Mark/Recapture Data for the Smooth Dogfish, *Mustelus Canis*, in the western North Atlantic from the NEFSC Cooperative Shark Tagging Program

N. E. Kohler, P. A. Turner, M. Pezzullo, and C. T. McCandless

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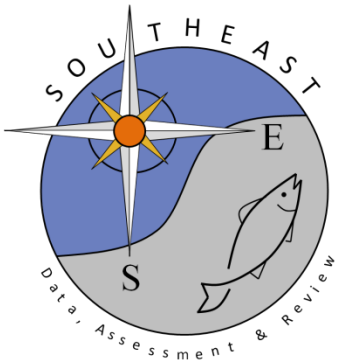

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Mark/Recapture Data for the Smooth Dogfish, *Mustelus canis*, in the Western North Atlantic from the NMFS Cooperative Shark Tagging Program

Nancy E. Kohler
Patricia A. Turner
Matthew Pezzullo
Camilla T. McCandless

NOAA, National Marine Fisheries Service
Northeast Fisheries Science Center
Narragansett Laboratory
28 Tarzwell Drive
Narragansett, RI 02882
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Summary
Mark/recapture data from the National Marine Fisheries Service (NMFS) Cooperative Shark Tagging Program (CSTP) were summarized for the smooth dogfish (*Mustelus canis*) along the Atlantic and Gulf coast of the US from 1963 through 2013. Data on fork length, life stage, time at large, and movement are provided. Overall, 1134 sharks were tagged, and 37 of these tagged sharks were recaptured, yielding a total of 1171 smooth dogfish capture locations between 1963 and 2013. All capture locations for smooth dogfish in this study fall within the documented geographic and depth range of *Mustelus canis canis*. Smooth dogfish were tagged from the Gulf of Maine to the Gulf of Mexico. All smooth dogfish were caught within 200 m depth throughout their range. Adult fish were the most commonly caught life stage with more than twice the number of juveniles for both males and females. Females were caught more often than males, resulting in a male to female sex ratio of 1:3.2. The largest smooth dogfish was estimated as a 130 cm FL female. Capture locations for mature females and YOY overlap off Long Island NY, in Delaware and Chesapeake Bay, and along coastal North Carolina. Maximum displacement distance was 460 nm with distance traveled increasing with increasing FL for the 12 fish at liberty less than 1 year. Seasonal changes in tagging locations were evident. This north-south seasonal migration pattern is further revealed by recaptures at liberty for less than one year with movements between Cape Cod, MA and North Carolina. The three remaining were at liberty for less than 30 days and traveled less than 60 miles from their tagging location during the winter months. Overall, none of the smooth dogfish moved between the Atlantic and Gulf of Mexico.

Introduction

The smooth dogfish is an abundant coastal species, ranging in the western Atlantic from the Bay of Fundy, Canada, southward to Florida and the Gulf of Mexico (Bigelow and Schroeder 1948), Venezuela, Surinam, French Guiana, Brazil, Uruguay and Argentina (Heemstra 1997). According to Heemstra (1997), *Mustelus canis canis* is replaced by *Mustelus canis insularis* in the Caribbean Islands, the Bahamas, and Bermuda. Off the US Atlantic coast, the smooth dogfish is commonly distributed in bays and inshore waters from Massachusetts to Florida on the east coast of the US with Cape Cod and Nantucket Shoals as a boundary to their dispersal northward. The smooth dogfish has only been caught as an occasional stray in Massachusetts Bay, the Gulf of Maine, and Passamaquoddy Bay at the mouth of the Bay of Fundy (Bigelow and Schroeder 1948). Smooth dogfish are primarily demersal sharks and except for a few records beyond 230 m, are found from shallow inshore and intertidal waters (including river mouths) to 200 m depth (Compagno 1984). The deepest record is in 360 m from off Tamaulipas, Mexico (Heemstra 1997).

Materials and Methods

The NMFS Cooperative Shark Tagging Program (CSTP) was initiated in 1962. Summary information on the history and methods of the CSTP has been published previously (Casey 1985, Casey and Kohler 1992, Kohler et al. 1998, Kohler and Turner 2001) and excerpts from these reports are included here. The two principal CSTP tags are a fin tag (Jumbo Rototag) and a dart tag (M-tag). Tagging studies have been mostly single release events in which recoveries are made opportunistically by recreational and commercial fishermen. If a tagged shark was recaptured, analogous information is sent to NMFS, allowing for the calculation of time at large and displacement. Distance traveled in nautical miles (nm) between tagging and recapture site is a minimum straight-line distance. Sizes for CSTP tag returns are reported in varying units of measure. Fork length (FL) was used whenever provided and converted to cm when applicable. Total length (TL) was converted to fork length by rearranging the following formula: TL cm = 3.43329 + 1.09539*FL cm (William Driggers, Pers. Comm.) Sharks were categorized into life stages by length. According to Conrath and Musick (2002), TL at 50% maturity is 102 cm for females and 86 cm for males and size at birth ranges from 30 to 40 cm. Therefore, young of the year (YOY) were defined as FL<34 cm; juvenile males from 34-75 cm FL; adult males >75 cm FL; and juvenile females from 34-90 cm FL; adult females >90 cm FL. Female sizes were used for determination of maturity for fish tagged as unknown sex. Seasons were defined as spring (March, April, May), summer (June, July, August), fall (September, October, November), and winter (December, January, February).

Results and Discussion

This report summarizes the CSTP mark/recapture information for the smooth dogfish in the western North Atlantic. Smooth dogfish were predominantly caught by longline (811), rod and reel (270), trawl (46), and gill net (32). Sharks were also caught in smaller numbers (12) with hand line, seine, set line, and by hand. Overall, 1134 sharks were tagged, and 37 of these tagged sharks were recaptured, yielding a total of 1171 smooth dogfish capture locations between 1963 and 2013 (Table 1, Figure 1).

All capture locations for smooth dogfish in this study fall within the documented geographic and depth range of *Mustelus canis canis*. Smooth dogfish were tagged from the Gulf of Maine

to the Gulf of Mexico (Figure 2). Only two fish were tagged in the Gulf of Maine; these fish were caught less than 5 miles from shore, off Ogunquit, ME (Figure 3). Historically, smooth dogfish have been infrequently caught north of Cape Cod as an occasional stray in Massachusetts Bay, the Gulf of Maine, and Passamaquoddy Bay at the mouth of the Bay of Fundy (Bigelow and Schroeder 1948). The species is reported to be uncommon south of North Carolina but is again common off Florida and turns up at many localities in the Gulf of Mexico to southern Mexico (Compagno 1984). Gulf of Mexico tagging in this study showed smooth dogfish from Florida to Texas, however data consisted of only 18 fish (Figure 4). The majority of smooth dogfish were caught between Cape Cod, MA and North Carolina with a fairly consistent number of tagging events along the Atlantic coast from North Carolina south to Florida.

All smooth dogfish were caught within 200 m depth throughout their range (Figure 2). The vast majority of fish were caught in considerably shallower waters along the coast and in sounds, bays, and estuaries in the Atlantic. Smooth dogfish in US temperate waters are thought to be common residents on continental shelves, bays, and other inshore waters that prefer shallow waters of less than 18 m in depth but may be found to depths of 200 m (Compagno 1984). Tagging locations were in deeper water in the Gulf of Mexico (Figure 4).

Literature suggests several distinct populations of smooth dogfish with little intermigration between different populations and few or no members of the species occurring in the broad gaps between them (Bigelow and Schroeder 1948, Compagno 1984) as well as geographic overlap of several *Mustelus* species (Heemstra 1997). To distinguish between *Mustelus* species and subspecies, however, involves recognizing fine differences in morphometric features, denticle and tooth configurations, buccopharyngeal denticle patterns, and vertebral numbers. These taxonomic characters may not be noticed or known when identifying the dogfish during the tagging process.

Information on the mark/recapture events by sex and life stage is provided in Table 2. Adult fish were the most commonly caught life stage with more than twice the number of juveniles for both males and females. Females were caught more often than males, resulting in a male to female sex ratio of 1:3.2.

The largest smooth dogfish was estimated as a 130 cm FL female (Table 2, Figure 5a). The largest measured male and female were 104 and 122 cm FL, respectively (Figure 5b). These compare to the maximum reported size of 133.8 cm FL (150 cm TL) (Compagno 1984).

Mature females were caught throughout the study area and were the majority of fish tagged in the Gulf of Mexico (Figure 6). Mid-Atlantic Bight estuaries are thought to be important nurseries for juvenile stages beyond the first year, as well as for the young of the year (Rountree and Able 1996). Females enter bays and estuaries during the pupping period with parturition occurring in May (Conrath and Musick 2002). In this study, capture locations for mature females and YOY overlap off Long Island NY, in Delaware and Chesapeake Bay, and along coastal North Carolina (Figure 6) and substantiate the location of these shallow nursery grounds. This overlap occurred primarily in summer and early fall.

Of the 37 fish recaptured (Figure 7), the majority were re-caught within 100 miles of their tagging location (Figure 8). Maximum displacement distance was 460 nm (Table 1) and was a smooth dogfish tagged off Martha's Vineyard, MA and recaptured off Hatteras Inlet, NC after 1.1 years. Distance traveled increased with increasing FL for the 12 fish at liberty less than 1 year (Figure 9a). This trend was also seen when analyzed for all years (Figure 9b).

Data on longevity of the species are sparse in the literature. Conrath et al. 2002 reported the oldest age estimate for male and female samples was ten and sixteen years, respectively. In the present study, maximum time at liberty was 6.8 years for a 96.4 cm FL female smooth dogfish tagged off Martha's Vineyard, MA that was recaptured 51 nm to the west of the tag location. The majority of the fish were at liberty for less than 2 years with a mean of 1.9 years (Table 1, Figure 10).

Seasonal changes in tagging locations were evident. In winter, all events are from the mouth of Chesapeake Bay and south along the coasts of Florida (Figure 11). In spring, locations expand further north to Nantucket Sound, south of Cape Cod, MA but are still located all along the Atlantic coast (Figure 12). The most northern locations in spring are tagged primarily during the month of May. During the warm summer months, the vast majority of mark/recapture locations are in the Mid-Atlantic and Northeast from Chesapeake Bay to the Gulf of Maine (Figure 13). Fall capture locations are still dominant north of Maryland, but several fish were also tagged off North and South Carolina. Along the Atlantic coast in fall, fish tagged from Maryland and north were all captured in September and October; smooth dogfish tagged from North Carolina and south were captured in November (Figure 14).

Similar results were found for smooth dogfish caught in a study in Little Egg harbor, Great Bay, NJ where fish were present in low numbers during late May, peaked in late August, and had disappeared from the catches by November (Rountree and Able 1996).

One population of smooth dogfish is thought to exist between the Carolinas north along the US Atlantic coast to New England and southern Canada and migrates seasonally in response to changing water temperatures. This population winters between Chesapeake Bay and South Carolina. In early spring, smooth dogfish begin migrating to their summer grounds between Delaware Bay and Cape Cod, remaining there until late autumn before migrating south again (Bigelow and Schroeder 1948, Castro 1983).

This north-south seasonal migration pattern is further revealed by recaptures at liberty for less than one year with movements between Cape Cod, MA and North Carolina (12) (Figure 15). Three fish tagged off Cape Cod, MA in summer were recaptured off New Jersey in late spring (May) and early summer (June) and off North Carolina in the early spring (March). Five smooth dogfish were tagged off New Jersey in summer; three traveled north and were re-caught in late summer (August) and fall (September, October); two moved south and were re-caught in spring (May) and winter (December). Three fish were tagged and recaptured in Delaware Bay in summer; two were recovered almost one year later in late spring (May) and summer (August); and one recovered in late fall (November). The one fish off North Carolina was tagged and recaptured in winter.

All except three fish traveled between Cape Cod, MA and North Carolina on a seasonal basis. The three remaining were at liberty for less than 30 days and traveled less than 60 miles from their tagging location during the winter months. Overall, none of the smooth dogfish moved between the Atlantic and Gulf of Mexico.

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Sex	Tagged	Recaptured	Recapture Rate (%)	Mean Displacement (nm)	Maximum Displacement (nm)	Mean Time at Liberty (days / years)	Max Time at Liberty (days / years)
Male	252	5	2.0	147.8	379	780 / 2.1	1484 / 4.1
Female	801	29	3.6	114.2	460	746 / 2.0	2489 / 6.8
Unknown	81	3	3.7	140.7	152	146.3 / 0.4	285 / 0.8
Total	1134	37	3.3	120.9	460	701 / 1.9	2489 / 6.8

Table 1. Data statistics by sex for smooth dogfish from the NMFS CSTP. Displacement is calculated using a straight-line distance from tagging location to recapture location.

						Fork Length (cm)				
Sex	Adult	Juveniles	YOY	Unknown Maturity	Total	Min	Max	Median	Mean	SD
Male	**174** *14.86* *67.70* *23.32*	**80** *6.83* *31.13* *20.05*	**1** *0.09* *0.39* *7.69*	**2** *0.17* *0.78* *15.38*	**257** *21.94*	31.56	108.24	80.00	76.66	14.65
Female	**551** *47.05* *66.39* *73.86*	**268** *22.89* *32.29* *67.17*	**7** *0.60* *0.84* *53.85*	**4** *0.34* *0.48* *30.77*	**830** *70.88*	24.25	130.00	96.00	91.49	17.87
Unknown Sex	**21** *1.79* *25.00* *2.82*	**51** *4.36* *60.71* *12.78*	**5** *0.43* *5.95* *38.46*	**7** *0.60* *8.33* *53.85*	**84** *7.17*	20.00	115.54	79.94	74.52	23.15
Total	**746** *63.71*	**399** *34.07*	**13** *1.11*	**13** *1.11*	**1171** *100*	20.00	130.00	91.00	87.09	18.93
						Sex Ratio (M:F) 1 : 3.23				

Key

Frequency
Percent
Row Percent
Column Percent

Table 2. Data distribution by sex and life stage for smooth dogfish, including all recaptures from the NMFS CSTP. YOY=Young of the Year.

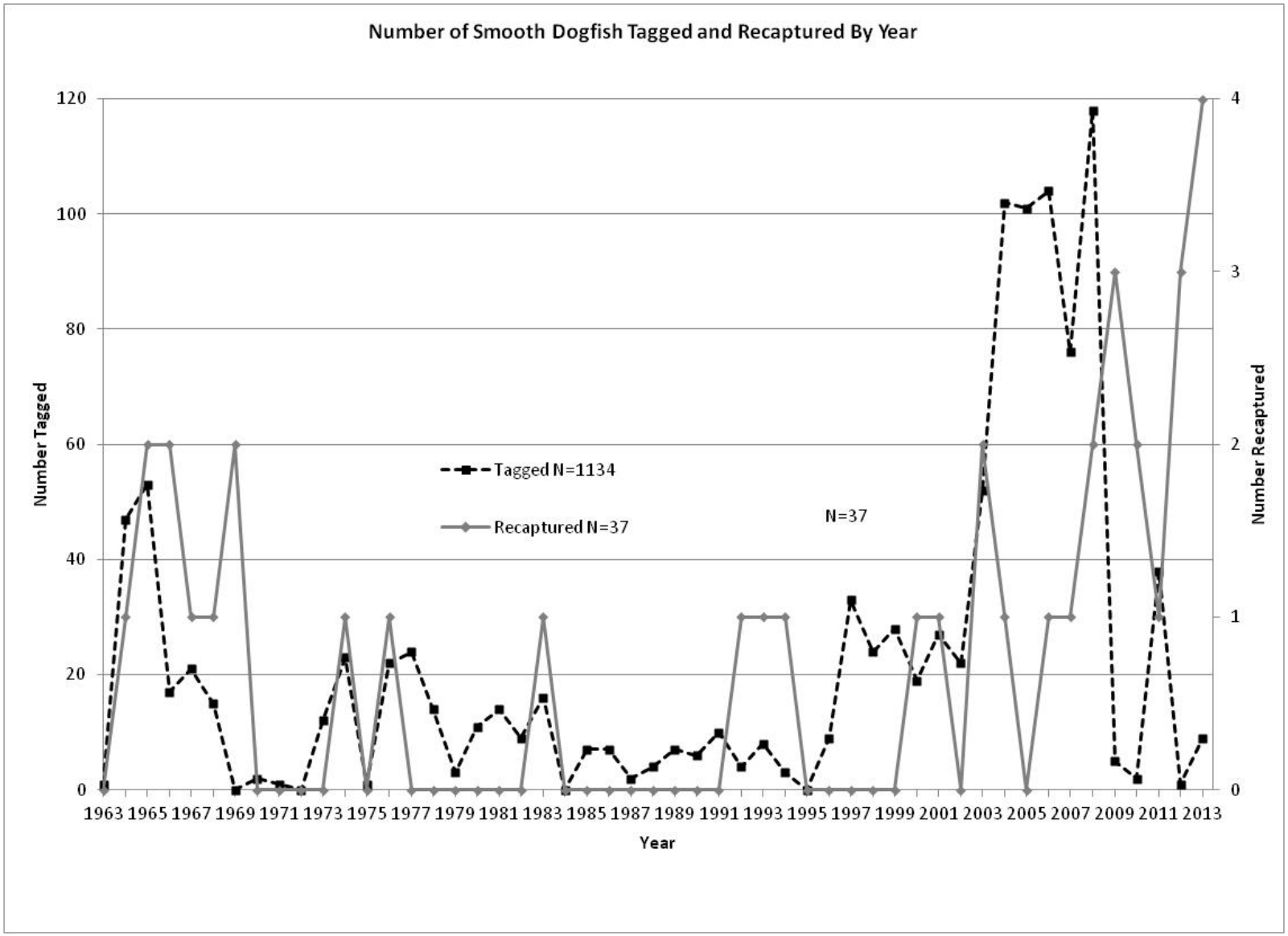

Figure 1. Total number of smooth dogfish tagged and recaptured from the NMFS CSTP.

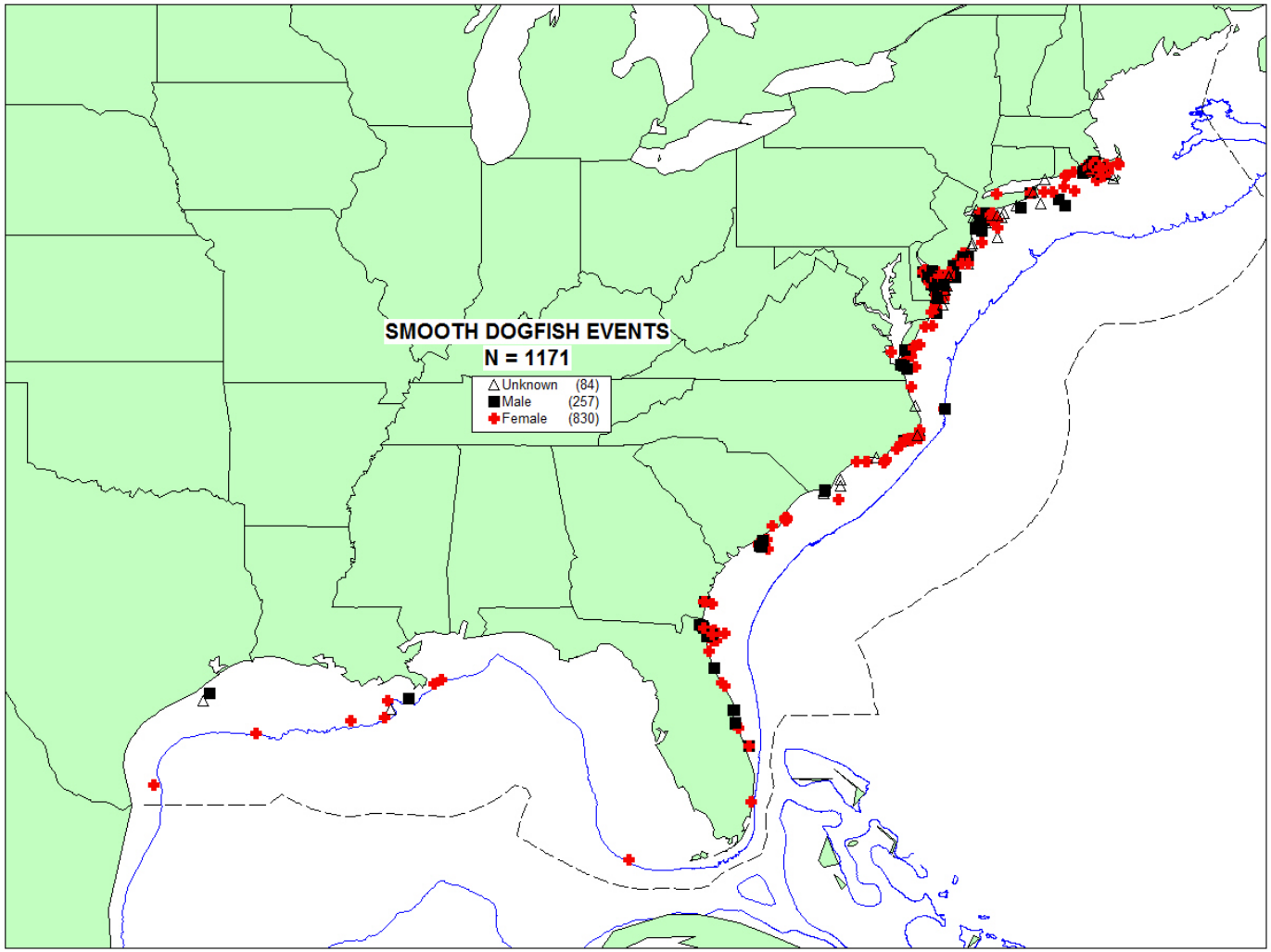

Figure 2. Smooth dogfish events by sex from the NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.

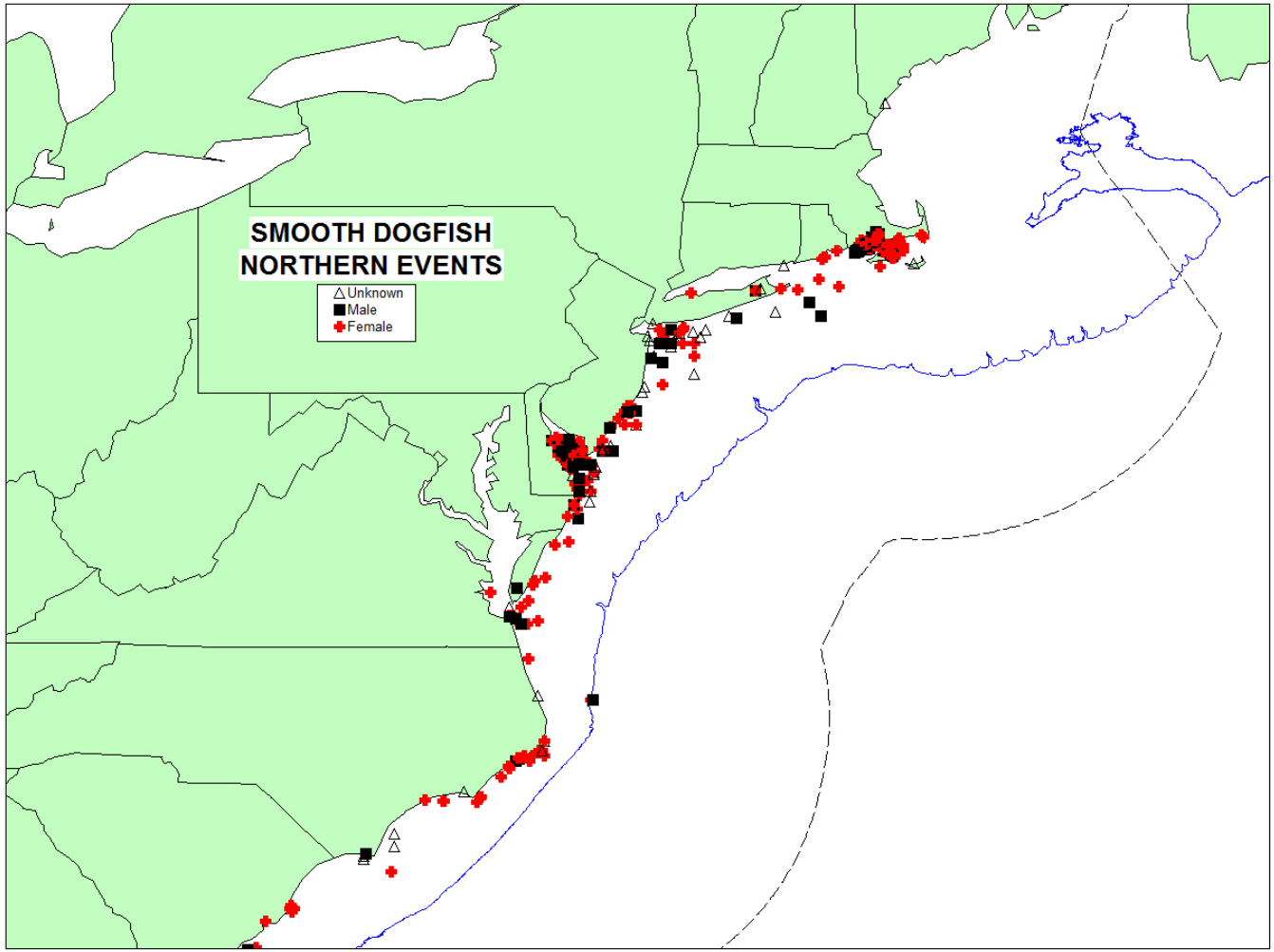

Figure 3. Smooth dogfish events by sex, northern area from the NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.

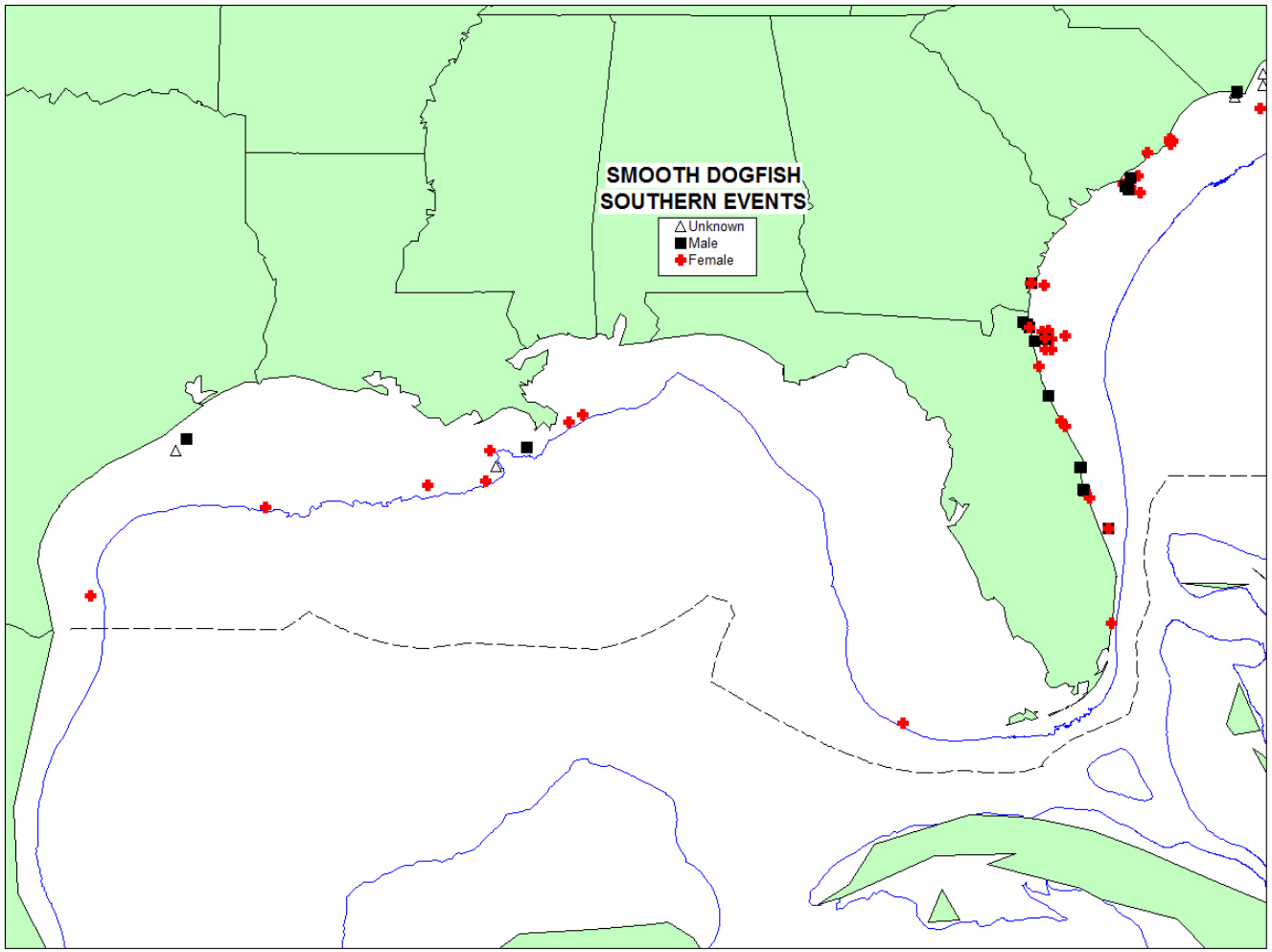

Figure 4. Smooth dogfish events by sex, southern area from the NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.

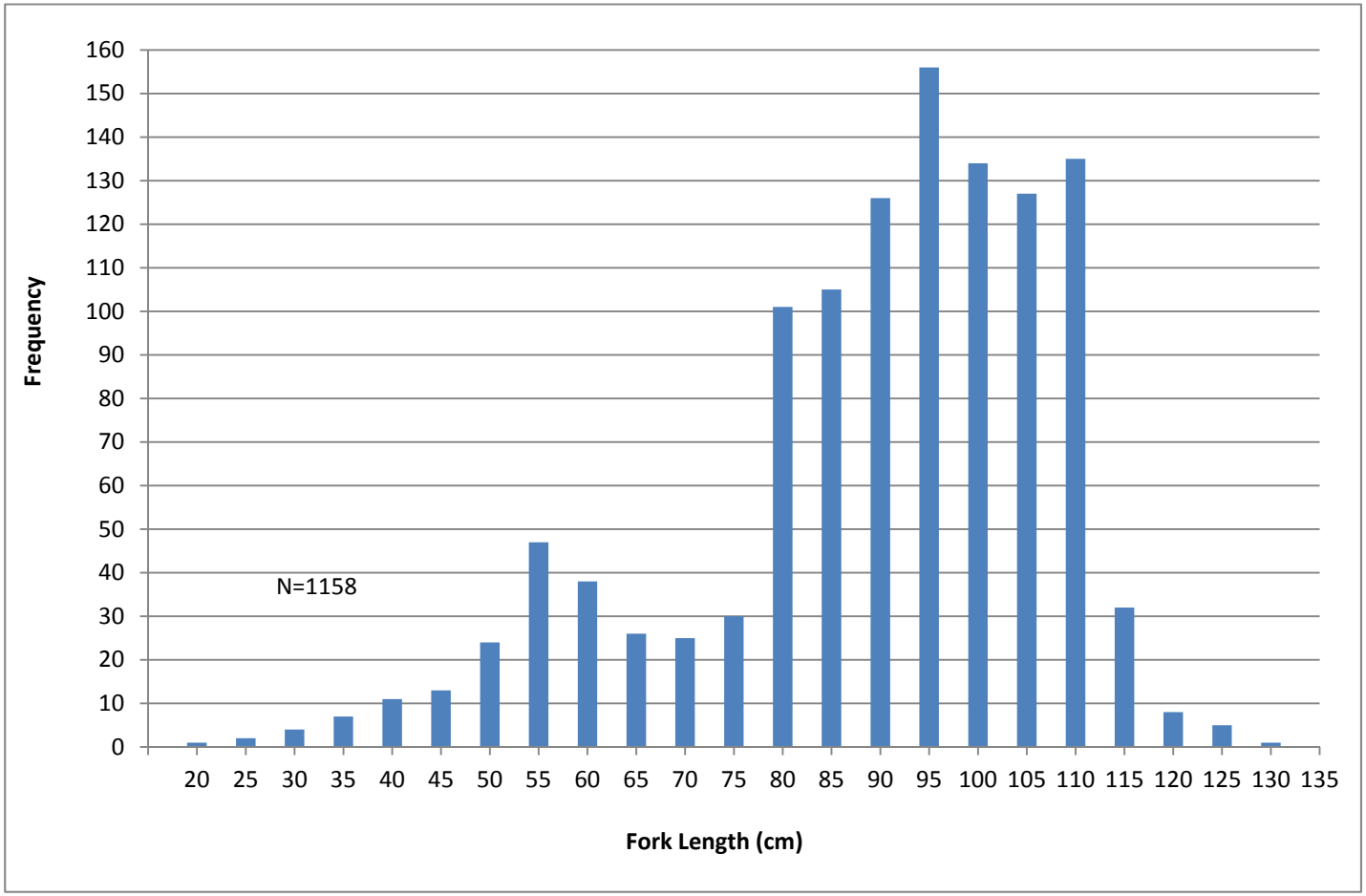

Figure 5a. Frequency of smooth dogfish by fork length (cm) from the NMFS CSTP.

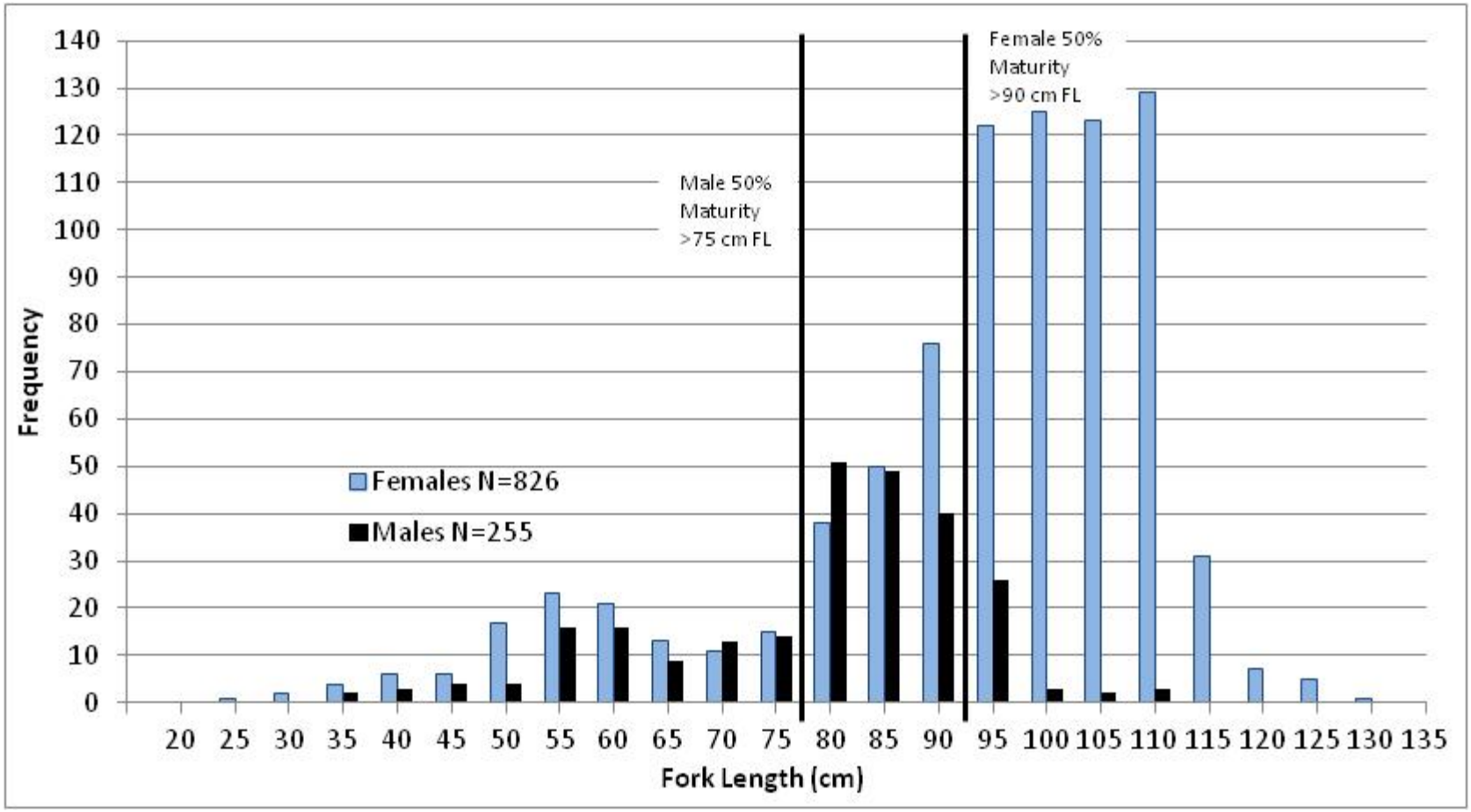

Figure 5b. Frequency of smooth dogfish by fork length (cm) and sex from the NMFS CSTP.

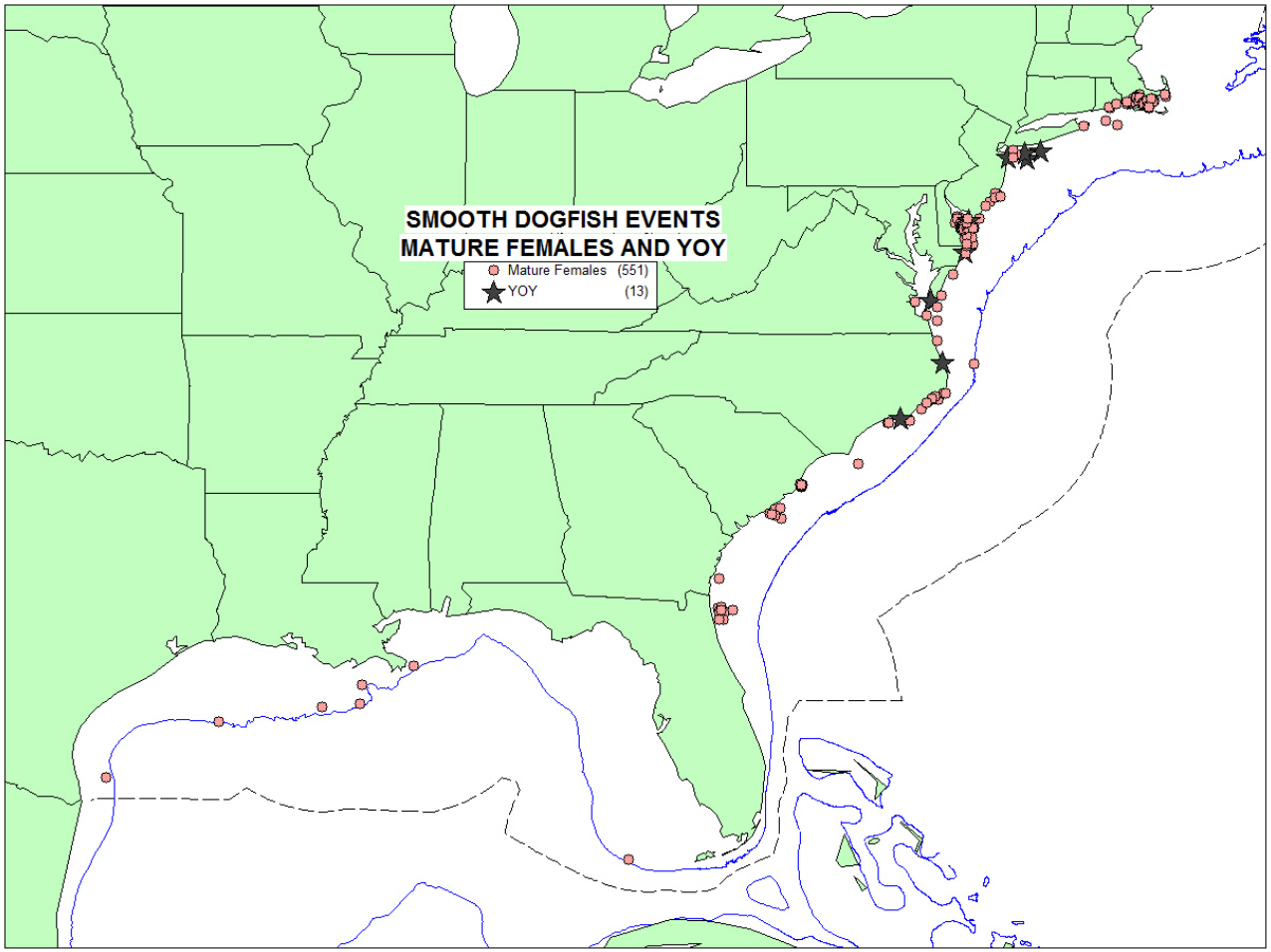

Figure 6. Locations of Young of the Year (YOY) and mature female smooth dogfish from NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.

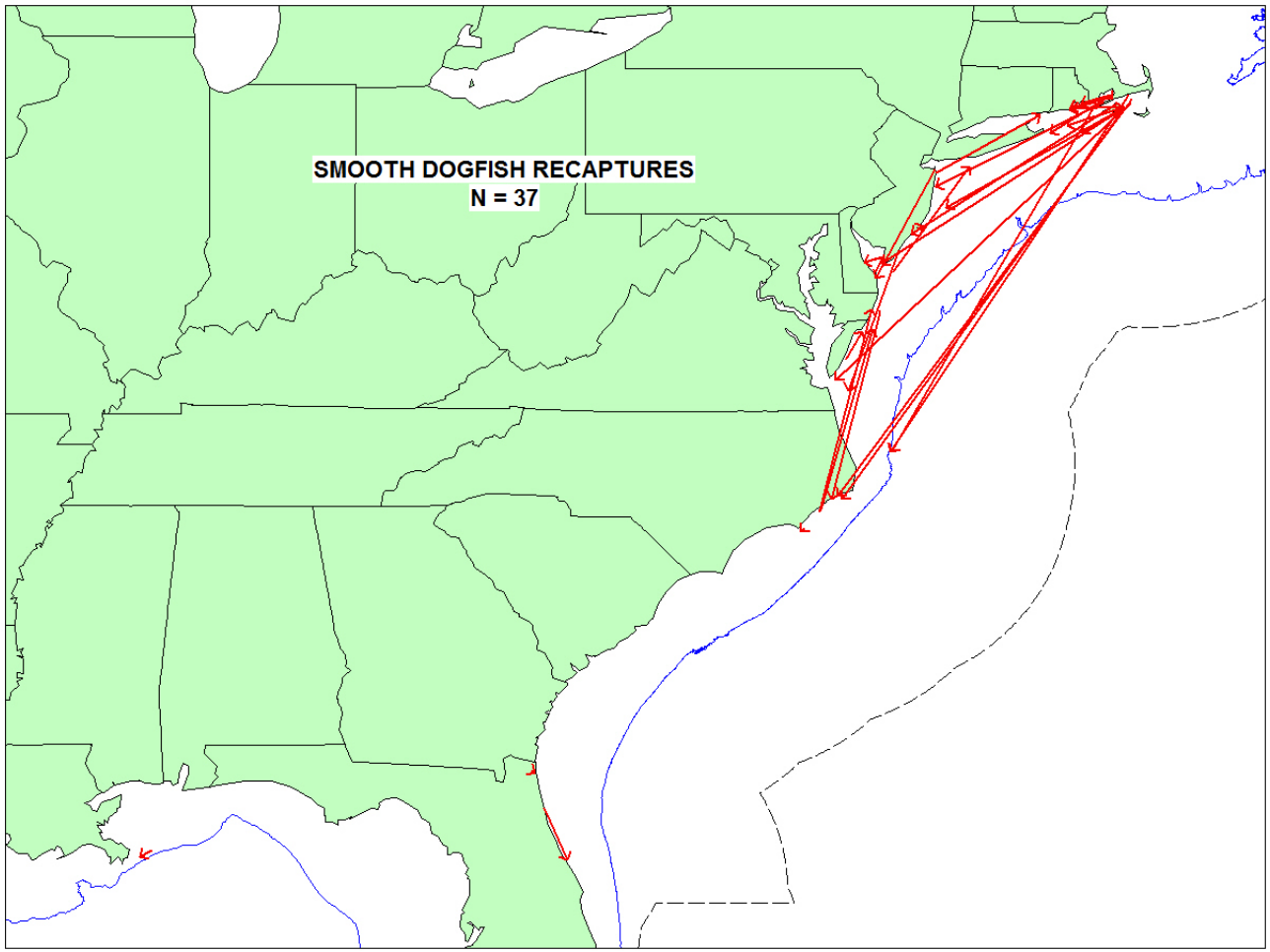

Figure 7. Smooth dogfish recaptures from the NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.

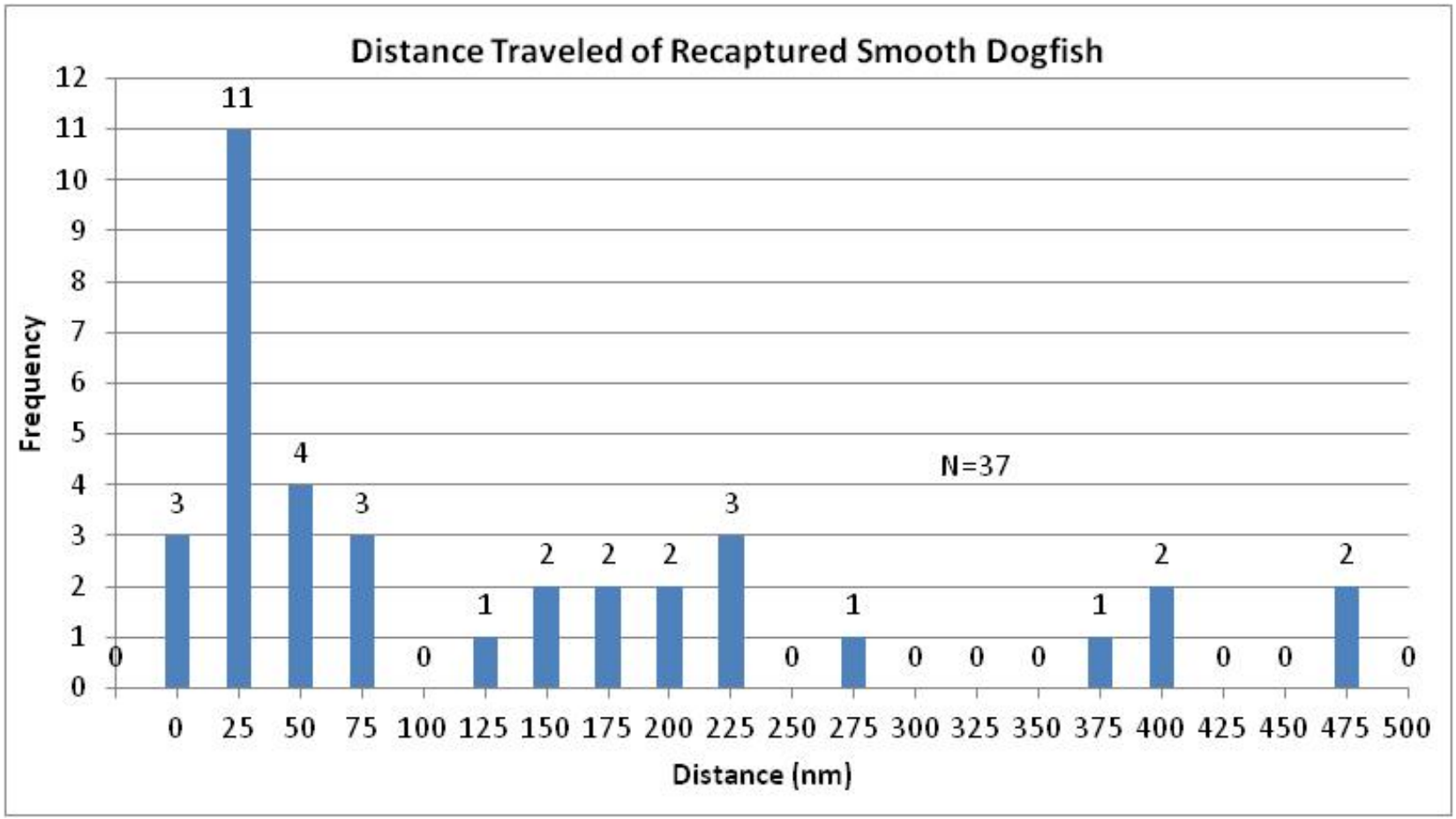

Figure 8. Frequency of distances traveled for recaptured smooth dogfish from the NMFS CSTP.

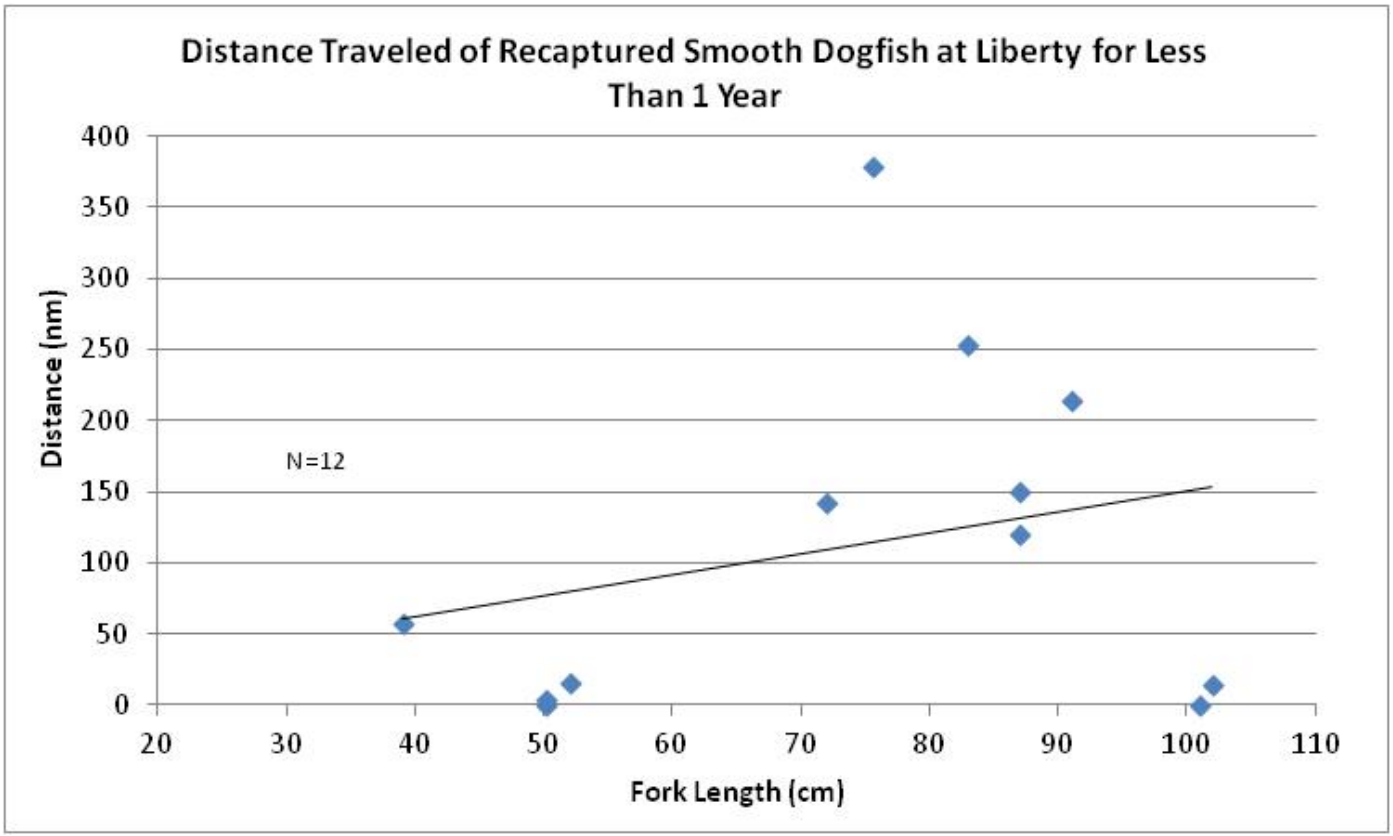

Figure 9a. Distances traveled for smooth dogfish recaptured within one year of initial tagging by fork length from the NMFS CSTP.

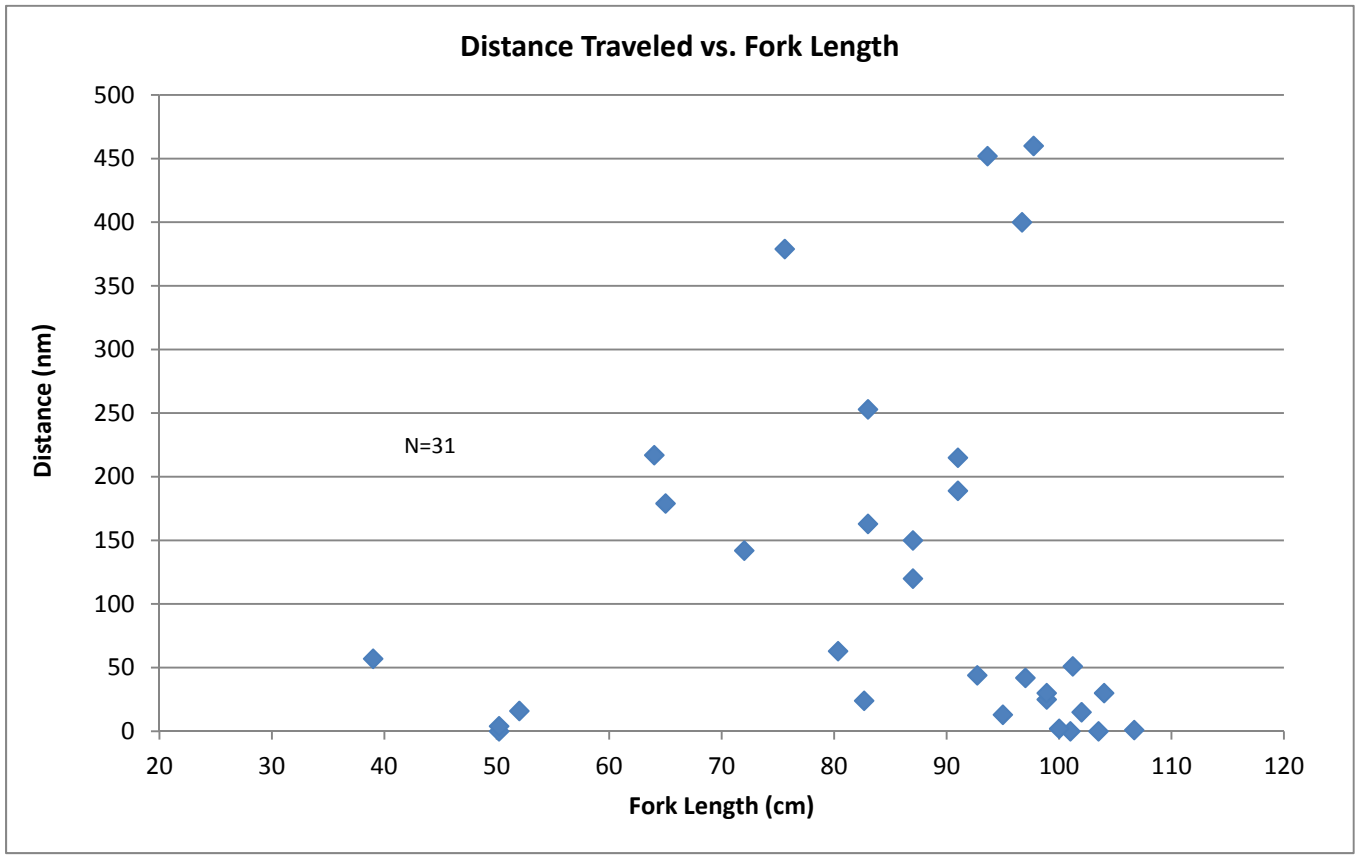

Figure 9b. Distances traveled for smooth dogfish by fork length from the NMFS CSTP.

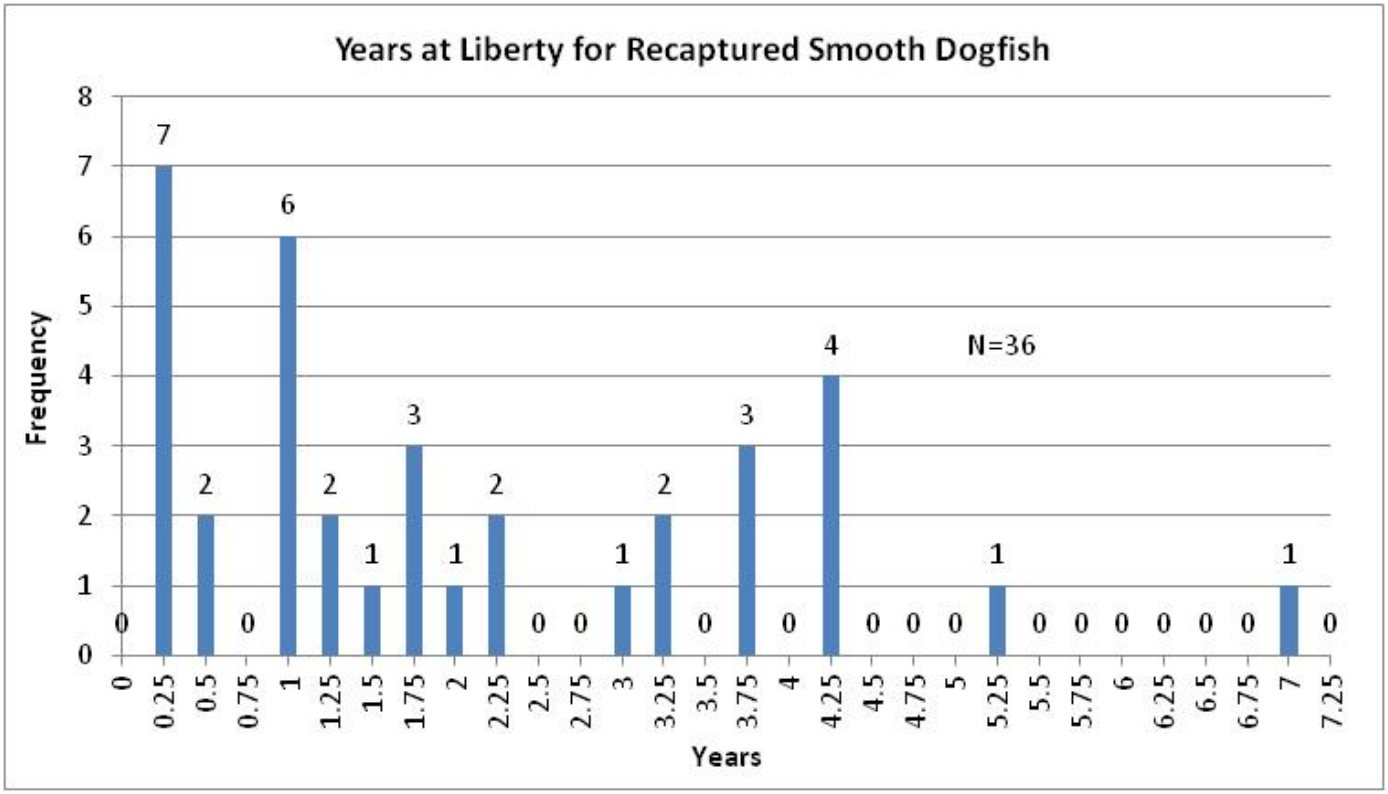

Figure 10. Frequency of years at liberty for all smooth dogfish recaptured from the NMFS CSTP.

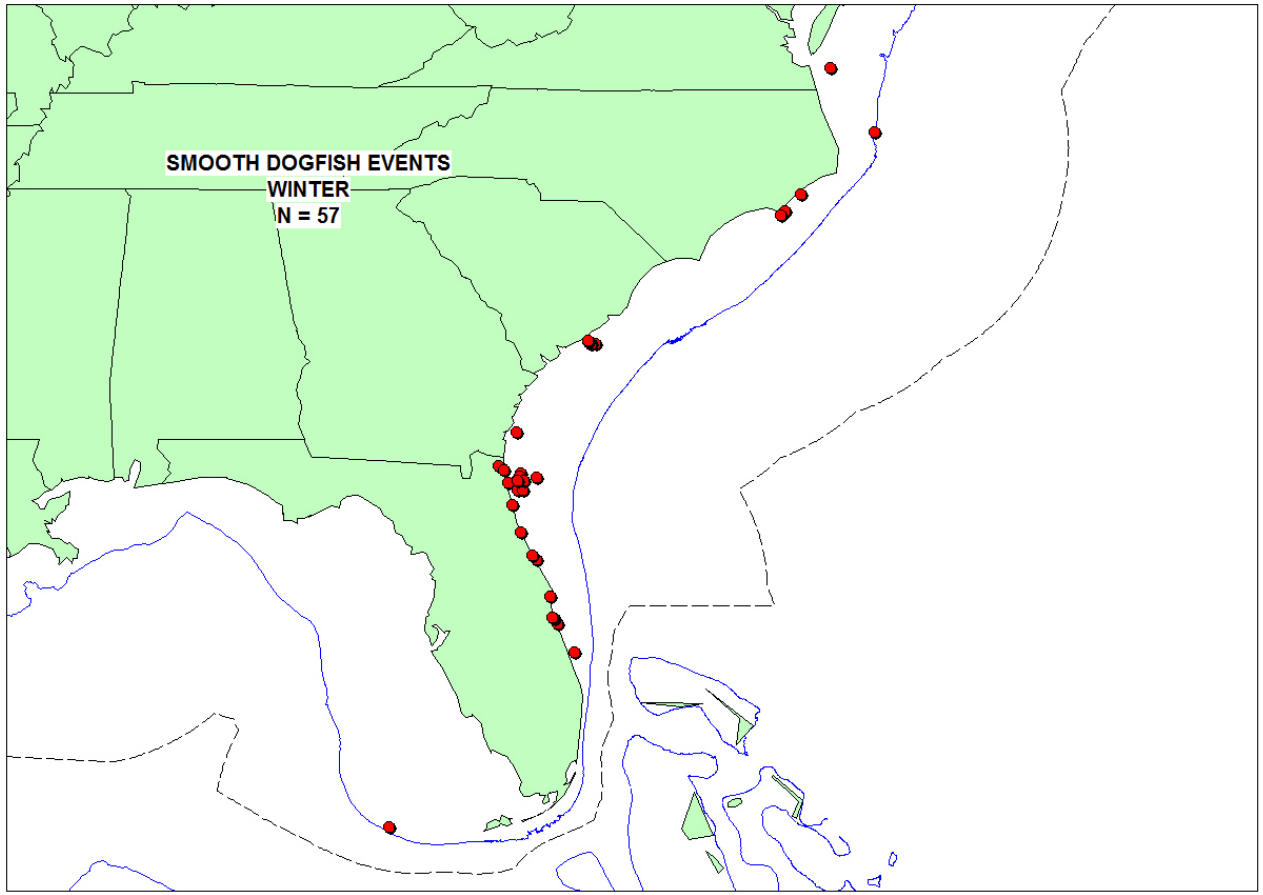

Figure 11. Smooth dogfish events in winter from the NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.

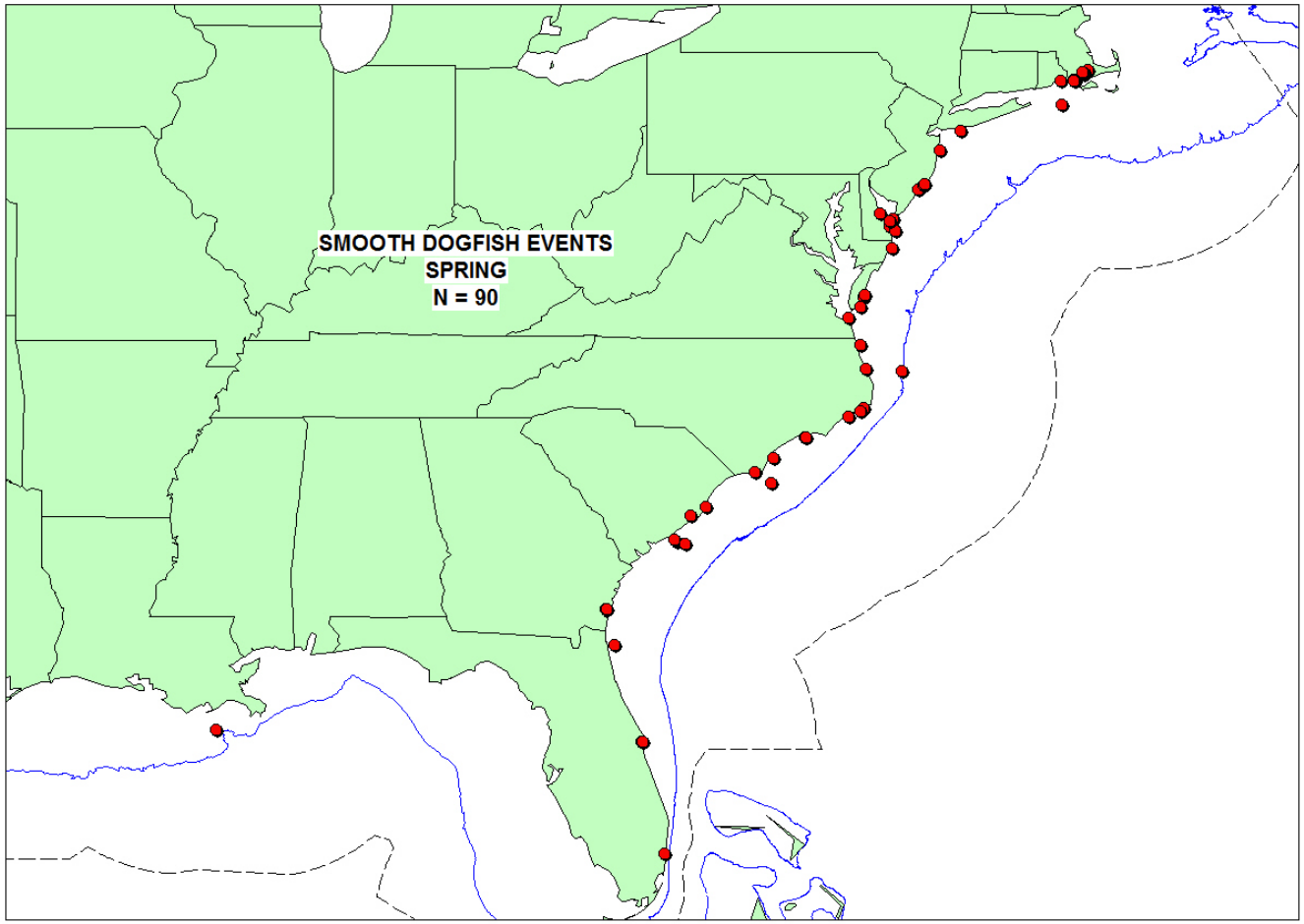

Figure 12. Smooth dogfish events in spring from the NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.

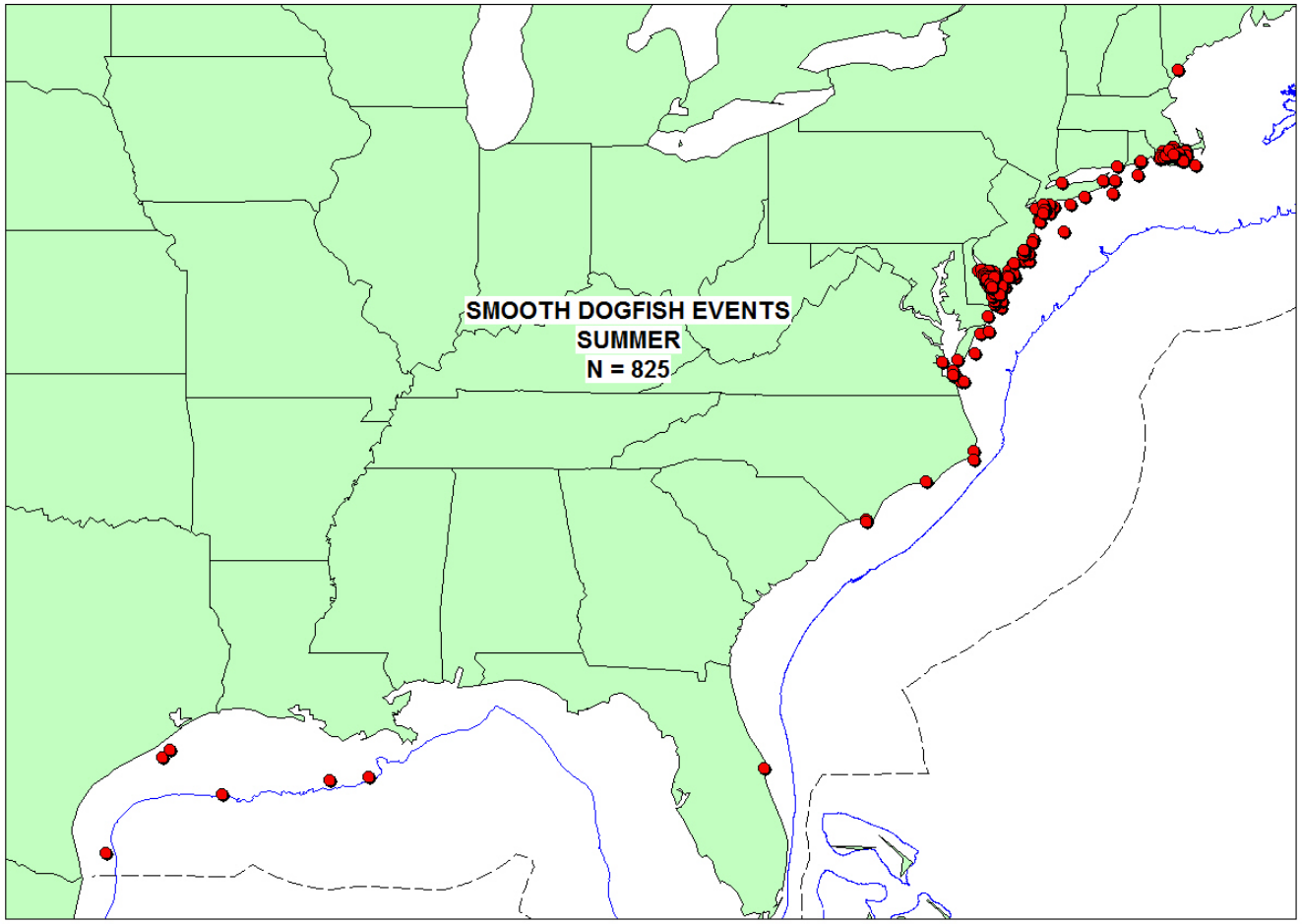

Figure 13. Smooth dogfish events in summer from the NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.

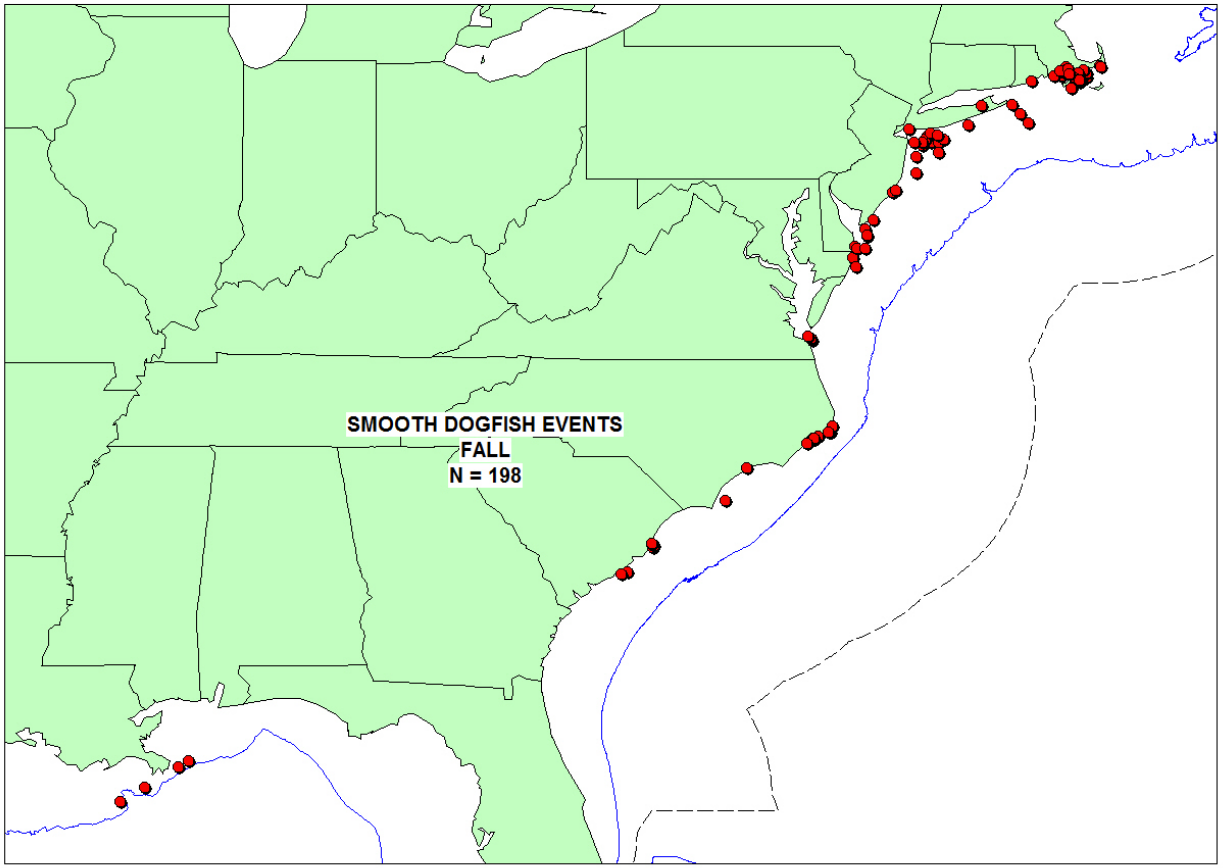

Figure 14. Smooth dogfish events in fall from the NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.

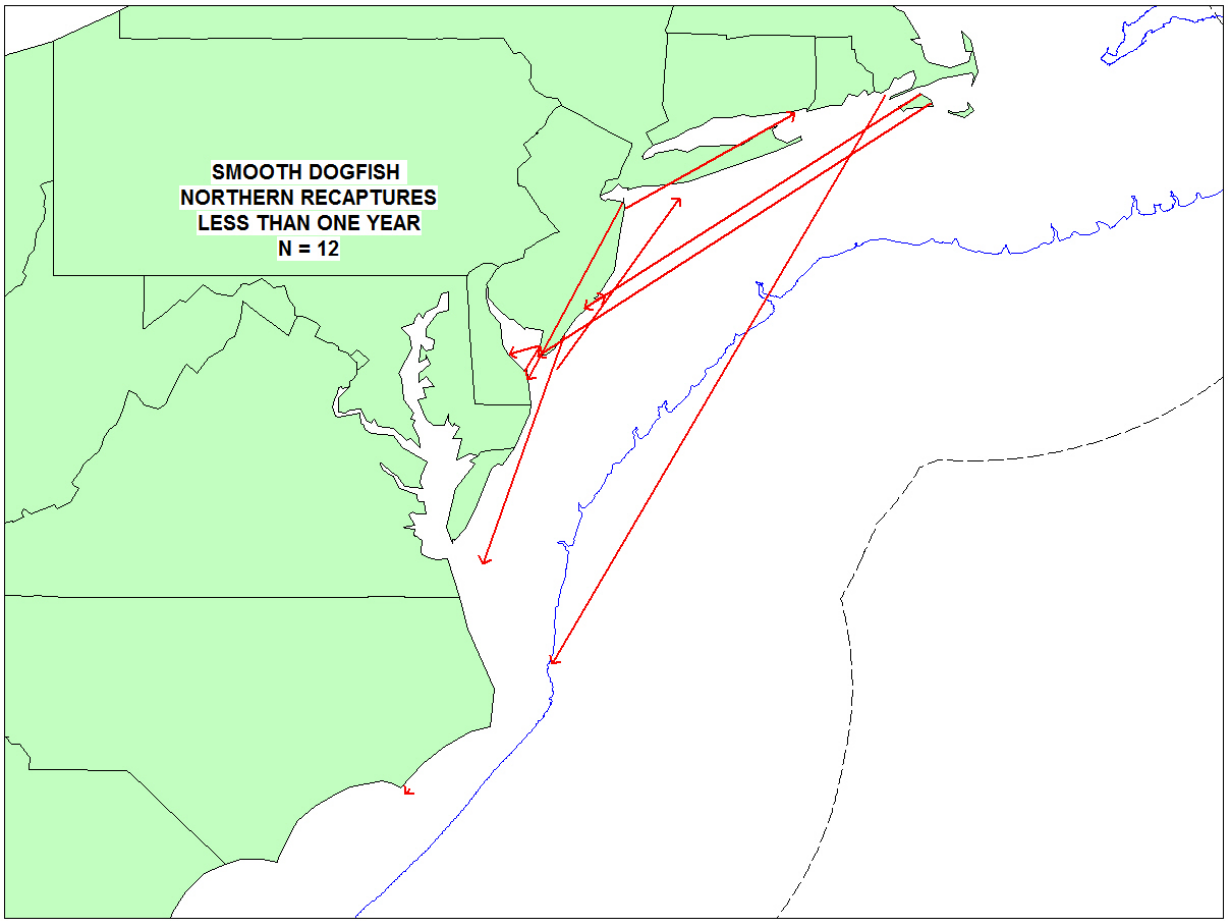

Figure 15. Northern smooth dogfish recaptures, less than one year at liberty from the NMFS CSTP. The solid line represents the 200m depth contour. The dotted-dashed line represents the U.S. EEZ.