Mark/Recapture Data for the Bonnethead (*Sphyrna tiburo)*, in the Western North Atlantic from the NEFSC Cooperative Shark Tagging Program

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Summary
Mark/recapture information from the National Marine Fisheries Service (NMFS) Cooperative Shark Tagging Program (CSTP) covering the period from 1965 through 2012 are summarized for the bonnethead shark (*Sphyrna tiburo)* in the western North Atlantic. The extent of the tagging effort, areas of release and recapture, and movements and length frequencies of tagged sharks are reported. Two areas were distinguished in order to identify exchange between the Atlantic and Gulf of Mexico. Overall, there was no movement between the Atlantic and Gulf of Mexico and limited exchange (1 fish) between the US and the Mexican-managed portion of the Gulf of Mexico. The true extent of this movement is unclear due to the possibility of under-reporting of recaptures.

Introduction

The Bonnethead shark, *Sphyrna tiburo*, is a small coastal shark found in the shallow waters of the Gulf of Mexico and southwest North Atlantic Ocean (Carlson and Parsons 1997). Females reproduce annually; they mate in November, fertilize in late March/early April and parturition occurs in late August/early September (Parsons 1993, Manire et al. 1995). Males mature at two years of age while females mature between two and three years of age. The maximum age of males is eight years, and for females is 12 years (Carlson and Parsons 1997).

The purpose of this document is to summarize mark/recapture information from the NMFS Cooperative Shark Tagging Program (CSTP) for the bonnethead shark (*Sphyrna tiburo*) in the western North Atlantic. These data cover the period from 1965 through 2012 presenting the extent of the tagging effort, areas of release and recapture, and movements of tagged sharks. Data synopses include numbers of fish tagged and recaptured, overall recapture rate, maximum and mean distance traveled, maximum time at liberty, mean lengths, and length frequencies.

Materials and Methods

The NMFS Cooperative Shark Tagging Program (CSTP) was initiated in 1962. Information on the history and methods of the CSTP are detailed in Kohler et al. 1998 and Kohler and Turner 2001. Recreational and commercial fishermen conducted the majority of tagging for these sharks, providing information on size, sex, condition, location, and date of capture. The two primary types of tags used were 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. When a marked shark is re-caught, information similar to that obtained at release is requested from the recapture, allowing for the calculation of time at large, displacement, and speed. Distance traveled in nautical miles (nm) between tagging and recapture sites is a minimum straight-line distance. For the purposes of these analyses, the boundary between the Gulf of Mexico and the Atlantic region was a line beginning on the east coast of Florida at 25º10.4'N latitude, proceeding due east to the U.S. EEZ.

This report summarizes the CSTP mark/recapture information for the bonnethead in the western North Atlantic from 1965 through 2012. Length and weight for CSTP tag returns are reported with 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) = (1.18) FL (cm) - 23.34 (Lombardi-Carlson 2007). When neither FL nor TL were provided, weight in kilograms was converted to FL by rearranging the following formula: Weight (kg) = $(9.52*10^{-11})$ TL $(cm)^{3.59}$ (Lombardi-Carlson 2007). Sharks were categorized into life stages according to length (Table 1). The boundary between young of the year and juveniles was defined using the maximum YOY size of 55.0cm TL from Carlson and Parson (1997); it was determined that the young of the year were less than or equal to 48cm FL. Males and females were considered mature when FL was greater than the median length at maturity, 63cm and 72cm, respectively (Lombardi-Carlson 2007). Males and females between 49cm FL and the median length at maturity were considered to be juveniles (49-63 for

males; 49-72 for females). Sharks of unknown sex that were between 49cm FL and 67cm FL were categorized as juveniles. Sharks without a size estimate were categorized as "unknown maturity." Sharks of unknown sex that were 67cm FL or larger were categorized as mature.

Results

A total of 4,123 bonnetheads were released with tags along the U.S. east coast and the Gulf of Mexico between 1965 and 2012 (Table 2, Figure 1). Of the 3,938 fish of known sex, 934 (24%) were males and 3,004 (76%) were females resulting in a 1:3.22 male:female sex ratio. Bonnetheads were predominantly caught by gillnet (51%), rod and reel (28%), and longline (21%). Sharks were also caught in smaller numbers ($n<10$) with handline, free swimming, beach seine, and by mid-water trawl. Mature fish were the most commonly caught life stage for both males and females (Table 3, Figure 2, 3). The largest measured male and female bonnetheads were 122cm FL and 135cm FL, respectively. The mean fork length for both males and females was 60.4 and 77.3cm FL, respectively and overall was 73.2cm FL (Table 3).

A total of 172 sharks were recaptured from 1972 through 2012 with an overall recapture rate of 4.2% and mean distance traveled of 10.0nm (Table 2). Young of the year had the highest mean displacement (32nm) relative to the juvenile and mature sharks (11nm and 6nm, respectively) (Figure 4). The bonnethead at liberty the longest was 7.0 years (2,572 days) and was recaptured 1 nm from its original tagging location off the coast of South Carolina. The longest distance traveled was 301nm from a fish that was originally tagged off Bulls Bay, South Carolina and recaptured off Melbourne Beach, FL, 7.9 months later. Both fish were released again after recapture. There was no movement between the Atlantic and Gulf of Mexico. The majority of the recaptured fish showed small Atlantic and Gulf coastal movements with only one bonnethead recovered just into Mexican waters (Figures 5-9).

Overall, there was no movement between the Atlantic and Gulf of Mexico and limited exchange (1 fish) between the US and the Mexican-managed portion of the Gulf of Mexico. The true extent of this movement is unclear due to the possibility of under-reporting of recaptures.

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Table 1. Literature values for lengths associated with maturity.

Reference	n	Location	Condition	Female (FL)*	Male (FL)*
Lombardi-Carlson 2007	539	Gulf of Mexico	Mature	72 Median length	63 Median length
Carlson & Parsons 1997	215	Gulf of Mexico	Juvenile	49	49
Lombardi-Carlson et al. 2003	539	North-west Florida	Near term embryo	27	27
		Tampa Bay	Near term embryo	22	22
		Florida Bay	Near term embryo	20	20
		North-west Florida	Maturity	82	72
		Tampa Bay	Maturity	72	62
		Florida Bay	Maturity	67	57

*Values given in TL were converted to FL (cm) using formula from Lombardi-Carlson 2007

Table 2. CSTP recapture statistics by sex for bonnetheads tagged and recaptured. Displacement and speed values are calculated using the straight line distance from the tagging location to the recapture location.

Sex	Tagged	Recaptured	Recaptured Rate	Mean Displacement (nm)	Max Displacement (nm)	Mean Time at Liberty (days)	Max Time at Liberty (days)	Mean Speed (nm/day)	Max Speed (nm/day)
Male	934	11	1.2	4.9	22	154	785	0.07	0.53
Female	3,004	156	5.2	10.1	301	363	2,572	0.10	2.88
Unknown	185	5	2.7	16.8	40	75	118	0.32	0.89
Total	4,123	172	4.2	10.0	301	343	2,572	0.10	2.88

Sex ratio (M:F) 1: 3.22

Table 3. CSTP data distributed by sex and life stage for bonnetheads tagged (including recaptures).
YOY=young of the year.

							Fork Length				
Sex	Mature	Juveniles	YOY	Embryos*	Unknown Maturity	Total	Min	Max	Median	Mean	SD
Males	**442** *10.30* *46.80* *16.60*	**322** *7.50* *34.10* *27.30*	**180** *4.20* *19.00* *40.50*	**0** *0* *0* *0*	**1** *0.02* *0.11* *9.10*	**945** *22.00*	25	122	61	60.5	12.93
Females	**2,133** *49.70* *67.50* *80.15*	**788** *18.30* *25.00* *18.30*	**230** *5.40* *7.30* *19.50*	**0** *0* *0* *0*	**9** *0.21* *0.28* *81.80*	**3,160** *73.60*	25	135	80	77.3	16.48
Unknown Sex	**86** *2.00* *45.30* *3.30*	**69** *1.61* *36.30* *5.85*	**34** *0.79* *17.90* *7.70*	**0** *0* *0* *0*	**1** *0.02* *0.53* *9.10*	**190** *4.40*	32	131	66	67.4	18.97
Total	**2,661** *62.00*	**1,179** *27.45*	**444** *10.30*	**0** *0*	**11** *0.25*	**4,295** *100*	25	135	74	73.2	17.38

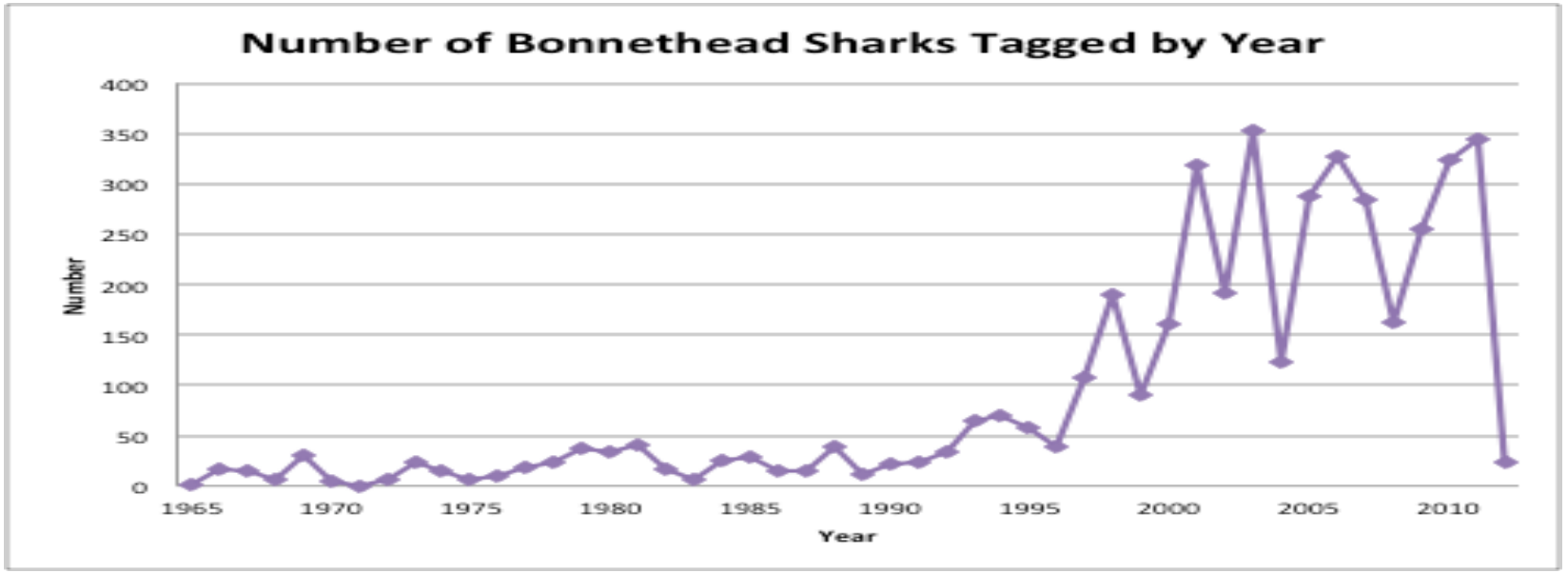
*embryos from captured pregnant females, that were tagged and released

Key

Frequency
Percent
Row percent
Column percent

Figure 1. Total number of bonnetheads tagged (A) and recaptured (B) by year.

A.



B.

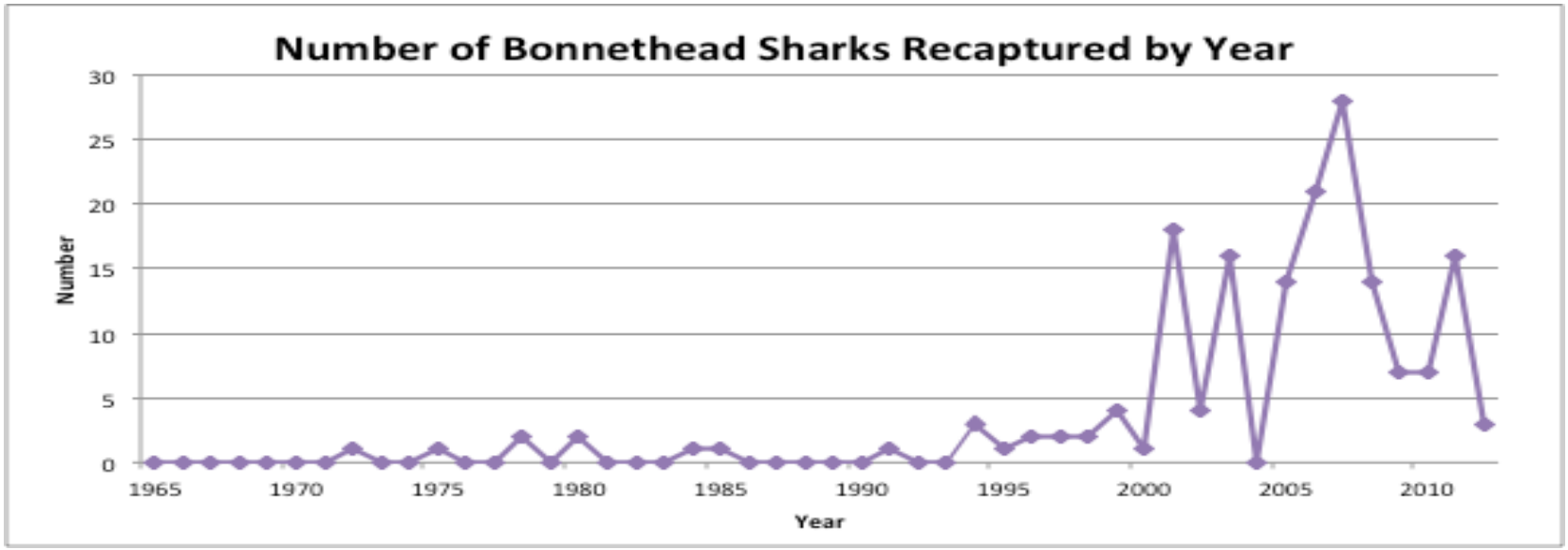


Figure 2. Length frequency for bonnetheads tagged (including recaptures).

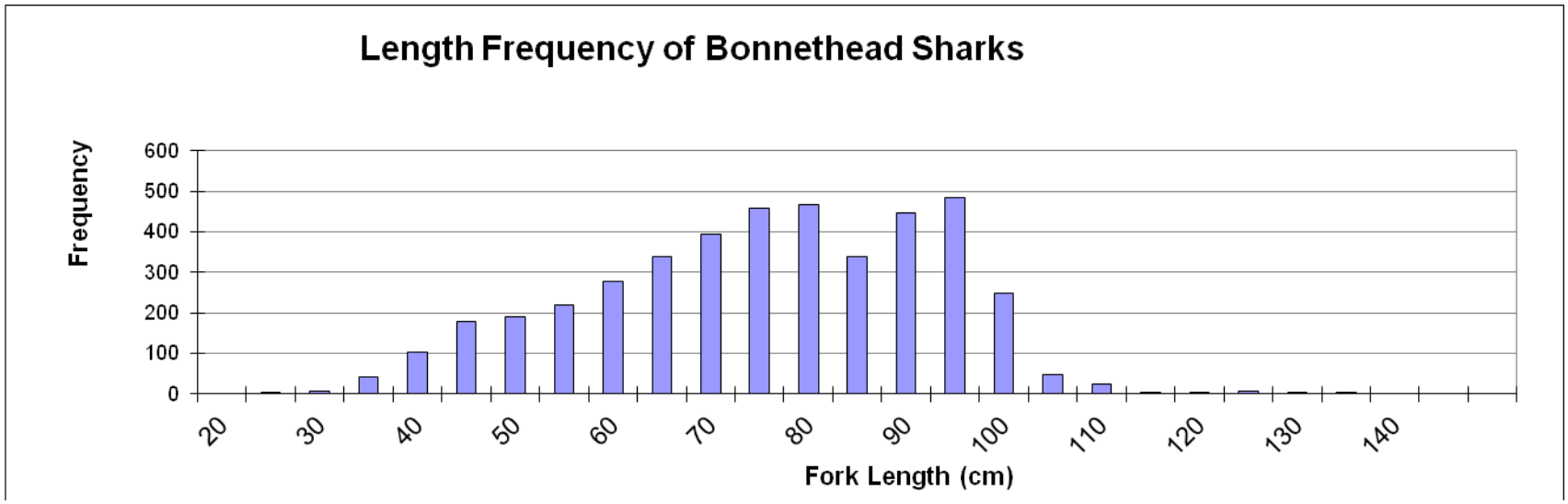


Figure 3. Length frequency by sex for bonnetheads tagged (including recaptures).

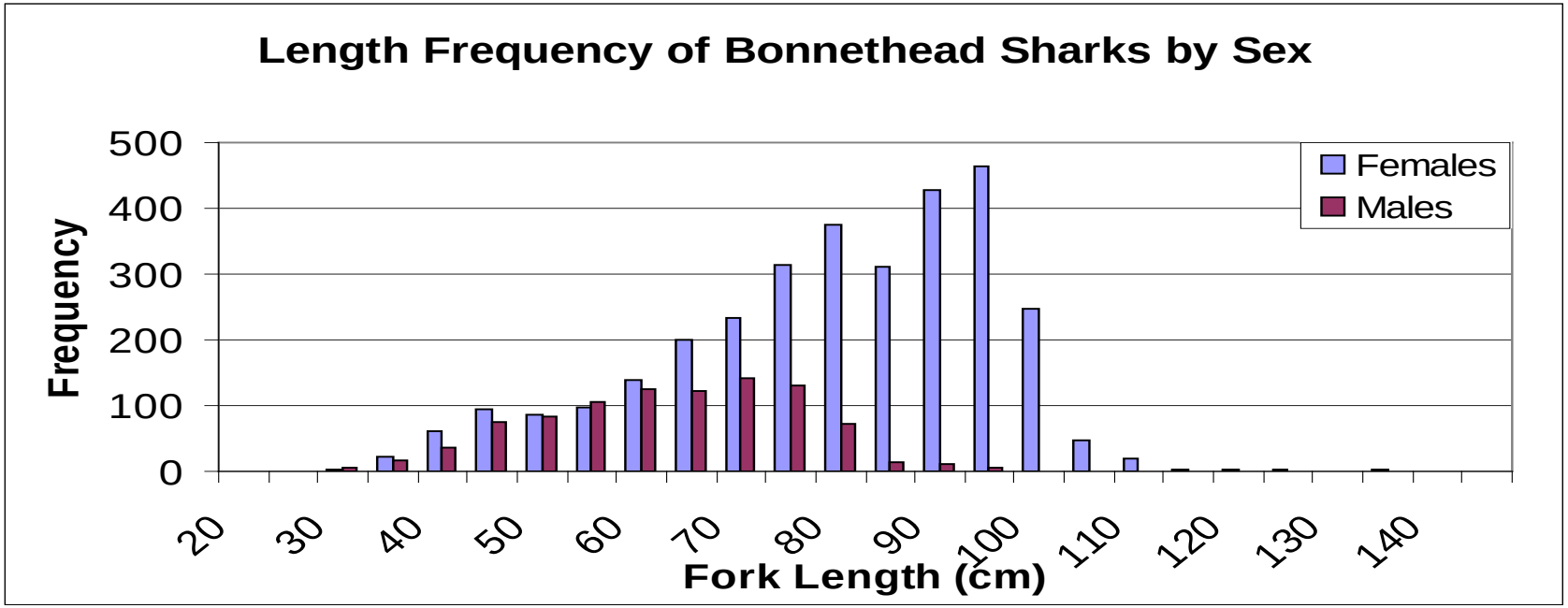


Figure 4. Mean displacement of bonnetheads at large for 1-2572 days. N=7, 40, and 116 for young of the year, juvenile, and mature sharks, respectively. Displacement values are calculated using the straight-line distance from the tagging location to the recapture location.

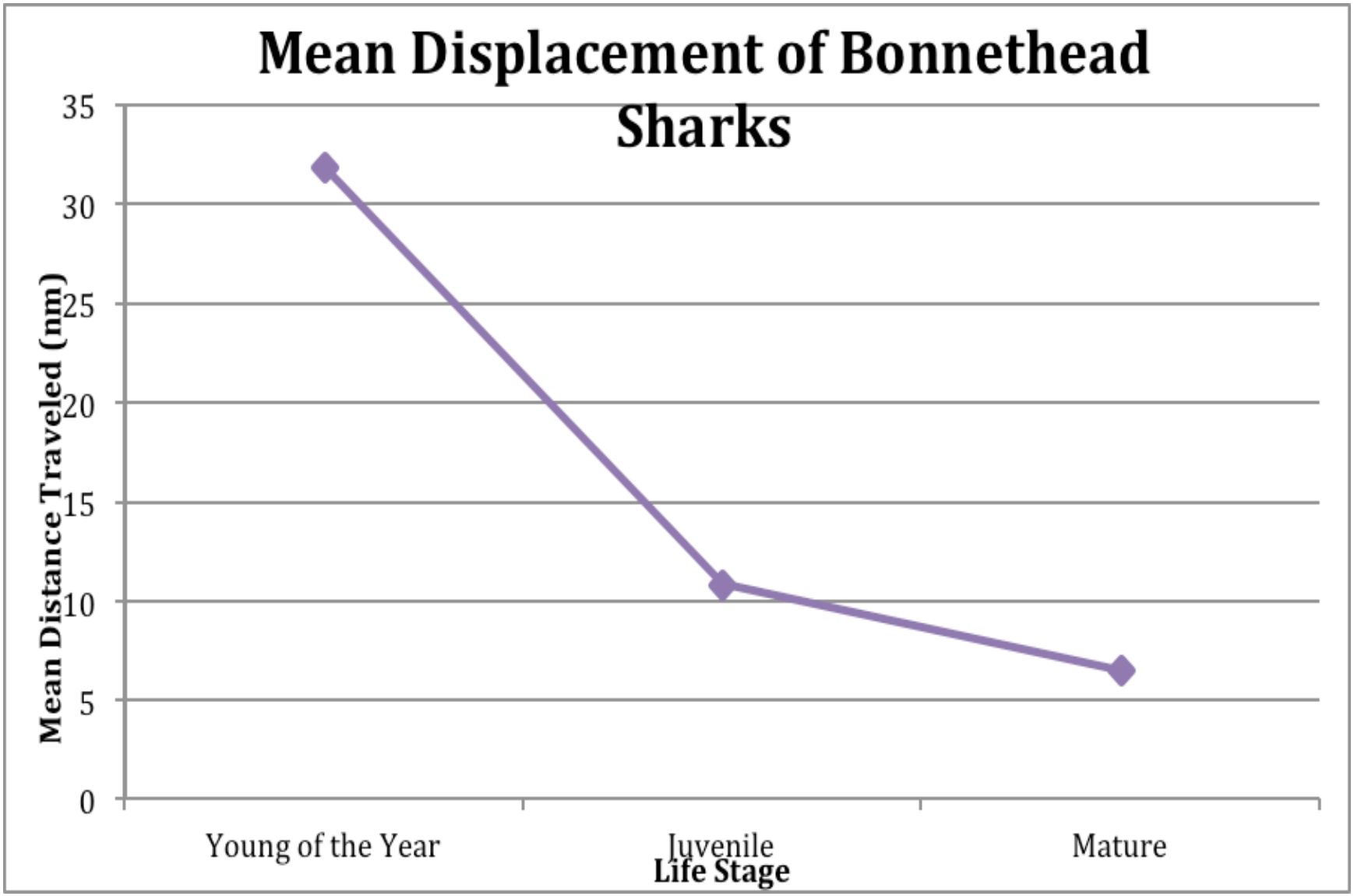


Figure 5. Bonnethead tagging data (including recaptures) by sex. The solid blue line represents the 200m depth contour. The solid black line represents the U.S. EEZ.

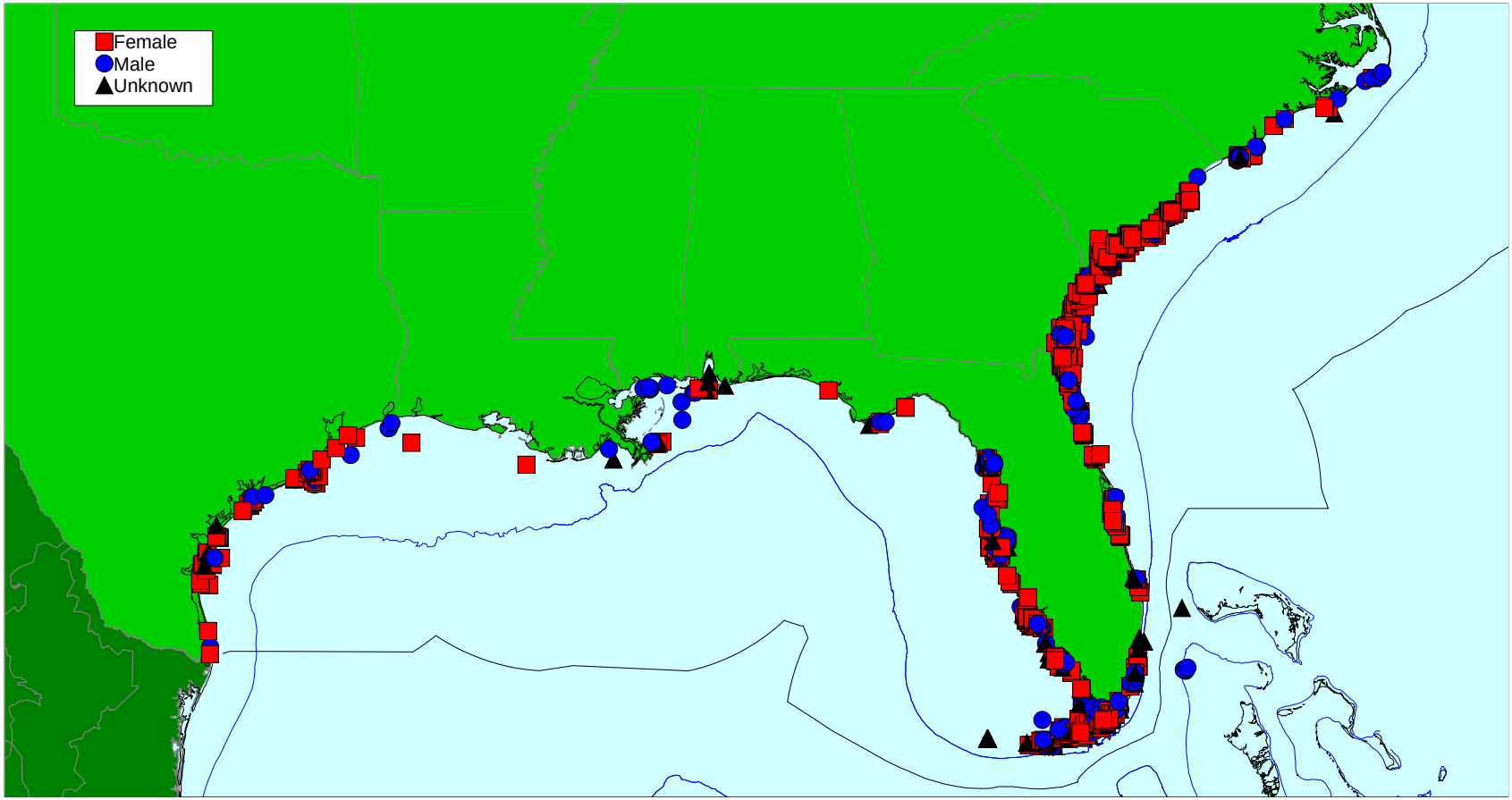


Figure 6. Bonnethead tagging data (including recaptures) by life stage. The solid blue line represents the 200m depth contour. The solid black line represents the U.S. EEZ.

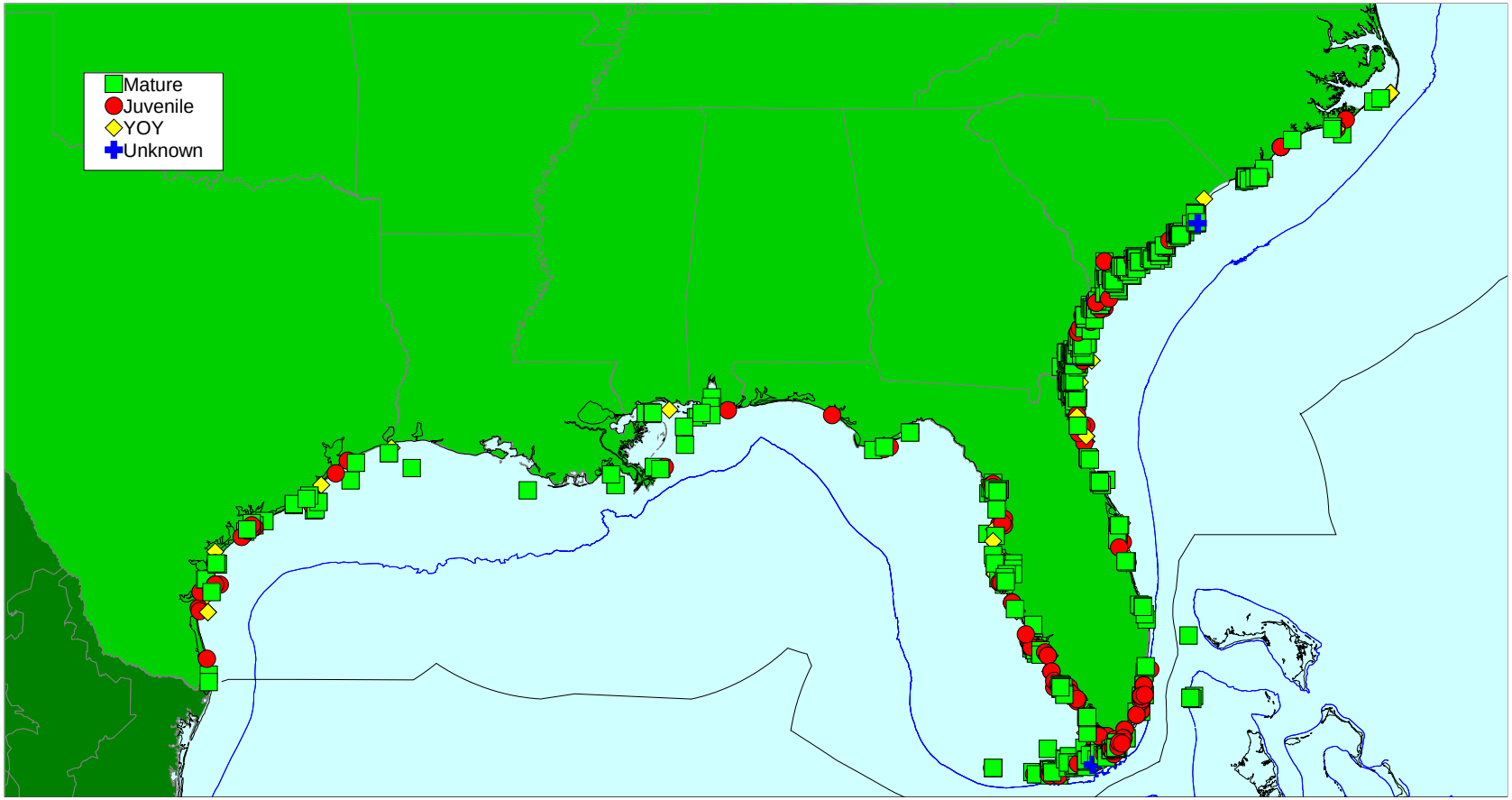


Figure 7. Locations of tagged young of the year and pregnant bonnetheads (including recaptures). The solid blue line represents the 200m depth contour. The solid black line represents the U.S. EEZ.

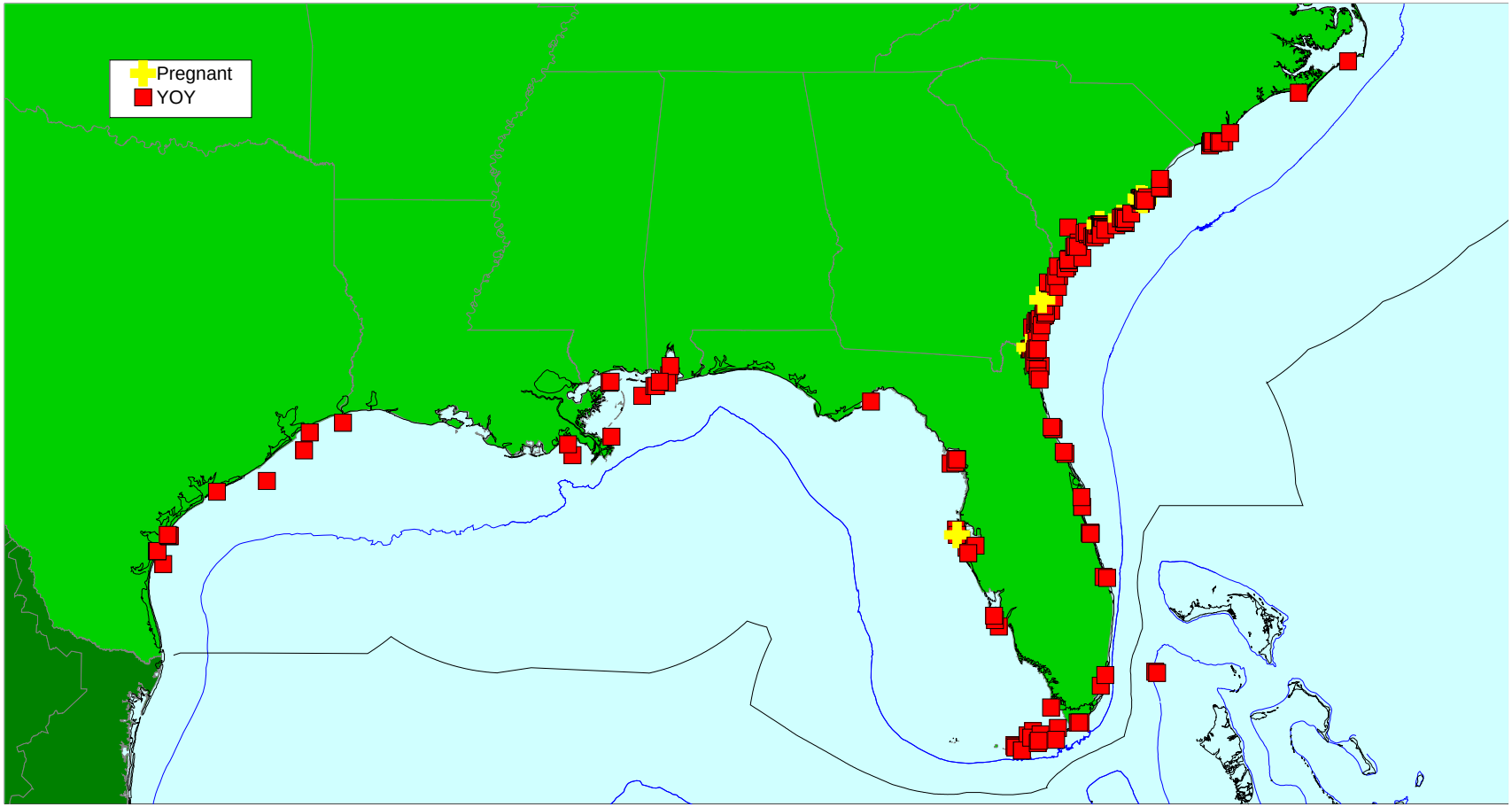


Figure 8. Bonnethead recaptures by sex. The solid blue line represents the 200m depth contour. The solid black line represents the U.S. EEZ.

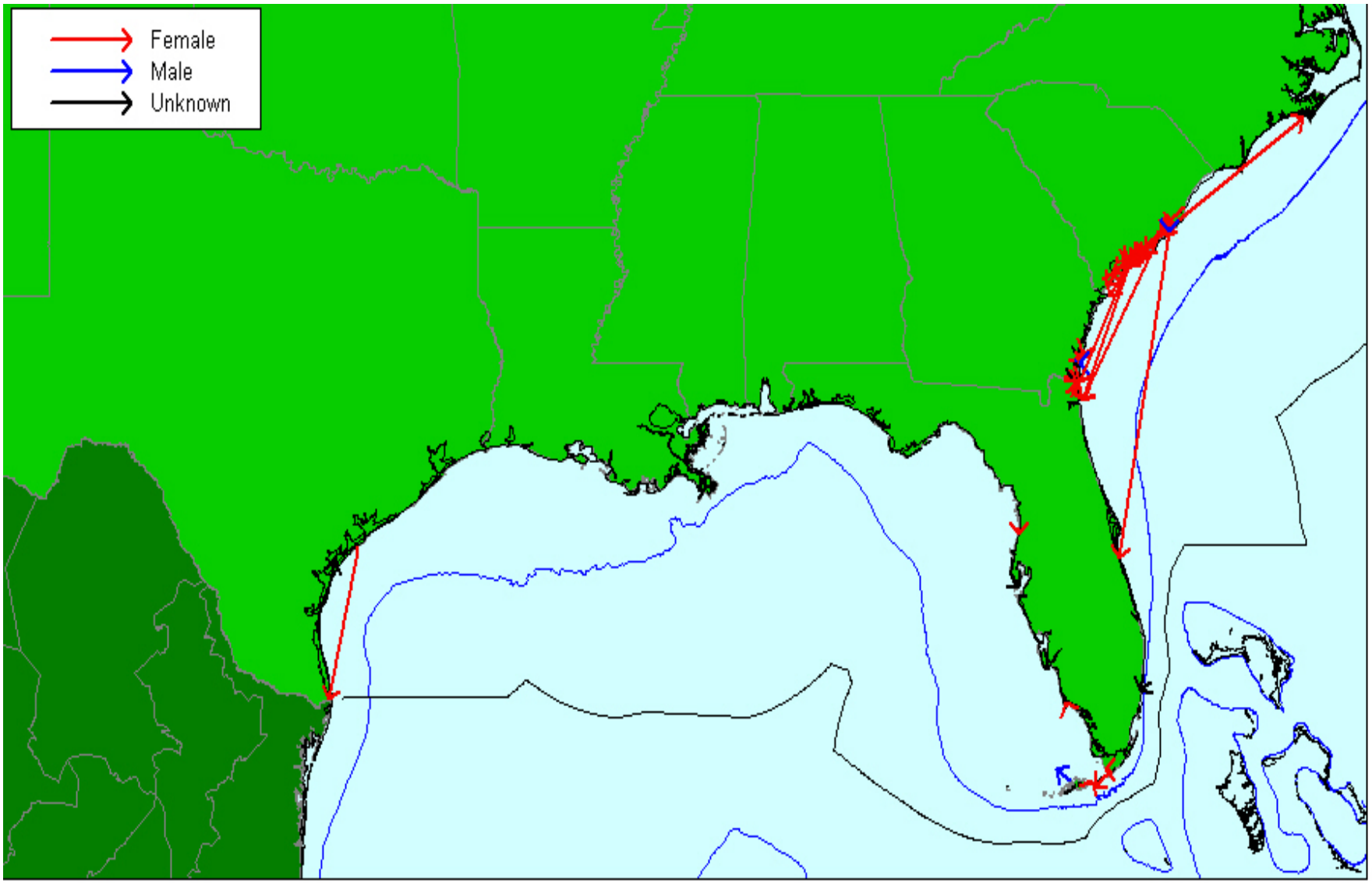


Figure 9. Bonnethead recaptures by sex and life stage. The solid blue line represents the 200m depth contour. The solid black line represents the U.S. EEZ.