–93.

Species	No. of sharks tagged	No. of sharks recaptured	Recapture rate (%)	Max. speed (n.mi./day)	Max. distance traveled (n.mi.)	Max. time at liberty (years)
Nurse shark, *Ginglymostoma cirratum*	923	101	10.9	1.3	292	7.8
Sand tiger, *Odontaspis taurus*	562	31	5.5	2.9	641	3.2
Bigeye thresher, *Alopias superciliosus*	329	7	2.1	9.4	1,494	6.5
Thresher shark, *A. vulpinus*	48	2	4.2	0.1	86	8
Basking shark, *Cetorhinus maximus*	156	0	0			
White shark, *Carcharodon carcharias*	36	2	5.6	0.9	546	2.5
Shortfin mako, *Isurus oxyrinchus*	3,457	320	9.3	35.7	2,453	9.5
Longfin mako, *I. paucus*	73	4	5.5	5.2	859	1.2
Porbeagle, *Lamna nasus*	457	31	6.8	22	1,005	8.6
Blacknose shark, *Carcharhinus acronotus*	387	6	1.6	0.8	170	9.2
Bignose shark, *C. altimus*	169	9	5.3	2.4	1,805	8.8
Spinner shark, *C. brevipinna*	341	9	2.6	3.3	899	0.8
Silky shark, *C. falciformis*	819	54	6.6	32.2	723	7.1
Galapagos shark, *C. galapagensis*	339	14	4.1	1	1,544	4.4
Finetooth shark, *C. isodon*	114	0	0			
Bull shark, *C. leucas*	520	10	1.9	1.6	235	7
Blacktip shark, *C. limbatus*	2,398	98	4.1	16.4	1,159	7.3
Oceanic whitetip shark, *C. longimanus*	542	6	1.1	17.5	1,226	3.3
Dusky shark, *C. obscurus*	5,983	124	2.1	22.3	2,052	15.8
Reef shark, *C. perezi*	546	10	1.8	< 0.1	16	4.4
Sandbar shark, *C. plumbeus*	15,617	727	4.7	11.7	2,039	27.8
Smalltail shark, *C. porosus*	29	0	0			
Night shark, *C. signatus*	191	12	6.3	6	1,441	12.9
Tiger shark, *Galeocerdo cuvier*	4,850	446	9.2	33.2	1,871	10.9
Lemon shark, *Negaprion brevirostris*	1,602	163	10.2	4	230	4.1
Blue shark, *Prionace glauca*	60,856	2,339	3.8	49.9	3,740	8.5
Atlantic sharpnose shark, *Rhizoprionodon terraenovae*	2,015	21	1	2.3	344	7.3
Scalloped hammerhead, *Sphyrna lewini*	2,131	34	1.6	6	902	9.6
Great hammerhead, *S. mokarran*	103	2	1.9	0.4	102	0.7
Bonnethead, *S. tiburo*	583	9	1.5	1.2	141	0.4
Smooth hammerhead, *S. zygaena*	166	6	3.6	2.6	496	2.1
Greenland shark, *Somniosus microcephalus*	22	1	4.5	0	0	1
Atlantic angel shark, *Squatina dumeril*	85	0	0			

recapture than a species that is highly migratory). Conversely, lower tagging and recapture success does not necessarily reflect low abundance but may mean that a species may be undesirable or inaccessible to the main body of fishing and tagging effort. Some species occur farther offshore, in deeper waters, are not present in areas during the primary fishing season, or are not readily caught. For instance, 156 basking sharks were tagged by members of the CSTP, but none have been recaptured. This is because basking sharks are relatively easy to tag free swimming but are not taken incidentally on most types of fishing gear and are not subject to commercial fisheries.

The annual number of fish tagged per year varied from 38 in 1962 to 8,113 in 1992 and averaged 5,700 during 1984–93. The number of fish recaptured by year ranged from 2 in 1963 to 444 in 1993 and averaged 300 for 1984–93 (Fig. 2). The fairly steady rise in number of recaptures is partially due to the fact that as the number of tagged fish increased (each year an additional 5,000 to 8,000 were added), the number of recaptures per year increased. Trends in number of fish tagged and recaptured must be interpreted with caution, because tagging effort can vary due to annual changes in fishing effort, weather conditions, water temperature, number of participants in the CSTP, occurrence of research cruises, opening or closure of a commercial fishery, and number of tags available. All these variables are difficult to measure and may mask any direct correlation of number of tags used per year and population size fluctuations.

Peaks in numbers of tags and recaptures per year can be further clarified by comparing the total with the data for the blue and sandbar sharks. Since blue sharks represent the largest percentage of the total numbers tagged and recaptured, the pattern in numbers per year for this species mirrors the total and dominates the trends. Species with fewer tags and recaptures are particularly affected by the variables discussed above, since single events can significantly increase or decrease their numbers. For example, there were large numbers of sandbar sharks tagged between 1964 and 1968 by NMFS biologists in conjunction with commercial fishermen off coastal Virginia. Likewise, since 1986, there was an increase in the number of sandbar sharks tagged (on NMFS research cruises in 1986, 1989, and 1991) and recaptured (due to the developed commercial fishery for coastal sharks).

Anglers using rod and reel accomplished the majority of the tagging (Fig. 3). Biologists, NMFS fisheries observers, and commercial fishermen using primarily longlines, handlines, and nets (gill, trawl) accounted for the remainder. Conversely, commercial fishermen (50%) using longlines and net gear, and rod and reel anglers (40%) were responsible for the majority of the tag returns (Fig. 4).

Distances traveled for the 33 species ranged from no movement to 3,740 n.mi. (Table 1). This maximum distance was for a blue shark that was tagged by

Figure 2.—Total number of sharks tagged and recaptured by year in the NMFS Cooperative Shark Tagging Program from 1962 to 1993.

a sport fisherman southeast of Shinnecock Inlet, N.Y., and recaptured approximately 560 miles east of Natal, Brazil 1.4 years later. In total, one species, the blue shark, traveled distances over 3,000 miles, 3 species traveled distances between 2,000 and 3,000 miles (shortfin mako, dusky, and sandbar shark), and 8 species between 1,000 and 2,000 miles (tiger; bignose, *Carcharhinus altimus*; Galapagos, *C. galapagensis*; bigeye thresher, *Alopias superciliosus*; night, *C. signatus*; oceanic whitetip, *C. longimanus*; blacktip, and porbeagle shark). Six species traveled distances of 500–1,000 miles (scalloped hammerhead; spinner, *C. brevipinna*; longfin mako, *Isurus paucus*; silky, *Carcharhinus falciformis*; sand tiger, *Odontaspis taurus*; and white shark).

The longest time at liberty for any shark in the CSTP is 27.8 years (Table 1). This record is for a sandbar shark that was tagged by NMFS Narragansett Laboratory biologist Charles Stillwell, fishing with a gill net in Great Machipongo Sound, Va., in June of 1965 and recaptured by a commercial shark longline fisherman east of Daytona Beach, Fla. Overall, 4 species of shark have been at liberty for over 10 years (sandbar, dusky, night, and tiger shark), and 13 have been at liberty between 5 and 10 years (scalloped hammerhead; shortfin mako; blacknose, *Carcharhinus acronotus*; bignose; porbeagle; blue; thresher, *Alopias vulpinus*; nurse; Atlantic sharpnose; blacktip; silky; bull; and bigeye thresher shark).

One of the major challenges to fisheries managers is the management and allocation of transboundary or migratory stocks (Hilborn et al., 1990). Data from tagging programs, such as the NMFS CSTP, play a major role in this process by providing direct evidence of the extent of fish movements with respect to national and international boundaries and for defining the stocks of Atlantic sharks (Fig. 5–161). Recapture data from the CSTP provide evidence of transboundary movements for the 29 shark species with recaptures (Table 2). Twenty species showed movement across the U.S. EEZ boundary. Of these, 6 belong to the pelagic sharks, 12 to the large coastal, and 2 to the small coastal shark species group as per the Fishery Management Plan for Sharks of the Atlantic Ocean (Anonymous, 1993). T/R data provide evidence that 25 of the species occur in the Gulf of Mexico. Of these, 12 show movement into the Gulf and 11 show movement out of the Gulf. Sixteen species occur in the Caribbean Sea, of which 8 show movement in and none show movement out. Eight species occur in the South Atlantic, and one species, the blue shark, shows evidence of crossing the equator. Overall, fishermen representing 32 countries have tagged sharks and 47 countries are represented in the tag returns. Thus, the need for international cooperation and management for some

Figure 3.—Summary of tag releases by gear and occupation of participants in the NMFS Cooperative Shark Tagging Program from 1962 to 1993.

Figure 4.—Summary of tag returns by gear and occupation of participants in the NMFS Cooperative Shark Tagging Program from 1962 to 1993.

Table 2.—Summary of occurrence and transboundary movement for 33 species of sharks from the NMFS Cooperative Shark Tagging Program during 1962–93.

Species	Shark species tagged and/or recaptured in:						Moved across U.S. EEZ	Moved into:			Moved out of Gulf of Mexico
	N. of Cape Hatteras	S. of Cape Hatteras	Gulf of Mexico	Caribbean Sea	E. N. Atl. Ocean	S. Atl. Ocean		Caribbean Sea	Gulf of Mexico	S. Atl. Ocean	
Ginglymostoma cirratum		X	X	X							X
Odontaspis taurus	X	X									
Alopias superciliosus	X	X	X	X	X		X		X		
A. vulpinus	X	X			X						
Cetorhinus maximus	X						NA[1]	NA	NA	NA	NA
Carcharodon carcharias	X	X				X					
Isurus oxyrinchus	X	X	X	X	X	X	X	X	X		X
I. paucus	X	X	X	X			X				X
Lamna nasus	X				X	X	X				
Carcharhinus acronotus		X	X								
C. altimus	X	X	X	X			X	X	X		X
C. brevipinna	X	X	X	X			X	X	X		
C. falciformis	X	X	X	X	X	X	X	X	X		X
C. galapagensis		X				X	X				
C. isodon	X	X	X				NA	NA	NA	NA	NA
C. leucas	X	X	X				X				
C. limbatus	X	X	X	X			X		X		X
C. longimanus	X	X	X	X	X	X	X	X			X
C. obscurus	X	X	X	X	X		X	X	X		X
C. perezi		X	X	X							
C. plumbeus	X	X	X				X		X		X
C. porosus				X			NA	NA	NA	NA	NA
C. signatus	X	X	X				X		X		
Galeocerdo cuvier	X	X	X	X			X	X	X		X
Negaprion brevirostris	X	X	X	X			X		X		X
Prionace glauca	X	X	X	X	X	X	X	X	X	X	
Rhizoprionodon terraenovae	X	X	X				X				
Sphyrna lewini	X	X	X				X				
S. mokarran	X	X	X								
S. tiburo		X	X				X				
S. zygaena	X	X	X	X	X	X					
Somniosus microcephalus	X				X						
Squatina dumeril	X	X	X				NA	NA	NA	NA	NA

[1] NA = Not applicable.

shark species is underscored by the fact that many have wide ranging distributions, frequently traverse national boundaries, and are exploited by multinational fisheries.

The CSTP is an ongoing means to increase our biological understanding of sharks and to obtain information required for their successful management. The tagging of sharks (and other aquatic animals) provides information on stock identity, movements and migration (including rates and routes), abundance, age and growth (including verification/validation of age-determination methods), mortality, behavior, and stocking success (McFarlane et al., 1990). This atlas is the foundation upon which to begin to fill in the gaps in our knowledge on the migrations and other elements of the biology of Atlantic sharks. Future reports will provide more detailed analysis of the T/R data in relation to stock identification, size distribution, reproductive biology, food habits, and environmental parameters that define the geographic ranges and help to explain movements of individual species.

Acknowledgments

We would like to acknowledge the thousands of sport and commercial fishermen, fisheries observers, research vessel captains and crew, tournament officials, and cooperating scientists who have helped make this one of the largest shark tagging programs in the world. It owes its success to their unselfish cooperation, spending many hours at sea tagging and recapturing sharks and providing valuable data from logbooks, tournament records, and field observations. Many sport, commercial, and research boats have allowed us sea time on their vessels at no cost. There are so many people involved in a program of this kind, including the people who make the tags, that it is difficult to single out any individuals or individual groups. Many thanks to all of you for your dedication and support of our program. Special thanks also to past and present API staff, including Ruth Briggs, Lisa Natanson, Gregg Skomal, H. Wes Pratt, Mike Couturier, Fred Lerch, Larry Lindgren, Nancy Kelley, and Patricia Hadfield for their assistance and support with data collection and processing. We also are very grateful to Steve Clark, Teri Frady, Daniel Sheehan, and Jon Gibson for providing valuable technical assistance.

Figure 5.—Atlantic distribution of tag and recapture locations for the nurse shark, *Ginglymostoma cirratum*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 6.—Total tagging distribution for the nurse shark, *Ginglymostoma cirratum*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ. The solid line represents the 200 m depth contour.

Figure 7a.—Recapture distribution for the nurse shark, *Ginglymostoma cirratum*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 7b.—Detailed map of southern Florida recapture distribution for the nurse shark, *Ginglymostoma cirratum*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 8.—Total number of nurse shark, *Ginglymostoma cirratum*, tagged and recaptured by year in the NMFS Cooperative Shark Tagging Program, from 1962 to 1993.

Figure 9.—Atlantic distribution of tag and recapture locations for the sand tiger, *Odontaspis taurus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 10.—Total tagging distribution for the sand tiger, *Odontaspis taurus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ. The solid line represents the 200 m depth contour.

Figure 11.—Recapture distribution for the sand tiger, *Odontaspis taurus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 12.—Total number of sand tiger, *Odontaspis taurus*, tagged and recaptured by year in the NMFS Cooperative Shark Tagging Program, from 1962 to 1993.

Figure 13.—Atlantic distribution of tag and recapture locations for the bigeye thresher, *Alopias superciliosus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 14.—Total tagging distribution for the bigeye thresher, *Alopias superciliosus*, from the NMFS Cooperative Shark Tagging Program during 1962–93.

Figure 15.—U.S. tagging distribution of the bigeye thresher, *Alopias superciliosus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ. The solid line represents the 200 m depth contour.

Figure 16.—Recapture distribution for the bigeye thresher, *Alopias superciliosus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 17.—Total number of bigeye thresher, *Alopias superciliosus*, tagged and recaptured by year in the NMFS Cooperative Shark Tagging Program, from 1962 to 1993.

Figure 18.—Atlantic distribution of tag and recapture locations for the thresher shark, *Alopias vulpinus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 19.—Total tagging distribution for the thresher shark, *Alopias vulpinus*, from the NMFS Cooperative Shark Tagging Program during 1962–93.

Figure 20.—U.S. tagging distribution of the bigeye thresher, *Alopias vulpinus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ. The solid line represents the 200 m depth contour.

Figure 21.—Recapture distribution for the thresher shark, *Alopias vulpinus*, from the NMFS Cooperative Shark Tagging Program during 1962–93.

Figure 22.—Total number of thresher shark, *Alopias vulpinus*, tagged and recaptured by year in the NMFS Cooperative Shark Tagging Program, from 1962 to 1993.

Figure 23.—Atlantic distribution of tag and recapture locations for the basking shark, *Cetorhinus maximus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 24.—Total tagging distribution for the basking shark, *Cetorhinus maximus*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ. The solid line represents the 200 m depth contour.

Figure 25.—Total number of basking shark, *Cetorhinus maximus*, tagged by year in the NMFS Cooperative Shark Tagging Program, from 1962 to 1993.

Figure 26.—Atlantic distribution of tag and recapture locations for the white shark, *Carcharodon carcharias*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 27.—Total tagging distribution for the white shark, *Carcharodon carcharias*, from the NMFS Cooperative Shark Tagging Program during 1962–93.

Figure 28.—U.S. tagging distribution of the white shark, *Carcharodon carcharias*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ. The solid line represents the 200 m depth contour.

Figure 29.—Northeastern U.S. tagging distribution of the white shark, *Carcharodon carcharias*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ. The solid line represents the 200 m depth contour.

Figure 30.—Recapture distribution for the white shark, *Carcharodon carcharias*, from the NMFS Cooperative Shark Tagging Program during 1962–93. The dotted-dashed line represents the U.S. EEZ.

Figure 31.—Total number of white shark, *Carcharodon carcharias*, tagged and recaptured by year in the NMFS Cooperative Shark Tagging Program, from 1962 to 1993.

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