# 3.0 DESCRIPTION OF AFFECTED ENVIRONMENT

## 3.1 INTRODUCTION

Sharks belong to the class Chondrichthyes (cartilaginous fishes) that also includes rays, skates, and deepwater chimaeras (ratfishes). From an evolutionary perspective, sharks are an old group of fishes characterized by skeletons lacking true bones. The earliest known sharks have been identified from fossils in the rocks of the Devonian period, over 400 million years ago. These primitive sharks were small creatures, about 60 to 100 cm long, that were preyed upon by larger armored fishes that dominated the seas. Sharks have survived competition for eons, evolving into the large and aggressive predators that dominate the seas today. The life span of sharks in the wild is not known, but it is believed that many species may live 30 to 40 years or longer.

Since sharks have evolved primarily as apex predators, they are not equipped to withstand predation themselves - especially in the form of intense exploitation. Relative to other marine fish, sharks have a very low reproductive potential. Several important commercial species, including large coastal carcharhinids such as sandbar (Casey *et al*., 1985; Sminkey and Musick, 1995; Heist *et al*., 1995), lemon (Brown and Gruber, 1988), and bull sharks (Branstetter and Stiles, 1987), do not reach maturity until 12 to 18 years of age. Various factors determine this low reproductive rate: slow growth, late sexual maturity, one- to two-year reproductive cycles, a small number of young per brood, and specific requirements for nursery areas. These biological factors leave many species of sharks vulnerable to overfishing.

There is extreme diversity among the 350 species of sharks, ranging from tiny pygmy sharks of only 20 cm in length to the giant whale sharks, over 12 meters in length. There are fast-moving, streamlined species such as mako and thresher sharks, and sharks with flattened, ray-like bodies, such as angel sharks. The most commonly known sharks are large apex predators including the white, mako, tiger, bull, and great hammerhead. Some shark species reproduce by laying eggs, others nourish their embryos through a placenta. Despite their diversity in size, feeding habits, behavior and reproduction, many of these adaptations have contributed greatly to the evolutionary success of sharks.

Sharks are generally aggressive predators feeding near the top of the food web. They have extremely sensitive smell receptors, eyes that can adapt to dim light, lateral line receptors that sense movement in the water, and electroreceptors that can detect prey buried in the sand even in the absence of scent or visual clues. In addition to their finely-tuned senses, sharks are armed with a formidable set of teeth and jaws. The teeth are replaced often, so sharks always have a sharp set capable of inflicting a clean bite. The tiger shark eats large turtles, and the tiny cookiecutter shark feeds by carving plugs of flesh out of large fishes and whales. Only basking sharks, whale sharks, and megamouth sharks feed by filtering small organisms from the water.

The most significant reproductive adaptations of sharks are internal fertilization and the production of fully developed young or “pups.” These pups are large at birth, effectively reducing the number of potential predators and enhancing their chances of survival. During mating, the male shark inseminates the female with copulatory organs, known as claspers, that develop on the pelvic fins. In most species, the embryos spend their entire developmental period protected within their mother's body, although some species lay eggs. The number of young produced by most shark species in each litter is small, usually ranging from two to 25, although large females of some species can produce litters of 100 or more pups. The production of fully-developed pups requires great amounts of nutrients to nourish the developing embryo. Traditionally, these adaptations have been grouped into three modes of reproduction: oviparity, ovoviviparity, and viviparity.

Oviparity is the most primitive condition, although it is still different from the reproductive strategy of bony fishes. Oviparous sharks lay large eggs that contain sufficient yolk to nourish the embryo and allow it to emerge fully developed. These eggs are enclosed in leathery cases that are deposited on the sea bottom, usually attached to plants or rocks. There is no parental care or brooding in sharks. The only protection for the embryo is its tough leathery case, composed of protein fibers. The development of these eggs is temperature-dependent and hatching usually occurs in a few months to a year. The pups of oviparous sharks are somewhat small because their growth is limited by the amount of nutrients stored in the egg. The embryos of the oviparous whale shark, the largest living fish, measure only 36 cm. Oviparity is found in four families of sharks: bullhead sharks (*Heterodontidae*), cat sharks (*Scyliorhinidae*), whale sharks (*Rhincodontidae*), and some species of nurse sharks (*Ginglymostomatidae).*

Ovoviviparity, also known as aplacental viviparity, is the most common mode of reproduction in sharks. The eggs of ovoviviparous sharks hatch in the uterus before the embryos are fully developed. The embryos continue to grow in the uterus, nourished by the yolk sac, without forming a placental connection with the mother. The size of the litter is highly variable, depending on the reproductive strategy of the species. In some ovoviviparous sharks, such as the sand tiger, the yolk is absorbed very early in development. Thereafter, the embryos nourish themselves by swallowing unfertilized eggs and smaller embryos in the uterus, in a form of embryonic cannibalism called oophagy. Having eaten its smaller siblings, usually only one embryo survives in each of the two uteri. Ovoviviparous sharks include cow, frill, sand tiger, goblin, mackerel, basking, thresher, false cat sharks, saw, angel, squaloid, some nurse sharks, some smooth dogfishes, and some cat sharks.

Viviparity, or placental viviparity, is the most advanced mode of reproduction. The embryos of viviparous sharks are initially dependent on stored yolk but are later nourished by the mother through a placental connection. Once connected to the blood supply of the mother, the embryo has an abundant and continuous supply of nutrients. The embryo can thus be nurtured to a relatively large size at birth. Most placental sharks produce broods of two to a dozen, with a few exceptional pelagic species producing 20 to 40 young. Smooth dogfishes, requiem sharks, and hammerheads are all viviparous sharks.

In spite of the diversity of adaptations, sharks generally have a low reproductive potential. Most species of sharks have gestation periods and ovarian cycles that each last about a year. These two cycles may or may not run concurrently. In most of the larger carcharhinid sharks, the cycles follow sequentially. Most of these species reproduce only once every two years. In other species, such as hammerheads and sharpnose sharks, the ovarian cycle and the gestation periods run concurrently. Females carry developing embryos and developing eggs at the same time; these species reproduce yearly. Other species have even longer gestation periods. The spiny dogfish has a gestation period of about 24 months, the longest known of any living vertebrate.

Adults usually congregate in specific areas to mate and females travel to specific nursery areas to pup. These nurseries are discrete geographic areas, usually in waters shallower than those inhabited by the adults. Frequently the nursery areas are in highly productive coastal or estuarine waters where abundant small fishes and crustaceans provide food for the growing pups. These areas also may have fewer large predators, thus enhancing the chances of survival of the young sharks. In temperate zones, the young leave the nursery with the onset of winter; in tropical areas, young sharks may stay in the nursery area for a few years.

Shark habitat can be described in four broad categories: (1) coastal, (2) pelagic, (3) coastal-pelagic, and (4) deep-dwelling. Coastal species inhabit estuaries, the nearshore and waters of the continental shelves, e.g., blacktip, finetooth, bull, lemon, and sharpnose sharks (which are thought to enter wetland tidal creeks). Pelagic species, on the other hand, range widely in the upper zones of the oceans, often traveling over entire ocean basins. Examples include mako, blue, and oceanic whitetip sharks. Coastal-pelagic species are intermediate in that they occur both inshore and beyond the continental shelves, but have not demonstrated mid-ocean or transoceanic movements. Sandbar, scalloped hammerhead, and dusky sharks are examples of coastal-pelagic species. Deep-dwelling species, e.g., most cat sharks and gulper sharks, inhabit the dark, cold waters of the continental slopes and deeper waters of the ocean basins. For additional information on the life history and habitat of each shark species in the management unit, see Chapters 5 and 6 of the HMS FMP and Chapter 10 of this document.

Seventy-three species of sharks are known to inhabit the waters along the U.S. Atlantic coast, including the Gulf of Mexico and the waters around Puerto Rico and the U.S. Virgin Islands. Seventy-two species are managed under this FMP; spiny dogfish also occur along the U.S. coast, however management for this species is under the authority of the Atlantic States Marine Fisheries Commission as well as the New England and Mid-Atlantic Fishery Management Councils. Based on a combination of ecology and fishery dynamics the sharks in the management unit have been divided into five species groups for management: (1) large coastal species, (2) small coastal species, (3) pelagic species, (4) prohibited species, and (5) deepwater/other species (See Table 3.1 for a classification of species in the management unit). This Amendment to the HMS FMP is proposing to remove deepwater/other species from the management unit.

## 3.2 STATUS OF THE STOCKS

The methods used to determine the status of HMS are fully described in Chapter 3 of the HMS FMP and in a paper describing the technical guidance for implementing National Standard 1 of the Magnuson-Stevens Act (Restrepo *et al.*, 1998). In summary, a species is considered overfished when the current biomass (B) is less than the minimum stock size threshold. The minimum stock size threshold is determined based on the natural mortality of the stock and the biomass at Maximum Sustainable Yield ($B_{MSY}$). The MSY is the maximum long-term average yield that can be produced by a stock on a continuing basis. Overfishing is occurring on a species if the current fishing mortality (F) is greater than the fishing mortality at MSY ($F_{MSY}$). When one or both of these measures occur, a species is declared overfished and action to rebuild the stock and/or prevent overfishing is needed within one year. A species is considered rebuilt when B is greater than $B_{MSY}$ and F is less than $F_{MSY}$. A species is considered healthy when B is greater than or equal to the biomass at optimum yield ($B_{OY}$) and F is less than or equal to the fishing mortality at optimum yield ($F_{OY}$).

### 3.2.1 Large Coastal Sharks (LCS)

The latest Shark Evaluation Workshop (SEW) was held in June 2002. Discussions focused on the availability of four additional years worth of catch estimates, biological data, catch rate series, and the types of models that should be used. The modeling itself was performed after the SEW and incorporated new catch and effort estimates for the years 1998-2001 as well as over 20 catch-per-unit-effort (CPUE) series for LCS, sandbar, and blacktip sharks (See Table 3.2).

A variety of stock assessment models were used to investigate the population dynamics of LCS including: (1) a non-equilibrium Schaefer biomass dynamic model using the sampling/importance re-sampling (SIR) algorithm (Bayesian SPM) and several weighting schemes; (2) a non-equilibrium Schaefer state-space surplus production model (SSSPM) using a Markov Chain Monte Carlo (MCMC) method for numerical integration; (3) a lagged recruitment, survival, and growth (SSLRSG) state-space model; (4) the maximum likelihood estimation model (MLE); and (5) a fully age-structured, state-space population dynamic model (ASPM). General descriptions of these models can be found in Table 3.3 and in the stock assessment. The use of multiple approaches in evaluating stock status can reduce uncertainty in the best available data and can balance individual model strengths and weaknesses.

Due to concerns that catch series may underestimate mortality from the commercial fishery, four separate catch scenarios were considered to evaluate catch histories: updated, baseline, and the alternative scenarios. The updated catch scenario was comprised of catches used in the 1998 SEW, including data through 1997, and additional catches for 1998-2001. The baseline catch scenario included similar information and discards from the menhaden fishery, and Mexican catches, bottom longline discards back to 1981, and commercial and recreational catches back to 1981. The alternative scenario reconstructed historical catches back in time (calendar years 1960 - 2001) and applied to the LCS complex only. The age-structured models for sandbar and blacktip shark included both updated and baseline scenarios in which specific catch series were linked to specific catchability and selectivity parameters. The alternative scenarios were used for sandbar and blacktip shark catch history evaluation.

Three different time periods were considered in the analysis of the catch rate series, including: (1) the whole period from 1974 through 2001, (2) the period following implementation of the 1993 FMP, and (3) the period of time since the 1998 assessment. For LCS, two out of three catch rate indices (i.e., Virginia LL, Crooke LL, and Port Salerno) show a general decline from 1978 to 1990 (See Figure 3.1). Most of the series (i.e., Virginia LL, Shark observer, Large Pelagic Survey, and NMFS LL SE) following the implementation of the 1993 FMP indicate increasing trends in LCS catch rates. However from 1998-2001, series data indicate a flat trajectory in LCS catch rates.

For sandbar sharks, the Virginia LL (1974-2001) and the early Rec (1981-1992)/late Rec (1993-1998) series suggest a declining trend which is then followed by an increasing trend in latter years (See Figure 3.2). Increasing catch rates are exhibited by series spanning 1993 forward in time (i.e., Virginia LL, SC LL recent, PLL, BLL Logs ST, Shark observer, and late Rec). Similar to that of LCS, sandbar shark series for recent years hold a flat trajectory, with deviations present in the PLL, shark observer, and LPS series, which noted increasing trends, and in the late rec series, which shows a decline.

For blacktip shark, the early rec (1981-1993) series fluctuated without trend relative to catch rates. For the period following implementation of the 1993 FMP, only the BLL Logs St series showed an increasing trend. Recent data (1998-2001) illustrate decreasing trends based upon shark observer and late Rec series, whereas PLL and BLL Logs St, and NMFS LL SE indicate a slight increase in catch rates (See Figure 3.3).

Catch rate analyses were also performed with age-specific catch series for sandbar and blacktip shark. In both cases, series data were divided into age segments including juvenile, adult, and all ages combined. For sandbar sharks, trends in juvenile (ages 0-12) catch rates indicate increases in the early 1980's followed by decreases in the early 1990s and subsequent increases in the latter half of the decade (See Figure 3.4a). Adult (ages 13+) sandbar shark catch rates present conflicting information where the Virginia LL series suggests decreasing trends and yet PLL series indicate increases from 1994 to 2001 (See Figure 3.4b). In reviewing catch rates for sandbar sharks, all ages combined, trends were generally conflicting, with Virginia LL, LPS, NMFS LL NE Early and late, and the NMFS LL SE pointing towards decreasing catch rates, while Shark observer, Driftnet observer, and BLL Logs ST present increasing rates.

For blacktip sharks, trends in juvenile (ages 0-5) catch rates indicate increasing trends early in the time series, but decreasing trends from the mid-1990's through 2001 (See Figure 3.5a). Blacktip adult (ages 6+) catch rates illustrate a slightly decreasing trend from 1992-2001 (See Figure 3.5b). In reviewing catch rates for blacktip sharks, all ages combined, trends were conflicting, with BLL Logs ST, NMFS LL SE, and NMFS LL NE Early and late pointing towards increasing trends, while Shark observer and Driftnet observer series showed decreasing trends.

Catch rates were also analyzed for other species included in the LCS complex such as tiger, hammerhead, dusky, and silky shark. Generally, commercial data indicate increasing catch rates for tiger shark (Brown and Cramer, 2002; Cortes *et al.*, 2002) as well as decreasing trends for dusky shark, sand tiger shark, and hammerhead shark (Brown, 2002; Cortes *et al.*, 2002; Brown and Cramer, 2002). Recreational catch data for hammerhead and bull shark point towards declining trends for both species (Cortes *et al.*, 2002).

Considering the outputs of all model analyses combined, the assessment results were considerably more pessimistic for the LCS aggregate as compared to those for individual species within the complex (i.e., sandbar and blacktip sharks). While results illustrate improvements in the LCS complex since 1998, all of the models and catch scenarios described above, with the exception of the Bayesian SPM scenario which used only fishery-independent CPUE series, indicate that overfishing may be occurring and that the LCS complex may be overfished. Tables 3.4 and 3.5 provide biomass and fishing mortality estimates used to make these determinations. As such, the stock assessment finds that at least a 50-percent reduction in 2000 catch levels for the complex could be required for the biomass to reach maximum sustainable yield (MSY) in 10, 20 or 30 years (See Figure 3.6). Furthermore, a 20-percent reduction in 2000 catch levels for the complex would result in less than a 50-percent probability of achieving MSY even after 30 years of implementation under those catch levels. Overall, the stock assessment found that the LCS complex as a whole is overfished and overfishing is occurring (Cortes *et al.*, 2002).

Model results for evaluating sandbar and blacktip sharks were at times conflicting, given model sensitivity to catch series and weighting methodologies employed. Nonetheless, sandbar and blacktip results point to biomass levels at or above those required to produce MSY (See Figures 3.7 and 3.8). Reductions in fishing mortality on sandbar sharks may be necessary to help mitigate overfishing concerns, however no such reductions were recommended for blacktip sharks, which could withstand an increase of 20-50-percent in total allowable catch (TAC) and continue to maintain the stock at or above MSY in the future with a 47 to 59-percent probability.

The assessment acknowledges that the results between the complex and sandbar and blacktip sharks may be considered conflicting, given that sandbar and blacktip sharks comprise the majority of LCS commercial harvests. Specifically, sandbar and blacktip sharks make up approximately 44 percent of the total commercial catch (Burgess and Morgan, 2003) and over 70 percent of the landings (Cortes and Neer, 2002). The remainder of the catch is comprised mostly of tiger, scalloped hammerhead, silky, and sand tiger, with catch composition varying by region (Burgess and Morgan, 2003). These species are less marketable and are often released, so they are reflected in the overall catch but not the landings. Nonetheless, the complex represents a variety of species beyond sandbar and blacktip shark, some of which are in apparent decline.

In December 2002, the peer review process of the 2002 LCS stock assessment was completed as required by a court settlement agreement. The peer reviews were conducted by three separate non-NOAA Fisheries reviewers who were asked to respond to five questions regarding the appropriateness of specific modeling approaches and the selection there of, consideration of available data and the quality of data sets, application of available data in selected models, reliability of projections, and the effects of various catch scenarios on stock trajectories. Peer review findings were generally positive in that reviewers agreed that a state-of-the-art assessment was performed and that the best available science was employed (See Appendix 2). Reviewers noted assessment strengths including (1) compilation of several indices of abundance, (2) consideration of multiple stock assessment models, including Bayesian analyses, (3) discussion of myriad alternative harvest policies, and (4) analytical changes to address concerns raised by previous reviewers. Further investigation of catch series indices, assessment of individual species within the LCS complex, investigation of age and age-sex-area assessment models, consideration of alternative harvest policies in contrast to the current constant-catch policy, and NOAA Fisheries support for observer programs to obtain fishery independent estimates of abundance were among the recommendations offered for improvements to future stock assessment for LCS.

### 3.2.2 Small Coastal Sharks

A stock assessment for small coastal sharks (SCS) was also conducted in 2002. This was the first assessment since 1992 and as such the assessment included new information regarding SCS age and growth, reproduction, and population dynamics. Additional information relative to commercial and recreational catches as well as extended bycatch estimates for the shrimp trawl fishery were also considered.

Trends in catch were analyzed for the SCS complex as well as the four species comprising this aggregate grouping. Overall, SCS commercial landings exceeded recreational harvest in all years since 1996, with the exception of 2000 (See Table 3.6). Of the four species of SCS analyzed, bonnetheads contributed to over 50 percent of all SCS commercial landings in 1995, but Atlantic sharpnose and finetooth sharks each accounted for over 30 percent of the commercial landings in years 1996-1999 and 1998-2000 respectively (See Table 3.7). Atlantic sharpnose dominated recreational catch in all years between 1995 and 2000 (See Table 3.7).

A total of 41 CPUE series (See Table 3.8) were available for catch rate analysis. Of the nine series available for the SCS complex, five indicated a declining trend. Five out of 13 series available for Atlantic sharpnose suggested a declining trend. Three out of five series available for bonnethead illustrated a declining trend and five out of eight series available for blacknose shark pointed towards increasing trends, although none of the slopes for blacknose were statistically significant. Finetooth catch rates, noted an increasing trend in three out of five of the series comparisons. Catch rate trends, in general, were characterized by flat slopes which suggest that relative abundance of SCS stocks has remained stable despite current exploitation. Table 3.9 provides summarized catch rate analysis details.

A variety of stock assessment models were employed to investigate the population dynamics of SCS, Atlantic sharpnose, bonnethead, blacknose, and finetooth sharks including: (1) Bayesian Surplus Production Model using the SIR algorithm, (2) Bayesian Surplus Production Model using State-Space methodology and the Gibbs sampler, and (3) Bayesian LRSG Model using State-Space methodology and the Gibbs sampler. General descriptions of these models can be found in Table 3.3 and in the stock assessment.

The SCS assessment results, considering all model outputs combined, suggest that biomass levels are at or above those which could produce MSY (See Table 3.10). Therefore, current levels of removal are sustainable for these stocks and they are not considered overfished. In general, biomass and fishing mortality trajectories for the complex and the individual species followed similar trends, where biomass was above 1 and mortality was below 1. Finetooth sharks were the only exception, in that fishing mortality in the final five years of data considered was above the mortality level associated with producing MSY. As such, finetooth sharks are not overfished however, overfishing is occurring (See Table 3.11).

Also, in 2002, researchers at the Mote Marine Laboratory and the University of Florida, conducted a stock assessment for SCS using similar data but different models. The results were similar to the NOAA Fisheries assessment in that current biomass levels for Atlantic sharpnose, bonnethead, and blacknose were at least 69 percent of the biomass in 1972 while the current biomass level for finetooth sharks was only 9 percent the level in 1972 (Simpfendorfer and Burgess, 2002). Both stock assessments note that the data used for finetooth sharks is not as high a quality as the data used for Atlantic sharpnose due to shorter catch-per-unit-effort (CPUE) and catch series, lack of bycatch estimates, and no catches reported in some years.

### 3.2.3 Pelagic Sharks

Pelagic sharks are subject to exploitation by many different nations and exhibit trans-oceanic migration patterns. As a result, ICCAT's Standing Committee on Research and Statistics (SCRS) Subcommittee on Bycatch has recommended that ICCAT take the lead in conducting stock assessments for pelagic sharks.

An ICCAT meeting was held in September 2001 to review available statistics for Atlantic and Mediterranean pelagic sharks. Newly available biological and fishery information presented for review included age and growth, length/weight relationships, species identification, species composition of catch, catch per unit effort, mortality (both natural and fishing estimates for blue sharks), bycatch, and tagging and migration studies. Landings estimates, which incorporated data for both the Atlantic and Mediterranean populations of blue shark, suggested that landings declined in 2000 (3,652 mt) following a peak of 32,654 mt in 1999 (See Table 3.12). Landings of porbeagles peaked in 1997, with an estimated total of 1,450 mt, and have slowly declined each year since that time period (1998-2000). Similarly, landing estimates for Shortfin mako also peaked in 1997 (5,057 mt) and have declined by 83 percent (863 mt in 2000) since that time. Meeting participants expressed concern regarding the lack of information pertaining to the number of fleets catching sharks, landing statistics, and dead discards for sharks. A summary of available and lacking data elements by region and species is summarized in Table 3.13. Due to concerns about data availability for pelagic sharks, meeting participants recommended that future assessment discussions occur no earlier than May 2002.

Recently, the SCRS decided to conduct an assessment of Atlantic pelagic sharks beginning in 2004. Emphasis will be placed on blue, shortfin mako, and porbeagle sharks. Several models such as non-equilibrium production and statistical age/length-structured models will be considered to analyze the population dynamics of pelagic shark species.

### 3.2.4 Prohibited Shark Species

In 1999, NOAA Fisheries prohibited possession of 19 species of sharks (See Table 3.1). These species were identified as highly susceptible to overexploitation and the prohibition on possession was a precautionary measure to ensure that directed fisheries did not develop. Three species on the prohibited list (i.e., dusky, night, and sand tiger) are also on the Candidate Species List under the Endangered Species Act (ESA).

To date there is sparse information available regarding status of individual prohibited species. For the most part, many species that were LCS before 1999 continue to be considered as part of the LCS complex in the latest LCS stock assessment. In 2001, NOAA Fisheries contracted Virginia Institute of Marine Science (VIMS) to conduct a status review under ESA of the dusky shark (Romine *et al.,* 2002). Additionally, VIMS continues to conduct a fisheries independent longline study off Virginia, which provides valuable information regarding the status of dusky shark. Specifically, relative abundance data (1974-2000) indicates increasing trends in abundance from 1997-2000, despite declines from 1980-1992 (Romine *et al.*, 2002). Catch data, which suggests increasing catch rates from 1994 to 1999, provides evidence that greater numbers of small dusky sharks are being caught. This finding is important considering that hooking mortality increases as shark size decreases. Romine *et al.* (2002) noted that mortality for dusky sharks less than 100 cm fork length was 79 percent as compared with 37 percent in sexually mature animals (Romine *et al.,* 2002). These data, when combined with other life history information and analyzed by a demographic model, suggest that dusky shark populations will continue to decline so long as fishery-induced mortality is incurred (Romine *et al.,* 2002).

NOAA Fisheries will be conducting status reviews for night and sand tiger sharks shortly.

### 3.2.5 Deepwater Sharks and Other Species

Deepwater and other shark species were included for data reporting purposes under the original shark FMP. To date, there is sparse information available on the status of deepwater and other species of shark. This is primarily due to the fact that these species are rarely caught or encountered except as bycatch in non-HMS fisheries.

## 3.3 FISHERY PARTICIPANTS AND GEAR TYPES

### 3.3.1 Description of Atlantic Shark Fisheries

#### 3.3.1.1 Commercial Shark Fisheries

*History*

In the early years of the 20th century, a Pacific shark fishery supplied limited demands for fresh shark fillets and fish meal as well as a more substantial market for dried fins of soupfin sharks. In 1937, the price of soupfin shark liver skyrocketed when it was discovered to be the richest source of vitamin A available in commercial quantities. A shark fishery in the Caribbean Sea, off the coast of Florida, and in the Gulf of Mexico developed in response to this demand (Wagner, 1966). At this time, shark fishing gear included gillnets, hook and line, anchored bottom longlines, floating longlines, and benthic lines for deepwater fishing. These gear types are slightly different than the gears used today and are fully described in Wagner (1966). By 1950, the availability of synthetic vitamin A caused most shark fisheries to be abandoned (Wagner, 1966).

A small fishery for porbeagle existed in the early 1960s off the U.S. Atlantic coast involving Norwegian fishermen. Between the World Wars, Norwegians and Danes had pioneered fishing for porbeagles in the North Sea and in the region of the Shetland, Orkney, and the Faroe islands. In the late 1940s, these fishermen caught from 1,360 to 2,720 metric tons (mt) yearly, with lesser amounts in the early 1950s (Rae, 1962). The subsequent scarcity of porbeagles in their fishing area forced the Norwegians to explore other grounds, and around 1960, they began fishing the Newfoundland Banks and the waters east of New York. Between 1961 and 1964, their catch increased from 1,800 to 9,300 mt, then declined to 200 mt (Casey *et al*., 1978).

Shark fisheries developed rapidly in the late 1970s due to increased demand for their meat, fins, and cartilage. At the time, sharks were perceived to be underutilized as a fishery resource. The high commercial value of shark fins led to the controversial practice of finning, or removing the valuable fins from sharks and discarding the carcass. Growing demand for shark products encouraged expansion of the commercial fishery throughout the late 1970s and the 1980s. Tuna and swordfish vessels began to retain a greater proportion of their shark incidental catch, and some directed fishery effort expanded as well. As catches accelerated through the 1980s, shark stocks suffered a precipitous decline. Peak commercial landings of large coastal and pelagic sharks were reported in 1989. While organized intensive shark fisheries have fluctuated, more localized shark fisheries have existed for many years.

*Catches - Bottom Longline Gear*

From 2000 through mid-2002, observed catches of sharks in the bottom longline fishery were dominated by large coastal sharks (66.2 percent), with small coastal sharks comprising 32.4

percent and pelagic sharks comprising less than three percent (Burgess and Morgan, 2003). Sandbar, tiger, and blacktip sharks combined dominated the large coastal shark catch at 59.0, 19.2, and 8.1 percent respectively (Burgess and Morgan, 2003). The remainder of the LCS catch was comprised mainly of scalloped hammerhead (3.4 percent), sand tiger (2.3 percent), silky (2.0 percent), dusky (1.5 percent), spinner (1.1 percent), and nurse sharks (1.0 percent). Individually, bull, great hammerhead, night, lemon, white, bignose, and smooth hammerhead sharks accounted for less than one percent of the total observed LCS catch (Burgess and Morgan, 2003). The actual catch composition varies by region. These species are less marketable and are often released so they are reflected in the overall catch but not the landings.

From 2000 to mid-2002, observed catches of SCS in the bottom longline fishery were dominated by Atlantic sharpnose sharks (96.1 percent), while blacknose and bonnethead sharks accounted for 3.8 and 0.2 percent respectively (Burgess and Morgan, 2003).

A total of 45 pelagic sharks were observed caught in the directed shark bottom longline fishery during the 2000 to mid-2002 study period. Of those 45 pelagic sharks caught, 29 shortfin mako sharks and nine blue sharks were retained. The remaining 16 pelagic sharks were tagged and released (Burgess and Morgan, 2003).

*Catches - Gillnet Gear*

In 2002, observed strikenet catch in the shark gillnet fishery during the non-right whale calving season consisted of three shark species (100.0 percent of total catch): blacknose (53.1 percent), blacktip (46.8 percent), and bonnethead sharks (0.1 percent). Observed driftnet catch during the 2002 non-right whale calving season consisted of 12 species of shark (84.9 percent of total catch). The driftnet shark catch was dominated by Atlantic sharpnose sharks (68.9 percent). The remainder of the catch consisted of finetooth (14.0 percent), blacknose (8.1 percent), blacktip (5.4 percent), and bonnethead sharks (2.9 percent). Individually, scalloped hammerhead, spinner, great hammerhead, tiger, sandbar, and lemon sharks each accounted for less than 0.5 percent of the total driftnet shark catch (Carlson and Baremore, 2002a).

During the 2002 right whale calving season, observed strikenet catch consisted of four species of shark (99.3 percent of total catch). The strikenet shark catch was dominated by blacktip sharks (99.4 percent). Individually, blacknose, spinner, and great hammerhead sharks accounted for less than 0.5 percent of the total strikenet shark catch. Observed driftnet catch during the 2002 right whale calving season consisted of 10 species of shark (90.7 percent of total catch). The driftnet shark catch consisted of Atlantic sharpnose (31.6 percent), blacktip (29.8 percent), blacknose (25.6 percent), bonnethead (6.7 percent), spinner (2.2 percent), finetooth (2.1 percent), and great hammerhead sharks (1.3 percent). Individually, scalloped hammerhead, tiger, and common thresher sharks accounted for less than one percent of the total driftnet shark catch (Carlson and Baremore, 2002b).

*Catches - Pelagic Longline Gear*

From May 1992 through December 2000, Pelagic Observer Program (POP) personnel recorded a total of 155,172 fish, marine mammals, sea turtles and birds from 4,462 observed sets. Of this catch, approximately 27 percent was sharks and rays. During the study period, 25,676 pelagic sharks (16.5 percent of total catch), 5,150 LCS (3.3 percent of total catch), 202 SCS (0.1 percent of total catch), and 3,006 sharks currently prohibited (2.0 percent of total catch) were observed caught (Beerkircher *et al.*, 2002).

The observed pelagic longline shark catch consisted of six pelagic species. The observed pelagic shark catch was dominated by blue sharks (89.5 percent). The remainder of the pelagic shark catch consisted mainly of shortfin mako (6.3 percent), mako spp. (2.1 percent) and oceanic whitetip sharks (1.4 percent). Individually, porbeagle, thresher spp., and common thresher sharks accounted for less than one percent of the total pelagic shark catch (Beerkircher *et al.*, 2002).

Of the pelagic sharks observed caught in the pelagic longline fishery, the following were recorded as dead; 3,647 blue, 492 shortfin mako, 155 mako spp., 108 oceanic whitetip, 28 common thresher, 14 porbeagle, and 13 thresher spp.. These statistics represent; 15.9 percent of all blue, 30.3 percent of all shortfin mako, 28.8 percent of all mako spp., 30.1 percent of all oceanic whitetip, 29.8 percent of all common thresher, 42.4 percent of all porbeagle, and 37.1 percent of all thresher spp. observed caught (Beerkircher *et al.*, 2002).

The observed pelagic longline shark catch consisted of 11 LCS species. Silky sharks dominated the observed pelagic longline catch of LCS (52.0 percent). The remainder of the LCS catch consisted mainly of sandbar (13.0 percent), tiger (10.6 percent), scalloped hammerhead (10.3 percent), hammerhead spp. (9.2 percent), blacktip (2.1 percent), and great hammerhead sharks (1.6 percent). Individually, bull, smooth hammerhead, lemon, nurse, and spinner sharks accounted for less than one percent of the total LCS catch (Beerkircher *et al.*, 2002).

Of the LCS observed caught in the pelagic longline fishery, the following were recorded as dead; 1,665 silky, 300 scalloped hammerhead, 205 hammerhead spp., 113 sandbar, 74 blacktip, 48 great hammerhead, 20 tiger, 12 bull, seven spinner, and four smooth hammerhead sharks. These statistics represent; 62.2 percent of all silky, 56.7 percent of all scalloped hammerhead, 43.2 percent of all hammerhead spp., 16.9 percent of all sandbar, 67.3 percent of all blacktip, 60.0 percent of all great hammerhead, 3.6 percent of all tiger, 35.3 percent of all bull, 35.0 percent of all spinner, and 80.0 percent of all smooth hammerhead sharks observed caught (Beerkircher *et al.*, 2002).

Atlantic sharpnose sharks accounted for 100 percent of the observed pelagic longline catch of SCS. Of the 202 Atlantic sharpnose sharks caught, 111 were recorded as dead (55 percent) (Beerkircher *et al.*, 2002).

During the period of May 1992 through December 2000, 3,006 sharks that are currently in the prohibited species group were observed caught in the pelagic longline fishery. Dusky sharks dominated the observed catch (59.2 percent of prohibited species caught). The remainder of the catch consisted mainly of night (23.2 percent), bigeye thresher (12.4 percent), longfin mako (3.5 percent), and bignose sharks (1.3 percent). Individually, basking, Caribbean reef, and sand tiger sharks accounted for less than one percent of the total prohibited species catch (Beerkircher *et al.*, 2002).

Of the prohibited species observed caught in the pelagic longline fishery, the following were recorded as dead; 719 dusky, 540 night, 156 bigeye thresher, 48 longfin mako, 26 bignose, two Caribbean reef, and one sand tiger shark. These statistics represent; 40.4 percent of all dusky, 77.6 percent of all night, 41.7 percent of bigeye thresher, 45.7 percent of longfin mako, 66.7 percent of bignose, 28.6 percent of all Carribean reef, and 25.0 percent of all sand tiger sharks observed caught (Beerkircher *et al.*, 2002).

*Landings*

An estimated 1,684 and 1,616 mt dressed weight (dw) of U.S. Atlantic LCS were landed in 2000 and 2001 respectively. Sandbar and blacktip sharks combined, accounted for approximately 84 and 71 percent of the 2000 and 2001 LCS landings, respectively (Cortes and Neer, 2002). In 2000 and 2001, approximately three and 21 percent of the landings were reported as unclassified sharks (Cortes and Neer, 2002). Approximately 84 to 91 percent of LCS landings came from the southeast region, mainly Louisiana, Florida, and North Carolina (Cortes and Neer, 2002). Observer data indicates that LCS discarded from the fishery accounts for approximately 5.7 percent of the total mortality (Cortes and Neer, 2002)

An estimated 269 and 326 mt dw of U.S Atlantic SCS were landed in 2000 and 2001 respectively (Cortes and Neer, 2002). Data from the directed shark fishery observer program indicates that small coastal sharks are generally not landed (1.6 percent), but are used for bait (98.3 percent) (Burgess and Morgan, 2003). Commercial landings of small coastal sharks represent only a small fraction of all catches, because they are also caught as bycatch and discarded in a variety of fisheries. The majority of small coastal sharks taken in commercial fisheries are landed in the southeastern region. Of the small coastal sharks caught during 1995 - 2000, the majority were caught in the South Atlantic region. In those years, gillnets were the dominant type of gear catching small coastal sharks. Atlantic sharpnose sharks accounted for over one third of all small coastal shark landings from 1996 - 1999. Finetooth sharks accounted for over one-third of the landings in 1998 - 2000. Commercial landings of small coastal sharks peaked in 1999 at 330 mt (Cortes, 2002).

An estimated 159 and 165 mt dw of U.S. Atlantic pelagic sharks were landed in 2000 and 2001 respectively (Cortes and Neer, 2002). Shortfin mako and thresher sharks are the two pelagic shark species most frequently landed (Cortes and Neer, 2002). According to Cortes and Neer (2002) approximately 56 - 64 percent of pelagic shark landings occurred in the southeast region during the period 1998 - 2001. In 1998 and 1999, pelagic sharks were mostly landed in North Carolina (57 percent and 48 percent respectively), Florida (23 percent and 38 percent respectively), and Louisiana (15 percent and 7 percent respectively). In 2000, most pelagic sharks were landed in North Carolina (34 percent), and Florida (33 percent), followed by South Carolina (10 percent), and Louisiana (8 percent). In 2001, the majority of pelagic sharks were landed in Florida (56 percent), Texas (19 percent), and South Carolina (13 percent) (Cortes and Neer, 2002).

*Permits*

Fishermen who wish to sell sharks caught in Federal waters must possess a Federal shark permit (directed or incidental). As part of the HMS FMP, NOAA Fisheries implemented a limited access system for the commercial fishery so permits can only be obtained through transfer or sale, subject to upgrading restrictions. The purpose of limited access was to reduce latent effort in the shark fishery and prevent further overcapitalization. Based on current and historical participation, implementation of limited access reduced the number of shark permit holders from over 2,200 permit holders before limited access, to 607 in October of 2003. The limited access system is fully described in Chapter 4 of the HMS FMP.

As of October 17, 2003, approximately 351 fishermen had active incidental commercial shark limited access permits and 256 had active directed commercial shark limited access permits. In the directed category, vessels range in length from 14 to 87 feet, with an average length of 45.7 feet. Vessels range in length from 15 to 123 feet in the incidental category, with an average length of 50.1 feet. The addresses of these permit holders range from Texas through Maine with nearly half of the permit holders located in Florida.

Since 1997, the LCS fishing season has generally been open for three months (January-March) in the first fishing season and a few weeks (July-August) in the second season. Given the short directed fishing season for sharks, fishermen have had to diversify in order to maintain their financial viability, either into other fisheries or other occupations. Many participants in the commercial shark fishery are engaged in the longline fishery for swordfish and tuna, the hook and line fisheries, or the snapper-grouper or reef fish fisheries. The NOAA Fisheries permit databases indicate that approximately 98 percent of permitted shark fishermen hold fishing permits in other fisheries.

*Bycatch*

Commercial fishermen use a number of gear types to target sharks, including bottom longline, pelagic longline, gillnet, and rod and reel. Different gear types can be used to target different species of sharks. For example, bottom longline gear is generally used to target LCS while pelagic longline gear is used to target pelagic sharks. Other gear types such as shrimp trawls catch sharks incidentally. All of these gears catch many species of fish. Some of the species captured are marketable and thus are retained, while others are discarded for economic or regulatory reasons. Non-shark species encountered on gear targeting sharks are snappers, groupers, red drum, cobia/dolphin, swordfish, tunas, billfish, wahoo, king and Spanish mackerel, little tunny, crevalle jack, and other finfish species. Sometimes fishermen also catch sea turtles, marine mammals, and sea birds, known collectively as "protected" species. All of these species are Federally managed, and NOAA Fisheries seeks to control the mortality that results from fishing effort. NOAA Fisheries also seeks to control the likelihood of mortality, injury, or other forms of take of protected species. For more information on bycatch, refer to section 3.5.

*Regulations*

Commercial regulations in 2003 for LCS include quotas, a trip limit of 4,000 lbs dw LCS for directed permits, and a trip limit of five LCS and 16 SCS and pelagic species combined for incidental permit holders. The commercial regulations for pelagic sharks include separate quotas for porbeagle and blue sharks and a trip limit of 16 pelagic and SCS for incidental permits. The commercial regulations for SCS include a trip limit of 16 pelagic and SCS for incidental permits. All three categories involve limited access permitting and reporting requirements, observer coverage requirements, a ban on finning, no filleting at sea, prohibited species, and authorized gears. While the LCS fishing season has generally been open for only a few months a year, the SCS and pelagic shark fisheries have never closed and their quotas have not been reached.

*Monitoring and Reporting*

Commercial fisheries for Atlantic sharks are monitored through a combination of vessel logbooks, dealer reports, port sampling, cooperative agreements with states, and scientific observer coverage.

NOAA Fisheries collects shark data through reports from owners/operators of permitted vessels under a mandatory commercial logbook program, the Commercial Shark Fishery Observer Program (CSFOP), the Pelagic Observer Program (POP), and the shark gillnet observer program. Logbooks contain information on fishing vessel activity, including dates of trips, number of sets, area fished, number of fish and other marine species caught, released and retained. Observer data contains additional information such as gear information and biological data for individual animals. Observer data can be used to verify logbook data. In 2003 NOAA Fisheries began to collect economic data such as volume and cost of fishing inputs from 20 percent of the fleet.

Commercial landings data for sharks are also collected by seafood dealers and port agents who routinely record the weight and average ex-vessel price of sharks. Dealer reports must be submitted to NOAA Fisheries twice a month for all sharks.

Species-specific catch and landings statistics for sharks are problematic, since there are many similar species and identification of dressed sharks is difficult. To increase species-specific reporting, NOAA Fisheries is developing a field guide for sharks to assist fishermen in the identification of species for the required catch reports.

The University of Florida and The Florida Museum of Natural History are continuing an observer program of the directed bottom longline commercial shark fishery in the Atlantic and Gulf of Mexico to enhance the reliability of management strategies for the shark fishery. Since 1994, the CSFOP has been monitoring and reporting on commercial bottom longline shark fishery catches. This program has been funded by the U.S. Department of Commerce through the Marine Fisheries Initiative (MARFIN) and Saltonstall-Kennedy (S-K) granting programs and more recently with contracts through NOAA Fisheries (Burgess and Morgan, 2003). The CSFOP provides baseline characterization information, by region, on the species composition, relative abundance, and size composition within species for the large coastal and small coastal bottom longline shark fisheries.

As of January 2002, the observer coverage requirements in the bottom longline fishery for sharks changed from voluntary participation to mandatory participation if selected. Vessels are selected, on a random basis, if they have a current directed shark permit and if they have reported fishing for sharks in the past. Selections are also made to ensure that areas that have more fishing effort will have more vessels selected. NOAA Fisheries has selected over 30 vessels each season since January 2002. From 2000 to mid-2002, three CSFOP observers logged 244 sea days on 66 shark fishing trips aboard 17 different fishing vessels in the Atlantic Ocean. The fishing areas observed include North Carolina to Florida, and the eastern Gulf of Mexico off Florida (Burgess and Morgan, 2003). During this time period, the CSFOP documented 33,177,457 hook-hours of effort that yielded 9,972 sharks of 28 different species. Of the 9,972 sharks observed, there were 6,461 LCS (14 species), 3,228 SCS (2 species), and 45 pelagic sharks (2 species) (Burgess and Morgan, 2003).

NOAA Fisheries initiated sampling of the U.S. large pelagic fisheries longline fleet in 1992, as mandated by the U.S. Swordfish Fisheries Management Plan and subsequently by the HMS FMP (Beerkircher *et al.*, 2002). The June 14, 2001 Biological Opinion (BiOp) requires that five percent of the pelagic longline trips be selected for observer coverage. In addition, ICCAT requires five percent observer coverage for all trips targeting yellowfin tuna and/or bigeye tuna (NOAA Fisheries, 2003a). The POP is located at the Southeast Fisheries Science Center (SEFSC) Miami laboratory and places scientific observers aboard vessels participating in the Atlantic large pelagic fishery. Since 1992, observer coverage has been provided by NOAA Fisheries-employed observers, independent contracted personnel, and personnel supplied by contracting companies. The POP observers record detailed information concerning gear characteristics, location, time of set and retrieval, environmental conditions, status of marine life caught (alive or dead, kept or discarded), as well as morphometric measures and sex identification. The POP observers also record incidental interactions with sea turtles, marine mammals, and sea birds (Beerkircher *et al.*, 2002).

From May 1992 through December 2000, 638 pelagic longline trips aboard 206 different vessels were observed by NOAA Fisheries observers. In total, the POP observers logged 7,898 days-at-sea and observed 4,462 sets (Beerkircher *et al.*, 2002). Five hundred ninety-one pelagic longline sets were observed and recorded by NOAA Fisheries observers in 2001 (NOAA Fisheries, 2003a).

From May 1992 through December 2000, POP personnel recorded a total of 155,172 fish, marine mammals, sea turtles and birds caught. Of this catch, approximately 27 percent was sharks and rays. During the study period, 25,676 pelagic sharks (16.5 percent of total catch), 5,150 LCS (3.3 percent of total catch), 202 SCS (0.1 percent of total catch), and 3,006 prohibited species (2.0 percent of total catch) were observed caught (Beerkircher *et al.*, 2002).

The Atlantic Large Whale Take Reduction Plan (ALWTRP) and the June 14, 2001, BiOp issued under section 7 of the Endangered Species Act mandate 100 percent observer coverage of the southeast shark gillnet fishery during right whale calving season. An interim final rule published in March 2001 (66 FR 17370) established a level of observer coverage outside of right whale calving season that would attain a sample size needed to provide estimates of sea turtle or marine mammal interactions. This rule was formalized with the rule that closed the Northeast Distant Statistical Reporting Area (NED) (67 FR 45393, July 9, 2002). It was determined that a 52.8 percent sampling fraction would be required outside of the right whale calving season. However, due to increased numbers of sea turtle strandings in May, 2002, 100 percent observer coverage was provided for all shark gillnet vessels fishing in the north Florida/Georgia area from May 8 through June 15, 2002 (Carlson and Baremore, 2002a).

The shark gillnet fishery observer program is coordinated by the NOAA Fisheries SEFSC. Observers are deployed on vessels participating in the shark gillnet fishery and collect information specific to shark gillnet gear set in both the driftnet and strikenet fashion. For each set and haul back, observers record: beginning and end times of setting and hauling, estimated length of net set, sea and wind states, latitude and longitude coordinates, and water depth. As the nets are retrieved, observers record species caught, estimate lengths and weights, and disposition (kept, discarded alive, or discarded dead) (Carlson and Lee, 1999).

### 3.3.1.2 Commercial Shark Fisheries by Gear Type

Below is a description of Atlantic shark fisheries by gear-type. Please refer to section 2.4 and 2.5 of the HMS FMP and section 4.5 of the latest SAFE report for additional information. Additional information specific to the pelagic longline fishery can be found in the Final Supplemental Environmental Impact Statement for the Reduction of Bycatch, Bycatch Mortality, and Incidental Catch in the Atlantic Pelagic Longline Fishery; in the Final Supplemental Environmental Impact Statement to Reduce Sea Turtle Bycatch and Bycatch Mortality in the Atlantic HMS Fisheries; or in the June 14, 2001, BiOp.

*Bottom Longline Fishery*

The Atlantic bottom longline fishery targets LCS, with landings dominated by sandbar and blacktip sharks. Bottom longlines were the primary commercial gear-type used to catch LCS from 1987-2001 in all regions (Cortes and Neer, 2002). Gear characteristics vary by region, but in general, a ten-mile long monofilament bottom longline, containing about 750 hooks, is fished overnight. Skates, sharks, or various finfishes are used as bait (GSAFDF, 1997). The gear typically consists of a heavy monofilament mainline with lighter weight monofilament gangions. Some fishermen may occasionally use a flexible 1/16 inch wire rope as gangion material or as a short leader above the hook. According to the most recent observer data report, Carolina region fishermen set more hooks (639 hooks/set) and fished longer (13.6 hr/set) than Florida Gulf fishermen (599 hooks/set, 12.3 hr/set) and Florida East Coast fishermen (382 hooks/set, 9.0 hrs/set) (Burgess and Morgan, 2003).

Commercial shark fishing effort is generally concentrated in the southeastern United States and Gulf of Mexico (Cortes and Neer, 2002). As with all HMS fisheries, some shark fishery participants move from their home ports to active fishing areas as the seasons change. McHugh and Murray (1997) found in a survey of shark fishery participants that the largest concentration of bottom longline fishing vessels is found along the central Gulf coast of Florida, with the John's Pass - Madeira Beach area considered the center of directed shark fishing activities. Cortes and Neer, 2002, found that 84 - 91 percent of the 1998 - 2001 U.S. Atlantic shark landings came from the southeast region. Approximately 84 - 91 percent of LCS, 56-64 percent of pelagic sharks, and nearly all of SCS landings came from the southeast region (Cortes and Neer, 2002). Estimates of total landings and dead discards for the large coastal shark species group from 1981 to 2001 can be seen in Table 3.14.

CSFOP data from the 2000 to mid-2002 study period show that the large coastal sharks comprised 66.2 percent of the total catch. Sandbar sharks dominated the observed catches in the Carolina and Florida Gulf Coast regions. In the Carolina region, sandbar sharks comprised 67.4 percent of the total catch and 77.2 percent of the large coastal shark catch. In the Florida Gulf region, sandbar sharks comprised 62.0 percent of the total catch and 66.5 percent of the large coastal catch (Burgess and Morgan, 2003).

In the Florida East Coast region, sandbar sharks comprised 17.2 percent of the total observed catch, and 37.1 percent of the large coastal shark catch. Tiger sharks comprised 17.1 percent of the total observed catch and 37.0 percent of the large coastal shark catch, while blacktip sharks comprised 7.9 percent of total observed catch and 17.2 percent of the large coastal catch (Burgess and Morgan, 2003).

CSFOP data also show that the SCS comprised 32.4 percent of the total observed catch. The small coastal catch was dominated by Atlantic sharpnose shark (96.6 percent). The remainder of the small coastal catch consisted of blacknose (3.8 percent), and bonnethead sharks (0.2 percent) (Burgess and Morgan, 2003).

The Atlantic sharpnose and the blacknose sharks were the most commonly captured small coastal sharks, but only in the Florida East Coast region were the Atlantic sharpnose and blacknose shark major contributors to the catch. The Atlantic sharpnose shark was the most frequently caught shark in the Florida East Coast region and accounted for 51.6 percent of the total observed catch, and 96.0 percent of the small coastal catch in that region (Burgess and Morgan, 2003).

During the 2000 to mid-2002 study period, pelagic sharks represented only 0.5 percent of the total catch. Shortfin mako sharks comprised 0.3 percent of the total observed catch and 76.3 percent of the pelagic shark catch. A total of 45 pelagic sharks were observed caught in the directed shark bottom longline fishery. Of those 45 pelagic sharks caught, 29 shortfin mako sharks and nine blue sharks were retained. The remaining 16 pelagic sharks were tagged and released (Burgess and Morgan, 2003).

As reported in the 2003 HMS SAFE Report, the 2002 observed catches of sharks in the directed bottom longline fishery were dominated by large coastal sharks (72 percent), with small coastal sharks comprising 28 percent and pelagic sharks comprising 0.3 percent (Table 3.15). Sandbar sharks dominated the large coastal catch and landings (34.7 and 47.0 percent, respectively), followed by blacktip sharks (23.1 and 30.5 percent, respectively), tiger sharks (19.5 and 6.5 percent, respectively), and nurse sharks (7.4 and 0 percent, respectively). Tiger sharks represent 62.6 percent of large coastal sharks tagged and released (Table 3.15) (NOAA Fisheries, 2003a).

In 2002, Atlantic sharpnose sharks dominated the observed bottom longline catches of small coastal sharks at 73.6 percent (Table 3.15). Approximately 76.3 percent of small coastal sharks are used for bait in this fishery (371 out of 1,562 individuals were landed). Only 18 pelagic sharks were caught, 17 of which were landed and all of which were shortfin mako (Table 3.15) (NOAA Fisheries, 2003a).

*Pelagic Longline Fishery*

The U.S. pelagic longline fishery for Atlantic HMS primarily targets swordfish, yellowfin tuna, or bigeye tuna in various areas and seasons and catches sharks incidentally. Although this gear can be modified (i.e., depth of set, hook type, etc.) to target swordfish, tuna, or sharks, like other hook and line fisheries, it is a multi-species fishery. Longline gear sometimes attracts and hooks non-target finfish with no commercial value, as well as species that cannot be retained by commercial fishermen, such as billfish or some species of sharks. Pelagic longlines may also interact with protected species such as marine mammals, sea turtles and sea birds.

Pelagic longline gear is composed of several parts. The primary mainline can vary from five to 40 miles in length, with approximately 20 to 30 hooks per mile. The depth of the mainline is determined by ocean currents and the length of the floatline, which connects the mainline to several buoys and periodic markers with radar reflectors and radio beacons. Lightsticks, which contain chemicals that emit a glowing light, are often used to attract bait fish which may, in turn, attract pelagic predators. When targeting swordfish, the lines generally are deployed at sunset and hauled in at sunrise to take advantage of the nocturnal near-surface feeding habits of the large pelagic species (Berkeley *et al*., 1981). In general, longlines targeting tuna are set in the morning, deeper in the water column, and hauled in the evening. Except for vessels of the distant water fleet which undertake extended trips, fishing vessels preferentially target swordfish during periods when the moon is full to take advantage of increased densities of pelagic species near the surface.

From May 1992 through December 2000, POP personnel recorded a total of 155,172 fish, marine mammals, sea turtles and birds caught by pelagic longline gear. Of this catch, approximately 27 percent was sharks and rays. During the study period, 25,676 pelagic sharks (16.5 percent of total catch), 5,150 LCS (3.3 percent of total catch), 202 SCS (0.1 percent of total catch), and 3,006 shark species currently prohibited (2.0 percent of total catch) were observed caught (Beerkircher *et al.*, 2002).

Approximately 132 mt whole weight (ww) of LCS and 154 mt ww of pelagic sharks (primarily blue sharks) were discarded dead in pelagic longline fisheries in 2001 (Cramer, 2002). Between 1996 and 1998, approximately 15,600 LCS were discarded dead by pelagic longline vessels (Table 3.14).

*Gillnet Fishery*

The southeast shark drift gillnet fishery is comprised of about five vessels that use nets typically 456 to 2,280 meters long and 6.1 to 15.2 meters deep, with stretched mesh from 12.7 to 22.9 cm. The entire process (time net was first set through time the haulback was completed) averaged 8.9 hours in 2002 (Carlson and Baremore, 2002a). A total of 69 drift gillnet sets were observed in 2002. During non-right whale season (28 sets), the observed drift gillnet catch consisted of 12 shark species (84.9 percent of total catch), 26 bony fish and rays, and one species of marine mammal (Carlson and Baremore, 2002a). During right whale season (41 sets), the observed drift gillnet catch consisted of 10 species of shark (90.7 percent of total catch), 26 species of teleosts and rays and two species of sea turtle (Carlson and Baremore, 2002b). The total observed drift gillnet shark catch for 2002 can be seen in Table 3.16.

Shark fishermen also use gillnet gear in a strikenet fashion. This can be done with a small second vessel actively setting the net around a school of sharks or the drift gillnet vessel actively setting the net in the wake of a shrimp vessel. Vessels fishing in a strikenet fashion used nets 364.8 meters long, 30.4 meters deep, and with mesh size 22.9 cm (Carlson and Baremore, 2002a). A total of 38 strikenet sets were observed in 2002. The total observed strikenet shark catch for 2002 can be seen in Table 3.17.

Legislation in South Carolina, Georgia, and Florida has prohibited the use of commercial gillnets in state waters, thereby forcing some of these vessels into deeper waters under Federal jurisdiction, where gillnets are less effective.

To reduce bycatch of right whales, NOAA Fisheries implemented a restricted area from November 15 through March 31, where only gillnets used in a strikenet fashion can operate during times when right whales are usually present (67 FR 59471, September 23, 2002).

Operation in this area at that time requires 100 percent observer coverage. NOAA Fisheries also designated an area open to shark gillnet fishing vessels fishing in a driftnet fashion but only under condition that they carry an observer at all times during right whale calving season. Outside of the right whale calving season, observer coverage to produce reliable estimates of bycatch is required.

Vessel operators intending to use gillnets in the "observer area" during right whale calving season must notify NOAA Fisheries at least 48 hours in advance of departure to arrange for observer coverage. Observations of right whales in the observer area or restricted area outside of this period, are rare, and a broader closure period was not considered necessary to meet the objectives of the Marine Mammal Protection Act (MMPA). After these requirements were implemented, NOAA Fisheries extended observer requirements to include all shark gillnet vessels at all times. The objective of that regulation was to collect bycatch information for all species (including turtles and finfish), consistent with requirements of the Magnuson-Stevens Act. NOAA Fisheries modified the requirement to have 100 percent observer coverage at all times (66 FR 17370, March 30, 2001; 67 FR 45393, July 9, 2002), by reducing the level required to a statistically significant level outside of right whale calving season (100 percent observer coverage is still required during the right whale calving season from November 15 through March 31). This modification of observer coverage reduced administrative costs while maintaining statistically significant and adequate levels of coverage to provide reasonable estimates of sea turtle and marine mammal takes outside the right whale calving season. The level of observer coverage necessary to maintain statistical significance will be reevaluated annually and adjusted accordingly.

Gear provisions were also implemented to further the goals of the MMPA. NOAA Fisheries restricted the way gillnets used in a strikenet fashion are set in the southeast gillnet fishery to minimize the risk of entanglement. In addition, shark gillnets must be marked to identify the fishery and region the gear is fished. Strikenetting in the restricted area is permitted during right whale season only if: (1) no nets are set at night or when visibility is less than 500 yards (460 m), (2) each set is made under the observation of a spotter plane, (3) no net is set within three miles of a right whale, humpback or a fin whale, and (4) if a whale comes within three miles of set gear, the gear is removed from the water immediately. These measures were designed to minimize the risk of entangling any large whale.

### 3.3.1.3 Recreational Atlantic Shark Fisheries

*History*

Recreational fishing for Atlantic sharks occurs in Federal and state waters from New England to the Gulf of Mexico and Caribbean Sea. In the past, sharks were often called "the poor man's marlin." Recreational shark fishing with rod and reel is now a popular sport at all social and economic levels, largely because of accessibility to the resource. Sharks can be caught virtually anywhere in salt water, with even large specimens available in the nearshore area to surf anglers or small boaters. Most recreational shark fishing takes place from small to medium-size vessels. Makos, white sharks, and large pelagic sharks are generally accessible only to those aboard ocean-going vessels. Recreational shark fisheries are exploited primarily by private vessels and charter/headboats although there are some shore-based fishermen active in the Florida Keys.

Charter vessel fishing for sharks is becoming increasingly popular. In most U.S. waters, this type of fishing occurs from May to September. In some regions, certain species are heavily targeted, e.g., sharpnose and blacktip in the Carolinas, and makos and large white sharks at Montauk, NY. Many charter vessels also fish for sharks out of ports in Ocean City, MD and Wachapreague, VA. Headboats may land the smaller shark species, but they usually do not target sharks specifically, except for a headboat fishery for sharpnose sharks based in Port Aransas, TX.

*Landings*

Recreational shark landings estimates are obtained from several data collection programs including the Marine Recreational Fishing Statistics Survey (MRFSS), NMFS Headboat Survey, and the Texas Parks and Wildlife Recreational Fishing Survey. Recreational shark harvests of large coastal sharks have declined by 80 percent from the peak recorded catches in 1983 (Table 3.18). Blacktip and sandbar sharks dominate the catches of large coastal sharks by 36 and 27 percent respectively (Table 3.19). Recreational harvests of small coastal sharks have fluctuated between 34,900 and 189,500 fish per year since the mid 1980s, with Atlantic sharpnose comprising about 60 percent of the catch in recent years (Table 3.18 and Table 3.20). For pelagic species, some of which are considered prized game fish (e.g., makos), recreational harvests have fluctuated from a peak of approximately 93,000 fish in 1985 to a low of about 6,200 fish in 1994. Recreational harvests of blue sharks accounted for 47 and 53 percent of the total catches of pelagic sharks in 1999 and 2000 (Table 3.21).

From 1991 through 2001, the MRFSS intercept survey sampled 13,056 shore- and vessel-based fishing trips which reported catching a shark in the management unit. These sampled trips caught a total of 40,960 sharks. The number of sharks caught per total trips sampled shows no trend, but the percentage of sharks released by private and party boats has increased as trip limits have been reduced. The percentage of sharks released from shore-based fishing trips has remained constant (Babcock and Pikitch, 2002).

*Regulations*

The 1993 FMP for Atlantic sharks established a recreational trip limit of four sharks per vessel for large coastal and pelagic species groups and a daily bag limit of five small coastal sharks per person per day. In 1997, NOAA Fisheries combined the recreational retention limit into an all-shark limit of two fish per vessel per trip with an allowance for two Atlantic sharpnose sharks per person per trip. This measure was designed to reduce fishing mortality by 50 percent as recommended by the 1996 LCS stock assessment, address concerns that juvenile large coastal sharks were being misidentified as small coastal sharks, and to allow anglers on charter/partyboats the opportunity to land a shark (Atlantic sharpnose). The 1999 HMS FMP further reduced the recreational retention limit to one shark per vessel per trip, established a minimum size limit of 4.5 feet fork length for all sharks, and reduced the allowance for Atlantic sharpnose sharks to one per person per trip with no minimum size restriction. Sharks that are not retained by the angler must be released in a manner to ensure the maximum possibility of survival. Recreational fishing for white sharks is catch and release only. Sharks that are kept must be kept whole through landing. They may be gutted and bled, but the head, tail, and fins must be attached to the carcass.

*Permits*

NOAA Fisheries has recently implemented an Atlantic HMS recreational fishing permit (67 FR 77437, December 18, 2002). The HMS Angling category permit became effective March 2003. NOAA Fisheries now requires the owners of vessels that target, retain, or possess HMS in Federal waters of the Atlantic, Gulf of Mexico, and U.S. Caribbean to obtain this Federal vessel permit. The HMS Angling category permit allows all anglers aboard permitted vessels to fish for HMS and is required to fish for, retain or possess, including catch-and-release fishing, any federally regulated HMS; sharks, swordfish, white and blue marlin, sailfish, spearfish, and federally regulated Atlantic tunas (bluefin, yellowfin, bigeye, skipjack, and albacore). As of September 30, 2003, there were 18,249 HMS Angling category permit holders.

*Monitoring and Reporting*

By definition, recreational landings of Atlantic HMS are those that are not marketed through commercial channels, therefore it is not possible to monitor anglers' catches through ex-vessel transactions as in the commercial fishery. Instead, NOAA Fisheries conducts statistical sampling surveys of the recreational fisheries. These survey programs have been used for well over a decade. The two primary survey vehicles of the recreational sector conducted by NOAA Fisheries are the Marine Recreational Fishing Statistics Survey (MRFSS) and the Large Pelagic Survey (LPS).

The MRFSS is a survey designed to provide regional and state-wide estimates of recreational catch for marine fish species in the Atlantic. It was not designed to account for the unique characteristics of HMS fisheries, although information on these species is occasionally collected by the survey. The MRFSS does not cover the state of Texas nor does it cover the charter/headboat fisheries. Therefore, data from the charter/headboat sector of the fishery are provided by an independent survey in the State of Texas and by the NMFS Headboat Survey in the southeast United States. NOAA Fisheries is in the process of implementing and evaluating a new For-Hire Survey for the charter/headboat sector on the Atlantic coast. A similar survey has been conducted in the Gulf of Mexico since January 2000. Information collected by the MRFSS on recreational shark landings is used to estimate the number of fishing trips, the number and species of sharks caught and/or landed, the weight of these sharks, and the number of persons fishing. Shark species are identified to the extent possible.

The MRFSS estimates three types of catch:

1. Fish that are available for identification, enumeration, weighing, and measuring by dockside interviewers are called Type A catch or *landings*;

2. Fish not brought ashore in whole form but used as bait, filleted, or discarded dead are called Type B1 catch (Type A and Type B1 catch together comprise *harvest*);

3. Fish released alive are called Type B2 catch; and

4. The sum of Catch Type A, Catch Type B1, and Catch Type B2 is called *total catch*.

The MRFSS estimates of recreational landings and harvest are calculated using Type A and B1 catches only. Estimates of Type B2 catches are not included. Thus, estimates of "catch" are actually estimates of immediate recreational fishing mortality as landings or harvest. A complete accounting of fishing mortality would include post-release mortality associated with Type B2 fish. Quantitative estimates of post-release or delayed mortality of HMS in recreational fisheries are not available at this time.

The Large Pelagic Survey was designed to estimate annual recreational catches of bluefin tuna from North Carolina through Massachusetts in the summer months and to evaluate abundance trends of bluefin tuna by monitoring catch and effort associated with all sizes of bluefin tuna. Although it was designed for bluefin tuna, the Large Pelagic Survey also collects catch information on other highly migratory species and is used to estimate catch information and monitor catch per unit effort trends. There are two phases to this survey: (1) dockside interviews and observation to obtain number, species, and sizes of fish caught during a trip; and (2) a telephone survey directed at those people who possess an HMS permit to obtain the amount of effort during the prior reporting period and corroborative information about the number of fish captured.

In April 1998, NOAA Fisheries implemented a mandatory registration system for tournaments involving any billfish, with mandatory reporting if selected. The HMS FMP extended the requirement to tournaments directed at any Atlantic HMS, in order to improve estimates of HMS catches and landings by tournament participants. Tournament registration allows NOAA Fisheries to establish a universe of registered tournaments in order to expedite outreach to recreational fishermen who participate in tournaments. The reporting forms also provide NOAA Fisheries with catch, release, and fishing effort statistics that are useful in characterizing the fishery. Because the Large Pelagic Survey does not collect recreational fishing data in the southeast United States or the Gulf of Mexico, tournament data can provide information on which species are targeted in these areas, as well as release rates for each species. Finally, this information allows NOAA Fisheries scientists to travel to selected tournaments to collect data on age/growth and sexual maturity that are used in stock assessments.

### 3.3.2 Economic Aspects of Shark Fisheries

#### 3.3.2.1 Fishing Costs and Revenues for Atlantic Commercial Fishermen

In general, a vessel owner will need to pay for supplies and provisions for each fishing trip (e.g. hooks, bait, light sticks, ice, fuel, groceries, etc.), vessel and gear repairs as needed, crew members (the number of crew members may change depending on the type of fishing trip and the gear used), and for the proper permits (the information here does not include the price of the permit which is small for an annual renewal but may be large for someone trying to enter a limited access fishery). Fishing trips themselves can be expensive and there is no guarantee that the revenues from the harvest will be enough to cover the owner's expenses for that trip.

There is demand for shark meat and fins in markets throughout the United States, Asia, and Europe. Ex-vessel prices for sharks vary, depending on a variety of factors including: quality of the fish, weight of the fish, the supply of fish, and consumer demand. The average ex-vessel prices per pound dressed weight (dw) for 1996 and 2001 by shark species group, major gear type, and area are summarized in Table 3.22. The average ex-vessel prices per pound dw for 1996 and 2001 by species group and area are summarized in Table 3.23.

From 1996 to 2001, the average ex-vessel price for large coastal sharks increased in the Gulf of Mexico, Mid-Atlantic and North Atlantic regions and decreased slightly in the South Atlantic region (Table 3.23). Average prices changed across regions and gear-type (Table 3.22). Also from 1996 to 2001, the average ex-vessel price for pelagic sharks decreased in the South, Mid-, and North Atlantic regions. The highest average prices were found with a variety of gears, mainly longline and handgear (Table 3.22). Small coastal sharks have the lowest average ex-vessel price of all shark species but this price generally increased in all regions (Table 3.23).

The average ex-vessel price for shark fins has generally increased (Table 3.22). No data was available in 1996 in the Gulf of Mexico or in 2001 in the Mid or North Atlantic regions (Table 3.23).

In general, the most valuable species include shortfin mako, thresher, porbeagle, and requiem sharks (Weber and Fordham, 1997). Weber and Fordham (1997) reported regional preferences for shark fins. In Hong Kong, processors seek the fins of hammerhead, tiger, oceanic whitetip, blacktip, dusky and blue sharks, while the fins of thresher, nurse sharks, and ray and skate wings have minimal value. In Taiwan, fin traders prefer the hammerhead, dusky, and blacktip reef sharks, and place a lower value on the thresher and blue sharks. In the United States domestic market, buyers generally prefer hammerhead and sandbar shark fins, followed by the dusky, tiger, blacktip, bull, and silky sharks (Weber and Fordham, 1997).

In addition to markets for shark meat and fins, there is extensive world trade in other shark products including leather, cartilage, liver oil, and jaws. While smaller sharks are preferred for human consumption, due to the greater ease of storage and lower concentrations of urea and mercury in the flesh, larger sharks are more often used for dried fins and leather products. It is difficult to process sharks for both meat and skins, primarily because skins must be processed immediately to preserve their quality (Rose, 1996). Shark cartilage is processed into tablets for cancer treatment. Liver oil is also used in pharmaceuticals, lubricants, and cosmetics.

*Pelagic longline*

The amount of economic data available for this gear type is increasing although current information is needed. Since 1996, NOAA Fisheries has been collecting economic information on a per trip basis through submission of voluntary forms in the pelagic logbook maintained in the Southeast Fisheries Science Center. Compared to the number of logbook reports, few economic data have been collected. In 2003, NOAA Fisheries initiated mandatory cost earnings reporting for selected vessels in order to improve the economic data available for all HMS fisheries. Mandatory submission of this economic data is needed for NOAA Fisheries to accurately assess the economic impacts of proposed fishery management regulations on fishermen and their communities as required by the National Environmental Policy Act (NEPA), Executive Order 12866, the Regulatory Flexibility Act (RFA), and National Standards 7 and 8 of the Magnuson-Stevens Act. Specifically, this information will be used to conduct cost-benefit analyses and develop regulatory impact analyses of proposed regulations in an effort to help NOAA Fisheries develop and improve fishery management strategies.

Larkin *et al.* (2000) examined 1996 logbooks and the 1996 voluntary forms and found that net returns to a vessel owner varied substantially depending on the vessel size and the fishing behavior (i.e. sets per trip, fishing location, season, target species). They found that out of 3,255 pelagic longline trips reported, 642 pelagic longline trips provided the voluntary economic information. From all trips, four species (swordfish, yellowfin tuna, dolphin fish, and sandbar sharks) comprised 77 percent of all species landed and accounted for 84 percent of the total gross revenues for the fleet. Generally, vessels that were between 46 and 64 feet in length, had between 10 and 21 sets per trip, fished in the second quarter, fished in the Caribbean, or had more than 75 percent of their gross revenues from swordfish had the highest net return to the owner (ranging from \$3,187 to \$13,097 per trip). Vessels that were less than 45 feet in length, had between one and three sets per trip, fished in the first quarter, fished between North Carolina and Miami, FL, or had between 25 and 50 percent of their gross revenues from swordfish had the lowest net return to the owner (ranging from \$642 to \$1,885 per trip).

Larkin *et al.* (in press) used the above data in a cost function model to determine if and how captains decide on levels of effort in order to minimize variable costs per trip. They found that on average increasing the price of bait increased the demand for light sticks (i.e. these inputs are complements); changing the price of fuel did not affect any purchase decisions; and for every additional 10 feet in length, vessel operators demanded an additional 149 light sticks, 319 pounds of bait, and 540 gallons of fuel per trip. They also found that on average increasing swordfish landings required additional light sticks, bait and fuel. Increasing tuna landings reduced the demand for light sticks while increasing the demand for bait and fuel. Additionally, some inputs (i.e. light sticks, bait demand, and fuel demand) varied significantly with region, quarter, number of sets, and target species. They also found that if the price of light sticks or bait increases, the quantity demanded falls, particularly for light sticks (i.e. own-price elasticities are negative). However, elasticities could also change depending on region, target species, or number of trips but did not change between seasons.

Porter *et al*. (2001) conducted a survey of 147 vessels along the Atlantic and Gulf of Mexico (110 surveys were completed) in 1998 regarding 1997 operations. The survey consisted of 55 questions divided into five categories (vessel characteristics, fishing and targeting strategies, demographics, comments about regulations, and economic information of variable and fixed costs). The vessels interviewed were diverse in vessel size and target species (swordfish, tuna, mixed). Information was also used from trip tickets and logbooks. They found that on average, the average vessel received approximately $250,000 annual gross revenues, annual variable costs were approximately $190,000, and annual fixed costs were approximately $50,000. Thus, vessels were left with approximately $8,000 to cover depreciation on the vessel and the vessel owner lost approximately $3,500 per year. On a per trip level, gross revenues averaged $22,000 and trip expenses, including labor, were $16,000. Labor cost the owner the most (43 percent) followed by gear. Generally trip returns were divided so the vessel owner received 43 percent and the captain and crew 57 percent. Along with other studies, Porter *et al*. (2001) noted differences between region, vessel size, and target species. Porter *et al*. (2001) also noted that 1997 was probably a financially poor year due to a reduction in swordfish quota and a subsequent closure of the fishery.

In all, these studies are consistent with Larkin *et al*. (1998) and Ward and Hanson (1999) in that characteristics of fishing trips can influence the success of the trip and that pelagic longline fishermen do not have large profits. Additional information specific to the pelagic longline fishery can be found in the Final Supplemental Environmental Impact Statement for the Reduction of Bycatch, Bycatch Mortality, and Incidental Catch in the Atlantic Pelagic Longline Fishery, and in the Environmental Assessment and Regulatory Impact Review to Reduce Sea Turtle Bycatch and Bycatch Mortality in the Atlantic Pelagic Longline Fishery or in the June 14, 2001, BiOp.

*Bottom Longline*

Nearly all Atlantic shark fishermen operate in the multispecies longline fishery where gear requirements are substantially similar. McHugh and Murray (1997) compared the proportion of catch per trip by value for a sample of directed shark fishing vessels in surveys conducted over two periods, one before and one after implementation of the shark FMP in April 1993. Survey data reveal that the share of sharks, in total trip catch value, declined from 90.8 percent to 62.1 percent. In contrast, the share of grouper, in total value, increased from 6.9 percent to 34 percent.

The 1993 finning prohibition and quota cuts, along with the 1994 commercial retention limit, likely played a role in this changing composition, although a more important factor may have been the increase in grouper prices while shark prices were relatively stable or declining. Examination of the trips by share of shark in total volume of catch indicates that there has been a notable shift in the concentration of activity away from shark products toward more diversified trips (McHugh and Murray, 1997).

McHugh and Murray (1997) estimated profits per fishing trip for shark vessels as the owner's share of total catch minus all expenses other than those for food, which are normally taken out of the crew's share of the revenues. For the entire fishery, per-day profit rates were calculated, with a seven-day trip averaging $1,589 (for comparison with figures provided below). When examined by vessel category, vessels in the 40 to 49 foot range averaged $1,975 in profits per seven-day trip ($282.18 in profits per day). A regression analysis shows that trip profitability is unrelated to the proportion of catch which is shark. Profits were also positively related to dummy variables for the 1994 and 1995 seasons, possibly indicating that the more efficient highliners remained in the fishery following implementation of the commercial retention limit. There is anecdotal evidence (supported in McHugh and Murray, 1997) that the implementation of the commercial retention limit rule resulted in the exit of some of the larger vessels from the shark fishery.

Additional data are needed for this fishery. NOAA Fisheries began collection of cost-earnings information for this fishery in 2003. As described earlier, this economic data is needed in order to accurately assess the economic impacts of management measures.

*Gillnets*

Currently, the only fishermen allowed to use this gear in HMS fisheries are fishermen targeting sharks. NOAA Fisheries knows of five vessels that actively participated in this fishery in recent years. NOAA Fisheries has very little economic information on the fishing costs related to this gear type. However, it is expected that the cost per trip would be less than those of a pelagic or bottom longline fishing trip because the trips are usually shorter in duration (an average of 18 hours per trip), vessels do not fish far offshore (within 30 nautical miles from port), and the gear does not need hooks, bait, or light sticks. Other costs may be incurred as the holes in the gear need to be repaired regularly. Based on recent landings and average ex-vessel prices, NOAA Fisheries estimates that most drift gillnet vessels fishing for sharks have gross revenues per trip of $380 to $9,000 with an average of $3,700.

Additionally, some shark drift gillnet vessels fish in a strike-net method. This method usually requires the use of a small vessel (used to run the net around the school of sharks) and can require the use of a spotter plane. While the cost per trip is higher than the traditional drift gillnet method, bycatch in this method is extremely low, catch rates of the target species is high, and vessels can complete a set in less time. NOAA Fisheries estimates that the smaller vessel could cost between $2,000 and $14,000 to buy. Because these second vessels need to be sturdy enough to hold the gillnet and move quicky around the school of sharks, it is likely that vessel owners would need to re-fit any vessel bought for this purpose. Additionally, a second vessel requires additional fuel and maintenance costs. Spotter planes in other fisheries are paid based on the percentage of the proceeds from the trip, generally 10 to 25 percent of gross revenues. Thus, given the average gross revenues per trip, converting a drift gillnet vessel to a strikenet vessel could be prohibitive unless the vessel is fishing for other species as well.

### 3.3.2.2 Costs and Revenues for Atlantic Dealers

NOAA Fisheries does not currently have information regarding the costs to HMS dealers. In general, dealer costs include: purchasing fish; paying employees to process the fish; rent or mortgage on the appropriate building; and supplies to process the fish. Some dealers may provide loans to vessel owners for vessel repairs, fuel, ice, bait, etc. In general, outlays and revenues of dealers are not as variable or unpredictable as those of a vessel owner; however, dealer costs may fluctuate depending upon supply of fish, labor costs and equipment repair.

Although NOAA Fisheries does not have specifics regarding HMS dealers, there is some information on the number of employees for processors and wholesalers in the United States provided in the HMS FMP. Table 3.24 provides a summary of available information. Recent trends indicate that while the number of fish processing facilities have decreased, the number of employees have increased. Florida and New York appear to have the largest number of processing facilities and employees on the Atlantic coast.

NOAA Fisheries also has information regarding the mark-up percentage paid by consumers. A mark-up or margin is the difference between the price paid for the product by the consumer and the wholesale or dockside value for an equivalent weight of the product. This information is presented in Table 3.25. In both 1996 and 2001, the mark up was over 90 percent.

Dealers and shoreside processors purchasing sharks directly from fishing vessels are required to obtain a NOAA Fisheries dealer permit. Similar to vessel permits, dealers often have permits for more than one species. As of October 2002, there were 267 dealers permitted to purchase Atlantic sharks. Based on information in the dealer database, dealer addresses ranged from Texas through Maine with 100 dealers (37 percent) based in Florida, 21 (8 percent) in North Carolina, 19 (7 percent) in Louisiana, 19 (7 percent) in Massachusetts, and 13 in South Carolina (5 percent).

### 3.3.2.3 Economics of Recreational Fisheries

Although NOAA Fisheries believes that recreational fisheries have a large influence on the economies of coastal communities, NOAA Fisheries has little current information on the costs and expenditures of anglers or the businesses that rely on them. An economic survey conducted by the U.S. Fish and Wildlife Service[1] in 2001 found that 9.1 million saltwater anglers went on approximately 72 million fishing trips and spent approximately $8.4 billion (USFWS, 2002). Expenditures included lodging, transportation to and from the coastal community, vessel fees, equipment rental, bait, auxiliary purchases (e.g. binoculars, cameras, film, foul weather clothing, etc.), and fishing licenses. Saltwater anglers spent $4.5 billion on trip related costs and $3.9 billion on equipment. Approximately 76 percent of the saltwater anglers surveyed fished in their home state (USFWS, 2002). The next USFWS survey is expected in 2006.

The American Sportfishing Association (ASA) also has a report listing the 2001 economic impact of sportfishing on specific states. This report states that all sportfishing has an overall economic importance of $116 billion dollars. Florida, Texas, North Carolina, New York, and Alabama are among the top 10 states in terms of overall economic impact for both saltwater and freshwater fishing. Florida is also one of the top states in terms of economic impact of saltwater fishing with $2.9 billion in angler expenditures, $5.4 billion in overall economic impact, $1.5 billion in salaries and wages related to fishing, and 59,418 fishing related jobs. After California, Texas and New Jersey were the next highest states in terms of economic impact (ASA, 2001).

In general, most anglers do not target HMS. In 2001, over 12 million people made 84 million marine recreational fishing trips in the United States and caught over 442 million fish (over 57 percent were released alive). Along the Atlantic and Gulf of Mexico, over 9.4 million participants took over 75.8 million trips and caught a total of more than 407 million fish. Of the trips that occurred in the Atlantic, 24 percent were made in east Florida, 14 percent in New Jersey, and 13 percent in North Carolina. The most commonly caught species by number in the Atlantic were summer flounder, Atlantic croaker, bluefish, black sea bass, and striped bass. The top five most commonly caught fish by weight included yellowfin tuna, the only HMS in that list. The most commonly caught species in federally managed waters were black sea bass, dolphin, Atlantic cod, summer flounder, Atlantic mackerel, and bluefish. Of the trips that occurred in the Gulf of Mexico, 72 percent originated in Florida, 16 percent in Louisiana, and 12 percent in Alabama and Mississippi. The most commonly caught species by number were spotted and sand seatrouts, red drum, white grunt, blue runner, Spanish mackerel, and Atlantic croaker. No HMS made the top five list for most commonly caught species by weight in the Gulf of Mexico. The most commonly caught species by number in federally managed waters were white grunt, red snapper, black sea bass, dolphin, and greater amberjack (NOAA Fisheries, 2002).

### 3.3.2.4 Willingness to Pay to Fish for Atlantic HMS

The most recent data NOAA Fisheries has comes from a 1994 survey of anglers in New England and the Mid-Atlantic (Hicks *et al.*, 1999). The data collected were used to estimate expenditures and economic value of the various groups of recreational fisheries in this area. One category of

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[1] This survey interviewed over 77,000 households during phase 1 and approximately 25,070 sports persons during phase 2. The response rate during phase two of the survey was 75 percent.

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fishing, called "Big Game" consisted primarily of HMS, including sharks, billfish, and tunas. Although this study is not an exhaustive picture of the entire HMS recreational fishery, the results provide considerable insight into the absolute and relative values of the recreational fisheries for HMS. Overall average willingness to pay (WTP) for a one-day fishing trip ranged from a low of less than a dollar in New Hampshire to a high of $42 in Virginia. Aggregate WTP (average WTP times the number of trips) ranged from $18,000 in New Hampshire to nearly $1 million in Virginia. Using model results, it was possible to estimate the WTP for a one fish increase in the expected catch rate across all sites in the choice set. The highest average value was attributed to big game fish, ranging from $5.00 to $7.00 per trip (about $5.40 on average), in addition to the value of the trip. The marginal value of an increase in catch per trip was highest for big game fish, and lowest for bottom fish.

The 1994 survey results also indicated that boat fees were responsible for the greatest percentage of expenditures. Roughly 70 percent and 53 percent of total expenditures went for private/rental boats and charter/party boats, respectively. Travel expenses were the smallest portion of expenditures, although travel costs for those fishing on party/charter vessels were about twice as high as for those fishing on private/rental boats ($28 *vs*. $16).

Angler WTP depends, in part, on the species sought and on the location. Fisher and Ditton (1992) found that anglers were willing to pay an additional $105 per trip rather than stop fishing for sharks and that 32 percent of shark anglers said that no other species would be an acceptable substitute for sharks.

While these results are useful in considering the economic value of HMS recreational fisheries, specific surveys focusing on HMS are preferable in order to consider the particular nature of these fisheries. NOAA Fisheries will continue to pursue options for funding economic surveys of the recreational HMS fisheries.

#### 3.3.2.5 Atlantic HMS Tournaments

A recent search for HMS tournaments on the web found a number of tournaments targeting HMS. This search found that HMS tournaments charge large fees for a team ($395 to $5000). This entry fee would pay for a maximum of two to six anglers per team during the course of the tournament. Additional anglers could join the team at a reduced rate of between $50-$450. The team entry fee did not appear to be directly proportional to the number of anglers per team, but rather with the amount of money available for prizes and, possibly, the species being targeted. For example, in 2001 and 2002, Bisbee's Black and Blue Marlin Jackpot Tournament had a $5,000 entry fee for teams consisting of a maximum of four anglers. This tournament awarded a total of $1.7 million in both 2001 and 2002. Conversely, the $15,000 New Jersey Shark tournament has an entry fee of $395 for a team with a maximum of five anglers. This tournament awarded a total of $15,000 in prizes with a possibility of a $50,000 bonus if a state record is landed. The number of vessels and participants at each tournament is also diverse. The smallest tournament found on the web had 18 vessels and 58 anglers participating. Some of the larger tournaments had between 250 and 400 vessels and over 1,300 anglers participating.

In general, it appears that billfish and tuna tournaments charge higher entry fees and award more prize money than shark tournaments although all species have a wide range. The web search found that while some tournaments award between $500 and $50,000 in prizes (third through first place) others award much larger prizes ranging from $81,000 to $840,000 in prizes. Some tournaments hand out equipment such as new cars, boats, fishing tackle with, or instead of, monetary prizes. The total amount of prize money distributed at any one tournament ranged from $9,500 to $2,385,900.

Most tournaments also have a type of betting called a "calcutta" where anglers pay between $200 to $5,000 to win more money than the advertised tournament prizes for a particular fish. Tournament participants do not have to enter calcuttas. Tournaments with calcuttas generally offer different levels depending on the amount of money an angler is willing to put down. Calcutta prize money is distributed based on the percentage of the total amount entered into that calcutta. Therefore, first place winner of a low level calcutta (entry fee ~$200) could win less than a last place winner in a high level calcutta (entry fee~$1000). On the web pages, it was not always clear if the total amount of prizes distributed by the tournament included prize money from the calcuttas or the estimated price of any equipment. As such, the range of prizes discussed above could be a combination of fish prize money, calcutta prize money, and equipment/trophies.

Tournaments can bring in a lot of money for the surrounding communities and local businesses. Besides the entry fee to the tournament and possibly the calcutta, anglers also pay for marina space and gas (if they have their own vessel), vessel rental (if they do not have their own vessel), meals and awards dinners (if not covered by the entry fee), hotel, fishing equipment, travel costs to and from the tournament, camera equipment, and other miscellaneous expenses.

### 3.3.2.6 Atlantic HMS Charter and Party Boat Operations

Currently, specific information on the economic impact of HMS charter/headboat operations is sparse. Most of the data, as reported in the HMS FMP, are related to the bluefin tuna fishery and other tunas. There are, however, limited data on charter/headboats in general. In 2001, HMS required all charter/headboat vessels fishing for Atlantic HMS to have a permit. This information indicates that a few thousand vessels either target, or feel they could catch, Atlantic HMS. As of September 30, 2003, there were 4,041 Atlantic HMS charter/headboat permit holders.

In 1998, a survey was completed of a number of charterboats (96 of an estimated 430) and party boats (21 out of 23) throughout Alabama, Mississippi, Louisiana, and Texas (Sutton *et al*., 1999). This study provides some economic information related to HMS. They defined charter boats as for-hire vessels that carry six or fewer passengers in addition to the crew while party boats are for-hire vessels that carry more than six passengers (up to 150 passengers). They found that the average charter boat base fees were $417 for a half day trip, $762 for a full day trip, and $1,993 for an overnight trip and 60 percent of all trips were taken May through August. The average party boat base fees were $41 for a half day trip, $64 for a full day trip, and $200 for an overnight trip and 48 percent were taken May through August. They found that 55 percent of charter boat operators reported targeting tuna at least once, 38 percent targeted sharks at least once, 41 percent reported targeting billfish at least once. Percentages by state are summarized in Table 3.26. Snapper (49 percent), king mackerel (10 percent) red drum (6 percent), cobia (6 percent), tuna (5 percent) and speckled trout (5 percent) were the species that received the largest percentage of effort by charter boat operators.

In the Sutton *et al*. study, party boat operators did not frequently target sharks, tunas or billfish. A total of 65 percent of party boat operators reported targeting sharks at least once; 55 percent indicated they had targeted tunas at least one time. Ninety percent reported that they did not target billfish. Snapper (70 percent), king mackerel (12 percent), amberjack (5 percent) and sharks (5 percent) were the species that received the largest percentage of effort by party boat operators. The economic information estimated in this study can be found in Table 3.27.

Holland *et al*. (1999) conducted a similar study on charter (boats that carry six or less passengers and charge for the entire boat) and headboats (boats that carry 10 or more passengers and charge by the person) in Florida, Georgia, South Carolina, and North Carolina. The survey interviewed 403 charter operators (24 percent of the estimated number of charter boats) and 52 headboat operators (35 percent of the estimated number of headboats). The average fees for charter and headboats are listed in Table 3.28. Charterboat and headboat operators did not target HMS as frequently as they did other species such as mackerel, grouper, snapper, dolphin, and red drum. The percentage of charter and headboat operators who report targeting HMS can be found in Table 3.29. Table 3.30 shows the economic information regarding these businesses. Unlike similar businesses in the Gulf of Mexico, the Holland study indicates that these businesses appear to be profitable except for charter boats in Florida which are, on average, unprofitable.

Overall, charter/headboats appear to provide a substantial amount of employment and are economically important to coastal communities. Although HMS are targeted, they do not appear to be the primary objective for the majority of operations, and as such, HMS charter/headboat fisheries probably do not contribute as substantially to the economies of these communities compared to other fisheries such as mackerel and snapper.

### 3.3.2.7 Other Recreational Fishing Costs Information

In addition to charterboat fees, recreational anglers can incur other costs associated with fishing. These may include the costs of owning, outfitting, and operating personal vessels used for fishing. NOAA Fisheries has no current data on the cost of recreational boat ownership and operating costs.

### 3.3.3 Fish Processing, Industry, and Trade

Over the past several years, the United States has taken steps to use international trade information to further domestic conservation policy related to Atlantic HMS. While this process is slow, it is important to note that by working multi-laterally, management actions taken by the United States are strengthened and provide protection from a challenge before the World Trade Organization. U.S. actions related to trade must be consistent not just with domestic fisheries legislation, but also with the General Agreements of Tariffs and Trade (GATT).

Because there are "missing links" surrounding the capture, processing, and trade of Atlantic HMS, NOAA Fisheries cannot re-create information about stock production based on trade data. Nevertheless, trade data is used to update information on international and domestic activities related to these fisheries and to question compliance with ICCAT management measures. Sharks are not included in ICCAT recommendations, however, in December 2000, a bill was signed that required the Secretary of Commerce to ban shark finning in the United States and to begin discussions on developing international agreements to prohibit shark finning.

#### 3.3.3.1 Overview of U.S. Trade Activities for HMS

It is unknown how many U.S. companies depend on HMS fisheries, other than those who buy fish directly from U.S. fishermen and those who import bluefin tuna or swordfish. The proportion of those companies that depend solely on Atlantic HMS versus those that handle other seafood and/or products is also unknown. This section provides a summary of the most recent trade data that NOAA Fisheries has analyzed, as well as a brief description of the processing and trade industries employed in transitioning Atlantic HMS from the ocean to the plate.

*Processing and Wholesale Sectors*

Quantitatively, NOAA Fisheries has limited information on the processing sector, i.e., the amount of HMS products sold in processed forms. In addition, knowledge regarding the utilization of Atlantic HMS is largely limited to the major product forms. The utilization of sharks is also not well known since trade statistics frequently do not indicate product forms such as skins and leather, jaws, fishmeal and fertilizer, liver oil, and cartilage (Rose, 1996). Domestically-landed sandbar and blacktip shark meat may be sold to supermarkets and processors of frozen fish products. NOAA Fisheries continues to work with industry to collect information specific to U.S. and foreign processing of Atlantic HMS to better track markets, conserve stocks, and manage sustainable fisheries.

The U.S. processing and wholesale sectors are dependent upon both U.S. and international HMS fisheries. Individuals involved in these businesses buy the seafood, cut it into pieces that transform it into a consumer product, and then sell it to restaurants or retail outlets. Employment varies widely among processing firms. Often employment is seasonal unless the firms also process imported seafood or a wide range of domestic seafood. The majority of firms handle other types of seafood and are not solely dependent on HMS. Other participants in the commercial trade sector include brokers, freight forwarders, and carriers (primarily commercial airlines, trucking, and shipping companies). Swordfish, tunas, and sharks are important commodities on world markets, generating significant amounts in export earnings in recent years.

NOAA Fisheries has recently observed that many seafood dealers that buy and sell HMS and other seafood products expand their operations into internet-powered trading platforms specifically designed to meet the needs of other seafood professionals. Through these platforms, interested parties can conduct very detailed negotiations with many trading partners simultaneously. Buyers and sellers can bargain over all relevant elements of a market transaction (not just price) and can specify the product needed to buy or sell in detail, using seafood-specific terminology. The platforms are purportedly easy to use because they mimic the pattern of traditional negotiations in the seafood industry. NOAA Fisheries expects that the use of the internet will change the way HMS trade occurs in the future. NOAA Fisheries staff intends to continue to learn about the new technologies being used by our constituents.

**3.3.3.2 Shark Exports**

Existing programs at NOAA Fisheries monitor exports of fish products and provide Bureau of the Census data online for the public at www.st.nmfs.gov/st1/trade/index. Census defines exports of "domestic" merchandise to include commodities which are grown, produced, or manufactured in the United States (e.g., fish caught by U.S. fishermen). For statistical purposes, domestic exports also include commodities of foreign origin which have been altered in the United States from the form in which they were imported, or which have been enhanced in value by further manufacture in the United States. The value of an export is the f.a.s. (free alongside ship) value defined as the value at the port of export based on a transaction price including inland freight, insurance, and other charges incurred in placing the merchandise alongside the carrier. It excludes the cost of loading the merchandise, freight, insurance, and other charges or transportation costs beyond the port of exportation.

NOAA Fisheries collects trade data on the export of sharks, although not in the level of detail found in the Bluefin Statistical Document program. Some regional entities, including the Food and Agriculture Organization of the United Nations (FAO), work to conserve sharks worldwide and gather trade information on shark species. Shark exports are not identified by species code with the exception of dogfish. In addition, they are not identified by specific product code other than fresh or frozen meat and fins. Shark shipments are not identified with respect to the flag of the harvesting vessel or the ocean of origin. Due to the popular trade in shark fins and their high relative value compared to shark meat, shark fins are tracked as a specific product code by U.S. Customs. In 2002, exported shark fins averaged \$28.00/kg (\$12.70/lb). In comparison, exported shark fins averaged \$8.54/kg (\$3.87/lb) in 1999 and \$8.95/kg (\$4.06/lb) in 1998. In 2002, exported fresh and frozen shark meat averaged \$1.52/kg (\$0.69/lb) and \$2.38/kg (\$1.08/lb), respectively. Table 3.31 indicates the magnitude of shark exports by the United States from 1997-2002. Errors in the Bureau of Census data for dried shark fin exports for the years 2000 and 2001 prevent its inclusion in the table and discussion. Corrected data will be made available when it is received by NOAA Fisheries.

Sharks are targeted in the coastal Pacific ocean by the driftnet thresher fishery and are caught incidental to the Bering Sea groundfish (trawl) fishery, and tuna and swordfish longline fisheries in the Western Pacific ocean. However, the Atlantic fishery catches a large number of sandbar and blacktip sharks which are thought to be sold domestically. As a result, it is unknown what percentage of total exports can be attributed to the Atlantic fishery.

Note that exports of fresh and frozen shark increased substantially in 2002. The volume of non-specific frozen shark exports increased in 2002 by 55 percent from 2001, and the volume of non-specific fresh shark exports increased by 191 percent in 2002. The average price quoted for exports of fresh shark remained relatively constant from 1999-2000, $1.82/kg ($0.83/lb) in 2000, but has decreased slightly in 2001 and 2002 to $1.64/kg ($0.74/lb) and $1.52/kg ($0.69/lb), respectively. Frozen shark product decreased in value slightly in 2000 to $2.35/kg ($1.07/lb) from $2.97/kg ($1.35/lb) in 1999, then increased significantly to $3.69/kg ($1.67/lb) in 2001. In 2002 frozen shark product decreased to $2.38/kg ($1.08/lb).

It should be noted that there is no tracking of other shark products besides meat and fins. Therefore, NOAA Fisheries cannot track trade in shark leather, oil, or shark cartilage products. Additionally, the United States has reported its imports of shark fins since 1964, but has only recently obtained a tariff code for exporting shark fins. Until that time, they were classified under a general heading.

Consistent with the directives of Section 5 of the Shark Finning Prohibition Act, the Department of Commerce and the Department of State have initiated an ongoing consultation regarding the development of international agreements. Discussions have focused on possible bilateral, multilateral, and regional agreements with other nations. The law calls for the U.S. to pursue an international ban on shark finning, and to encourage improved data collection (including biological data, stock abundance and bycatch levels, and information on the nature and extent of shark finning and trade). The Secretary of Commerce is required to annually provide Congress with a list of nations whose vessels conduct shark finning, including estimates of harvest and value of fins, and recommendations to ensure that U.S. actions are consistent with international obligations. Determining the nature and extent of shark finning is the first step toward reaching agreements that will decrease the practice of finning worldwide.

### 3.3.3.3 Shark Imports

All seafood import shipments are required to be accompanied by a 7501 Customs entry form. The information submitted on this form is analyzed by NOAA Fisheries and those data are available online at www.st.nmfs.gov/st1/trade/index. As mentioned on the web page, two methods are used to track imports: "general" imports are reported when a commodity enters the country, and "consumption" imports consist of entries into the United States for immediate consumption combined with withdrawals from Customs bonded warehouses. "Consumption" import data reflect the actual entry of commodities originating outside the United States into U.S. channels of consumption. These are the data used by NOAA Fisheries.

The United States imports both fresh and frozen shark meat. These imports and shark fins can be tracked using data from the Customs 7501 entry form. NOAA Fisheries does not require importers to submit additional data regarding shark shipments. These meat products are reported to be high-quality and are supplied to restaurants and other seafood dealers that import other high-quality seafood products (Rose, 1996). NOAA Fisheries does not have specific product information on imported shark meat such as the proportion of fillets, steaks, or loins. NOAA Fisheries also has no data on imports of the condition of shark fins; i.e., wet, dried, or further processed products such as canned shark fin soup. The United States may be an important trans-shipment port for shark fins; shark fins may be imported wet and then exported dried. It is also probable that U.S.-caught shark fins are exported to Hong Kong or Singapore for processing, then imported back into the United States for consumption by urban-dwelling Chinese Americans (Rose, 1996). There is no longer a separate tariff code for shark leather, making it impossible to track imports of shark leather through analysis data from the Customs 7501 entry form. Imports of frozen sharks have increased by nearly 54 percent since 1997 while imports of shark fins have decreased by approximately 50 percent (by weight) (Table 3.32).

In 2002, dried shark fin imports decreased by 11,523 kg, non-specific fresh shark decreased by 11,588 kg, and non-specific frozen shark imports decreased by 32,017 kg. Imported shark fins averaged $26.16/kg ($11.86/lb), increasing from $21.45/kg ($9.73/lb) in 2001. Fresh shark averaged $1.56/kg ($0.71/lb), increasing slightly from $1.52/kg ($0.69/lb) in 2001. Prices for non-specific frozen shark decreased from $14.38/kg ($6.52/lb) in 2001 to $11.88/kg ($5.39/lb) in 2002. The average price for imported dried shark fins increased by 22 percent from the average price in 2001. The Shark Finning Prohibition Act was enacted in December of 2000 and fully implemented in February 2002, therefore, decreases in shark fin trade are to be expected.

## 3.4 HABITAT

This section of Chapter 3 and Chapter 10 identify and describe habitats, including essential fish habitat (EFH), for some of the sharks covered by this FMP Amendment, on behalf of the Secretary of Commerce and in accordance with the Magnuson-Stevens Act. Chapter 10 contains all of the mandatory elements for updating EFH identification, description and conservation, including descriptions of the locations and characteristics of EFH for five of the managed species in text with referenced tables and maps. In addition, Chapter 10 considers threats to EFH from fishing activities and potential threats to EFH from non-fishing activities, and identifies options for the conservation and enhancement of shark EFH that should be considered in the planning of projects that may adversely affect those habitats. These measures are representative of the conservation and enhancement measures that may be recommended by NOAA Fisheries during consultation with Federal action agencies, as required by section 305(b) of the Magnuson-Stevens Act, on projects that may potentially impact shark EFH. Chapters 5 and 6 of the HMS FMP contain EFH identification information for the rest of the managed shark species.

### 3.4.1 Regulatory Requirements

Section 303(a)(7) of the Magnuson-Stevens Act, 16 U.S.C. §§ 1801 *et seq*., as amended by the Sustainable Fisheries Act in 1996, requires that FMPs describe and identify EFH, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat. The Magnuson-Stevens Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." (16 U.S.C. § 1802 (10)). The EFH regulations (at 50 C.F.R. 600 Subpart J) provide additional interpretation of the definition of essential fish habitat: "'Waters' include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate; 'substrate' includes sediment, hard bottom, structures underlying the waters, and associated biological communities; 'necessary' means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and 'spawning, breeding, feeding, or growth to maturity' covers a species' full life cycle."

The EFH regulations (67 FR 2343, January 17, 2002) require NOAA Fisheries to periodically review and revise or amend the EFH provisions as warranted based on available information. The EFH regulations further require NOAA Fisheries to review all EFH information at least once every 5 years. EFH, including habitat areas of particular concern (HAPCs), for sharks were identified in the 1999 HMS FMP. This Amendment does not constitute the comprehensive 5-year review of EFH for all HMS, including sharks, required by the regulations. The complete review of EFH for all HMS will likely be addressed in a future rulemaking. However, this Amendment does provide an update to EFH for several species of sharks for which there has either been a change in management status, or for which new information has become available. These species include the sandbar, blacktip, dusky, finetooth, and nurse sharks.

#### 3.4.1.1 Description and Identification of EFH

The EFH regulations require that EFH be described and identified within the U.S. Exclusive Economic Zone (EEZ) for all life stages of each species in a fishery management unit. FMPs must describe EFH in text and tables that provide information on the biological requirements for each life history stage of the species. According to the EFH regulations, an initial inventory of available environmental and fisheries data sources should be undertaken to compile information necessary to describe and identify EFH and to identify major species-specific habitat data gaps. Available information should be evaluated through a hierarchical analysis based on: distribution data for some or all portions of the geographic range of a species (Level 1); habitat-related densities or relative abundances (Level 2); growth, reproduction, or survival rate comparisons between habitats (Level 3); and habitat-dependent production rates (Level 4). This information should be interpreted with a risk-averse approach to ensure that adequate areas are protected as EFH for the managed species. Habitats that satisfy the criteria in the Magnuson-Stevens Act and HMS EFH regulations have been identified and described as EFH.

For this FMP Amendment, NOAA Fisheries scientists at the Northeast Fisheries Science Center (NEFSC) and the Southeast Fisheries Science Center (SEFSC) conducted a review of the most recent life history and EFH information available for some species of sharks, with an emphasis on the factors that influence distribution of the species. NOAA Fisheries scientists at NEFSC completed a thorough review of shark nursery grounds of the Gulf of Mexico and the East Coast waters of the U.S. (McCandless *et al*., 2003). Information was available in the form of fishery-independent sources (directed research investigations) fishery-dependent sources (capture and bycatch reporting), and observer data.

Chapter 10 contains all of the required provisions as specified in the EFH regulations, covering all life stages of the species managed under this FMP for which information is available.

#### 3.4.1.2 Fishing Activities That May Adversely Affect EFH

The EFH regulations and the Magnuson-Stevens Act require the fishery management councils (Councils) and NOAA Fisheries, on behalf of the Secretary of Commerce, to minimize adverse effects on EFH from fishing activities to the extent practicable. Adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss of or injury to benthic organisms, prey species and their habitat, and other components of the ecosystem. Based on an assessment of the potential adverse effects of all fishing equipment types used within an area identified as EFH, the Council should act if there is evidence that a fishing practice is having an identifiable adverse effect on the EFH.

An assessment was made of the gears and practices in order to determine whether HMS fishing activities cause adverse impacts on EFH. Impacts of HMS and non-HMS fishing gears and practices were analyzed by examining published literature and anecdotal evidence of potential impacts or comparable impacts from other fisheries (Section 10.4). Based on this assessment, NOAA Fisheries considers the fishing gears and methods of the HMS fisheries do not appear to have adverse impacts on HMS EFH. Even if there were any adverse impacts, such impacts are not expected to be "more than minimal and not temporary in nature" (50 CFR 600.815(a)(2)(ii)). There is the possibility that other (non-HMS) fisheries may adversely impact HMS EFH, and some HMS gear may impact other EFH; however, the degree of that impact is difficult to ascertain from the data currently available. Although, at this time, there is no evidence that HMS fishing practices are causing adverse impacts on EFH, two conservation recommendations are included in Section 10.4 as a precautionary measure in the event that impacts may be occurring but are currently unverified. NOAA Fisheries is aware that other actions may be required in the future as a greater understanding of the impacts of fishing gear on fish habitat is gained. Future management measures could include fishing gear or practice restrictions, additional time/area closures, or harvest limits on the take of species that provide structural habitat or of prey species. Areas that are currently closed to fishing should be used as experimental control areas to research the effects of fishing gears on habitat.

### 3.4.1.3 Non-Fishing Activities That May Adversely Affect EFH and Respective Conservation Measures

Section 600.815 (a)(4) of the EFH regulations requires that FMPs identify non-fishing related activities that may adversely affect EFH of managed species, either quantitatively or qualitatively, or both. In addition, Section 600.815 (a)(6) requires that FMPs recommend conservation measures describing options to avoid, minimize, or compensate for the adverse effects identified.

Broad categories of activities that may adversely affect HMS EFH include, but are not limited to: (1) actions that physically alter structural components or substrate, e.g., dredging, filling, excavations, water diversions, impoundments and other hydrologic modifications; and (2) actions that result in changes in habitat quality, e.g., point source discharges, activities that contribute to non-point-source pollution and increased sedimentation, introduction of potentially hazardous materials, or activities that diminish or disrupt the functions of EFH. If these actions are persistent or intense enough they can result in major changes in habitat quantity as well as quality, conversion of habitats, or in complete abandonment of habitats by some species.

As required under the EFH regulations, Chapter 10 identifies non-fishing activities that may adversely affect HMS EFH. In many cases these activities are regulated under particular statutory authorities. As long as they are regulated within those guidelines, their potential to adversely affect EFH may be reduced, although not necessarily eliminated. Many of the standards that are used to regulate these activities are based on human health needs and do not consider long-term impacts on fish and fish habitats. Additionally, if the activity fails to meet or is operated outside of its permitted standards, it may adversely affect EFH. The EFH regulations require NOAA Fisheries to identify actions with the potential to adversely affect EFH, including the biological, chemical and physical nature of the impact. The EFH regulations also recommend the examination of cumulative impacts on EFH. It is possible that many permitted actions operating within their regulatory bounds may cause adverse impacts on EFH. Chapter 10 lists a broad range of activities to ensure that their potential to adversely affect HMS EFH will be adequately considered.

The review of HMS habitat use undertaken for Chapter 10 identified both benthic and water column habitats in coastal, estuarine and offshore areas as EFH, although in many cases the particular habitat characteristics that control species habitat use are not clearly identified. Many of these factors seem to be related to water quality, e.g., temperature, salinity, and dissolved oxygen.

In addition to identifying activities having the potential to adversely affect EFH, the Magnuson-Stevens Act requires the inclusion of measures to conserve and enhance EFH. Each activity discussed in Chapter 10 is followed by actions to encourage conservation to avoid, minimize or mitigate adverse impacts on EFH. These include examples of both general and specific conservation actions that might be appropriate for NOAA Fisheries to recommend when consulting on similar proposed activities. In some cases the actions are based on site-specific activities, in others the actions represent broad policy-type guidelines. During EFH consultations, NOAA Fisheries will evaluate each project based on its merits and potential threat to EFH, and the appropriate conservation measures will be assessed at that time. The Federal action agency with the statutory authority to regulate the proposed action must weigh all comments and decide on the appropriate action, modifications, or mitigation before proceeding with a project. The conservation actions included in this FMP provide examples of NOAA Fisheries' recommendations that potentially could be made regarding particular projects. They are intended to assist Federal and state agencies and other entities during the planning process when adverse impacts on EFH can be minimized most effectively, and may be incorporated into project designs and goals in order to help conserve EFH.

Maps geographically depicting threats to EFH should be included in an FMP. At the present time, however, the information for producing accurate maps depicting threats to HMS EFH is not available. The use of Geographic Information Systems (GIS) for mapping EFH distributions will allow the addition of this information as it becomes available.

#### 3.4.1.4 Cumulative Impacts Analysis

The EFH regulations require that to the extent feasible and practicable, FMPs and FMP amendments should analyze how fishing and non-fishing activities influence habitat function on an ecosystem or watershed scale. At this time the technology is not available to provide a site-specific analysis of cumulative impacts for each area that has been identified as EFH for HMS, although the use of GIS technology to map EFH will facilitate the investigation of cumulative impacts in the future.

#### 3.4.1.5 Habitat Areas of Particular Concern

The EFH regulations suggest that FMPs and FMP amendments identify HAPCs within EFH for habitats that satisfy the criteria of being sensitive or vulnerable to environmental stresses, are rare, or are particularly important ecologically. HAPCs represent subsets of identified EFH areas based upon the importance of their ecological function, their sensitivity to human-induced environmental degradation, development activities that serve as stressors on the habitat, and the rarity of the habitat. These areas should be identified to provide additional focus for conservation efforts.

Because of the lack of specific, detailed information regarding HMS habitat associations, the 1999 HMS FMP identified HAPC for only one HMS. The HAPC areas identified were for sandbar shark nursery and pupping grounds in Great Bay, NJ, Chesapeake Bay, MD, and the Outer Banks, NC in areas of Pamlico Sound. As information becomes available in the future, it may become possible to identify additional HAPCs within HMS EFH.

#### 3.4.1.6 Research and Information Needs

The EFH regulations suggest that FMPs and FMP amendments should contain recommendations, preferably in priority order, for research efforts that have been identified as necessary for carrying out the EFH management mandate. The 1999 HMS FMP contained numerous recommendations for data needs, and many of these are being addressed through ongoing research efforts and data collection. For example, the highest priority recommendation was to continue the delineation of shark nurseries and establish geographic boundaries of the summer nurseries of commercially important species. To address this, in 2002, NOAA scientists with the NEFSC completed a research project to delineate shark nursery areas on the Atlantic East coast and the Gulf of Mexico (McCandless *et al*., 2003).

Chapter 10 contains a listing of research and information needs that should be addressed in order to improve the ability to conserve and manage habitat concerns under the EFH mandate. These efforts vary from the gathering of additional information from diverse sources in order to better map the distributions of EFH, to long range research projects that will provide additional life history information for use in better defining the environmental parameters that influence the distribution of the HMS.

### 3.4.2 Habitat Types and Distributions

The following section is intended to provide a general overview of the various habitats with which sharks are most frequently associated. Specific environmental parameters such as temperature, salinity, depth, and dissolved oxygen that are associated with particular species or life stages of sharks are described in detail in Chapter 10.

Sharks are found in wide variety of coastal and ocean habitats including estuaries, nearshore areas, the continental shelf, continental slope, and open ocean. Many species are migratory and, like all other marine species, are affected by the condition of the habitat. Degraded habitat may impact sharks by altering their ecological patterns and reducing the availability of prey species. Analysis of habitats utilized by sharks has led to the identification of various habitats essential to the productivity of the species. Atlantic sharks are broadly distributed as adults but have been found to utilize specific estuaries as pupping and nursery areas during pupping season and throughout their neonate (newborn) life stages which may vary from a few to many months.

As described earlier in this chapter, sharks and the habitat they occupy can be divided into four broad categories: (1) coastal, (2) pelagic, (3) coastal-pelagic, and (4) deep dwelling. Coastal species tend to inhabit nearshore areas and the continental shelves. Examples include blacktip, finetooth, and sharpnose sharks. Pelagic species, on the other hand, range widely in the upper zones of the oceans, often traveling over entire ocean basins. Examples include mako, blue, and oceanic whitetip sharks. Coastal-pelagic species are intermediate in that they occur both inshore and beyond the continental shelves, but have not demonstrated mid-ocean or transoceanic movements. Sandbar, scalloped hammerhead, and dusky sharks are examples of coastal-pelagic species. Deep-dwelling species inhabit the dark, cold waters of the continental slopes and deeper waters of the ocean basins. Examples of this category include the cat sharks and gulper sharks. There may be overlap in the habitats frequented by the different categories depending on the life stages and associated habitat preferences or requirements.

Since coastal and coastal pelagic species frequently appear near shore and have pupping and nursery areas near shore, much more is known about their habitat requirements, particularly for early life history stages. Much less is known about the habitat requirements, spawning areas, and other details of pelagic and deep dwelling species. The following sections provide an overview of the habitat characteristics of the major ecosystems which Atlantic sharks occupy. Detailed information about specific habitat requirements by species and life stage are provided in Chapter 10.

#### 3.4.2.1 Atlantic Ocean

(Material in this section is largely a summary of information in MMS, 1992; 1996. Original sources of information are referenced in those documents)

*Coastal and Estuarine Habitat*

During early life stages, estuaries and coastal environments provide important nursery habitat for many species of sharks. Females of many coastal and coastal-pelagic sharks travel to specific nursery areas to give birth to pups (neonates) at certain times of the year. These nurseries are discrete geographic areas, usually in shallow, coastal waters. Shark nursery areas are frequently located in highly productive coastal or estuarine waters (Castro, 1987). Examples include Great Bay, New Jersey, Chesapeake Bay, Maryland and Delaware Bay, Delaware which provide important nursery habitat for sandbar sharks, and Bull's Bay, South Carolina, and Terrebone Bay, Louisiana which are important blacktip shark nursery areas. Studies suggest that these inshore nursery areas provide the advantages of low predation (Branstetter, 1990) and high forage abundance (Rountree and Able, 1996).

Natural and human-induced alterations of this fragile environment have modified freshwater inflow and altered or removed much of the suitable habitat. The amount of remaining wetlands suitable for shark production had not been quantified, however, Alexander *et al*. (1986) estimated that over the last 25 years, coastal wetlands have been depleted at an average rate of 80 sq km per year. In some areas, this rate may be even higher. Aside from direct loss of habitat, estuaries have also been impacted by decline in water quality.

The degree to which habitat alterations have affected sharks is unknown. Turner and Boesch (1987) examined the relationship between wetland habitat area and the yield of fishery species dependent on coastal bays and estuaries, noting apparent stock declines following wetland loss, and stock increases following wetland gains. While most of the studies related to shrimp production, other similar trends may exist for other species. Thus, production of some shark species may well be at risk for loss of habitat. Further research is needed to determine the degree to which shark nursery habitat may be correlated with wetland acreage, and the degree to which shark nurseries may be affected by continued loss of this habitat.

In determining EFH for sharks, consideration has been given to habitat associations for all life stages. Although they typically range throughout open ocean waters, many sharks move inshore, including coastal estuaries, at some time during their life cycles. For example, several species of Atlantic sharks are broadly distributed as adults but have been found to utilize specific estuaries and shallow coastal areas during pupping. Typically, the neonates remain in these same areas throughout their early life stages, which may vary from a few to many months. Many of these estuaries and shallow coastal areas used for pupping have been characterized only in general terms (e.g., salinity, temperature and/or season). Associations with particular bottom types are often undefined, and this lack of information has been identified as an important research need.

Recent tagging studies have shown that some sharks return to summer nursery areas in subsequent years. Grubbs and Musick (2003) demonstrated that juvenile sandbar sharks returned to their summer nursery grounds in the Chesapeake Bay following at least one winter migration out of the Bay. This provides some of the first evidence of philopatry or natal homing in sharks. Coastal areas in North Carolina and South Carolina were also demonstrated to be important overwintering grounds that may be used repeatedly as secondary nurseries by juvenile sandbar sharks.

Estuaries are highly productive, yet fragile, environments that support a great diversity of fish and wildlife species, including sharks. Many commercially valuable fish and shellfish stocks are dependent on these areas during some stage of their development. In the vicinity of North Carolina, Virginia, and Maryland, approximately 90 percent of the commercially valuable fish species are dependent on the estuaries for at least part of their life cycle.

Estuaries contain a number of important habitats which thrive in the mixture of salt and fresh water, and provide a number of functions for aquatic and terrestrial organisms. Coastal wetlands such as salt marshes, tidal freshwater marshes and forested and non-forested non-tidal wetlands are common in mid-Atlantic estuaries. Submerged aquatic vegetation is a diverse group of rooted vascular plants that range from saline to fresh water. Their distributions are indicative of water quality, as they require a delicate balance of sediments, nutrients, and light to survive. Tidal flats, which are exposed to air during low tides, are nondescript habitats that often are important in nutrient cycling and to seabirds as forage grounds.

Along the Atlantic seaboard coastal wetlands are located predominantly south of New York because these coastal areas have not been glaciated. Nearly 75 percent of the Atlantic coast salt marshes are found in the states of North Carolina, South Carolina, and Georgia. These three states contain approximately nine million acres of salt marsh.

Wetland vegetation plays an important role in nutrient cycling, and provides stability to coastal habitats by preventing the erosion of sediments and by absorbing the energy of storms. The dominant salt marsh vegetation along much of the Atlantic coast includes the cordgrasses (*Spartina* sp.), salt grass (*Distichlis spicata*), needle rushes (*Juncus roemerianus*), and other salt tolerant species. Because of the unique adaptations necessary for plants to survive in salt water environments, species diversity is much lower than in freshwater environments.

There are 13,900 square miles of estuarine habitat along the Atlantic coast, of which approximately 68 percent (9,400 square miles) occurs north of the Virginia/ North Carolina border, with Chesapeake Bay contributing significantly to the total. The dominant submerged aquatic vegetation in these estuaries are eelgrass (*Zostera marina*) and widgeongrass (*Ruppia maritima*). South of the Gulf of Maine, where there is a wider coastal plain and greater agriculture activity, estuaries carry higher sediment and nutrient loads. The increased fertility and generally higher water temperatures resulting from these nutrient loads allow these estuaries to support greater numbers of fish and other aquatic organisms.

South of the Virginia/North Carolina border, there are approximately 4,500 square miles of estuarine habitat. The Currituck, Albemarle, and Pamlico Sounds, which together constitute the largest estuarine system along the entire Atlantic coast, make up a large portion of these southern estuaries. A unique feature of these sounds is that they are partially enclosed and protected by a chain of fringing islands, the Outer Banks, located 32 to 48 km from the mainland. Dominant submerged aquatic vegetation in most of the southern estuaries are eelgrass, widgeongrass, and shoalgrass (*Halodule wrightii*).

Because of their low tidal flushing rates, estuaries are generally more susceptible to pollution than other coastal water bodies. The severity of the problem varies depending on the extent of tidal flushing. An indication of the potential efficiency of tidal flushing is tidal range. With the exception of estuaries along the coasts of North Carolina and south Florida, most estuaries along the Atlantic coast are mesotidal, having tidal ranges from two to four meters. Estuaries along the coasts of North Carolina and south Florida are classified as microtidal, having tidal ranges less than two meters. Since microtidal estuaries exhibit poor tidal flushing capacity, North Carolina and south Florida estuaries are more susceptible to water pollution than are other estuaries along the Atlantic coast.

In Maryland and Virginia, the primary problems reported are excessive nutrients (nitrates and phosphates), particularly in the Chesapeake Bay and adjoining estuarine areas. Other problems included elevated bacterial and suspended sediment levels. Non-point sources of pollution are considered one of the main causes of pollution. Elevated bacterial levels were also listed as a local coastal pollution problem in Maryland.

In North Carolina, the primary problems listed for estuarine areas were enrichment in organics and nutrients, fecal coliform bacteria, and low dissolved oxygen. Insufficient sewage treatment, wide-spread use of septic systems in coastal areas, as well as agricultural runoff are considered to be major causes of these pollution problems. Oil spills from vessel collisions and groundings, as well as illegal dumping of waste oil, are a common cause of local, short-term water quality problems, especially in estuaries along the north and mid-Atlantic coasts. These sources of pollution and habitat degradation may have a negative impact on sharks populations, particularly during vulnerable early life stages.

Many of the coastal bays and estuaries along the East coast and Gulf of Mexico are described in greater detail in the 1999 HMS FMP (Chapter 5), including the distribution, size, depth, freshwater inflow, habitat types, tidal range and salinity for each of the major estuaries and bays on the Atlantic East coast and Gulf coast, and are not repeated here.

*Continental Shelf and Slope Areas*

Moving away from the coast, the next major geologic features encountered are the continental shelf and slope areas. The continental shelf is characterized by depths ranging from a few meters to approximately 60 meters, with a variety of bottom habitat types. The continental shelf is habitat for some of the most important commercial shark species, including sandbar, blacktip, and tiger sharks. Far less research has been done in this area than on the coasts and estuaries, and consequently much less is known about the specific habitat requirements of sharks that occur in this area. Many of the commercially harvested sharks species are caught on bottom longlines suggesting that benthic habitat may play an important role in the feeding ecology, behavior, and development of these species.

The shelf area of the Mid-Atlantic Bight averages about 100 km (approximately 60 miles) in width, reaching a maximum of 150 km (approximately 90 miles) near Georges Bank and a minimum of 50 km (approximately 30 miles) offshore Cape Hatteras. Current speeds are strongest at the narrowest part of the shelf where wind-driven current variability is highest. The distribution of marine species, including sharks along the Atlantic seaboard may be strongly influenced by currents, the warm Gulf Stream in the middle and south portions of the region, and generally by the combination of high summer and low winter temperatures.

The continental shelf in the South Atlantic Bight varies in width from 50 km (32 miles) off Cape Canaveral, FL to a maximum of 120 km (75 mi) off Savannah, GA and a minimum of 30 km (19 miles) off Cape Hatteras. The shelf is divided into three cross-shelf zones. Waters on the inner shelf (0 to 20 m [0 to 66 feet]) interact extensively with rivers, coastal sounds, and estuaries. This interaction tends to form a band of low-salinity, stratified water near the coast that responds quickly to local wind-forcing and seasonal atmospheric changes. Mid-shelf (20 to 40 m [66 to 132 feet]) current flow is strongly influenced by local wind events with frequencies of two days to two weeks. In this region, vertically well mixed conditions in fall and winter contrast with vertically stratified conditions in the spring and summer. Gulf Stream frontal disturbances (e.g., meanders and cyclonic cold core rings) that occur on time scales of two days to two weeks dominate currents on the outer shelf (40 to 60 m [132 to 197 feet]).

The mid-Atlantic area from Cape Cod to Cape Hatteras represents a transition zone between northern cold-temperate waters of the north and the warm-temperate waters to the south. Water temperatures in the mid-Atlantic vary greatly by season. Consequently, many of the fish species of importance in the mid-Atlantic area, including sharks, migrate seasonally, whereas the major species in the other three areas are typically resident throughout the year (MMS, 1992; 1996). The shelf-edge habitat may range in water depth between 40 and 100 m (131 and 328 feet). The bottom topography varies from smooth sand to mud to areas of high relief with associated corals and sponges. The fish species found in this area include parrotfish (*Scaridae*) and the deepwater species of the snapper-grouper assemblage.

The continental slope generally has smooth mud bottoms in water depths of 100 to 200 m (328 to 656 feet). Many of the species in this zone are representatives of cold water northern species exhibiting tropical submergence (i.e., being located in deeper, cooler water as latitude decreases).

A topographic irregularity southeast of Charleston, SC, known as the Charleston Bump, is an area of productive sea floor which rises abruptly from 700 to 300 m (2,300 to 980 feet) within a distance of about 20 km, and at an angle which is approximately transverse to both the general isobath pattern and the Gulf Stream currents. The Charleston Gyre is a persistent oceanographic feature that forms in the lee of the Charleston Bump. It is a location in which larval swordfish have been commonly found and may serve as nursery habitat.

*Physical Oceanography*

Many Atlantic sharks spend their entire lives in the pelagic, or open ocean environment. These sharks are highly mobile and physiologically adapted to traveling great distances with minimal effort. Much of what is known about the association between sharks and their migrations across vast open ocean habitat comes from tagging studies. The greatest distance a tagged shark has been known to travel was a blue shark which was tagged off the northeastern coast of the United States and recovered south of the equator 3,740 miles away (Kohler *et al*., 1998).

While the open ocean may appear featureless, there are major oceanographic features such as currents, temperature gradients, eddies, and fronts that occur on a large scale and may influence the distribution patterns of many oceanic species, including sharks. For instance, the Gulf Stream produces meanders, filaments, and warm and cold core rings that significantly affect the physical oceanography of the continental shelf and slope. These features tend to aggregate both predators and prey and are frequently targeted by commercial fishing vessels. This western boundary current has its origins in the tropical Atlantic Ocean (i.e., the Caribbean Sea). The Gulf Stream system is made up of the Yucatan Current that enters the Gulf of Mexico through the Yucatan Straits; the Loop Current which is the Yucatan Current after it separates from Campeche Bank and penetrates the Gulf of Mexico in a clockwise flowing loop; the Florida Current, as it travels through the Straits of Florida and along the continental slope into the South Atlantic Bight; and the Antilles Current as it follows the continental slope (Bahamian Bank) northeast to

Cape Hatteras. From Cape Hatteras it leaves the slope environment and flows into the deeper waters of the Atlantic Ocean.

The flow of the Gulf Stream as it leaves the Straits of Florida reaches maximum speeds of about 200 cm/s. During strong events, maximum current speeds greater than 250 cm/s have been recorded offshore of Cape Hatteras. The width of the Gulf Stream at the ocean surface ranges from 80 to 100 km (50 to 63 miles) and extends to depths of between 800 and 1,200 m (2,624 to 3,937 feet).

As a meander passes, the Gulf Stream boundary oscillates sequentially onshore (crest) and offshore (trough). A meander can cause the Gulf Stream to shift slightly shoreward or well offshore into deeper waters. The Gulf Stream behaves in two distinct meander modes (small and large), with the size of the meanders decreasing as they move northward along the coast. During the large meander mode the Gulf Stream front is seaward of the shelf break, with its meanders having large amplitudes. Additionally, frontal eddies and accompanying warm-water filaments are larger and closer to shore. During the small meander mode the Gulf Stream front is at the shelf break. Frontal eddies and warm-water filaments associated with small amplitude meanders are smaller and farther from shore. Since HMS tend to follow the edge of the Gulf Stream, their distance from shore can be greatly influenced by the patterns of meanders and eddies.

Meanders have definite circulation patterns and conditions superimposed on the statistical mean (average) condition. As a meander trough migrates in the direction of the Gulf Stream's flow, it upwells cool nutrient-rich water, which at times may move onto the shelf and may evolve into an eddy. These boundary features move south-southwest. As warm-water filaments, they transfer momentum, mass, heat, and nutrients to the waters of the shelf break.

Gulf Stream filaments are mesoscale events which occur regularly offshore the southeast United States. The filament is a tongue of water extending from the Gulf Stream pointing to the south. These form when meanders cause the extrusion of a warm surface filament of Gulf Stream water onto the outer shelf. The cul-de-sac formed by this extrusion contains a cold core that consists of a mix of outer-shelf water and nutrient-rich water. This water mix is a result of upwelling as the filament/meander passes along the slope. The period from genesis to decay typically is about two to three weeks.

The Charleston Gyre is a permanent oceanographic feature of the South Atlantic Bight, caused by the interaction of the Gulf Stream waters with the topographically irregular Charleston Bump. The gyre produces an upwelling of nutrients, which contributes significantly to primary and secondary productivity of the Bight. The degree of upwelling varies with the seasonal position and velocity of the Gulf Stream currents.

Offshore water quality in the Atlantic is controlled by oceanic circulation, which, in the mid-Atlantic is dominated by the Gulf Stream and by oceanic gyres. A shoreward, tidal and wind-driven circulation dominates as the primary means of pollutant transport between estuaries and the nearshore. Water quality in nearshore water masses adjacent to estuarine plumes and in water masses within estuaries is also influenced by density-driven circulation. Suspended sediment concentration can also be used as an indication of water quality. For the Atlantic coastal areas, suspended sediment concentration varies with respect to depth and distance from shore, the variability being greatest in the mid-Atlantic and south Atlantic. Re-suspended bottom sediment is the principal source of suspended sediments in offshore waters.

### 3.4.3.2. Gulf of Mexico

(Material in this section is largely a summary of information in MMS, 1996; Field *et al.*, 1991; and NOAA 1997c. Original sources of information are referenced in those documents.)

The Gulf of Mexico supports a great diversity of fish resources that are related to a variety of ecological factors, such as salinity, primary productivity, and bottom type. These factors differ widely across the Gulf of Mexico and between inshore and offshore waters. Characteristic fish resources are not randomly distributed; high densities of fish resources are associated with particular habitat types (e.g., east Mississippi Delta area, Florida Big Bend sea grass beds, Florida Middle Grounds, mid-outer shelf, and the De Soto Canyon area). The highest values of surface primary production are found in the upwelling area north of the Yucatan Channel and in the De Soto Canyon region. In terms of general biological productivity, the western Gulf is considered to be more productive in the oceanic region than is the eastern Gulf. Productivity of areas where HMS are known to occur varies between the eastern and western Gulf, depending on the influence of the Loop Current.

*Coastal and Estuarine Habitats*

There are 5.62 million hectares (ha) of estuarine habitat among the five states bordering the Gulf. This includes 3.2 million ha of open water, 2.43 million ha of emergent tidal vegetation (including about 162,000 ha of mangroves), and 324,000 ha of submerged vegetation. Estuaries are found from east Texas through Louisiana, Mississippi, Alabama, and northwest Florida and encompass more than 23,938 square miles of water surface area. Estuaries of the Gulf of Mexico export considerable quantities of organic material, thereby enriching the adjacent continental shelf areas, and many of these estuaries provide important habitat for species such as fine-tooth, blacktip, bonnethead, spinner, and other Atlantic sharks.

The importance of wetlands to the coastal environment has been well documented. Coastal wetlands are characterized by high organic productivity, high detritus production, and efficient nutrient recycling. Wetlands provide habitat for a great number and wide diversity of invertebrates, fishes, reptiles, birds, and mammals. Inshore and estuarine areas bordered by wetlands are particularly important as pupping and nursery grounds for juvenile stages of many important invertebrate and fish species including many species of Atlantic sharks.

Coastal wetland habitat types that occur along the Gulf Coast include mangroves, non-forested wetlands (fresh, brackish, and saline marshes), and forested wetlands. Marshes and mangroves form an interface between marine and terrestrial habitats, while forested wetlands occur inland from marsh areas. Wetland habitats may occupy narrow bands or vast expanses, and can consist of sharply delineated zones of different species, monospecific stands of a single species, or mixed plant species communities.

*Continental Shelf and Slope Areas*

The Gulf of Mexico is a semi-enclosed, subtropical sea with a surface area of approximately 1.6 million square km. The main physiographic regions of the Gulf basin are the continental shelf, continental slope, and associated canyons, the Yucatan and Florida Straits, and the abyssal plains. The U.S. continental shelf is narrowest, at only 16 km (9.9 miles ) wide, off the Mississippi River. The continental shelf width varies significantly from about 350 km (217 miles) offshore west Florida, 156 km (97 miles) off Galveston, TX, decreasing to 88 km (55 miles ) off Port Isabel near the Mexican border. The depth of the central abyss ranges to 4,000 m (13,000 feet). The Gulf is unique because it has two entrances: the Yucatan Strait and the Straits of Florida. The Gulf's general circulation is dominated by the Loop Current and its associated eddies. The Loop current is caused by differences between the sill depths of the two straits. Coastal and shelf circulation, on the other hand is driven by several forcing mechanisms: wind stress, freshwater input, buoyancy and mass fluxes, and transfer of momentum and energy through the seaward boundary.

In the Gulf, the continental shelf extends seaward from the shoreline to about the 200-m water depth and is characterized by a gentle slope of less than one degree. The continental slope extends from the shelf edge to the continental rise, usually at about the 2,000-m (6,500 feet) water depth. The topography of the slope in the Gulf is uneven and is broken by canyons, troughs, and escarpments. The gradient on the slope is characteristically one to six degrees, but may exceed 20 degrees in some places, particularly along escarpments. The continental rise is the apron of sediment accumulated at the base of the slope. The incline is gentle with slopes of less than one degree. The abyssal plain is the basin floor at the base of the continental rise.

*Physical Oceanography*

The Gulf receives large amounts of freshwater runoff from the Mississippi River as well as from a host of other drainage systems. In recent years, large amount of nutrient laden runoff from the Mississippi River have resulted in large hypoxic or low oxygen areas in the Gulf. This "dead zone" may affect up to 16,500 square kilometers during the summer, resulting in unfavorable habitat conditions for a wide variety of species.

Sea surface salinities along the north Gulf vary seasonally. During months of low freshwater input, salinities near the coastline range between 29 to 32 ppt. High freshwater input conditions during the spring and summer months result in strong horizontal gradients and inner shelf salinities less than 20 ppt. The mixed layer in the open Gulf, from the surface to a depth of approximately 100 to 150 m (330 to 495 feet), is characterized by salinities between 36.0 and 36.5 ppt.

The Loop Current is a highly variable current entering the Gulf through the Yucatan Straits and exiting through the Straits of Florida (as a component of the Gulf Stream) after tracing an arc that may intrude as far north as the Mississippi-Alabama shelf. This current has been detected down to about 1,000 m below the surface. Below that level there is evidence of a countercurrent. When the Loop Current extends into or near shelf areas, instabilities, such as eddies, may develop that can push warm water onto the shelf or entrain cold water from the shelf. These eddies consist of warm water rotating in a clockwise fashion. Major Loop Current eddies have diameters on the order of 300 to 400 km (186 to 249 miles) and may extend to a depth of about 1,000 m. Once these eddies are free from the Loop Current, they travel into the western Gulf along various paths to a region between 25° N to 28° N and 93° W to 96° W. As eddies travel westward a decrease in size occurs due to mixing with resident waters and friction with the slope and shelf bottoms. The life of an individual eddy, until its eventual assimilation by regional circulation in the west Gulf, is about one year. Along the Louisiana/Texas slope, eddies are frequently observed to affect local current patterns, hydrographic properties, and possibly the biota of fixed oil and gas platforms or hard bottoms. Once an eddy is shed, the Loop Current undergoes major dimensional adjustments and reorganization.

Sea-surface temperatures in the Gulf range from nearly constant throughout (isothermal) (29 to 30°C) in August to a sharp horizontal gradient in January, (25°C in the Loop Current core to 14 to 15° C along the northern shelves). Surface salinities along the northern Gulf are seasonal. During months of low freshwater input, salinities near the coastline range between 29 to 32 ppt. High freshwater inputs (spring-summer months) are characterized by strong horizontal salinity gradients and inner shelf values of less than 20 ppt. The vertical distribution of temperature reveals that in January, the thermocline depth is about 30 to 61 m (98 to 200 feet) in the northeast Gulf and 91 to 107 m (298 to 350 feet) in the northwest Gulf. In May, the thermocline depth is about 46 m (150 feet) throughout the entire Gulf.

### 3.4.3.3 U.S. Caribbean

(Material in this section is largely a summary of information in Appeldoorn and Meyers, 1993. Original sources of information are referenced in that document.)

The waters of the Caribbean region include the coastal waters surrounding the U.S. Virgin Islands and Puerto Rico. The territory of the U.S. Virgin Islands includes roughly 63 islands, the largest of which are St. Thomas (83 square km or 32 square miles), St. John (52 square km or 20 square miles), and St. Croix (207 square km or 80 square miles). The commonwealth of Puerto Rico includes many islands, the largest of which is Puerto Rico. To the south lie numerous cays covered with sand, coral, and mangroves. To the west lie Mona, Monito, and Desecheo Islands. To the northeast lies the chain of islands called La Cordillera. To the southeast lies Vieques

Island. All of these Caribbean islands, with the exception of St. Croix, are part of a volcanic chain of islands formed by the subduction of one tectonic plate beneath another. Tremendously diverse habitat (rocky shores, sandy beaches, mangroves, seagrasses, algal plains, and coral reefs) and the consistent light and temperature regimes characteristic of the tropics are conducive to high species diversity (Appledoorn and Meyers, 1993).

The waters of the Florida Keys and southeast Florida are intrinsically linked with the waters of the Gulf of Mexico and the waters of the Caribbean to the west, south, and east, and to the waters of the South Atlantic Bight to the north. These waters represent a transition from insular to continental regimes and from tropical to temperate regimes. This zone, therefore, contains one of the richest floral and faunal complexes.

*Coastal and Estuarine Habitats*

Although the U.S. waters of the Caribbean are relatively nutrient poor, and therefore have low rates of primary and secondary productivity, they display some of the greatest diversity of any part of the south Atlantic region. High and diverse concentrations of biota are found where habitat is abundant. Coral reefs, sea grass beds, and mangrove ecosystems are the most productive of the habitat types found in the Caribbean, but other areas such as soft-bottom lagoons, algal hard grounds, mud flats, salt ponds, sandy beaches, and rocky shores are also important in overall productivity. These diverse habitats allow for a variety of floral and faunal populations.

Offshore, between the sea grass beds and the coral reefs and in deeper waters, sandy bottoms and algal plains dominate. These areas may be sparsely or densely vegetated with a canopy of up to one meter of red and brown algae. Algal plains are not areas of active sand transport. These are algae-dominated sandy bottoms, often covered with carbonate nodules. They occur primarily in deep water (> 15 m or 50 feet) and account for roughly 70 percent of the area of the insular shelf of the U.S. Virgin Islands. Algal plains support a variety of organisms including algae, sponges, gorgonians, solitary corals, molluscs, fish, and worms, and may serve as critical juvenile habitat for commercially important (and diminishing) species such as queen triggerfish and spiny lobsters.

Coral reefs and other coral communities are some of the most important ecological (and economic) coastal resources in the Caribbean. They act as barriers to storm waves and provide habitat for a wide variety of marine organisms, including most of the economically important species of fish and shellfish. They are the primary source for carbonate sand, and serve as the basis for much of the tourism. Coral communities are made by the build up of calcium carbonate produced by living animals, coral polyps, in symbiosis with a dinoflagellate, known as zooxanthellae. During summer and early fall, most of the coral building organisms are at or near the upper temperature limit for survival and so are living under natural conditions of stress. Further increase in local or global temperature could prove devastating.

Sea grass beds are highly productive ecosystems that are quite extensive in the Caribbean; some of the largest sea grass beds in the world lie beyond the shore on both sides of the Keys. Sea grass beds often occur in close association with shallow-water coral reefs. Turtle grass (*Thalassia testudinium*), manatee grass (*Syringodium filiforme*), and shoal grass (*Halodule wrightii*) are the three most abundant species. Seagrasses are flowering plants that spread through the growth of roots and rhizomes. Seagrasses act to trap and stabilize sediments, reduce shoreline erosion, and buffer coral reefs; they provide food for fish, sea turtles (heavy grazers), conch, and urchins; they provide shelter and habitat for many adult species and numerous juvenile species who rely on the sea grass beds as nursery areas; and they provide attachment surfaces for calcareous algae.

Mangrove habitats are very productive coastal systems that support a wide variety of organisms. The mangrove food web is based largely on the release of nutrients from the decomposition of mangrove leaves, and in part on the trapping of terrestrial material. Red mangroves (*Rhizophora mangle*), with their distinctive aerial prop roots, grow along the shoreline, often in mono-specific stands. The roots of the red mangroves help to trap sediments and pollutants associated with terrestrial runoff and help to buffer the shore from storm waves. Red mangrove forests support a diverse community of sponges, tunicates, algae, larvae, and corals, as well as juvenile and adult fish and shellfish. Black mangroves (*Aveicennia germinans*) and white mangroves (*Laguncularia racemosa*) grow landward of the red mangroves. They also act as important sediment traps. Exposed and sheltered mangrove shorelines are common throughout the U.S. Caribbean.

Throughout the U.S. Caribbean, both rocky shores and sandy beaches are common. While many of these beaches are high-energy and extremely dynamic, buffering by reefs and seagrasses allows some salt-tolerant plants to colonize the beach periphery. Birds, sea turtles, crabs, clams, worms, and urchins use the intertidal areas.

Salt ponds, common in the U.S. Virgin Islands, are formed when mangroves or fringing coral reefs grow or storm debris is deposited, effectively isolating a portion of a bay. The resulting “pond” undergoes significant fluctuations of salinity with changes in relative evaporation and runoff. The biota associated with salt ponds, are, therefore very specialized, and usually somewhat limited. Salt ponds are extremely important in trapping terrestrial sediments before they reach the coastal waters.

*Insular Shelf and Slope Areas*

Puerto Rico and the U.S. Virgin Islands contain a wide variety of coastal marine habitats, including coral and rock reefs, sea grass beds, mangrove lagoons, sand and algal plains, soft bottom areas, and sandy beaches. These habitats are, however, very patchily distributed. Nearshore waters range from zero to 20 m in depth, and outer shelf waters range from 20 to 30 m in depth, the depth of the shelf break. Along the north coast the insular shelf is very narrow (two to three km wide), seas are generally rough, and few good harbors are present. The coast is a mixture of coral and rock reefs, and sandy beaches. The east coast has an extensive shelf that extends to the British Virgin Islands. Depth ranges from 18 to 30 m. Much of the bottom is sandy, commonly with algal and sponge communities. The southeast coast has a narrow shelf (eight km wide). About 25 km to the southeast is Grappler Bank, a small seamount with its summit at a depth of 70 m. The central south coast broadens slightly to 15 km and an extensive sea grass bed extends nine kilometers offshore to Caja de Muertos Island. Further westward, the shelf narrows again to just two km before widening at the southwest corner to over 10 kilometers. The entirety of the southern shelf is characterized by hard or sand-algal bottoms with emergent coral reefs, grass beds, and shelf edge. Along the southern portion of the west coast the expanse of shelf continues to widen, reaching 25 km at its maximum. A broad expanse of the shelf is found between 14 and 27 meters where habitats are similar to those of the south coast. To the north, along the west coast, the shelf rapidly narrows to two to three kilometers.

*Physical Oceanography*

U.S. Caribbean waters are primarily influenced by the westward flowing North Equatorial Current, the predominant hydrological driving force in the Caribbean region. It flows from east to west along the north boundary of the Caribbean plateau and splits at the Lesser Antilles, flowing westward along the north coasts of the islands.

The north branch of the Caribbean Current flows west into the Caribbean Basin at roughly 0.5 m (1.7 feet) per second. It is located about 100 km south of the islands, but its position varies seasonally. During the winter it is found further to the south than in summer. Flow along the south coast of Puerto Rico is generally westerly, but this is offset by gyres formed between the Caribbean Current and the island. The Antilles Current flows to the west along the northern edge of the Bahamas Bank and links the waters of the Caribbean to those of southeast Florida.

Coastal surface water temperatures remain fairly constant throughout the year and average between 26° and 30°C. Salinity of coastal waters is purely oceanic and so is usually around 36 ppt. However, in the enclosed or semi-enclosed embayments salinity may vary widely depending on fluvial and evaporational influences.

It is believed that no up-welling occurs in the waters of the U.S. Caribbean (except perhaps during storm events) and, since the waters are relatively stratified, they are severely nutrient-limited. In tropical waters nitrogen is the principal limiting nutrient.

## 3.5 BYCATCH, INCIDENTAL CATCH, AND PROTECTED SPECIES

Atlantic HMS fisheries encounter many species of sharks and finfish during fishing operations. Some of these species are marketable, while others are discarded for economic or regulatory reasons. Sharks are also caught incidental to non-HMS fisheries such as in the shrimp trawl and menhaden purse seine fisheries. If such a vessel has a shark permit, the vessel may land the shark. Otherwise the shark must be discarded. Bycatch and incidental catch of non-targeted species such as sea turtles, marine mammals, and seabirds, known collectively as "protected" species, may also occur. A description of known data accounting for the frequency of such interactions is outlined below.

### 3.5.1 Atlantic Sharks

Bycatch of sharks occurs in many fisheries, including trawl, set-net, and hook and line fisheries. Estimates of shark dead discards from the pelagic longline fishery range from 4,300 to 9,000 fish in 1998 and 1999 (Cramer, 1999; Cramer and Adams, 2000; Cortes *et al.*, 2002). Pelagic longline dead discards combined represented about 2.8 percent of total mortality of LCS in 2001 (Cortes *et al.*, 2002) (See Table 3.14). Observer data collected from the directed bottom longline shark fishery indicate that LCS discarded dead represent approximately 5.7 percent of the total mortality of these species in that fishery from 1994 through 2001 (Cortes *et al.*, 2002).

Observer data in the Gulf of Mexico menhaden fishery for the period 1994-1995 indicate that 75 percent of the sharks encountered died (de Silva *et al.*, 2001; Cortes, 2000). Based on estimates from the de Silva *et al.* (2001) study, approximately 26,200 and 24,000 LCS were discarded dead in 1994 and 1995, respectively. The average numbers of sharks caught in the menhaden fishery during these two years were used as estimates of bycatch for all other years (25,100). Blacktip sharks made up 35.3 percent of the total shark bycatch observed during 1994-95, and an additional group described as "mixed blacktip and spinner sharks" made up 20.1 percent of the total. Based on these estimates, in 2001, the Gulf of Mexico menhaden fishery accounted for approximately 7.5 percent of the total mortality of LCS (See Table 3.14). Gear modifications implemented by the Gulf of Mexico menhaden fishing industry since the de Silva *et al.* (2001) study was conducted may have had some effect on the magnitude of the shark bycatch (Rester and Condrey, 1999). Further quantification of the current magnitude of the shark bycatch would be needed to evaluate the effectiveness of the gear modifications. In any event, consideration of discard estimates from the Gulf menhaden fishery had virtually no effect on results of the LCS stock assessment (Cortes *et al.* 2002).

Annual estimates of small coastal shark bycatch in the Gulf of Mexico shrimp fishery range from 1,500,000 lbs dw in 1972 to 1,257,000 lbs dw in 2000, with a high of 3,123,000 lbs dw in 1987 (Cortes, 2002).

### 3.5.2 Other Finfish

Bycatch of other finfish including, but not limited to, little tunny, Atlantic bonito, crevalle jack, great barracuda, cobia and king mackerel is known to occur in shark bottom longline and gillnet fisheries.

Observer data collected in 1998 from shark bottom longline fisheries indicate that approximately 6,277 sharks were caught compared to 594 other fish (8.6 percent of total catch) (Burgess and Johns, 1998). Similar data collected during 2000, 2001, and 2002 (season 1 only) suggest that bycatch of other finfish varies by region (Burgess and Morgan, 2003). In Florida waters, bycatch primarily includes groupers, jacks, and snappers. By comparison, bycatch in North Carolina commonly involves stingrays, skates, rays, swordfish, wahoo, tuna, and great barracuda (Burgess and Morgan, 2003). Regional differences in bycatch are often associated with fishery differences in targeted species.

During the 2002 right whale calving season, observed drift gillnet sets caught 26 species of teleosts and rays (9.2 percent of the total number of animals caught were teleosts and rays) (See Table 3.33) (Carlson and Baremore, 2002a). Three teleost and ray species made up 56.2 percent by number of the overall non-shark catch: little tunny (29.2 percent), king mackerel (15.2 percent), and great barracuda (11.8 percent). The highest proportion of species discarded dead (for those species with observed catch greater than 10 individuals) was for Atlantic sailfish (97.7 percent; 42 out of 43 discarded dead), and cobia (25.7 percent; 17 out of 66 discarded dead). Remoras had the highest live discard proportion (72.2 percent; 8 out of 11 discarded alive) (Carlson and Baremore, 2002a).

Outside of the 2002 right whale calving season, observed drift gillnet catch consisted of 26 species of teleosts and rays (See Table 3.34). Five species of teleosts and one species of ray made up 90.6 percent by number of the overall non-shark catch. Little tunny (44.1 percent), king mackerel (20.8 percent), great barracuda (12.5 percent), Atlantic moonfish (9.4 percent), and cobia (3.8 percent) dominated the bycatch (See Table 3.34) (Carlson and Baremore, 2002b). During drift gillnet fishing, the highest proportion of species discarded dead (for species with greater than 10 individuals) was for tarpon, crevalle jack, king mackerel, and red drum. Cownose rays and red drum had the highest proportion of discarded alive with 78.1 percent and 50.0 percent, respectively (See Table 3.34) (Carlson and Baremore, 2002b).

Observed catch in strikenet sets outside of the 2002 right whale calving season consisted of three species of sharks (Carlson and Baremore, 2002b). No other fish or protected species were observed caught (See Table 3.35).

### 3.5.3 Marine Mammals

Under the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 et seq.) the Atlantic Ocean, Caribbean, and Gulf of Mexico pelagic longline fishery is classified as a Category I fishery (frequent serious injuries and mortalities incidental to commercial fishing) and the southeastern Atlantic shark gillnet fishery is classified as Category II (occasional serious injuries and mortalities). The Gulf of Maine and mid-Atlantic tuna, swordfish, and shark hook-and-line/harpoon, southeastern mid-Atlantic and Gulf of Mexico shark bottom longline, and mid-Atlantic, southeastern Atlantic, and Gulf of Mexico pelagic hook-and-line/harpoon fisheries are all classified as Category III (remote likelihood or no known serious injuries or mortalities. The same listings have been adopted for 2003 (68 FR 41725, July 15, 2003). Additionally, the 2001 HMS BiOp concluded that the continued operation of these fisheries would not adversely affect marine mammals. A new Biological Opinion for Atlantic shark fisheries (NOAA Fisheries, 2003a) was prepared in October of 2003 in response to the proposed measures in Amendment 1. It concluded that the continued operation of the shark fisheries would not adversely affect marine mammals.

In accordance with the MMPA, NOAA Fisheries published stock assessment reports for Atlantic and Gulf of Mexico marine mammals in September 2002. Species such as bottlenose dolphin, north Atlantic right whale, Atlantic spotted dolphin, humpback whale, minke whale, harbor porpoise, long-finned pilot whale, short finned pilot whale, white-sided dolphin, common dolphin, harbor seal, and harp seal are sometimes hooked during commercial fishing operations and fishermen are required to report takes of mammals to NOAA Fisheries in a marine mammal logbook (68 FR 41725, July 15, 2003). Observations in 1996 through 2000 have been extrapolated to estimate serious injury and mortality of 784 marine mammals, including 242 Risso's dolphin, 514 long and short-finned pilot whales, and 28 pygmy sperm whales by pelagic longline fisheries (Waring *et al.*, 2002). The shark bottom longline fishery has been observed to interact with two delphinid species between 1994 and 2002 (Burgess pers. comm., 2003). Bycatch estimates for the shark bottom longline fishery have not been extrapolated for marine mammals. Observed takes of marine mammals in the Southeast Atlantic shark gillnet fishery during 1999-2002, totaled 10 bottlenose dolphins and four spotted dolphins (See Table 3.39). Extrapolated observations from these data suggest serious injury and mortality of 25 bottlenose dolphin and one Atlantic spotted dolphin in the shark gillnet fishery from 1999 through 2002 (Garrison, 2003).

In April 1999, NOAA Fisheries implemented a restricted area in the South Atlantic to reduce the bycatch of right whales (64 FR 7529, Feb. 16, 1999). Only gillnets used in a strikenet fashion can be fished from November 15 through March 31, when right whales are usually present. Fishing in this area during that time requires 100 percent observer coverage. NOAA Fisheries also designated an area open to shark gillnet vessels fishing in a driftnet fashion but only under the condition that they carry an observer at all times during right whale calving season. Outside of the right whale calving season, observer coverage to produce reliable estimates of bycatch is required.

Vessel operators intending to use gillnets in the "observer area" during right whale season must notify NOAA Fisheries at least 48 hours in advance of departure to arrange for observer coverage. Observations of right whales in the observer area or restricted area outside this period, are rare, and a broader closure period, was not considered necessary to meet the objectives of the MMPA. After these requirements were implemented, NOAA Fisheries extended observer requirements to include all shark gillnet vessels at all times. The objective of that regulation was to collect bycatch information for all species (including turtles and finfish), consistent with requirements of the Magnuson-Stevens Act. In March 2001, the observer coverage for this fishery during non-right whale calving season was reduced to a level that would ensure a statistically significant level of coverage (66 FR 17370, March 30, 2001).

Gear provisions were also implemented to further the goals of the MMPA. NOAA Fisheries restricted the way gillnets used in a strikenet fashion are set in the southeast gillnet fishery to minimize the risk of entanglement (67 FR 45393, July 9, 2002). In addition, shark gillnets must be marked to identify the fishery and region in which the gear is fished. Strikenetting in the restricted area is permitted during right whale season only if: (1) no nets are set at night or when visibility is less than 500 yards (460 m), (2) each set is made under the observation of a spotter plane, (3) no net is set within 3 miles of a right, humpback or fin whale, and (4) if a whale comes within 3 miles of set gear, the gear is removed from the water immediately. These measures were designed to minimize the risk of entangling any large whale.

During the 2002 right whale calving season, no marine mammal interactions occurred in 41 separate drift gillnet sets (Carlson and Baremore, 2002a). Observed strikenet sets, during the 2002 right whale calving season, caught no marine mammals (See Table 3.35) (Carlson and Baremore, 2002a). Outside of right whale calving season, observed drift gillnet catch in 2002 consisted of one species of marine mammal, which was discarded dead (See Table 3.34). Observed catch in strikenet sets outside of right whale calving season consisted of three species of sharks (Carlson and Baremore, 2002b). No marine mammals were observed caught.

### 3.5.4 Sea Turtles

This section provides a summary of background information from the June 14, 2001, Biological Opinion and the October 29, 2003, Biological Opinion (NOAA Fisheries, 2001a; 2003a). Please refer to Section 3.5 of the HMS FMP (NMFS, 1999) and Section 8.0 of the latest SAFE (NOAA Fisheries, 2003b) report for additional information. Additional information specific to the pelagic longline fishery can be found in the Final Supplemental Environmental Impact Statement for the Reduction of Bycatch, Bycatch Mortality, and Incidental Catch in the Atlantic Pelagic Longline Fishery, and in the Environmental Assessment and Regulatory Impact Review to Reduce Sea Turtle Bycatch and Bycatch Mortality in the Atlantic Pelagic Longline Fishery. For reference, the status of Atlantic sea turtles can be found in Table 3.36. The latest Biological Opinion, undertaken in response to the preferred measures in draft Amendment 1, found that the selected actions are not likely to jeopardize the continued existence of the endangered Kemp's Ridley, green, hawksbill, and leatherback sea turtles, and the threatened loggerhead sea turtle (NOAA Fisheries, 2003a). Critical habitat has not been designated for these species in the action area, therefore, none will be affected. Further detail on the October 2003 Biological Opinion is provided in Section 4.10.

*Loggerhead sea turtles*

Western Atlantic, Caribbean, and Gulf of Mexico loggerhead sea turtles represent differing proportions of five western north Atlantic subpopulations, as well as unidentified subpopulations from the eastern Atlantic. These animals are protected by ESA and NOAA Fisheries enacted additional measures in 2002 to reduce commercial fishing interactions, including gear requirements and a closed area applicable to the pelagic longline fishery.

Loggerhead sea turtles are primarily exposed to pelagic longline gear in the pelagic juvenile stage. According to observer records, an estimated 7,891 loggerhead sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992-1999, of which 66 were estimated to be released dead (See Table 3.37) (NOAA Fisheries SEFSC, 2001). An additional 1,256 loggerhead sea turtles were estimated to have been caught in 2000 (Yeung, 2001). The U.S. fleet accounts for a small proportion (5 to 8 percent) of the total hooks fished in the Atlantic Ocean compared to other nations, including Taipei, Brazil, Trinidad, Morocco, Cyprus, Venezuela, Korea, Mexico, Cuba, United Kingdom, Bermuda, People's Republic of China, Grenada, Canada, Belize, France, and Ireland (Carocci and Majkowski, 1998). Reports of incidental takes of turtles are incomplete for many of these nations (see NOAA Fisheries SEFSC, 2001 for a complete description of take records). Projections based on known takes for the 23 actively fishing countries, after accounting for the unobserved fraction, likely result in an estimate of thousands of animals taken annually over different life stages.

In the bottom longline fishery a total of 43 sea turtles out of 862 observed sets, were caught from 1994 through 2002 (See Figures 3.9 and 3.10) (Burgess and Morgan, 2003; NOAA Fisheries, 2003a). Of the 43 observed sea turtles, 31 were loggerhead sea turtles of which 17 were released alive. Another nine loggerheads were released in an unknown condition and five were released dead. Based on extrapolation of observer data, it was estimated that a total of 2,003 loggerhead sea turtles were taken in the shark bottom longline fishery from 1994 through 2002 (NOAA Fisheries, 2003a). An additional 503 unidentified sea turtles were estimated to have been taken. On average, 222 loggerhead sea turtles and 56 unidentified sea turtles were taken annually during this time period in the shark bottom longline fishery.

Furthermore, this analysis only estimates takes without discriminating between live and dead releases. Of the observed takes in the shark bottom longline fishery, 23 percent were lethal. Based on this information it is estimated that 51 loggerhead turtles (222 x 0.23) will be killed as a result of an interaction with a bottom longline. The highest estimate of post release mortality is 42 percent for sea turtles that ingested the hook (the percent mortality is lower depending on how the animal was hooked) (NOAA Fisheries, 2001a). Being conservative and assuming all sea turtles ingest the hook, 42 percent of those released alive will die as a result of their interaction with the bottom longline. This results in another 72 loggerhead sea turtles (222-51=171 then 171 x 0.42) estimated to be killed. Therefore, it is estimated that 123 loggerheads will be killed (72 + 51) per year.

In the shark gillnet fishery, loggerhead sea turtles are rarely caught. During the 1999 right whale calving season no loggerhead sea turtles were caught in this fishery (Carlson and Lee, 1999). No loggerhead sea turtles were observed caught with strikenets during the 2000-2002 right whale calving seasons (Carlson, 2000; Carlson and Baremore, 2001; Carlson and Baremore, 2002a). However, three loggerhead sea turtles have been observed caught with drift gillnets during right whale calving season, one each year from 2000 to 2002 (See Table 3.39) (Carlson, 2000; Carlson and Baremore, 2001; Carlson and Baremore, 2002a; Garrison, 2003).

During the 2000 and 2001 non-right whale calving seasons, no loggerhead sea turtles were observed caught in gillnets fished in a strikenet method and one loggerhead sea turtle was observed caught and released alive in gillnets fished in a driftnet method (See Table 3.39) (Carlson and Baremore, 2001). No loggerhead sea turtles were caught outside of the right whale calving season in 2002 (Carlson and Baremore, 2002b).

Expanded take estimates for sea turtles were developed for the shark drift gillnet fishery for the October 2003 BiOp (NOAA Fisheries, 2003a). Estimates were based on analysis of observer data from NOAA Fisheries' Southeast Fisheries Science Center. Observer data gathered from 1999-2002 were used to estimate takes in the drift gillnet fishery. Prior to 1999, observer coverage was limited and inconsistent. However, since 1999 a much higher degree of observer coverage has occurred, including very high coverage in the southern Florida area during the right whale calving season (November 15 - March 30) when sea turtle takes are known to be much more likely. The estimated takes of loggerhead sea turtles by year, were as follows: 1999 - none; 2000 - one mortality and 4.4 live takes; 2001 - one live take; and 2002 - 1.7 live takes (NOAA Fisheries, 2003a).

Because of the high degree of variability in takes which is associated with variability in water temperatures, sea turtle abundances, and other factors that cannot be predicted, a 5-year estimated take was utilized for the incidental take statement (ITS) instead of a 1-year average estimated take. Over a 5-year period the expected take of loggerhead sea turtles from the drift gillnet fishery would be 10 total captures of which one would be expected to be killed (NOAA Fisheries, 2003a).

*Leatherback sea turtles*

Female leatherback sea turtles nest from the southeastern United States to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic. The most significant nesting beaches in the Atlantic, and perhaps in the world, are in French Guiana and Surinam (NOAA Fisheries SEFSC, 2001). When they leave the nesting beaches, leatherback sea turtles move offshore but eventually utilize both coastal and pelagic waters. The leatherback is the largest living turtle and it ranges farther than any other sea turtle species, exhibiting broad thermal tolerances (NOAA Fisheries and USFWS, 1995). Leatherback sea turtles feed primarily on cnidarians (medusae, siphonophores) and tunicates (salps, pyrosomas) and are often found in association with jellyfish.

Leatherback sea turtles are exposed to pelagic fisheries throughout their life cycle. According to observer records, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992-1999, of which 88 were released dead (See Table 3.37) (NOAA Fisheries SEFSC, 2001). An additional 769 leatherback sea turtles were estimated to have been caught in 2000 (Yeung, 2001). Leatherback sea turtles make up a significant portion of takes in the Gulf of Mexico and south Atlantic areas, but are more often released alive. The U.S. fleet accounts for five to eight percent of the hooks fished in the Atlantic Ocean.

In the bottom longline fishery a total of 43 sea turtles have been observed from 1994 through 2002 (See Figure 3.10) (Burgess and Morgan, 2003; NOAA Fisheries, 2003a). Four of the 43 observed sea turtles were leatherback sea turtles and three of these were released with their condition unknown. One leatherback was released dead. Based on extrapolation of observer data, it was estimated that 269 leatherback sea turtles were taken in the shark bottom longline fishery from 1994 through 2002 (NOAA Fisheries, 2003a). On average, 30 leatherback sea turtles each year were taken by the shark bottom longline fishery during 1994 through 2002. This analysis only estimates takes without discriminating between live and dead releases. Of the observed leatherback takes, 25 percent were lethal. Applying the observed mortality rate of 25 percent to the total leatherback takes and an additional 42 percent post-release mortality estimate due to hook ingestion to the remaining, results in an estimated total number of leatherbacks killed as a result of the selected action at 17 per year. The leatherback mortality is very conservative because it is known that leatherbacks rarely ingest or bite hooks, but are usually foul hooked on their flippers or carapaces, reducing the likelihood of post-hooking release mortality. However, leatherback-specific data for this fishery is not available and therefore the most conservative estimate is used.

In the shark gillnet fishery, leatherback sea turtles are sporadically caught. During the 1999 right whale calving season two leatherback sea turtles were caught in this fishery, and both were released alive (Carlson and Lee, 1999). No leatherback sea turtles were observed caught with strikenets during the 2000 - 2002 right whale calving seasons (Carlson, 2000; Carlson and Baremore, 2001; Carlson and Baremore, 2002a). Leatherback sea turtles have been observed caught in shark drift gillnets including fourteen in 2001 and two in 2002 (See Table 3.39) (Carlson, 2000; Carlson and Baremore, 2001; Carlson and Baremore, 2002a; Garrison, 2003). NOAA Fisheries temporarily closed the shark gillnet fishery (strikenetting was allowed) from March 9 to April 9, 2001, due to the increased number of leatherback interactions that year (66 FR 15045, March 15, 2001).

During the 2000 and 2001 non-right whale calving seasons, no leatherback sea turtles were observed caught in gillnets fished in strikenet or driftnet methods (Carlson and Baremore, 2001). No leatherback sea turtles were caught outside of the right whale calving season in 2002 (Carlson and Baremore, 2002b).

Expanded take estimates for sea turtles were developed for the shark drift gillnet fishery for the October 2003 BiOp (NOAA Fisheries, 2003a). Estimates were based on the analysis of observer data from the NOAA Fisheries' Southeast Fisheries Science Center. Observer data gathered from 1999-2002 were used to estimate takes in the drift gillnet fishery. Prior to 1999, observer coverage was limited and inconsistent. However, since 1999 a much higher degree of observer coverage has occurred, including very high coverage in the southern Florida area during the right whale calving season (November 15 - March 30) when sea turtle takes are known to be much more likely. The estimated takes of leatherback sea turtles by year, were as follows: 1999 - none; 2000 - none; 2001 - two mortalities and 12 live takes; and 2002 - 3.4 live takes (NOAA Fisheries, 2003a).

Because of the high degree of variability in takes which is associated with variability in water temperatures, sea turtle abundances, and other factors that cannot be predicted, a 5-year estimated take was utilized for the incidental take statement (ITS) instead of a 1-year average estimated take. Over a 5-year period the expected take of leatherback sea turtles from the drift gillnet fishery would be 22 total captures of which three would be expected to be killed (NOAA Fisheries, 2003a).

### 3.5.5 Seabirds

Seabirds forage on the surface but can also pursue prey fish swimming at shallow depths which makes seabirds somewhat susceptible to driftnets, shallow set longlines, and longline gear being deployed. As such, they are possibly at the highest risk during the process of setting and hauling fishing gear. Many seabird populations are especially slow to recover from mortality because their reproductive potential is low (one egg per year and late sexual maturation).

Concerns such as these have resulted in protection of seabirds under the Migratory Bird Treaty Act, protection of endangered seabirds under the Endangered Species Act, and protection of all migratory birds under Executive Order 13186. The United States has also developed a National Plan of Action in response to the Food and Agriculture Organization International Plan of Action to Reduce Incidental Seabird Takes in Longline Fisheries.

Observer data for the Atlantic pelagic longline fishery from 1992 through 2002 indicate that seabird bycatch is relatively low (See Table 3.38). Since 1992, a total of 113 seabird interactions have been observed, with 77 seabirds observed killed in the Atlantic pelagic longline fishery. No expanded estimates of seabird bycatch or catch rates are available for the pelagic longline fishery. Observed bycatch has ranged from 1 to 18 seabirds observed dead per year and 0 to 15 seabirds observed released alive per year from 1992 through 2002.

In the Atlantic shark bottom longline fishery, one pelican has been observed killed from 1994 through 2002. The pelican was caught in January 1995 off the Florida Gulf Coast (between 25 18.68 N, 81 35.47 W and 25 19.11 N, 81 23.83 W) (G. Burgess, pers. comm., 2003). No expanded estimates of seabird bycatch or catch rates are available for the bottom longline fishery.

NOAA Fisheries has not identified a need to implement gear modifications to reduce takes of seabirds in Atlantic HMS longline fisheries. Takes of seabirds are minimal in these fisheries in the Atlantic, probably due to night setting of the longlines or fishing in areas where there are not significant numbers of birds. Interested readers can refer to Alexander *et al.* (1997), for additional possibilities of mitigating measures for seabird mortality in longline fisheries. No seabirds have been observed caught in the shark gillnet fishery.

### 3.5.6 Sawfish

Sawfish, like sharks, skates and rays, belong to a class of fish called elasmobranchs, whose skeletons are made of cartilage. Sawfish are actually modified rays with a shark-like body, and gill slits on their ventral side. Early sawfish arose around 100 million years ago, but these first sawfish are actually distant cousins to the modern day sawfishes, which first appeared around 56 million years ago. Sawfish get their name from their "saws" - long, flat snouts edged with pairs of teeth which are used to locate, stun and kill prey. Their diet includes mostly fish but also some crustaceans.

Sawfish species inhabit shallow coastal waters of tropical seas and estuaries throughout the world. They are usually found in shallow waters very close to shore over muddy and sandy bottoms. They are often found in sheltered bays, on shallow banks, and in estuaries or river mouths. Certain species of sawfish are known to ascend inland in large river systems, and they are among the few elasmobranchs that are known from freshwater systems in many parts of the world.

As of April 1, 2003, NOAA Fisheries listed smalltooth sawfish as an endangered species (68 FR 15674) under the Endangered Species Act (ESA). After reviewing the best scientific and commercial information, the status review team determined that the continued existence of the U.S. DPS (Distinct Population Segment) of smalltooth sawfish is in danger of extinction throughout all or a significant portion of its range from a combination of the following four listing factors: the present or threatened destruction, modification, or curtailment of habitat or range; overutilization for commercial, recreational, scientific, or educational purposes; inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting its continued existence.

To date there has been only one observed catch of a smalltooth sawfish in shark gillnet fisheries. The sawfish was taken on June 25, 2003, in a gillnet set off of southeast Florida and it was released alive (Carlson pers. comm., 2003). The set was characteristic of a typical drift gillnet set, with gear extending 30 to 40 feet deep in 50 to 60 feet of water. Prior to this event it was speculated that the depth at which drift gillnets are set above the sea floor may preclude smalltooth sawfish from being caught. Although sometimes described as a lethargic demersal species, smalltooth sawfish feed mostly on schooling fishing, thus they would occur higher in the water column during feeding activity. In fact, smalltooth sawfish and Atlantic sharks may be attracted to the same schools of fish, potentially making smalltooth sawfish quite vulnerable if present in the area fished. The previous absence of smalltooth sawfish incidental capture records is more likely attributed to the relatively low effort in this fishery and the rarity of smalltooth sawfish, especially in Federal waters. These factors may result in little overlap of the species with the gear.

The recently observed smalltooth sawfish was cut from the net and released alive with no visible injuries. This indicates that smalltooth sawfish can be removed safely if entangled gear is sacrificed.

As discussed previously, gillnets are also used to "strikenet". When strike gillnetting fishers target and encircle specific schools of sharks after visually detecting them (usually by spotter pilot). Given the large and or distinct morphology of smalltooth sawfish, this species would likely be detected visually, as well as distinguished from shark species, thus avoided. This fishing method has been shown to also reduce potential encounters by limiting the time that gear is in the water. Strike gillnet sets are typically only one to two hours in contrast to six to 10 hours for each drift gillnet set. Endangered and threatened species, or protected marine mammals for that matter, have never been observed taken in strikenet sets.

Given the high rate of observer coverage in the shark gillnet fishery, NOAA Fisheries believes that smalltooth sawfish takes in this fishery are very rare. The fact that there were no smalltooth sawfish caught during 2001 when 100 percent of the fishing effort was observed, indicates that smalltooth sawfish takes (observed or total) most likely do not occur on annual basis. Based on this information, the 2003 BiOp estimates that one incidental capture of a sawfish (released alive) over the next five years, will occur as a result of the use of gillnets in this fishery (NOAA Fisheries, 2003a).

However, sawfish have been observed caught (seven known interactions, six released alive, one released in unknown condition) in shark bottom longline fisheries from 1994 through 2002 (See Figure 3.11) (Morgan pers. comm., 2003). Based on these observations, expanded sawfish take estimates for 1994-2002 were developed for the shark bottom longline fishery (NOAA Fisheries, 2003a). A total of 466 sawfish were estimated to have been taken in this fishery during 1994-2002, resulting in an average of 52 per year. Additionally, it is important to note that all of the sawfish takes observed, except for one, were released alive.

### 3.5.7 NOAA Fisheries National Bycatch Strategy and HMS Bycatch Implementation Plan

The NOAA Fisheries National Bycatch Strategy is based on the 1998 NOAA Fisheries Report, *Managing the Nation's Bycatch* (NOAA 1998), which contains the Agency's national bycatch goal, "to implement conservation and management measures for living marine resources that will minimize, to the extent practicable, bycatch and the mortality of bycatch that cannot be avoided." The national strategy contains six components, the first of which is to assess the progress towards meeting the national bycatch goal, its supporting objectives and strategies, and regional recommendations as set forth in *Managing the Nation's Bycatch* (NOAA, 1998). This includes meeting the bycatch reduction requirements of relevant statutes including National Standard 9 of the Magnuson-Stevens Act, the MMPA, and the ESA. The National Bycatch Strategy is available on the NOAA Fisheries' bycatch website at www.nmfs.noaa.gov/bycatch.html. The HMS Division is in the process of developing an implementation plan to improve upon and possibly expand current bycatch reduction efforts in HMS fisheries under this guidance.

**Table 3.1 Sharks in the Management Unit by Species Groups.** Source: NMFS, 1999.

| Large Coastal Sharks | |
|---|---|
| *Ridgeback Species* | |
| Sandbar | *Carcharhinus plumbeus* |
| Silky | *Carcharhinus falciformis* |
| Tiger | *Galeocerdo cuvier* |
| *Non-Ridgeback Species* | |
| Blacktip | *Cancharhinus limbatus* |
| Spinner | *Carcharhinus brevipinna* |
| Bull | *Carcharhinus leucas* |
| Lemon | *Negaprion brevirostris* |
| Nurse | *Ginglymostoma cirratum* |
| Scalloped hammerhead | *Sphyrna lewini* |
| Great hammerhead | *Sphyrna mokarran* |
| Smooth hammerhead | *Sphyrna zygaena* |

| Prohibited Species | |
|---|---|
| Sand tiger | *Odontaspis taurus* |
| Bigeye sand tiger | *Odontaspis noronhai* |
| Whale | *Rhincodon typus* |
| Basking | *Cetorhinus maximus* |
| White | *Carcharodon carcharias* |
| Dusky | *Carcharhinus obscurus* |
| Bignose | *Carcharhinus altimus* |
| Galapagos | *Carcharhinus galapagensis* |
| Night | *Carcharhinus signatus* |
| Caribbean reef | *Carcharhinus perezi* |
| Narrowtooth | *Carcharhinus brachyurus* |
| Caribbean sharpnose | *Rhizoprionodon porosus* |
| Smalltail | *Carcharhinus porosus* |
| Atlantic angel | *Squatina dumerili* |
| Longfin mako | *Isurus paucus* |
| Bigeye thresher | *Alopias superciliosus* |
| Sevengill | *Heptranchias perlo* |
| Sixgill | *Hexanchus griseus* |
| Bigeye sixgill | *Hexanchus vitulus* |

| Small Coastal Sharks | |
|---|---|
| Atlantic sharpnose | *Rhizoprionodon terraenovae* |
| Finetooth | *Carcharhinus isodon* |
| Blacknose | *Carcharhinus acronotus* |
| Bonnethead | *Sphyrna tiburo* |

| Pelagic Sharks | |
|---|---|
| Blue | *Prionace glauca* |
| Oceanic whitetip | *Carcharhinus longimanus* |
| Porbeagle | *Lamna nasus* |
| Shortfin mako | *Isurus oxyrinchus* |
| Thresher | *Alopias vulpinus* |

| Deepwater and Other Species (Data Collection Only) | |
|---|---|
| Iceland catshark | *Apristurus laurussoni* |
| Smallfin catshark | *Apristurus parvipinnis* |
| Deepwater catshark | *Apristurus profundorum* |
| Broadgill catshark | *Apristurus riveri* |
| Marbled catshark | *Galeus arae* |
| Blotched catshark | *Scyliorhinus meadi* |
| Chain dogfish | *Scyliorhinus retifer* |
| Dwarf catshark | *Scyliorhinus torrei* |
| Japanese gulper shark | *Centrophorus acus* |
| Gulper shark | *Centrophorus granulosus* |
| Little gulper shark | *Centrophorus uyato* |
| Kitefin shark | *Dalatias licha* |
| Flatnose gulper shark | *Deania profundorum* |
| Portuguese shark | *Centroscymnus coelolepis* |
| Greenland shark | *Somniosus microcephalus* |
| Lined lanternshark | *Etmopterus bullisi* |
| Broadband dogfish | *Etmopterus gracilispinnis* |
| Caribbean lanternshark | *Etmopterus hillianus* |
| Great lanternshark | *Etmopterus princeps* |
| Smooth lanternshark | *Etmopterus pusillus* |
| Fringefin lanternshark | *Etmopterus schultzi* |
| Green lanternshark | *Etmopterus virens* |
| Cookiecutter shark | *Isistius brasiliensis* |
| Bigtooth cookiecutter | *Isistius plutodus* |
| Smallmouth velvet Dogfish | *Scymnodon obscurus* |
| Pygmy shark | *Squaliolus laticaudus* |
| Roughskin spiny dogfish | *Squalus asper* |
| Blainville's dogfish | *Squalus blainvillei* |
| Cuban dogfish | *Squalus cubensis* |
| Bramble shark | *Echinorhinus brucus* |
| American sawshark | *Pristiophorus schroederi* |
| Florida smoothhound | *Mustelus norrisi* |
| Smooth dogfish | *Mustelus canis* |

**Table 3.2 Summary of Catch Series Available for the 2002 LCS Stock Assessment.**
Source: Cortes *et al.*, 2002. FI: Fishery Independent

| LCS Species | | | Series Name | Year(s) | Fishery/Type |
|---|---|---|---|---|---|
| Aggregate | Sandbar | Blacktip | | | |
| ✔ | | | Brannon | 86-91 | Commercial |
| ✔ | | | Hudson | 85-91 | Recreational |
| ✔ | | | Crooke LL | 75-89 | Commercial |
| ✔ | ✔ | ✔ | Shark Observer | 94-01 | Commercial |
| ✔ | | | Jax. | 74;89;90 | Recreational |
| ✔ | | | NC# | 88-89 | Commercial |
| ✔ | ✔ | ✔ | SC LL Recent | 95-01 | FI |
| ✔ | ✔ | | SC LL Early | 83;94 | FI |
| ✔ | | | Port Salerno | 76-90 | Recreational |
| ✔ | | | Tampa Bay | 85-90 | Recreational |
| ✔ | ✔ | | VA LL | 74-01 | FI |
| ✔ | ✔ | | Large Pelagic Survey | 86-01 | Recreational |
| ✔ | | | Charterboat | 89-95 | Recreational |
| ✔ | ✔ | ✔ | Pelagic log | 86-01 | Commercial |
| ✔ | ✔ | ✔ | Early Rec. | 81-93 | Recreational |
| ✔ | ✔ | ✔ | Late Rec. | 94-00 | Recreational |
| ✔ | ✔ | ✔ | NMFS LL NE Recent | 96;98;01 | FI |
| ✔ | ✔ | ✔ | NMFS LL NE Early | 89;91 | FI |
| ✔ | ✔ | ✔ | NMFS LL SE | 95-97; 99-01 | FI |
| ✔ | | ✔ | Gillnet observer | 93-95;98-01 | Commercial |
| ✔ | ✔ | | NE Trawl | 72-01 | FI |
| ✔ | | | SE Trawl | 7x-01 | FI |
| ✔ | | ✔ | PC LL | 93-00 | FI |
| ✔ | | ✔ | PC Gillnet | 96-01 | FI |
| ✔ | ✔ | ✔ | Bottom LL Logs | 96-01 | Commercial |
| | | ✔ | Mote Gillnet | 95-01 | FI |

**Table 3.3 Stock Assessment Models Utilized in 2002 LCS and SCS Stock Assessments.**
Source: Cortes *et al.*, 2002; Cortes, 2002.

| Model | Description | Informational Basis (Data Input) | Stock Assessment |
|---|---|---|---|
| Bayesian SPM | Model used to describe fluctuations in resource abundance by accounting for existing biomass, recruitment, growth, catch, and natural mortality | Time series of catch, fishing effort, and prior information (i.e., intrinsic rate of increase, catch in years with zero catch observations, carrying capacity, abundance in year 1) | ✔(1996 - LCS)<br>✔(1998 - LCS)<br>✔(2002 - LCS/SCS) |
| SSPM/MCMC | Model used to relate observed catch rates to unobserved states (i.e., biomass) | Time series of catch, fishing effort, and prior information (i.e., intrinsic rate of increase, catch in years with zero catch observations, carrying capacity, abundance in year 1) | ✔(2002 - LCS/SCS) |
| SSLRSG | Model used to account for the lag in time between birth and subsequent recruitment to the adult stock as well as age structure effects on population dynamics | Time series of catch, fishing effort, and prior information (i.e., intrinsic rate of increase, catch in years with zero catch observations, carrying capacity, abundance in year 1) | ✔(2002 - LCS/SCS) |
| MLE | Model used to process recruitment, immigration, emigration, and all mortality except that due to fishing | Time series of fishing effort, annual estimate of catch and its variance or average individual weight and its variance, and total annual yield | ✔(1992 - SCS/LCS)<br>✔(1996 - LCS)<br>✔(2002 - LCS) |
| ASPM | Model used to describe fluctuations in resource abundance by accounting for existing biomass, recruitment, growth (age-specific), catch (demographic representation), and natural mortality | Time series of catch, fishing effort, prior information (i.e., natural mortality, catchability, effort), selectivity, historical fishing mortality values, maturity ogive, and fecundity, survival, length and weight at age | ✔(2002 - LCS) |

**Table 3.4 Summary Table of the Status of the Biomass of Large Coastal Sharks.** Sources: 2002 LCS stock assessment; E. Cortes, personal communication; L. Brooks, personal communication. SPM=surplus production model (thousands of fish); ASPM=age structured surplus production model (numbers of fish); SSLRSG=state-space lagged recruitment, survival, and growth model;. Only models shown in figures 71, 73, and 76 of the 2002 LCS stock assessment are summarized below.

| Species / Model | | Current Biomass $N_{2001}$ | $N_{MSY}$ | Current Relative Biomass Level $N_{2001}/N_{MSY}$ | Biomass Target $B_{OY} = 125\% B_{MSY}$ | Outlook |
|---|---|---|---|---|---|---|
| LCS Complex | SPM | 2,940 - 10,156 | 4,469 - 8,371 | 0.46 - 1.18 | 5,586 - 10,464 | STOCK IS OVERFISHED.<br>$B_{2001}<B_{MSY}$<br>The majority of the models, including the models not summarized here, indicate that the resource is overfished. Even in the models where the resource is not overfished, the rebuilding target ($B_{OY}$) has not been met. |
| Sandbar | SPM | 1,027 - 2,588 | 786 - 1,890 | 0.77 - 2.22 | 983 - 2,363 | STOCK IS NOT OVERFISHED; REBUILDING IS STILL NEEDED.<br>$B_{2001} \geq B_{MSY}$; $B_{2001}<B_{OY}$<br>The models have conflicting results. These conflicts are due, in part, to the sensitivity of certain models to catch or CPUE series. The Bayesian SPM models and SSLRSG models appear to correspond with each other, have good convergence[1], and fit well with CPUE data. These models generally indicate that the biomass is at or above $B_{MSY}$ levels and below $B_{OY}$ levels. |
| Sandbar | ASPM | 4.48E5 - 4.86E8 | 6.78E5 - 1.5E12 | 3.25E-4 - 1.68 | 8.48E5 - 1.88E12 | |
| Blacktip | SPM | 5,587 - 8,034 | 3,430 - 5,417 | 1.20 - 1.45 | 4,288 - 6,771 | STOCK IS NOT OVERFISHED AND IS REBUILT.<br>$B_{2001} \geq B_{OY}$<br>The majority of the models indicate that biomass levels exceed $B_{MSY}$ and $B_{OY}$. Some of the models that were very optimistic had difficulty converging. The other models were sensitive to the catch series. |
| Blacktip | ASPM | 1.35E6 - 3.16E7 | 1.71E6 - 2.64E6 | 0.79 - 1.66 | 2.14E6 - 3.30E6 | |

1Convergence indicates that the algorithm has become stable and come to an optimal solution.

**Table 3.5 Summary Table of the Status of the Fishing Mortality on Large Coastal Sharks.** Sources: 2002 LCS stock assessment; E. Cortes, personal communication. SPM=surplus production model (thousands of fish); ASPM=age-structured surplus production model (numbers of fish). Only models shown in figures 71, 73, and 76 of the 2002 LCS stock assessment are summarized below.

<table>
<tr><th colspan="2">Species / Model</th><th>Current F<br>$F_{2001}$</th><th>Maximum Fishing Mortality Threshold<br>MFFT = $F_{MSY}$</th><th>Current Relative Fishing Mortality Rate<br>$F_{2001}/F_{MSY}$</th><th>Fishing Mortality Target<br>$F_{OY} = 0.75F_{MSY}$</th><th>Outlook</th></tr>
<tr><td>Large Coastal Complex</td><td>SPM</td><td>0.07 - 0.21</td><td>0.05 - 0.10</td><td>0.89 - 4.48</td><td>0.05 - 0.08</td><td>OVERFISHING<br>$F_{2001}>F_{MSY}$<br>The majority of the models indicate that current F levels exceed $F_{MSY}$.</td></tr>
<tr><td rowspan="2">Sandbar</td><td>SPM</td><td>0.10 - 0.70</td><td>0.07 - 0.46</td><td>1.08 - 1.68</td><td>0.05 - 0.34</td><td rowspan="2">OVERFISHING<br>$F_{2001}>F_{MSY}$<br>The majority of the models indicate the overfishing is occurring. Most of the models that indicate overfishing also indicated that biomass levels are at or above MSY.</td></tr>
<tr><td>ASPM</td><td>0.0001 - 0.2</td><td>0.05 - 0.09</td><td>0.00156 - 2.45</td><td>0.03 - 0.07</td></tr>
<tr><td rowspan="2">Blacktip</td><td>SPM</td><td>0.04 - 0.08</td><td>0.07 - 0.18</td><td>0.42 - 0.82</td><td>0.05 - 0.14</td><td rowspan="2">NOT OVERFISHING<br>$F_{2001}<F_{OY}$<br>The majority of the models indicate that current fishing rates are below $F_{OY}$. Most of these models are the same models that indicate biomass levels are above $B_{MSY}$.</td></tr>
<tr><td>ASPM</td><td>0.01 - 0.21</td><td>0.06 - 0.12</td><td>0.13 - 1.72</td><td>0.04 - 0.09</td></tr>
</table>

**Table 3.6 Estimates (In Pounds Dressed Weight) of Total Landings for Small Coastal Sharks.** Source: Cortes, 2002.

| Year | Commercial Landings (lb dw) | Rec. Catches (lb dw) | Total (lb dw) |
|---|---|---|---|
| 1995 | 538.5 | 431.1 | 969.6 |
| 1996 | 484.8 | 241.3 | 726.1 |
| 1997 | 704.9 | 259.9 | 964.8 |
| 1998 | 631.9 | 508.3 | 1140.2 |
| 1999 | 727.3 | 280.3 | 1007.6 |
| 2000 | 577.2 | 434.7 | 1011.9 |

**Table 3.7 Estimates of Total Landings for Atlantic Sharpnose, Blacknose, Bonnethead, and Finetooth Sharks.** Source: Cortes, 2002.

| Species/Year | | Commercial (lb dw) | Recreational Catches (lb dw) | Total (lb dw) |
|---|---|---|---|---|
| Atlantic Sharpnose | 1995 | 93,663 | 368,213 | 461,876 |
| | 1996 | 165,406 | 182,955 | 348,361 |
| | 1997 | 256,562 | 192,056 | 448,618 |
| | 1998 | 230,920 | 442,887 | 673,807 |
| | 1999 | 244,356 | 195,768 | 440,124 |
| | 2000 | 129,467 | 305,565 | 435,032 |
| Blacknose | 1995 | 96,487 | 8,664 | 105,151 |
| | 1996 | 144,433 | 15,192 | 159,625 |
| | 1997 | 202,781 | 19,050 | 221,831 |
| | 1998 | 119,689 | 23,207 | 142,896 |
| | 1999 | 137,619 | 5,343 | 142,962 |
| | 2000 | 176,394 | 14,329 | 190,723 |
| Bonnethead | 1995 | 295,026 | 42,382 | 337,408 |
| | 1996 | 78,638 | 32,887 | 111,525 |
| | 1997 | 75,787 | 31,794 | 107,581 |
| | 1998 | 13,949 | 50,812 | 64,761 |
| | 1999 | 58,150 | 73,878 | 132,028 |
| | 2000 | 69,258 | 86,167 | 155,425 |
| Finetooth | 1995 | 50,193 | 4,519 | 54,712 |
| | 1996 | 94,134 | 2,326 | 96,460 |
| | 1997 | 169,733 | 12,103 | 181,836 |
| | 1998 | 267,224 | 8,27 | 268,051 |
| | 1999 | 285,214 | 2,81 | 285,495 |
| | 2000 | 190,313 | 4,392 | 194,705 |

**Table 3.8 Summary of Catch Series Available for 2002 SCS Stock Assessment.** Source: Cortes, 2002; Cortes pers. comm., 2003.

| SCS Species | | | | | Series Name | Year(s) | Fishery/Type |
|---|---|---|---|---|---|---|---|
| Aggregate | Atl.Shar | Bonnethead | Blacknose | Finetooth | | | |
| ✔ | ✔ | | | | Oregon II | 72-00 | FI |
| ✔ | ✔ | | | | SCDNR LL | 95-00 | FI |
| ✔ | ✔ | ✔ | ✔ | ✔ | Rec | 81-98 | FD |
| ✔ | ✔ | | ✔ | ✔ | NMFS LL PC | 93-00 | FI |
| ✔ | ✔ | ✔ | ✔ | ✔ | NMFS GN PC | 96-01 | FI |
| ✔ | ✔ | ✔ | ✔ | ✔ | DGNOP | 93-01 | FD |
| ✔ | ✔ | ✔ | | | SEAMAP | 89-01 | FI |
| ✔ | ✔ | | | | VIMS | 74-01 | FI |
| ✔ | ✔ | | | | NEFSC Bottom Trawl | 68-00 | FI |
| ✔ | ✔ | | | | NMFS LL SE ATL | 95-00 | FI |
| ✔ | ✔ | | ✔ | | NMFS LL SE EGM | 95-00 | FI |
| ✔ | ✔ | | ✔ | ✔ | NMFS LL SE WGM | 95-00 | FI |
| ✔ | ✔ | | | | NMFS LL NE | 86, 89, 91, 96, 98, 01 | |

**Table 3.9** **Trends in Catch Rates of Small Coastal Sharks.** Source: Cortes, 2002. Slopes were obtained from linear regressions of relative catch rates on year. Slopes significantly different from 0 are denoted as * (5% level), ** (1% level), and *** (0.1% level).

| Species | Series | Slope | SE | P Value | $r^2$ |
|---|---|---|---|---|---|
| SCS | Oregon II[1] | -0.0213** | 0.0065 | 0.0027 | 0.29 |
| | SCDNR LL[1] | -0.0078 | 0.0137 | 0.6022 | 0.07 |
| | Recreational | 0.0398** | 0.0124 | 0.0054 | 0.39 |
| | NMFS LL PC[1] | 0.0435 | 0.0346 | 0.2556 | 0.21 |
| | NMFS GN OC | -0.0734 | 0.0769 | 0.3939 | 0.18 |
| | DGNOP[2] | 0.0588* | 0.0148 | 0.0108 | 0.76 |
| | SEAMAP | 0.0389 | 0.0191 | 0.0668 | 0.27 |
| | VIMS LL[2] | -0.0101 | 0.0115 | 0.3914 | 0.04 |
| | NEFSC Trawl[1] | -0.0142** | 0.0045 | 0.0045 | 0.23 |
| Atlantic Sharpnose | Oregon II[1] | -0.0168* | 0.0073 | 0.0291 | 0.16 |
| | VIMS LL[2] | -0.0103 | 0.0115 | 0.3805 | 0.04 |
| | SCDNR LL[1] | -0.0067 | 0.0164 | 0.7048 | 0.04 |
| | NMFS NE LL[2] | -0.1100 | 0.0891 | 0.2845 | 0.28 |
| | Recretaional | 0.0640** | 0.0169 | 0.0016 | 0.47 |
| | NMFS SE LL ATL[2] | 0.2566 | 0.1359 | 0.1997 | 0.64 |
| | NMFS SE LL EGM[2] | 0.1006 | 0.1853 | 0.6251 | 0.09 |
| | NMFS SE LL WGM[2] | 0.0986 | 0.0877 | 0.3425 | 0.30 |
| | NMFS LL PC[1] | 0.0532 | 0.0430 | 0.2625 | 0.20 |
| | NMFS GN PC[1] | -0.0177 | 0.0368 | 0.6557 | 0.05 |
| | DGNOP[1,2] | 0.0614 | 0.0319 | 0.1125 | 0.42 |
| | SEAMAP | 0.0337 | 0.0214 | 0.1439 | 0.18 |
| | NEFSC Trawl[2] | 0.0059 | 0.0222 | 0.7927 | 0.004 |
| Bonnethead | Oregon II | -0.1337*** | 0.0236 | 0.0000052 | 0.54 |
| | Recreational | -0.0195 | 0.0206 | 0.3578 | 0.05 |
| | NMFS GN PC[1] | -0.0498 | 0.0706 | 0.5193 | 0.11 |
| | DGNOP[1,2] | 0.0145 | 0.0112 | 0.2532 | 0.25 |
| | SEAMAP | 0.0100 | 0.0343 | 0.7761 | 0.01 |
| Blacknose | Recreational | 0.0574 | 0.0400 | 0.1710 | 0.11 |
| | NMFS SE LL EGM[1,2] | 0.0687 | 0.0300 | 0.1060 | 0.64 |
| | NMFS SE LL WGM[1,2] | 0.0712 | 0.0557 | 0.2913 | 0.35 |
| | NMFS LL PC | 0.1742 | 0.1326 | 0.2370 | 0.22 |
| | NMFS GN PC | -0.2570 | 0.1607 | 0.1849 | 0.39 |
| | Oregon II | -0.0382 | 0.0416 | 0.3666 | 0.03 |
| | DGNOP[2] | 0.0310 | 0.0339 | 0.4031 | 0.14 |
| | SCDNR LL | -0.0702 | 0.0747 | 0.4004 | 0.18 |
| Finetooth | Recreational | 0.0431 | 0.0781 | 0.5884 | 0.02 |
| | NMFS SE LL WGM[2] | 0.3448 | 0.3982 | 0.5456 | 0.43 |
| | NMFS LL PC[1] | -0.2350 | 0.1255 | 0.1103 | 0.37 |
| | NMFS GN PC | -0.1061 | 0.1259 | 0.4471 | 0.15 |
| | DGNOP[2] | 0.0338* | 0.0113 | 0.0305 | 0.64 |

[1] Indicates that the dependent variable (catch rate) was log-transformed.
[2] Indicates that there are missing data for some years.

**Table 3.10 Summary Table of the Status of the Biomass of Small Coastal Sharks.** Sources: 2002 SCS stock assessment; E. Cortes, personal communication.

| Species | Current Biomass $B_{2001}$ | $B_{MSY}$ | Current Relative Biomass Level<br>$B_{2001}/B_{MSY}$ | Minimum Stock Size Threshold<br>MSST = $(1\text{-}M)B_{MSY}$ if M<0.5<br>MSST = 0.5 $B_{MSY}$ if M>=0.5 | Minimum Biomass Flag<br>Bflag = $(1\text{-}M)B_{OY}$ | Biomass Target<br>$B_{OY}$ = 125% $B_{MSY}$ | MSY | Outlook |
|---|---|---|---|---|---|---|---|---|
| Sharpnose | 72.7 - 73.2 | 23 - 43.3 | 1.69 - 3.16 | 11.5 - 33.4 | 9.0 - 41.8 | 28.75 - 54.12 | 7.8 mill lb dw to 1.9 mill lb dw | Stock not overfished $B_{2001} > B_{OY}$ |
| Bonnethead | 12.8 - 13.4 | 4.6 - 9.2 | 1.46 - 2.78 | 2.3 - 7.3 | 0.8 - 9.2 | 5.75 - 11.50 | 1.8 mill lb dw to 0.5 mill lb dw | Stock not overfished $B_{2001} > B_{OY}$ |
| Blacknose | 10.4 | 3.3 - 5.4 | 1.92 - 3.15 | 1.6 - 4.5 | 2.0 - 5.6 | 4.12 - 6.75 | 0.8 mill lb dw to 0.2 mill lb dw | Stock not overfished $B_{2001} > B_{OY}$ |
| Finetooth | 1.9 - 2.3 | 0.8 - 1.65 | 1.39 - 2.37 | 0.4 - 1.4 | 0.5 - 1.7 | 1.00 - 2.06 | 0.26 mill lb dw to 0.05 mill lb dw | Stock not overfished $B_{2001} > B_{OY}$ |
| SCS aggregate | 77.1 - 83.8 | 32.3 - 60.75 | 1.38 - 2.39 | 16.2 - 50.2 | 12.4 - 62.7 | 40.38 - 75.94 | 7.0 mill lb dw to 2.2 mill lb dw | Stock not overfished $B_{20010} > B_{OY}$ |

**Table 3.11 Summary Table of the Status of the Fishing Mortality on Small Coastal Sharks.** Sources: 2002 SCS stock assessment; E. Cortes, personal communication.

| Species | Current F $F_{2000}$ | Maximum Fishing Mortality Threshold MFFT = $F_{MSY}$ | Current Relative fishing Mortality Rate $F_{2000}/F_{MSY}$ | Fishing Mortality Target $F_{OY} = 0.75F_{MSY}$ | Outlook |
|---|---|---|---|---|---|
| Sharpnose | 0.02 - 0.06 | 0.04 - 0.42 | 0.14 - 0.42 | 0.03 - 0.31 | Not overfishing |
| Bonnethead | 0.03 - 0.18 | 0.05 - 0.53 | 0.35 - 0.56 | 0.04 - 0.40 | Not overfishing |
| Blacknose | 0.02 - 0.19 | 0.03 - 0.32 | 0.61 - 0.65 | 0.02 - 0.24 | Not overfishing |
| Finetooth | 0.13 - 1.50 | 0.03 - 0.44 | 3.42 - 4.13 | 0.02 - 0.33 | OVERFISHING |
| SCS aggregate | 0.03 - 0.24 | 0.04 - 0.28 | 0.24 - 0.78 | 0.03 - 0.21 | Not overfishing but $F_{2000} >= F_{OY}$ |

**Table 3.12 Landings Estimates (mt ww) for All Countries Available in the ICCAT Database for Three Shark Species.** Source: ICCAT, 2001. Note estimates exclude landings that were in numbers or dressed weight.

| Year | Porbeagle | Blue | Shortfin Mako |
|---|---|---|---|
| 1982 | 0 | | |
| 1983 | | | |
| 1984 | 0 | | |
| 1985 | 0 | | |
| 1986 | 0 | 1 | |
| 1987 | 1 | 526 | |
| 1988 | 2 | 421 | |
| 1989 | 3 | 480 | |
| 1990 | 2 | 2129 | 193 |
| 1991 | 6 | 3029 | 314 |
| 1992 | 4 | 1768 | 246 |
| 1993 | 51 | 6886 | 1111 |
| 1994 | 110 | 7845 | 1023 |
| 1995 | 1417 | 8134 | 1113 |
| 1996 | 1101 | 8116 | 1343 |
| 1997 | 1450 | 11247 | 5057 |
| 1998 | 1048 | 32313 | 3901 |
| 1999 | 974 | 32654 | 3573 |
| 2000 | 918 | 3652 | 863 |

**Table 3.13 Summary of Available Data for Pelagic Sharks.** Source: ICCAT, 2001. NA = North Atlantic; SA = South Atlantic; MED = Mediterranean; NWA = Northwest Atlantic; NEA = Northeast Atlantic; SWA = Southwest Atlantic; SEA = Southeast Atlantic. Checks mark indicates information is available, whereas bullets note that some information is available. Blanks indicate questionable or lacking data.

| | | Blue shark | | | Shortfin Mako shark | | | Porbeagle shark | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NA | SA | MED | NA | SA | MED | NWA | NEA | SWA | SEA |
| Life History | Growth (length at age) | ✔ | ✔ | | | | | ✔ | | | |
| | Length/Weight | ✔ | ✔ | | ✔ | ✔ | | ✔ | ✔ | | |
| | Natural Mortality/Survival by age | ✔ | ✔ | | ✔ | | | ✔ | | | |
| | Maximum age observed | ✔ | ✔ | | | | | ✔ | | | |
| | Stock Identification | ● | ● | | ● | ● | | ✔ | ✔ | | |
| | Migration rates between stocks | | | | | | | ✔ | ✔ | | |
| | Locations of pupping areas | ✔ | ✔ | | ✔ | ✔ | | | | ✔ | |
| | Stock/recruit relationship | | | | | | | ✔ | | | |
| | Intrinsic rate of increase (r) | ✔ | | | ✔ | | | ✔ | | | |
| | Unfished biomass (K) | | | | | | | ✔ | | | |
| Reproductive | Age at maturity | ✔ | ✔ | | | | | ✔ | | | |
| | Pups per female | ✔ | ✔ | | ✔ | ✔ | | ✔ | ✔ | | |
| | Inter-spawning interval | ✔ | | | ✔ | | | ✔ | | | |
| | Gestation period | ✔ | ✔ | | ✔ | ✔ | | ✔ | ✔ | | |
| | Sex ratio of pups | ✔ | ✔ | | ✔ | ✔ | | ✔ | ✔ | | |
| | Maternal size/Litter size | ✔ | ✔ | | | ✔ | | ✔ | | | |
| Catch | Number of fleets catching sharks | ● | ● | ● | ● | ● | ● | ✔ | ✔ | ● | ● |

| | | Blue shark | | | Shortfin Mako shark | | | Porbeagle shark | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NA | SA | MED | NA | SA | MED | NWA | NEA | SWA | SEA |
| | Total catch | ● | ● | ● | ● | ● | ● | ✔ | ● | ● | ● |
| | Length or age composition | ● | ● | | ● | ● | | ✔ | ● | | ● |
| | Sex ratio | ● | ● | | ● | ● | | ✔ | ● | | ● |
| | Selectivity by age or size by gear | | | | | | | ● | | | |
| | Conversions of whole/dressed weight, etc. | ✔ | ✔ | | ✔ | ✔ | | ✔ | | ✔ | |
| | Locations of catch/bycatch (5 x 5 degrees) | ● | ● | | ● | ● | | ✔ | | ● | ● |
| | Dead discard rate or total amount | ● | ● | | ● | ● | | ✔ | | | |
| | Live discard survival | ✔ | | | ✔ | | | ✔ | | | |
| | Bycatch rate (shark catch as % of tuna catch) | ● | ● | | ● | ● | | ✔ | | | ● |
| CPUE series | Index of targeting vs. bycatch fisheries | ● | ● | | ● | ● | | ✔ | | | ● |
| | Gear indices, etc. | ● | ● | | ● | ● | | ✔ | | | ● |

**Table 3.14 Estimates of Total Landings and Dead Discards for Large Coastal Sharks: 1981-2001 (Numbers of Fish in Thousands).** Source: Cortes *et al.*, 2002.

| Year | Commercial Landings | Pelagic Longline Discards | Recreational Catches | Unreported | Bottom Longline Discards | Mexican Catches | Menhaden Fishery bycatch | Total |
|---|---|---|---|---|---|---|---|---|
| 1981 | 16.2 | 0.9 | 265.0 | N/A | 0.9 | 120.0 | 25.1 | 428.1 |
| 1982 | 16.2 | 0.9 | 413.9 | N/A | 0.9 | 81.9 | 25.1 | 538.9 |
| 1983 | 17.5 | 0.9 | 746.6 | N/A | 1.0 | 85.4 | 25.1 | 876.5 |
| 1984 | 23.9 | 1.3 | 254.6 | N/A | 1.4 | 120.7 | 25.1 | 426.9 |
| 1985 | 22.2 | 1.2 | 365.6 | N/A | 1.3 | 87.7 | 25.1 | 503.1 |
| 1986 | 54.0 | 2.9 | 426.1 | 24.9 | 3.1 | 81.8 | 25.1 | 617.9 |
| 1987 | 104.7 | 9.7 | 314.4 | 70.3 | 5.9 | 80.2 | 25.1 | 610.3 |
| 1988 | 274.6 | 11.4 | 300.6 | 113.3 | 15.5 | 89.3 | 25.1 | 829.8 |
| 1989 | 351.0 | 10.5 | 221.1 | 96.3 | 19.9 | 105.6 | 25.1 | 829.4 |
| 1990 | 267.5 | 8.0 | 213.2 | 52.1 | 15.1 | 122.2 | 25.1 | 703.3 |
| 1991 | 200.2 | 7.5 | 293.4 | 11.3 | 11.3 | 95.7 | 25.1 | 644.5 |
| 1992 | 215.2 | 20.9 | 304.9 | N/A | 12.2 | 103.4 | 25.1 | 681.6 |
| 1993 | 169.4 | 7.3 | 249.0 | N/A | 11.3 | 119.8 | 25.1 | 581.9 |
| 1994 | 228.0 | 8.8 | 160.9 | N/A | 16.3 | 110.7 | 26.2 | 550.9 |
| 1995 | 222.4 | 5.2 | 176.3 | N/A | 13.9 | 96.0 | 24.0 | 537.8 |
| 1996 | 160.6 | 5.7 | 188.5 | N/A | 7.6 | 106.1 | 25.1 | 493.6 |
| 1997 | 130.6 | 5.6 | 165.1 | N/A | 8.3 | 83.1 | 25.1 | 417.8 |
| 1998 | 174.9 | 4.3 | 169.8 | N/A | 9.9 | 74.1 | 25.1 | 458.1 |
| 1999 | 111.5 | 9.0 | 90.1 | N/A | 3.8 | 57.1 | 25.1 | 297.5 |
| 2000 | 111.2 | 9.4 | 140.4 | N/A | 4.8 | 52.1 | 25.1 | 343.0 |
| 2001 | 99.2 | 9.4 | 142.0 | N/A | 6.3 | 52.1 | 25.1 | 334.1 |

**Table 3.15 Directed Bottom Longline Shark Observed Catch and Disposition for 2002.** Source: NOAA Fisheries, 2003a.

| | FLORIDA EAST COAST | | | | FLORIDA GULF COAST | | | | CAROLINAS and GEORGIA | | | | TOTAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Caught** | **Kept** | **Other Kill*** | **Tagged/ Released** | **Caught** | **Kept** | **Other Kill*** | **Tagged/ Released** | **Caught** | **Kept** | **Other Kill*** | **Tagged/ Released** | **Caught** | **Kept** | **Other Kill*** | **Tagged/ Released** |
| Sandbar | 291 | 287 | | | 582 | 573 | 4 | 1 | 536 | 525 | 3 | 2 | 1409 | 1385 | 7 | 3 |
| Blacktip | 215 | 208 | 7 | | 571 | 542 | 24 | 1 | 151 | 148 | 2 | | 937 | 898 | 33 | 1 |
| Dusky | 2 | | 1 | 1 | 6 | | 3 | 3 | 17 | | 14 | 3 | 25 | | 18 | 7 |
| Silky | 8 | 8 | | | 69 | 48 | 13 | 8 | 13 | 5 | 8 | | 90 | 61 | 21 | 8 |
| Bull | 16 | 14 | | | 53 | 48 | | | 4 | 3 | | | 72 | 65 | | |
| Bignose | | | | | 1 | | | 1 | | | | | 1 | | | 1 |
| Spinner | 6 | 4 | 2 | | 46 | 39 | 4 | 1 | 4 | 3 | 1 | | 56 | 46 | 7 | 1 |
| Night | | | | | 17 | 2 | 15 | | 1 | | | 1 | 18 | 2 | 15 | 1 |
| Lemon | 18 | 17 | | | 130 | 123 | | | 4 | 4 | | | 152 | 144 | | |
| Scalloped HH | 59 | 41 | 18 | | 66 | 49 | 16 | | 11 | 8 | 2 | 1 | 136 | 98 | 36 | |
| Great HH | 4 | 1 | 3 | | 56 | 50 | 6 | | 7 | 4 | 3 | | 67 | 55 | 12 | |
| Nurse | 29 | | | 28 | 267 | | | 264 | 5 | | | 5 | 301 | | | 297 |
| Tiger | 139 | 34 | 5 | 97 | 137 | 37 | 10 | 92 | 515 | 127 | 43 | 345 | 791 | 193 | 58 | 534 |
| Sand tiger | 1 | | | 1 | | | | | | | | | 1 | | | 1 |
| White | | | | | | | | | | | | | | | | |
| Unidentified | | | | | | | | | | | | | | | | |
| Atlantic sharpnose | 315 | 3 | 312 | | 321 | 68 | 251 | 2 | 513 | 111 | 402 | | 1149 | 182 | 965 | 2 |
| Bonnethead | 1 | | 1 | | | | | | | | | | 1 | | 1 | |
| Blacknose | 22 | 13 | 9 | | 355 | 155 | 197 | 4 | 33 | 20 | 13 | | 411 | 188 | 219 | 4 |

| | FLORIDA EAST COAST | | | | FLORIDA GULF COAST | | | | CAROLINAS and GEORGIA | | | | TOTAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Caught** | **Kept** | **Other Kill*** | **Tagged/ Released** | **Caught** | **Kept** | **Other Kill*** | **Tagged/ Release d** | **Caught** | **Kept** | **Other Kill*** | **Tagged/ Released** | **Caught** | **Kept** | **Other Kill*** | **Tagged/ Released** |
| Finetooth | | | | | | | | | 1 | 1 | | | 1 | 1 | | |
| Thresher | | | | | | | | | | | | | | | | |
| Shortfin mako | | | | | | | | | 18 | 17 | | | 18 | 17 | | |
| LCS | 788 | 614 | 36 | 125 | 2001 | 1506 | 95 | 371 | 1268 | 827 | 76 | 357 | 4057 | 2947 | 207 | 853 |
| SCS | 338 | 16 | 322 | 0 | 676 | 223 | 448 | 6 | 547 | 132 | 415 | 0 | 1562 | 371 | 1185 | 6 |
| Pelagic | | | | | | | | | 18 | 17 | | | 18 | 17 | | |
| **Total** | **1126** | **630** | **358** | **125** | **2677** | **1729** | **543** | **377** | **1833** | **976** | **491** | **357** | **5637** | **3335** | **1392** | **859** |

*NOTE: Other Kill means that the species was used for bait, biological samples, or personal purposes.

**Table 3.16 Total Drift Gillnet Shark Catch by Species During All Observed Trips, 2002.** RW = right whale calving season; NRW = non-right whale calving season. Source: Carlson and Baremore, 2002a; Carlson and Baremore, 2002b.

| Species | Total Number Caught | | Kept (%) | | Discarded Alive (%) | | Discarded Dead (%) | |
|---|---|---|---|---|---|---|---|---|
| | RW | NRW | RW | NRW | RW | NRW | RW | NRW |
| Atlantic sharpnose shark | 1,885 | 7,332 | 97.9 | 98.9 | 0.5 | 0.4 | 1.6 | 0.7 |
| Blacknose shark | 1,531 | 859 | 99.9 | 100.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Blacktip shark | 1,777 | 572 | 98.4 | 1.2 | 0.0 | 30.9 | 1.6 | 67.8 |
| Finetooth shark | 125 | 1,490 | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bonnethead shark | 402 | 305 | 97.5 | 100.0 | 0.2 | 0.0 | 2.3 | 0.0 |
| Scalloped hammerhead shark | 38 | 37 | 97.3 | 2.7 | 0.0 | 5.4 | 2.7 | 91.9 |
| Tiger shark | 3 | 2 | 66.6 | 50.0 | 0.0 | 50.0 | 33.4 | 0.0 |
| Spinner shark | 132 | 17 | 100.0 | 23.6 | 0.0 | 5.8 | 0.0 | 70.6 |
| Sandbar shark | 0 | 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Lemon shark | 0 | 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Great hammerhead shark | 75 | 18 | 61.4 | 0.0 | 0.0 | 0.0 | 38.6 | 100.0 |
| Common thresher shark | 1 | 0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 3.17 Total Strikenet Shark Catch by Species During All Observed Trips, 2002.** RW = right whale calving season; NRW = non-right whale calving season. Source: Carlson and Baremore, 2002a; Carlson and Baremore, 2002b.

| Species | Total Number Caught | | Kept (%) | | Discarded Alive (%) | | Discarded Dead (%) | |
|---|---|---|---|---|---|---|---|---|
| | RW | NRW | RW | NRW | RW | NRW | RW | NRW |
| Blacknose shark | 13 | 620 | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Blacktip shark | 4,179 | 547 | 99.8 | 99.8 | 0.2 | 0.2 | 0.0 | 0.0 |
| Bonnethead shark | 0 | 1 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Spinner shark | 13 | 0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Great hammerhead shark | 1 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 |

**Table 3.18 Estimates of Recreational Catches by Shark Grouping.** Note: Recreational catches are reported in numbers of fish in thousands. Source: NMFS, 1999; Cortes, 1999; Cortes *et al.*, 2002; and Cortes, 2002.

| Year | Large Coastal Sharks | Small Coastal Sharks | Pelagic Sharks | Total |
|---|---|---|---|---|
| 1981 | 265.0 | -- | -- | 265.0 |
| 1982 | 413.9 | -- | -- | 413.9 |
| 1983 | 746.6 | -- | -- | 746.6 |
| 1984 | 254.6 | -- | -- | 254.6 |
| 1985 | 365.6 | -- | 93.0 | 365.6 |
| 1986 | 426.1 | 34.9 | 42.1 | 503.1 |
| 1987 | 314.4 | 48.8 | 37.3 | 400.5 |
| 1988 | 300.6 | 82.4 | 33.4 | 416.4 |
| 1989 | 221.1 | 62.3 | 22.6 | 306 |
| 1990 | 213.2 | 47.3 | 15.4 | 275.9 |
| 1991 | 293.4 | 137.0 | 11.6 | 442 |
| 1992 | 304.9 | 116.2 | 16.4 | 437.5 |
| 1993 | 249.0 | 78.7 | 31.3 | 359 |
| 1994 | 160.9 | 103.2 | 6.2 | 270.3 |
| 1995 | 176.3 | 135.1 | 32.9 | 344.3 |
| 1996 | 188.5 | 112.7 | 20.8 | 322 |
| 1997 | 165.1 | 97.0 | 8.4 | 270.5 |
| 1998 | 169.8 | 77.9 | 7.7 | 255.4 |
| 1999 | 91.0 | 115.9 | 11.1 | 218 |
| 2000 | 140.4 | 184.7 | 13.3 | 338.4 |
| 2001 | 142.0 | 189.5 | 3.8 | 335.3 |

**Table 3.19 Recreational Harvest Estimates of U.S. Atlantic Large Coastal Sharks by Species for 1999, 2000, and 2001.** Note: Recreational catches are reported in numbers of fish. Source: Cortes and Neer, 2002.

| Species | Large Coastal Sharks | | |
|---|---|---|---|
| | 1999 | 2000 | 2001 |
| Blacktip | 34,962 | 74,055 | 48,848 |
| Bull | 3,107 | 6,045 | 3,751 |
| Dusky | 5,570 | 2,397 | 5,703 |
| Great Hammerhead | 352 | 921 | 3,367 |
| Hammerhead, genus | 75 | 3,693 | -- |
| Lemon | 146 | 2,801 | 5,946 |
| Night | 50 | -- | -- |
| Nurse | 1,503 | 2,138 | 4,280 |
| Reef | 3 | 182 | 182 |
| Requiem family | 3,975 | 6,349 | 11,397 |
| Requiem genus | 8,978 | 11,600 | 4,887 |
| Sandbar | 20,553 | 10,743 | 35,880 |
| Sand Tiger | -- | -- | 604 |
| Scalloped Hammerhead | 1,349 | 3,517 | 1,108 |
| Silky | 3,863 | 5,109 | 4,070 |
| Smooth Hammerhead | 1 | -- | 703 |
| Spinner | 6,391 | 6,355 | 2,896 |
| Tiger | 153 | 1,479 | 784 |
| Total | 91,031 | 137,384 | 134,406 |

**Table 3.20 Recreational Harvest Estimates of U.S. Atlantic Small Coastal Sharks by Species for 1999, 2000, and 2001.** Note: Recreational catches are reported in numbers of fish. Source: Cortes and Neer, 2002.

| Species | Small Coastal Sharks | | |
|---|---|---|---|
| | 1999 | 2000 | 2001 |
| Atlantic Sharpnose | 68,621 | 114,973 | 109,114 |
| Blacknose | 6,019 | 10,463 | 15,059 |
| Bonnethead | 41,128 | 57,405 | 58,600 |
| Finetooth | 78 | 1,786 | 6,729 |
| Smalltail | 4 | 29 | -- |
| Total | 115,850 | 184,656 | 189,502 |

**Table 3.21 Recreational Harvest Estimates of U.S. Atlantic Pelagic Sharks by Species for 1999, 2000, and 2001.** Note: Recreational catches are reported in numbers of fish. Source: Cortes and Neer, 2002.

| Species | Pelagic Sharks | | |
|---|---|---|---|
| | 1999 | 2000 | 2001 |
| Blue | 5,218 | 7,010 | 950 |
| Shortfin Mako | 1,383 | 5,808 | 2,882 |
| Thresher | 5,512 | 528 | -- |
| Total | 11,113 | 13,346 | 3,832 |

**Table 3.22 Average Ex-vessel Prices per lb. dw for Atlantic Sharks by Gear and Area.** 2001 dollars are converted to 1996 dollars using the consumer price index conversion factor of 0.886. Source: Dealer weigh out slips from the Southeast Fisheries Science Center and Northeast Fisheries Science Center. HND=Handline, harpoon, and trolls, PLL=Pelagic longline, BLL=Bottom longline, Net=Gillnets and pound nets, TWL=Trawls. Gulf of Mexico includes: TX, LA, MS, AL, and the west coast of FL. S. Atlantic includes: east coast of FL. GA, SC, and NC dealers reporting to Southeast Fisheries Science Center. Mid-Atlantic includes: NC dealers reporting to Northeast Fisheries Science Center, VA, MD, DE, NJ, NY, and CT. N. Atlantic includes: RI, MA, NH, and ME.

| Species | Gear | Gulf of Mexico | | S. Atlantic | | Mid-Atlantic | | N. Atlantic | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1996 | 2001 | 1996 | 2001 | 1996 | 2001 | 1996 | 2001 |
| Large Coastal Sharks | HND | $0.23 | $0.45 | $0.72 | $0.85 | $0.74 | $0.78 | - | $0.44 |
| | PLL | - | $0.40 | $1.54 | $1.50 | $0.58 | $2.32 | $1.03 | $1.07 |
| | BLL | $0.60 | $0.39 | $0.73 | $0.79 | $0.54 | $0.49 | $0.99 | $1.27 |
| | NET | $0.38 | $0.44 | $1.30 | $1.32 | $0.45 | $0.79 | $0.83 | $0.88 |
| | TWL | $0.15 | $0.22 | $0.86 | $0.45 | $0.47 | $0.49 | $0.80 | $0.82 |
| Pelagic sharks | HND | - | $1.31 | $0.82 | $0.63 | $1.47 | $1.12 | $1.60 | $1.22 |
| | PLL | - | $1.17 | $0.68 | $0.84 | $1.25 | $1.38 | $1.26 | $1.21 |
| | BLL | - | $1.26 | $0.59 | $0.69 | $1.47 | $0.86 | $1.85 | - |
| | NET | - | - | $0.33 | $0.32 | $0.99 | $0.90 | $1.12 | $0.87 |
| | TWL | - | - | - | $0.23 | $1.00 | $0.61 | $0.96 | $1.05 |
| Small Coastal sharks | HND | - | $0.33 | $0.25 | $0.41 | - | $0.35 | - | - |
| | PLL | - | $0.66 | - | $0.56 | $0.25 | $0.43 | - | - |
| | BLL | - | $0.54 | - | $0.47 | - | $0.45 | - | - |
| | NET | - | $0.40 | $0.25 | $0.48 | - | $0.39 | - | $1.34 |
| | TWL | - | - | - | $0.20 | - | $0.84 | - | |
| | TRP | - | $0.66 | - | - | | - | - | |
| Shark fins | HND | - | $14.09 | $14.00 | $17.50 | $2.74 | - | - | - |
| | PLL | - | $18.68 | - | $10.14 | $7.79 | - | $4.25 | - |
| | BLL | - | $19.05 | $14.00 | $19.68 | $8.00 | - | $3.00 | - |
| | NET | - | $9.76 | - | $9.39 | $4.77 | - | $1.96 | - |
| | TWL | - | - | $9.11 | $10.78 | $1.99 | - | $2.32 | - |

**Table 3.23 Average Ex-vessel Prices per lb. For Atlantic Sharks by Area.** 2001 dollars are converted to 1996 dollars using the consumer price index conversion factor of 0.886.

| Species | Gulf of Mexico | | S. Atlantic | | Mid-Atlantic | | N. Atlantic | |
|---|---|---|---|---|---|---|---|---|
| | 1996 | 2001 | 1996 | 2001 | 1996 | 2001 | 1996 | 2001 |
| Large coastal sharks | $0.21 | $0.39 | $1.02 | $0.99 | $0.55 | $0.97 | $0.88 | $0.90 |
| Pelagic sharks | - | $1.26 | $0.62 | $0.60 | $1.21 | $0.97 | $1.31 | $1.09 |
| Small coastal sharks | - | $0.51 | $0.25 | $0.46 | $0.25 | $0.49 | - | $1.34 |
| Shark fins | - | $18.52 | $10.74 | $16.33 | $4.60 | - | $2.69 | - |

**Table 3.24 The Number of Plants and Employees for Atlantic Processors and Wholesalers, by State, in 1996 and 2000.** Source: NOAA Fisheries, 1998; NOAA Fisheries, 2002. 2001 data is not yet available.

| State | 1996 | | 2000 | |
|---|---|---|---|---|
| | Number of plants | Number of employees | Number of plants | Number of employees |
| Maine | 267 | 3,353 | 270 | 2,953 |
| New Hampshire | 37 | 455 | 37 | 425 |
| Massachusetts | 374 | 4,964 | 345 | 5,025 |
| Rhode Island | 82 | 793 | 69 | 790 |
| Connecticut | 44 | 339 | 44 | 429 |
| New York | 339 | 2,622 | 362 | 2,779 |
| New Jersey | 150 | 2,090 | 131 | 2,072 |
| Pennsylvania | 68 | 2,017 | 71 | 2,400 |
| Delaware | - | - | (2) | (2) |
| District of Columbia | 7 | 73 | (2) | (2) |
| Maryland | 126 | 1,889 | 99 | 1,626 |
| Virginia | 129 | 2,115 | 113 | 2,087 |
| N. Carolina | 145 | 2,064 | 140 | 1,952 |
| S. Carolina | 37 | 337 | 30 | 177 |
| Georgia | 66 | 1,649 | 61 | 1,788 |
| Florida | 504 | 5,794 | 464 | 6,111 |
| Alabama | 144 | 2,425 | 125 | 2,194 |
| Mississippi | 64 | 1,142 | 70 | 2,887 |
| Louisiana | 311 | 4,280 | 268 | 3,344 |
| Texas | 136 | 2,384 | 142 | 3,061 |
| Total | 3,030 | 40,785 | 2,845 | 42,104 |

**Table 3.25 Summary of the Mark-up and Consumer Expenditure for the Primary Wholesale and Processing of Domestic Commercial Marine Fishery Products on a Nationwide Basis: 1996 and 2001.** Source: NOAA Fisheries, 1997 and NOAA Fisheries, 2002.

| | 1996 | 2001 |
|---|---|---|
| Purchase of Fishery inputs | $5,377,442 | $6,281,066 |
| Percent mark-up of fishery inputs | 96.6% | 99.9% |
| Total mark-up | $5,192,619 | $6,271,680 |
| Total value of fishery inputs | $10,570,061 | $12,555,745 |

**Table 3.26 The Percent of Charter Boat Operators in Alabama, Louisiana, Mississippi, and Texas Who Reported Targeting HMS at Least Once.** Source: Sutton *et al.*, 1999.

| Target | | Alabama | Louisiana | Mississippi | Texas |
|---|---|---|---|---|---|
| Tuna | Yes | 61.9 | 66.7 | 6.3 | 65.2 |
| | No | 38.1 | 33.3 | 93.8 | 32.6 |
| | Incidental | 0.0 | 0.0 | 0.0 | 2.2 |
| Sharks | Yes | 4.5 | 16.7 | 75.0 | 67.4 |
| | No | 95.5 | 66.7 | 18.8 | 42.7 |
| | Incidental | 0.0 | 16.7 | 6.3 | 32.6 |
| Billfish | Yes | 61.9 | 41.7 | 6.3 | 43.5 |
| | No | 38.1 | 58.3 | 93.8 | 56.5 |
| | Incidental | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 3.27 The Financial Operations and Economic Impact of Charter and Party Boat Operators in Alabama, Louisiana, Mississippi, and Texas.** Source: Sutton *et al.*, 1999.

| | | Charter boats | Party boats |
|---|---|---|---|
| Average capital investment | Hull and superstructure | $97,713 | $214,922 |
| | Engine | $9,058 | $2,571 |
| | Electronics | $5,231 | $7,429 |
| | Other equipment and tackle | $7,298 | $6,686 |
| Annual costs | Wages and Salaries | $19,725 | $64,064 |
| | New hull or superstructure | $18,300 | $23,076 |
| | Maintenance and repair | $8,584 | $26,919 |
| | Engine | $4,890 | $15,153 |
| | Insurance | $3,799 | $11,491 |
| | Other costs | $6,020 | $28,404 |
| Average annual gross revenues | | $68,934 | $137,308 |
| Average annual net revenues (includes capital expenses - e.g. purchase of new hull) | | -$12,099 | -$128,703 |
| Average annual operating profit (does not include capital expenses - e.g. purchase of new hull) | | $14,650 | -$73,064 |
| Economic output | Alabama | $13.8 M | $0.8 M |
| | Mississippi | $6.6 M | - |
| | Louisiana | $4.4 M | - |
| | Texas | $17.6 M | $3.5 M |
| Employment generated | Alabama | $5.6 M (282 jobs) | $0.3 M (16 jobs) |
| | Mississippi | $2.1 M (211 jobs) | - |
| | Louisiana | $1.8 M (118 jobs) | - |
| | Texas | $6.1 M (385 jobs) | $1.7 M (77 jobs) |

**Table 3.28 The Average Fees for Charter and Headboats in Florida, Georgia, South Carolina, and North Carolina.** Source: Holland *et al*., 1999.

| State | Length of trip | Charter boat | Headboat |
|---|---|---|---|
| Florida | Half-day | $348 | $29 |
| | Full day | $554 | $45 |
| | Overnight | $1,349 | -- |
| Georgia | Half-day | $320 | -- |
| | Full day | $562 | -- |
| | Overnight | $1000-$2000 | -- |
| South Carolina | Half-day | $296 | $34 |
| | Full day | $661 | $61 |
| | Overnight | $1000-$2000 | -- |
| North Carolina | Half-day | $292 | $34 |
| | Full day | $701 | $61 |
| | Overnight | $1000-$2000 | -- |

**Table 3.29 The Percent of Charter and Headboat Operators in Florida, Georgia, South Carolina, and North Carolina Who Reported Targeting HMS at Least Once.** Source: Holland *et al*., 1999.

| Target species | Florida | | Georgia | | S. Carolina | | N. Carolina | |
|---|---|---|---|---|---|---|---|---|
| | Charter | Head | Charter | Head | Charter | Head | Charter | Head |
| Tuna | 8.5 | 0.0 | 8.3 | - | 0.0 | - | 60.0 | - |
| Sharks | 22.6 | 9.7 | 33.3 | - | 35.0 | - | 23.3 | - |
| Billfish | 9.9 | 0.0 | 8.3 | - | 20.0 | - | 40.0 | - |

**Table 3.30 The Financial Operations and Economic Impact of Charter and Party Boat Operators in Florida, Georgia, South Carolina, and North Carolina.** Source: Holland *et al*., 1999.

| | | Charter boats | | Party boats | |
|---|---|---|---|---|---|
| | | Florida | Other states | Florida | Other states |
| Average capital investment | Hull and superstructure | $90,989 | $39,445 | $214,158 | $178,833 |
| | Engine | $40,518 | $5,900 | $40,000 | $38,181 |
| | Electronics | $5,568 | $5,900 | $5,560 | $6,277 |
| | Other equipment and tackle | $5,878 | $4,463 | $9,183 | $3,600 |
| Annual costs | Wages and Salaries | $25,810 | $17,928 | $52,000 | $33,077 |
| | New hull or superstructure | $3,020 | $793-1,340 | $3,333 | $0.00 |
| | Maintenance and repair | $5,720 | $4,991-6,910 | $13,385 | $16,577 |
| | Engine | $6,334 | $172-2,738 | $9,450 | $14,545 |
| | Insurance | $2,970 | -- | $8,570 | – |
| | Other costs | $24,723 | $971-18,883 | $48,999 | $40,846 |
| Average annual gross revenues | | $56,264 | $26,304-$60,135 | $140,714 | $123,000 |
| Average annual net revenues (Gross revenues - Annual costs) | | -$12,313 | $3,069-13,237 | $4,977 | $17,955 |
| Economic output | | $128 M | $34.4 M | $23.4 M | $5.8 M |
| Employment generated | | $31 M (3,074 jobs) | $15.6 M (1,066 jobs) | $5.8 M (450 jobs) | $2.2 (81 jobs) |

**Table 3.31 1997-2002 U.S. Exports of Shark Products (kg).** Source: NOAA Fisheries, 2003b.

| Year | Shark Fins Dried (kg, US$) | | Non-specified Fresh Shark (kg, US$) | | Non-specified Frozen Shark (kg, US$) | | Total for all Products (kg, US$) | |
|---|---|---|---|---|---|---|---|---|
| 1997 | NA* | NA* | 459,542 | 920,887 | 439,992 | 884,588 | 899,534 | 1,805,475 |
| 1998 | 141,149 | 1,264,077 | 524,249 | 814,319 | 102,939 | 250,107 | 768,337 | 2,328,503 |
| 1999 | 106,723 | 911,671 | 270,343 | 487,610 | 155,275 | 461,362 | 532,341 | 1,860,643 |
| 2000 | NA** | NA** | 430,725 | 784,704 | 345,942 | 814,456 | 776,667• | 1,599,160• |
| 2001 | NA** | NA** | 332,948 | 545,568 | 634,060 | 2,341,215 | 967,008• | 2,886,783• |
| 2002 | 123,890 | 3,468,458 | 968,915 | 1,477,305 | 982,774 | 2,340,756 | 2,075,579 | 7, 286,519 |

* There was no product code for the export of shark fins prior to 1998. Therefore, any exported shark fins may have been identified as unspecified shark product or as unspecified dried fish.

** Table will be updated as values become available.

•Values do not include dried shark fin data.

**Table 3.32 1997-2002 U.S. Imports of Shark Products.** Source: NOAA Fisheries, 2003b.

| Year | Shark Fins Dried | | Non-specified Fresh Shark | | Non-specified Frozen Shark | | Total For All Products | |
|---|---|---|---|---|---|---|---|---|
| | kg | US$ | kg | US$ | kg | US$ | kg | US$ |
| 1997 | 77,626 | 3,060,438 | 1,191,044 | 3,044,984 | 59,641 | 914,783 | 1,328,278 | 7,020,205 |
| 1998 | 62,169 | 1,698,646 | 947,545 | 2,160,985 | 148,167 | 1,125,994 | 1,157,881 | 4,985,625 |
| 1999 | 59,872 | 2,104,846 | 1,095,119 | 2,038,016 | 105,398 | 621,499 | 1,260,389 | 4,764,361 |
| 2000 | 66,107 | 2,355,575 | 1,066,144 | 1,859,203 | 90,166 | 575,226 | 1,222,417 | 4,790,004 |
| 2001 | 50,664 | 1,086,716 | 913,421 | 1,389,054 | 123,809 | 1,780,726 | 1,087,894 | 4,256,496 |
| 2002 | 39,141 | 1,023,914 | 797,538 | 1,240,650 | 91,792 | 1,090,428 | 928,471 | 3,354,992 |

**Table 3.33 Total Teleost and Ray Bycatch in NOAA Fisheries Observed Drift Gillnet Sets During 2002 Right Whale Calving Season.** Source: Carlson, 2002a.

| Species | Total Number Caught | Kept (%) | Discard Alive (%) | Discard Dead (%) |
|---|---|---|---|---|
| King mackerel | 93 | 75.3 | 0.0 | 24.7 |
| Cownose ray | 6 | 33.3 | 66.6 | 0.0 |
| Cobia | 66 | 68.2 | 6.1 | 25.7 |
| Great barracuda | 72 | 100.0 | 0.0 | 0.0 |
| Bluefish | 9 | 44.4 | 0.0 | 55.5 |
| Spanish mackerel | 16 | 87.5 | 0.0 | 12.5 |
| Little tunny | 178 | 96.1 | 0.0 | 3.9 |
| Spotted eagle ray | 9 | 0.0 | 100.0 | 0.0 |
| Crevalle jack | 41 | 97.5 | 2.5 | 0.0 |
| Remora | 11 | 0.0 | 72.7 | 27.3 |
| Atlantic manta ray | 2 | 0.0 | 100.0 | 0.0 |
| Tripletail | 3 | 100.0 | 0.0 | 0.0 |
| Atlantic sailfish | 43 | 0.0 | 2.3 | 97.7 |
| Wahoo | 2 | 100.0 | 0.0 | 0.0 |
| Atlantic thread herring | 3 | 0.0 | 33.3 | 66.7 |
| Blackfin tuna | 4 | 100.0 | 0.0 | 0.0 |
| Blue runner | 2 | 100.0 | 0.0 | 0.0 |
| Tarpon | 3 | 0.0 | 33.3 | 66.7 |
| Gag grouper | 1 | 100.0 | 0.0 | 0.0 |
| Atlantic bumper | 2 | 0.0 | 50.0 | 50.0 |
| Dolphin | 3 | 100.0 | 0.0 | 0.0 |
| Atlantic bonito | 20 | 100.0 | 0.0 | 0.0 |
| Atlantic moonfish | 3 | 66.7 | 0.0 | 33.3 |
| Devil ray | 6 | 0.0 | 33.3 | 66.7 |
| Permit | 2 | 100.0 | 0.0 | 0.0 |
| Sea basses | 2 | 0.0 | 0.0 | 100.0 |
| Silver perch | 1 | 100.0 | 0.0 | 0.0 |
| Jacks | 1 | 100.0 | 0.0 | 0.0 |

**Table 3.34 Total Bycatch in NOAA Fisheries Observed Drift Gillnet Sets Outside of 2002 Right Whale Calving Seasons.** Source: Carlson, 2002b.

| Species | Total Number Caught | Kept (%) | Discard Alive (%) | Discard Dead (%) |
|---|---|---|---|---|
| Little tunny | 817 | 94.5 | 0.0 | 5.5 |
| King mackerel | 386 | 41.7 | 1.0 | 57.3 |
| Barracuda | 231 | 100.0 | 0.0 | 0.0 |
| Blue runner | 21 | 100.0 | 0.0 | 0.0 |
| Cownose ray | 32 | 0.0 | 78.1 | 21.9 |
| Cobia | 72 | 80.5 | 7.0 | 12.5 |
| Remora | 21 | 0.0 | 90.5 | 9.5 |
| Atlantic moonfish | 174 | 72.4 | 22.4 | 5.2 |
| Crevalle jack | 29 | 3.5 | 24.1 | 72.4 |
| Atlantic sailfish | 4 | 0.0 | 0.0 | 100.0 |
| Blackfin tuna | 1 | 100.0 | 0.0 | 0.0 |
| Spotted eagle ray | 1 | 0.0 | 100.0 | 0.0 |
| Manta ray | 3 | 0.0 | 100.0 | 0.0 |
| African pompano | 2 | 100.0 | 0.0 | 0.0 |
| Tarpon | 22 | 0.0 | 22.7 | 77.3 |
| Spanish mackerel | 3 | 100.0 | 0.0 | 0.0 |
| Red Drum | 28 | 0.0 | 50.0 | 50.0 |
| Bullet | 21 | 100.0 | 0.0 | 0.0 |
| Permit | 6 | 0.0 | 16.6 | 83.4 |
| Dolphin | 2 | 100.0 | 0.0 | 0.0 |
| Atlantic Sturgeon | 1 | 0.0 | 100.0 | 0.0 |
| Balloonfish | 1 | 100.0 | 0.0 | 0.0 |
| Skipjack tuna | 1 | 100.0 | 0.0 | 0.0 |
| Atlantic manta ray | 1 | 0.0 | 0.0 | 100.0 |
| Devil ray | 1 | 100.0 | 0.0 | 0.0 |
| Bottlenose dolphin | 1 | 0.0 | 0.0 | 100.0 |

**Table 3.35 Total Bycatch in NOAA Fisheries Observed Strikenet Sets During 2002 Right Whale Season.** Source: Carlson and Baremore, 2002a.

| Species | Total Number Caught | Kept (%) | Discard Alive (%) | Discard Dead (%) |
|---|---|---|---|---|
| Great barracuda | 26 | 84.6 | 11.6 | 3.8 |
| Cownose ray | 1 | 0.0 | 100.0 | 0.0 |
| Houndfish | 1 | 0.0 | 100.0 | 0.0 |

**Table 3.36 Status of Atlantic sea turtle populations: Species taken in HMS fisheries 1992-1997.** Source: NOAA Fisheries, 2001a.

| Species/Stock | Status: trend in U.S. nesting population |
|---|---|
| Loggerhead: Northern sub-population | Threatened: stable or declining |
| Leatherback | Endangered: loss of some nesting populations, otherwise stable |
| Green | Endangered: increasing |
| Kemp's Ridley | Endangered: thought to be increasing |
| Hawksbill | Endangered: unknown if there is a recent trend |

**Table 3.37 Annual estimates of total marine turtle bycatch and the subset that were dead when released in the U.S. pelagic longline fishery.** Source: NOAA Fisheries, 2001a.

| Species | Loggerhead | | Leatherback | | Green | | Hawksbill | | Kemp's Ridley | | Unidentified | | Sum Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | Dead * | Total | Dead * | Total | Dead * | Total | Dead* | Total | Dead * | Total | Dead* | |
| 1992 | 293 | 0 | 914 | 88 | 87 | 30 | 20 | 0 | 1 | 0 | 26 | 0 | 1,341 |
| 1993 | 417 | 9 | 1,054 | 0 | 31 | 0 | | | | | 31 | 0 | 1,533 |
| 1994 | 1,344 | 31 | 837 | 0 | 33 | 0 | | | 26 | 0 | 34 | 0 | 2,274 |
| 1995 | 2,439 | 0 | 934 | 0 | 40 | 0 | | | | | 171 | 0 | 3,584 |
| 1996 | 917 | 2 | 904 | 0 | 16 | 2 | | | | | 2 | 0 | 1,839 |
| 1997 | 384 | 0 | 308 | 0 | | | 16 | 0 | 22 | 0 | 47 | 0 | 777 |
| 1998 | 1,106 | 1 | 400 | 0 | 14 | 1 | 17 | 0 | | | 1 | 0 | 1,538 |
| 1999 | 991 | 23 | 1,012 | 0 | | | | | | | 66 | 0 | 2,069 |
| Total | 7,891 | 66 | 6,363 | 88 | 221 | 33 | 53 | 0 | 49 | 0 | 378 | 0 | 14,955 |

* Does not account for fishing related mortality that may occur after release.

**Table 3.38 Seabird Bycatch in the Atlantic Pelagic Longline Fishery from 1992 to 2002.** MAB - Mid-Atlantic Bight, SAB - South Atlantic Bight, NEC - Northeast Coastal, GOM - Gulf of Mexico. Source: NOAA Fisheries, 2003b.

| Year | Month | Area | Type of Bird | Number observed | Status |
|---|---|---|---|---|---|
| 1992 | October | MAB | Gull | 4 | Dead |
| | October | MAB | Shearwater, Greater | 2 | Dead |
| 1993 | February | SAB | Gannet, Northern | 2 | Alive |
| | February | MAB | Gannet, Northern | 2 | Alive |
| | February | MAB | Gull, Black Backed | 1 | Alive |
| | February | MAB | Gull, Black Backed | 3 | Dead |
| | November | MAB | Gull | 1 | Alive |
| 1994 | June | MAB | Shearwater, Greater | 3 | Dead |
| | August | MAB | Shearwater, Greater | 1 | Dead |
| | November | MAB | Gull | 4 | Dead |
| | December | MAB | Gull, Herring | 7 | Dead |
| 1995 | July | MAB | Seabird | 5 | Dead |
| | August | GOM | Seabird | 1 | Dead |
| | October | MAB | Storm Petrel | 1 | Dead |
| | November | NEC | Gannet, Northern | 2 | Alive |
| | November | NEC | Gull | 1 | Alive |
| 1997 | June | SAB | Seabird | 11 | Dead |
| | July | MAB | Seabird | 1 | Dead |
| | July | NEC | Seabird | 15 | Alive |
| | July | NEC | Seabird | 6 | Dead |
| 1998 | February | MAB | Seabird | 7 | Dead |
| | July | NEC | Seabird | 1 | Dead |
| 1999 | June | SAB | Seabird | 1 | Dead |
| 2000 | June | SAB | Gull, Laughing- | 1 | Alive |
| | November | NEC | Gannet, Northern | 1 | Dead |
| 2001 | June | NEC | Shearwater, Greater | 7 | Dead |
| | July | NEC | Shearwater, Greater | 1 | Dead |

| Year | Month | Area | Type of Bird | Number observed | Status |
|---|---|---|---|---|---|
| 2002 | July | NEC | Seabird | 1 | Dead |
| | August | NED | Shearwater, Greater | 1 | Dead |
| | August | NED | Seabird | 1 | Dead |
| | September | NED | Shearwater, Greater | 3 | Dead |
| | September | NED | Seabird | 3 | Alive |
| | September | NED | Shearwater SPP | 1 | Dead |
| | October | NED | Gannet Northern | 1 | Alive |
| | October | NED | Shearwater SPP | 1 | Dead |
| | October | NED | Seabird | 2 | Dead |
| | October | MAB | Gull | 3 | Alive |
| | October | MAB | Gull | 1 | Dead |
| | November | MAB | Gull | 3 | Alive |

**Table 3.39 Summary of Catch/Bycatch Observed in Shark Gillnet Fisheries 1999-2002, during and outside of right whale calving season.** Sources: Carlson and Lee, 1999; NOAA Fisheries 2000, 2001, 2002, 2003.

| Year/ Source | Right Whale Calving Season | | Non-Right Whale Calving Season | | Total Protected Resources Interactions |
|---|---|---|---|---|---|
| | Drift Gillnet | Strikenet | Drift Gillnet | Strikenet | |
| 1999 (SAFE 2000) | 20 sets/20 trips<br>12 spp shark: 1,110 LCS & 1,498 SCS;<br>21 spp teleost & ray; 4 bottlenose dolphin; 2 leatherbacks;<br>47 tarpon; 23 king mackerel | | | | 4 bottlenose dolphin; 2 leatherbacks |
| 2000 (SAFE 2001) | 14 spp shark: 3,290 LCS & 2,553 SCS; 33 spp teleost & ray; 1 loggerhead; 1 spotted dolphin; 1 bottlenose dolphin; 35 tarpon; 36 king mackerel | 2 spp shark: 909 LCS (BT) & 1 other shark;<br>2 spp teleost & ray | | | 1 loggerhead; 1 spotted dolphin; 1 bottlenose dolphin |
| 2000 & 2001 (SAFE 2002) | 70 sets (2001)<br>12 spp shark: 5,238 LCS & 9,570 SCS; 34 spp teleost & ray; 14 leatherbacks; 1 loggerhead; 1 hawksbill; 4 bottlenose dolphin; 3 spotted dolphin; 99 red drum; 343 king mackerel; 2 tarpon | 12 sets/32 trips (2001)<br>4 spp shark: 3,039 LCS & 1 SCS;<br>3 spp teleost & ray | 37 sets (15 in 2000; 22 in 2001)<br>10 spp shark: 444 LCS & 9,701 SCS;<br>25 spp teleost & ray; 1 loggerhead; 1,059 king mackerel; 3 tarpon | 8 sets (3 in 2000; 5 in 2001)<br>4 spp shark: 64 LCS & 115 SCS;<br>1 spp ray | 2 loggerheads; 14 leatherbacks; 1 hawksbill; 4 bottlenose dolphin; 3 spotted dolphin |
| 2002 (SAFE 2003) | 41 sets<br>10 spp shark: 2,026 LCS & 3,943 SCS;<br>26 spp teleost & ray;<br>2 leatherbacks; 1 loggerhead; 93 king mackerel; 3 tarpon | 24 sets/85 trips<br>4 spp shark: 4,193 LCS & 13 SCS;<br>3 spp teleost & ray | 28 sets (Apr-Oct) & 14 sets (Aug-Oct)<br>12 spp shark: 649 LCS & 9,986 SCS;<br>26 spp teleost & ray; 1 bottlenose dolphin | 3 spp shark: 547 LCS & 621 SCS | 2 leatherbacks; 1 loggerhead; 1 bottlenose dolphin |
| Total Protected Resources | 3 loggerheads; 18 leatherbacks; 1 hawksbill; 4 spotted dolphin; 9 bottlenose dolphin | | 1 loggerhead; 1 bottlenose dolphin | | 4 loggerheads; 18 leatherbacks; 1 hawksbill; 10 bottlenose dolphin; 4 spotted dolphin |

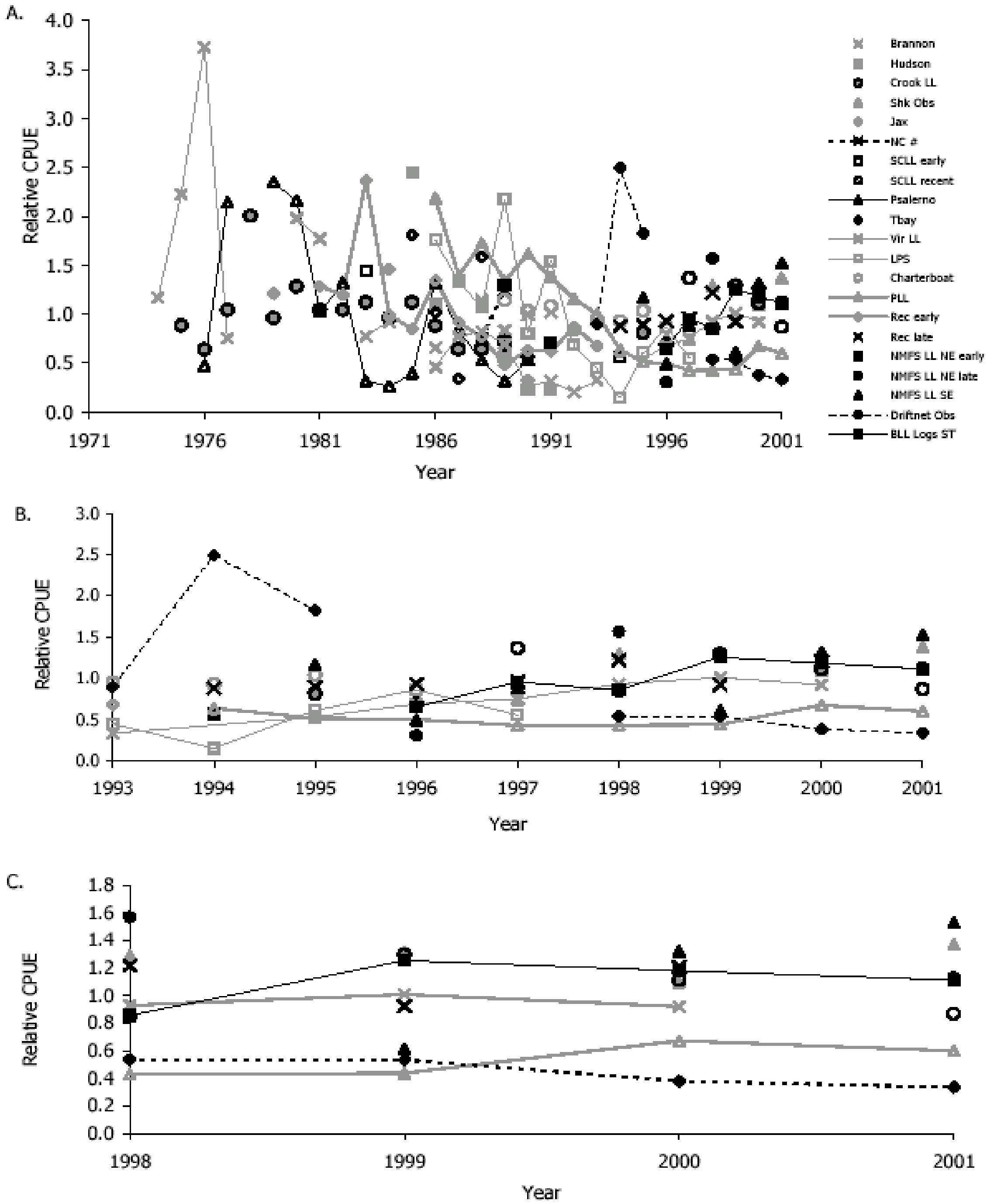



**Figure 3.1** **Large Coastal Shark Complex CPUE Series: A) 1974-2001, B) 1993-2001, C) 1998-2001.** Series are scaled (divided by the mean) to appear on a common scale. Source: Cortes *et al.*, 2002.

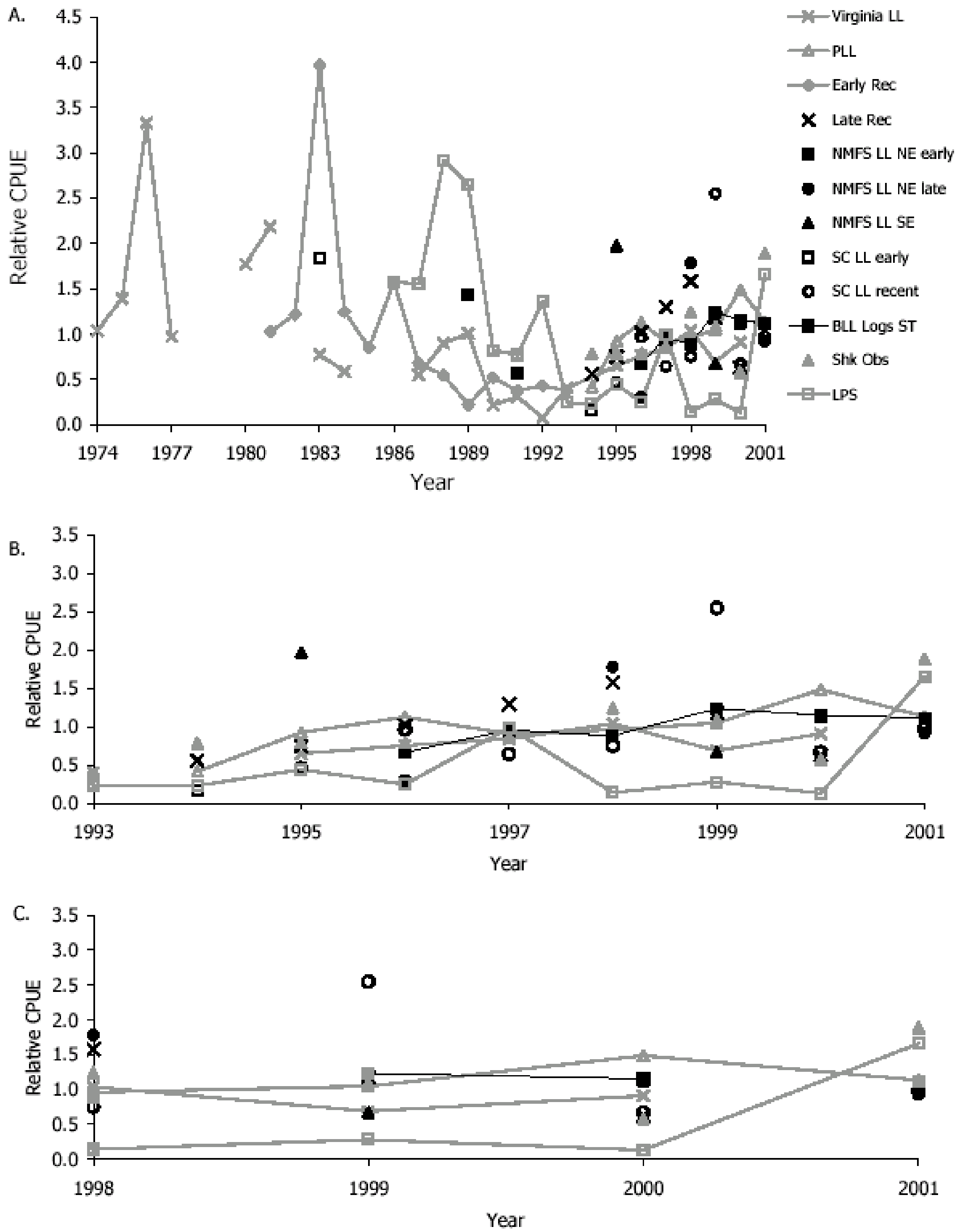



**Figure 3.2 Sandbar Shark CPUE Series: A) 1974-2001, B) 1993-2001, C) 1998-2001.** Series are scaled (divided by the mean) to appear on a common scale. Source: Cortes *et al.*, 2002.

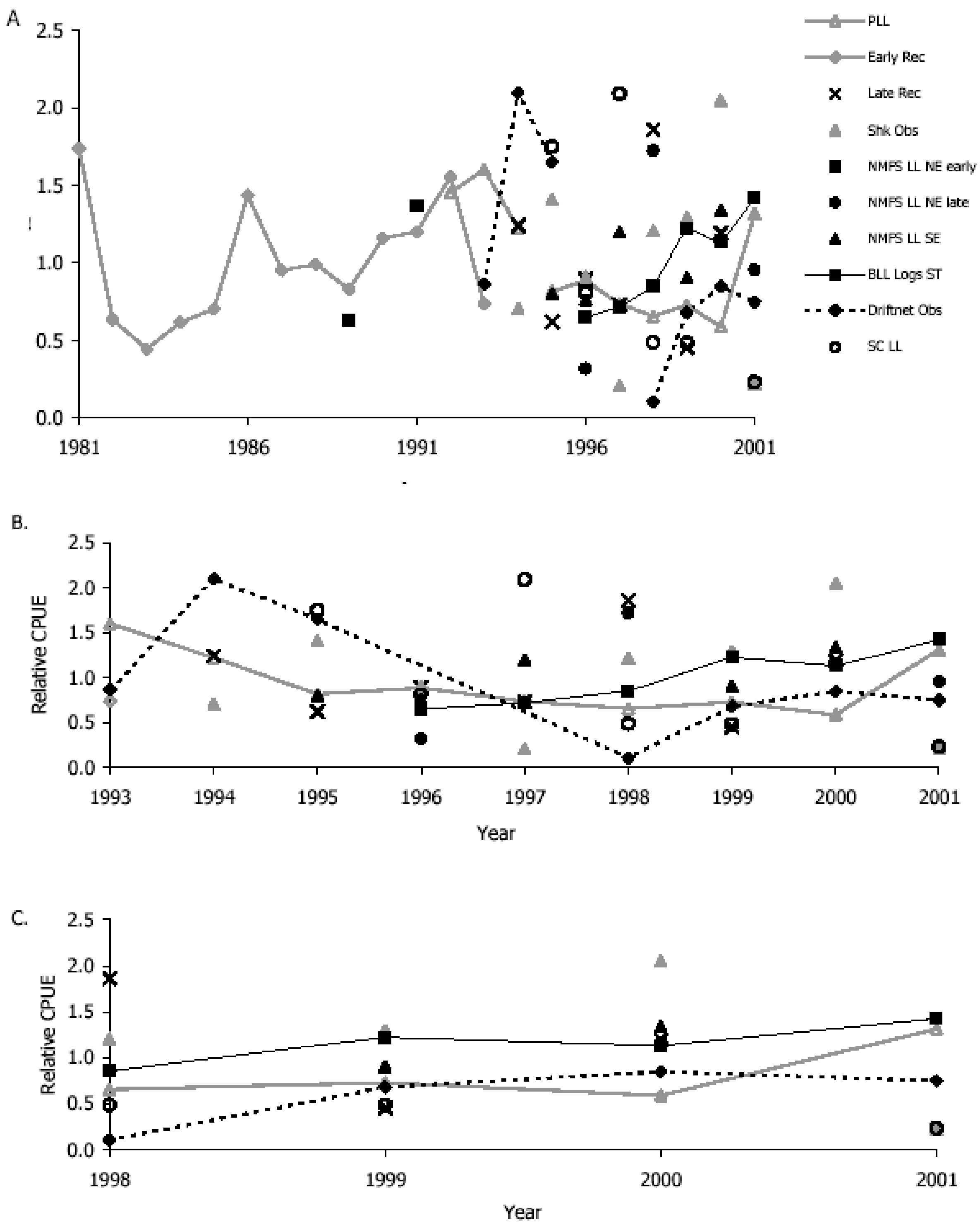



**Figure 3.3 Blacktip Shark CPUE Series: A) 1974-2001, B) 1993-2001, C) 1998-2001.** Series are scaled (divided by the mean) to appear on a common scale. Source: Cortes *et al.*, 2002.

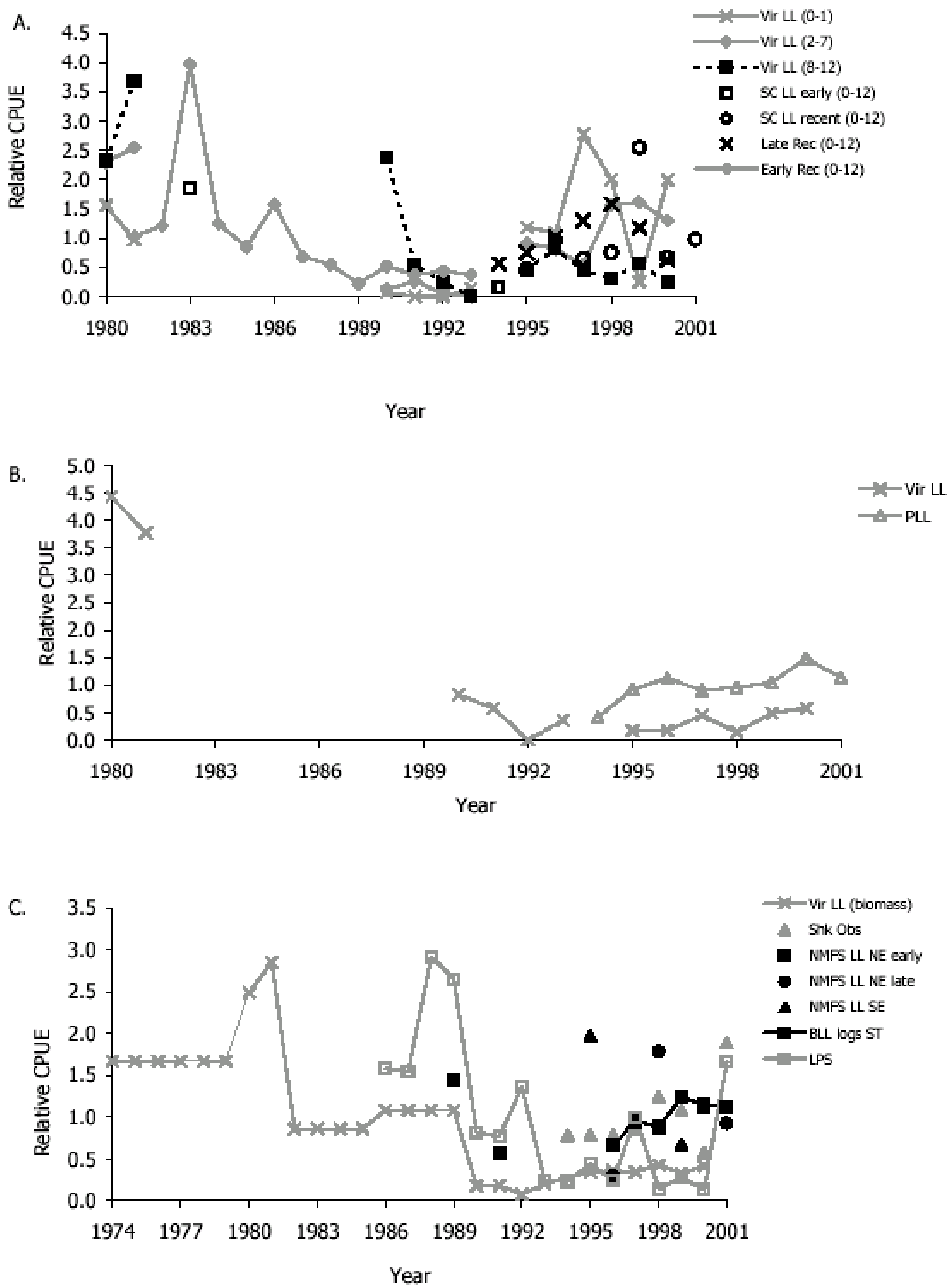



**Figure 3.4 Age-specific CPUE Series for the Sandbar Shark: A) Juveniles (Ages 0-12), B) Adults (Ages 13 and Older), C) All Ages Combined.** Source: Cortes *et al.*, 2002.

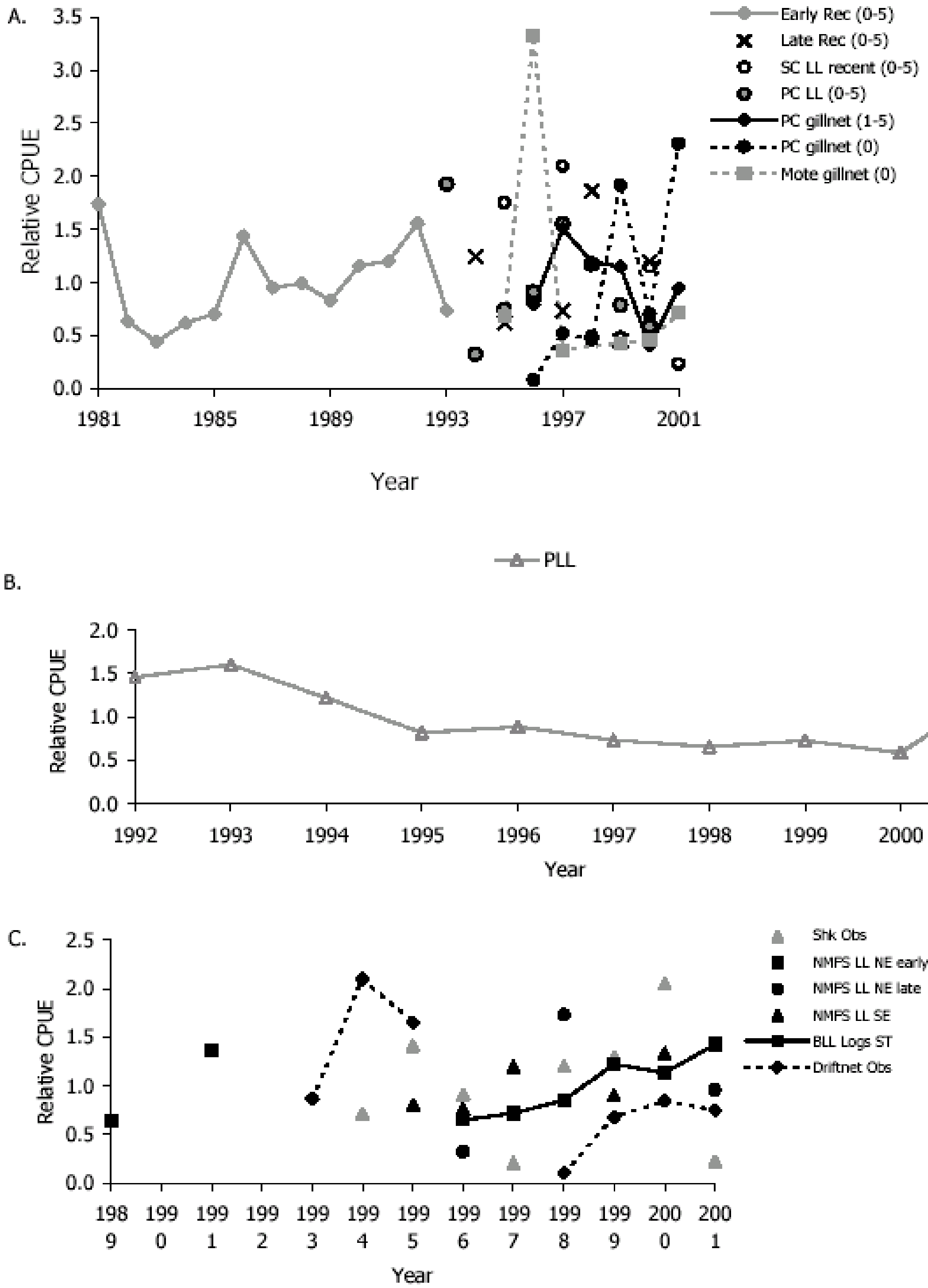



**Figure 3.5 Age-specific CPUE Series for the Blacktip Shark: A) Juveniles (Ages 0-5), B) Adults (Ages 6 and Older), C) All Ages Combined.** Source: Cortes *et al.*, 2002.

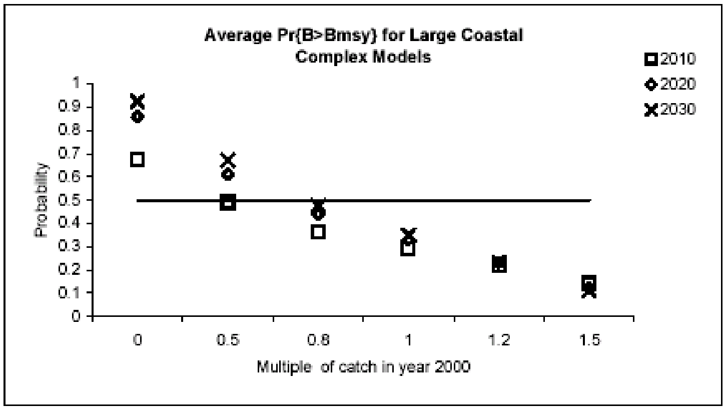



**Figure 3.6 Summary Plot for Large Coastal Shark Complex of the Mean Probability That B>$B_{MSY}$ Obtained in Six Main Scenarios Using the Bayesian SPM with the SIR Algorithm.** The scenarios include: LCU (updated scenario), LCB_FD (baseline scenario with only fishery-dependent indices), LCB_FI (baseline with only fishery-independent indices), LCB (baseline scenario), LCB_all (baseline with all available indices), and LCA (alternative catch scenario). Mean probabilities are shown for three different time horizons (10, 20, and 30 years) under each of six different harvest policies (expressed as a multiple of the 2000 catch). The solid horizontal line denotes 50 percent probability. Source: Cortes *et al.*, 2002.

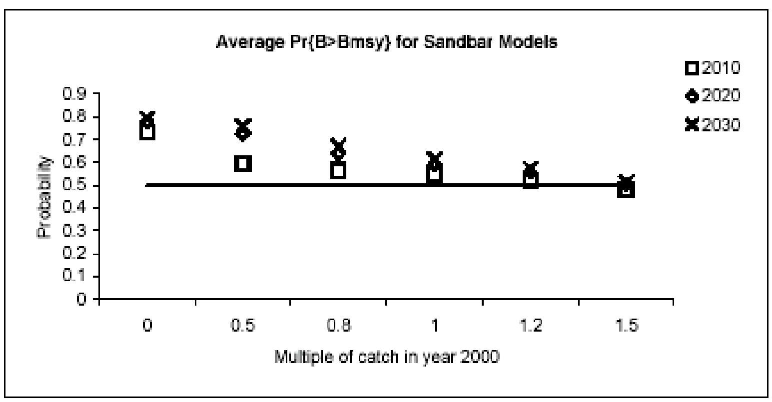



**Figure 3.7 Summary Plot for Sandbar Shark of the Mean Probability That B>$B_{MSY}$ Obtained in Five Main Scenarios Using the Bayesian SPM with the SIR Algorithm and Five Main Scenarios Using the ASPM Model.** The scenarios for the Bayesian SPM include: SBU (updated scenario), SBB_FD (baseline scenario with only fishery-dependent indices), SBB_FI (baseline with only fishery0independent indices), SBB (baseline scenario), and SBB_all (baseline with all available indices). For the ASPM, scenarios include: SB_U (updated scenario), SB_U_FD (updated scenario with only fishery-dependent indices), SB_U_FI (updated with only fishery-independent indices). Mean probabilities are shown for three different time horizons (10, 20, and 30 years) under each of six different harvest policies (expressed as a multiple of the 2000 catch). The solid horizontal line denotes 50 percent probability. Source: Cortes *et al.*, 2002.

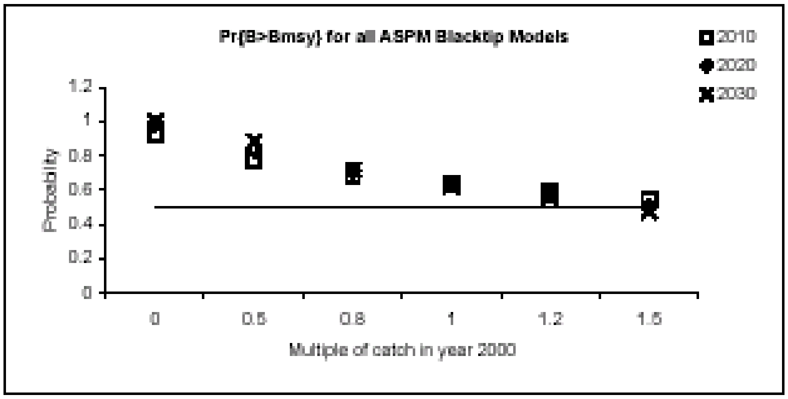



**Figure 3.8 Summary Plot for Blacktip Shark of the Mean Probability That $B > B_{MSY}$ Obtained in Five Main Scenarios Using the Bayesian SPM with the SIR Algorithm and Four Main Scenarios Using the ASPM Model.** The scenarios for the Bayesian SPM include: BTU (updated scenario), BTB_FD (baseline scenario with only fishery-dependent indices), BTB_FI (baseline with only fishery0independent indices), BTB (baseline scenario), and BTB_all (baseline with all available indices). For the ASPM, scenarios include: BT_U (updated scenario), BT_U_FD (updated scenario with only fishery-dependent indices), BT_U_FI (updated with only fishery-independent indices), and BT_B (baseline scenario). Mean probabilities are shown for three different time horizons (10, 20, and 30 years) under each of six different harvest policies (expressed as a multiple of the 2000 catch). The solid horizontal line denotes 50 percent probability. Source: Cortes *et al.*, 2002.

**Figure 3.9 Location of observed shark bottom longline sets, 1994-2002.** Source: Shark Bottom Longline Observer Program, 1994-2002.

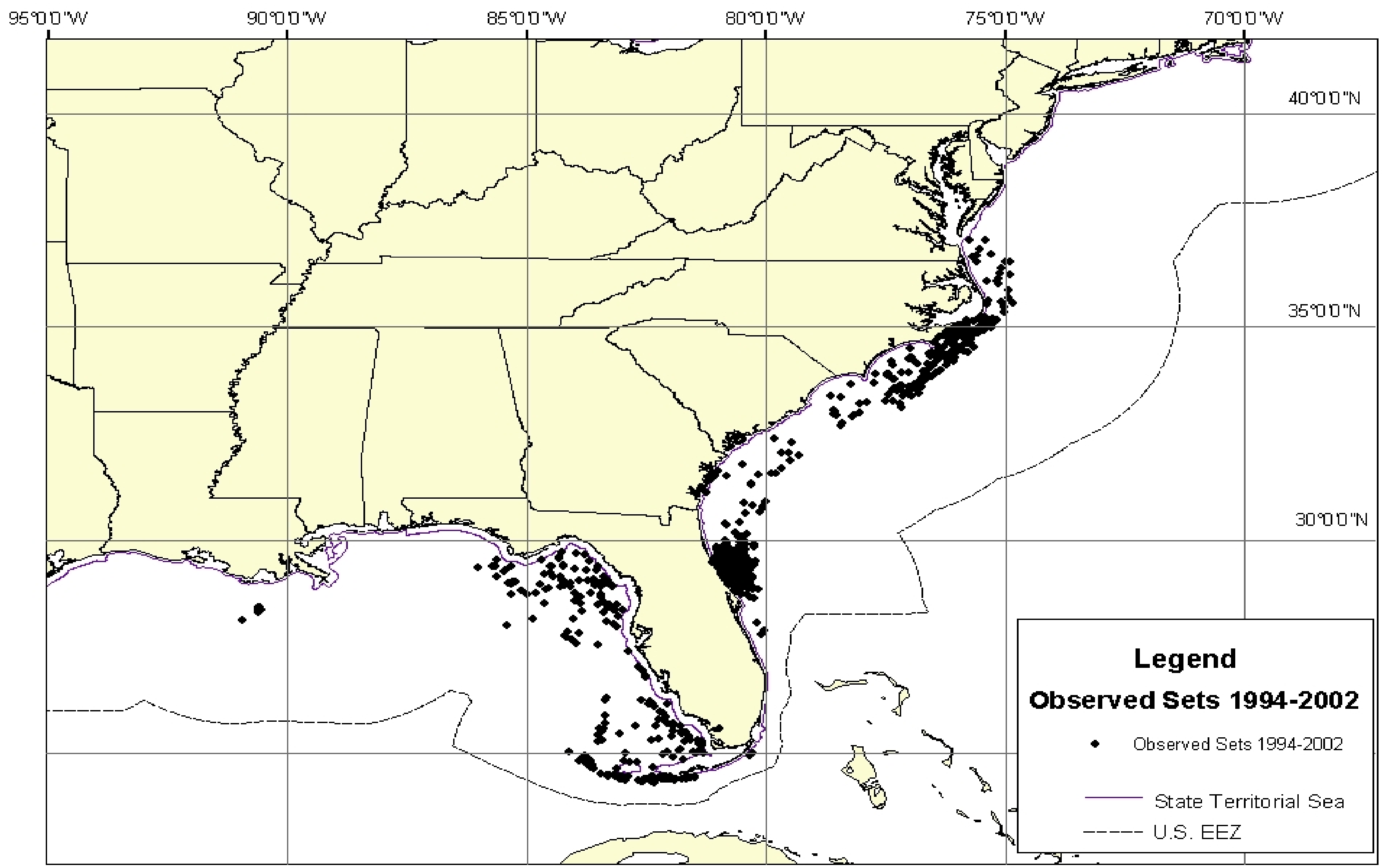


**Figure 3.10 Locations of observed sea turtle bycatch by species, 1994-2002.** Source: Shark Bottom Longline Observer Program, 1994-2002.

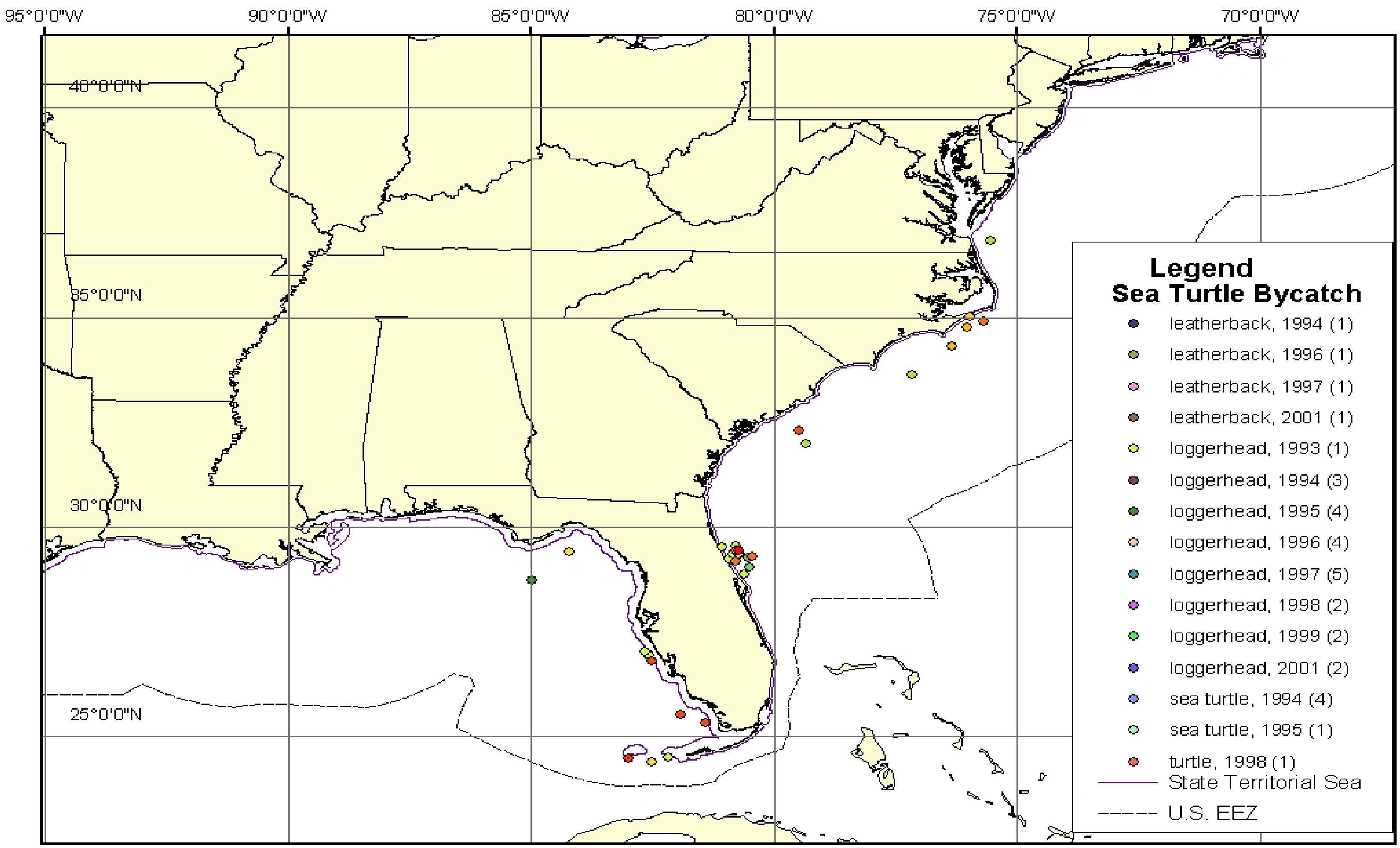
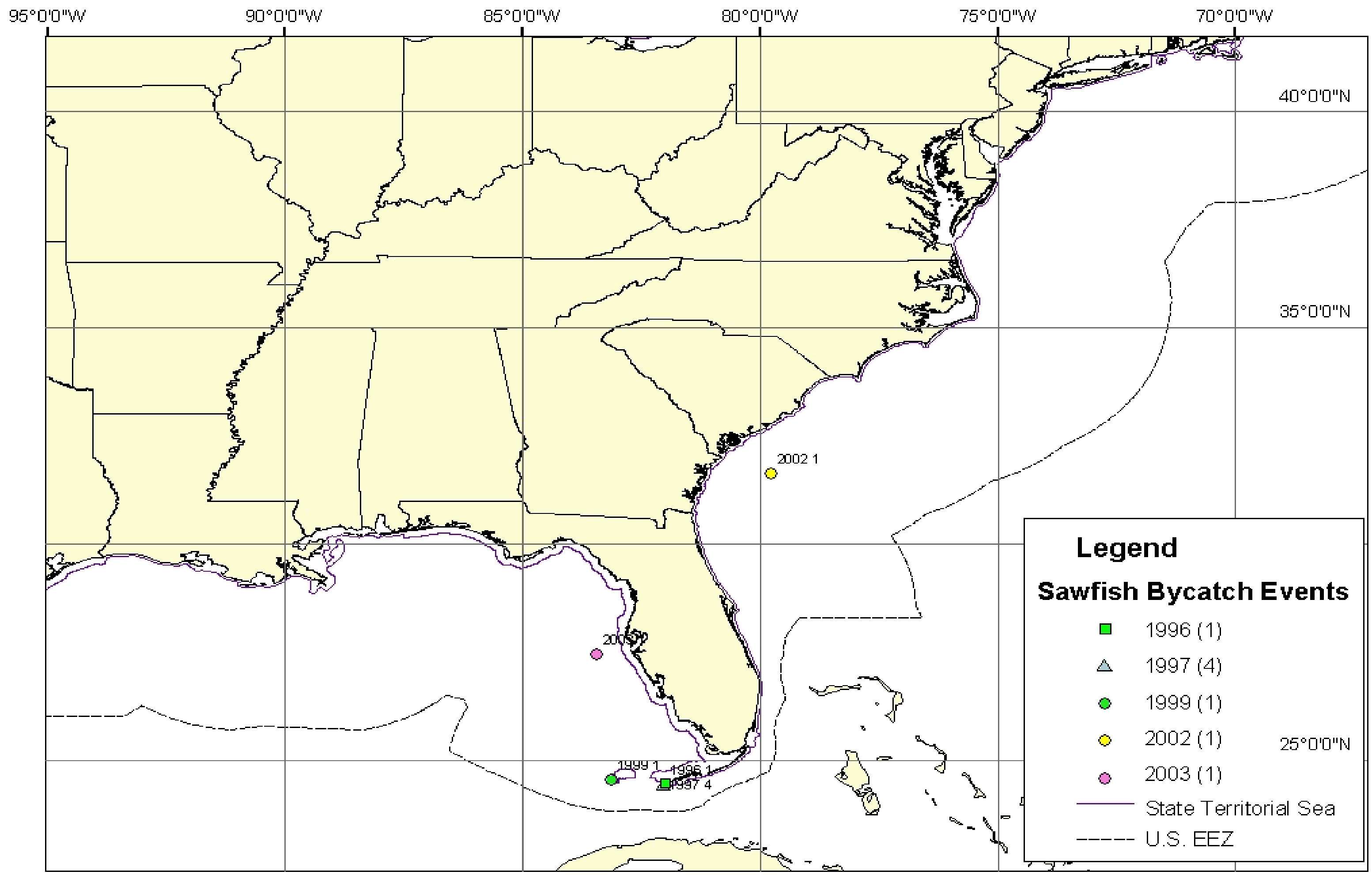


**Figure 3.11 Locations of observed smalltooth sawfish bycatch, 1994-2002.** Source: Shark Bottom Longline Observer Program, 1994-2002.



**References for Section 3.0**

No references cited.

**References for Section 3.1**

Branstetter, S. and R. Stiles. 1987. Age and growth estimates of the bull shark, *Carcharhinus leucas*, from the northern Gulf of Mexico. Environ. Biol. Fishes 20(3): pp. 169-181.

Brown, C. 2002. Updated standardized catch rates of four shark species in the Virginia - Massachusetts (U.S.) rod and reel fishery (1986-2001). 2002 SEW Document SB-02-06. 8 pp.

Brown, C.A. and J. Cramer. 2002. Large Pelagic Logbook catch rates for Large Coastal Sharks. 2002 SEW Document SB-02-07. 6pp.

Brown, C.A. and S.H. Gruber. 1988. Age assessment of the lemon shark, *Negaprion brevirostris*, using tetracycline validated vertebral centra. Copeia 1988(3): pp. 747-753.

Casey, J.G. and J.J. Hoey. 1985. Estimated catch of large shark by U.S. recreational fishermen in the Atlantic and Gulf of Mexico. In: Shark catches from selected fisheries off the U.S. east coast. U.S. Dept of Commerce, NOAA Tech Report NMFS 31, July: pp. 15-19.

Heist, E.J., J.E. Graves, and J.A. Musick. 1995. Population genetics of the sandbar shark, Carcharhinus plumbeus, in the Gulf of Mexico and Mid-Atlantic Bight. Copeia 1995(3): pp. 555-562.

National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division. 1999. Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks. Silver Spring, MD.

Sminkey, T.R. and J.A. Musick. 1995. Age and growth of the sandbar sharks, *Carcharhinus plumbeus*, before and after population depletion. Copeia 1995(4): pp. 871-83.

**References for Section 3.2**

Alverson, D. 2002. Review of 2002 Stock Assessment for Large Coastal Sharks. Prepared in fulfillment of settlement agreement. DG133F-02-SE-0666. 22pp.

Burgess, G.H. and A. Morgan. 2003. Commercial shark fishery observer program: Support for an observer program monitoring the directed commercial shark fishery in the eastern Gulf of Mexico and Atlantic Ocean. Final report to the Highly Migratory Species Division, NMFS, Award No. NA06FM0194. 87 pp.

Cortes, E. 2002. Analysis of catch rate series for Large Coastal Sharks. 2002 SEW Document. SB-02-12. 24 pp.

Cortes, E. and J. Neer. 2002. Updated Catches of Sharks. 2002 SEW Document SB-02-15.

Cortes, E. 2002. Stock Assessment of Small Coastal Sharks in the U.S. Atlantic and Gulf of Mexico. National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City Laboratory. Panama City, FL.

Cortes, E., L. Brooks, and G. Scott 2002. Stock Assessment of Large Coastal Sharks in the U.S. Atlantic and Gulf of Mexico: Final Meeting Report of the 2002 Shark Evaluation Workshop. National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City Laboratory. Panama City, FL.

Holland, K. 2002. Review of 2002 Stock Assessment for Large Coastal Sharks. Prepared in fulfillment of settlement agreement. DG133F-02-SE-0666. 19 pp.

ICCAT. 2001. ICCAT Preparatory Meeting for Atlantic Shark Stock Assessment. Halifax, Canada. 21 pp.

National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division. 2003. Issues and Options for Revised Management of Atlantic Sharks. Silver Spring, MD.

Restrepo, V.R., G.G. Thompson, P.M. Mace, W.L. Gabriel, L.L. Low, A.D. MacCall, R.D. Methot, J.E. Powers, B.L. Taylor, P.R. Wade, and J.F. Witzig. 1998. Technical Guidance On The Use of Precautionary Approaches to Implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Technical Memorandum NMFS-F/SPO-###. 54 pp.

Romine, J.G., J.A. Musick, and G.H. Burgess. 2002. An Analysis of the Status of Ecology of The Dusky Shark, *Carcharhinus obscurus*, in the western North Atlantic. Gloucester Point, VA. 40 pp.

Simpfendorfer, C.A. and G.H. Burgess. 2002. Assessment of the status of the Small Coastal Sharks in U.S. Waters using an Age-structured Model. Mote Marine Laboratory Technical Report No. 836. Sarasota, FL.

Quinn, T. 2002. Review of 2002 Stock Assessment for Large Coastal Sharks. Prepared in fulfillment of settlement agreement. DG133F-02-SE-0666. 26 pp.

**References for Section 3.3**

ASA. 2001. The economic importance of sport fishing. Funded by the International Association of Fish and Wildlife Agencies through the U.S. Fish and Wildlife Service under Cooperative Grant Agreement No. VA M-3-EO.

Babcock, EA. and E.K. Pikitch. 2002. The effectiveness of bag limits in the U.S. Atlantic recreational fishery. 2002 Shark Evaluation Workshop Document SB-02-02.

Berkeley, S.A., E.W. Irby, Jr., and J.W. Jolley, Jr. 1981. Florida's Commercial Swordfish Fishery: Longline Gear and Methods. MAP-14, Marine Advisory Bulletin, Florida Sea Grant College in cooperation with University of Miami, Rosenstiel School of Marine and Atmospheric Science and Florida Department of Natural Resources, Florida Cooperative Extension Service, University of Florida, Gainesville, FL. 23 pp.

Beerkircher, L.R., C.J. Brown, and D.W. Lee. 2002. Southeast Fisheries Science Center pelagic observer program data summary for 1992-2000. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL. Sustainable Fisheries Division Contribution SFD-01/02-165. 22 pp.

Burgess, G.H. and A. Morgan. 2003. Commercial shark fishery observer program; support for an observer program monitoring the directed commercial shark fishery in the eastern Gulf of Mexico and Atlantic Ocean. Final report to Highly Migratory Species Division, National Marine Fisheries Service. Award No. NA06FM0194.

Carlson, J.K. and I. Baremore. 2002a. The directed shark gillnet fishery: non-right whale season, 2002. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL. Sustainable Fisheries Division Contribution PCB-02/12. 10 pp.

Carlson, J.K. and I. Baremore. 2002b. The directed shark gillnet fishery: right whale season, 2002. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL. Sustainable Fisheries Division Contribution PCB-02/13. 8 pp.

Carlson, J.K. and D.W. Lee. 1999. Catch and bycatch in the shark drift gillnet fishery off east Florida during the critical right whale season, 1999. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL. Sustainable Fisheries Division Contribution No. SFD-98/99-60.

Casey, J.G., F.J. Mather, J.M. Mason, and J. Hoenig. 1978. Offshore fisheries of the Middle Atlantic Bight. In: Marine recreational fisheries. IGFA, NCMG, and SFI. Washington, D.C.: pp. 107-129.

Cortes, E. 1999. 1999 Shark evaluation annual report. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City Laboratory, Panama City, FL. Sustainable Fisheries Division Contribution No. SFD-98/99-64. 10 pp.

Cortes, E. 2002. Stock assessment of small coastal sharks in the U.S. Atlantic and Gulf of Mexico. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City Laboratory, Panama City, FL. Sustainable Fisheries Division Contribution SFD- 01/02-152. 133 pp.

Cortes, E. and J. Neer. 2002. Updated Catches of Sharks. 2002 Shark Evaluation Workshop Document SB-02-15.

Cortes E., L. Brooks, G. Scott. 2002. Stock assessment of large coastal sharks in the U.S. Atlantic and Gulf of Mexico. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City Laboratory, Panama City, FL. Sustainable Fisheries Division Contribution SFD-02/03-177. 222 pp.

Cramer, J. 2002. Pelagic longline bycatch. Sustainable Fisheries Division Contribution No. SFD-02/03-173. SCRS/02/117.

Fisher, M.R. and R.B. Ditton. 1992. A social and economic characterization of the U.S. Gulf of Mexico recreational shark fishery. Marine Fisheries Review 55(3): pp. 21-27.

GSAFDF. 1997. Continuation of an observer program to characterize and compare the directed commercial shark fishery in the eastern Gulf of Mexico and South Atlantic, Marine Fisheries Initiative Grant No., NA57FF0286.

Hicks, R., S. Steinback, A. Gautam, and E. Thunberg. 1999. Volume II: The economic value of New England and mid-Atlantic sportfishing in 1994. National Oceanic and Atmospheric Administration Technical Memo F/SPO-38.

Holland, S. M., A. J. Fedler, and J. W. Milon. 1999. The operations and economics of the charter and head boat fleets of the Eastern Gulf of Mexico and South Atlantic Coasts. University of Florida, Gainesville, FL. Marine Fisheries Initiative Grant No., NA77FF0553.

Larkin, S.L., D.J. Lee, C. M. Adams. 1998. Costs, earnings, and returns to the U.S. Atlantic pelagic longline fleet in 1996. Staff paper series SP 98-9. University of Florida, Institute of Food and Agriculture Sciences, Food and Resource Economics Department, Gainesville, FL. 46 p.

Larkin, S. L., C. M. Adams, D. J. Lee. 2000. Reported trip costs, gross revenues, and net returns for U.S. Atlantic pelagic longline vessels. Marine Fisheries Review 62(2): pp. 49-60.

Larkin, S. L., L. A. Perruso, D. J. Lee, C. M. Adams. *In press*. An empirical investigation of the U.S. Atlantic pelagic longline fleet: Specification and estimation of a multi-species profit function with suggestions for missing data problems. Presented at North American Association of Fisheries Economists 1st Annual Meeting, April 2001. Revised October 2001 for proceedings.

McHugh, R.J. and T.J. Murry. 1997. An analysis of the demand for, and supply of shark. Marine Fisheries Initiative Grant No., NA57FF0052, Univ. of South Florida and Georgia State Univ.

NMFS. 1993. Fishery Management Plan for Sharks of the Atlantic Ocean. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document.

NMFS. 1999. Fishery Management Plan for Atlantic Tunas, Swordfish and Sharks. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document.

NOAA Fisheries. 1997. Fisheries of the United States: 1996. B. K. O'Bannon, Editor. Office of Science and Technology, Fisheries Statistics and Economics Division, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, MD. 169 pp.

NOAA Fisheries. 1998. Fisheries of the United States: 1997. B. K. O'Bannon, Editor. Office of Science and Technology, Fisheries Statistics and Economics Division, National

Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, MD. 156 pp.

NOAA Fisheries. 2002. Fisheries of the United States: 2001. B. K. O'Bannon Editor. Office of Science and Technology, Fisheries Statistics and Economic Division, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, MD. 126 pp.

NOAA Fisheries. 2003a. 2003 Stock Assessment and Fishery Evaluation for Atlantic Highly Migratory Species. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. 264 pp.

NOAA Fisheries. 2003b. Fisheries Statistics and Economics web page. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Fisheries Statistics and Economics Division, Silver Spring, MD. <http://www.st.nmfs.gov/st1/index.html>

Porter, R. M., M. Wendt, M. D. Travis, I. Strand. 2001. Cost-earnings study of the Atlantic-based U.S. pelagic longline fleet. Pelagic Fisheries Research Program. SOEST 01-02; JIMAR contribution 01-337. 102 pp.

Rae, B.B. 1962. Porbeagle sharks. Scot. Fish. Bull. 18: pp. 17-19.

Rose, D. 1996. An Overview of World Trade in Sharks. TRAFFIC International. 105 pp.

Sutton S. G., R. B. Ditton, J. R. Stoll, and J. W. Milon. 1999. A cross-sectional study and longitudinal perspective on the social and economic characteristics of the charter and party boat fishing industry of Alabama, Mississippi, Lousiana, and Texas. Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX. Report # HD-612. Marine Fisheries Initiative Grant No., NA77FF0551. 198 pp.

USFWS. 2002. 2001 National Survey of Fishing, Hunting, and Wildlife Associated Recreation. U.S. Department of Interior, U.S. Department of Commerce, Bureau of the Census.

Wagner, M.H. 1966. Shark fishing gear: a historical review. Circular 238, U.S. Dept. of Interior, Fish and Wildlife Service, Washington, D.C.

Ward, J. and E. Hanson. 1999. The regulatory flexibility act and HMS management data needs. Presentation at the American Fisheries Society Annual Meeting. Charlotte, North Carolina.

Weber, M.L. and S.V. Fordham. 1997. Managing Shark Fisheries: Opportunities for International Conservation. TRAFFIC International and the Center for Marine Conservation. 61 pp.

**<u>References for Section 3.4</u>**

Alexander, C.E., M.A. Broutman, and D.W. Field 1986. An inventory of coastal wetlands of the USA. National Oceanic and Atmospheric Administration (NOAA), U.S. Dept. of Commerce, Silver Spring, MD. 14 pp.

Appeldoorn, R. and S. Meyers. 1993. Puerto Rico and Hispañola, pp. 99-158, *in:* Marine fishery resources of the Antilles: Lesser Antilles, Puerto Rico and Hispañiola, Jamaica, Cuba. Food and Agriculture Organization (FAO), Fisheries Technical Paper. No. 326. Rome, FAO, 235 pp.

Branstetter, S.1990. Early life history implications of selected carcharhinoid and lamnoid sharks of the northwest Atlantic. NOAA Tech. Rep. NOAA Fisheries90: pp. 17-28.

Castro, J. I. 1987. The position of sharks in marine biological communities. An overview. In*:* S. Cook (ed.) Sharks, an inquiry into biology, behavior, fisheries, and use. Oregon State University Extension Service, Corvallis. pp. 11-17.

Field, D.W., A.J. Reyer, P.V. Genovese, and B.D. Shearer. 1991. Coastal Wetlands of the United States; An Accounting of a Valuable National Resource. National Oceanic and Atmospheric Administration (NOAA). Silver Spring, MD. 59 pp.

Grubbs, R. D. and J. A. Musick. 2003. Shark nurseries of Virginia: spatial and temporal delineation, migratory patterns, and habitat selection; a case study. In: C. T. McCandless, H. L. Pratt, Jr. and N. E. Kohler (eds.), Shark Nursery grounds of the Gulf of Mexico and the East Coast waters of the United States: an overview. pp 25-60.

Gulf of Mexico Fishery Management Council (GMFMC). 1998. Generic Amendment for Addressing Essential Fish Habitat Requirements in the Fishery Management Plans of the Gulf of Mexico (abridged title), September 1998. Gulf of Mexico Fishery Management Council. Tampa, FL.

McCandless, C. T., H. L. Pratt, and N. E. Kohler 2003. Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States: an overview. USDOC/NOAA/NMFS/NEFSC Apex Predators Program, Narragansett, RI, 287 pp.

Minerals Management Service (MMS), US Dept. of Interior. 1992. Comprehensive Program 1992-1997. Final Environmental Impact Statement (EIS). Outer Continental Shelf EIS/EA MMS 92-0004.

Minerals Management Service (MMS), US Dept. of Interior. 1996. Outer Continental Shelf Oil & Gas Leasing Program 1997-2002. Final Environmental Impact Statement. USDOI.MMS, OCS EIS/EA, MMS 96-0043.

National Oceanic and Atmospheric Administration (NOAA), 1996. NOAA's Estuarine Eutrophication Survey. Volume 1: South Atlantic Region. Silver Spring, MD. Office of Ocean Resources Conservation Assessment. 50 pp.

National Oceanic and Atmospheric Administration (NOAA), 1997a. NOAA's Estuarine Eutrophication Survey. Volume 2: North Atlantic Region. Silver Spring, MD. Office of Ocean Resources Conservation and Assessment. 45 pp.

National Oceanic and Atmospheric Administration (NOAA), 1997b. NOAA's Estuarine Eutrophication Survey. Volume 3: Mid-Atlantic Region. Silver Spring, MD. Office of Ocean Resources Conservation and Assessment. 51 pp.

National Oceanic and Atmospheric Administration (NOAA), 1997c. NOAA's Estuarine Eutrophication Survey. Volume 4: Gulf of Mexico Region. Silver Spring, MD. Office of Ocean Resources Conservation Assessment. 77 pp.

Rountree, R. A. and K. W. Able. 1996. Seasonal abundance, growth, and foraging habits of juvenile smooth dogfish, *Mustelus canis*, in a New Jersey estuary. Fish Bull. 94: pp. 522-534.

Turner and Boesh. 1987. Aquatic animal production and wetland relationships: Insights gleaned following wetland loss or gain; in D. Hooks (ed.), Ecology and Management of Wetlands. Croon Helms, LTD, Beckenham, Kent, UK. pp. 25-39.

**References for Section 3.5**

Alexander, K., G. Robertson, and R. Gales. 1997. The incidental mortality of Albatrosses in longline fisheries. A report on the Workshop from the First International Conference on the Biologic and Conservation of Albatrosses. Hobart, Australia, September 1995. 44 pp.

Burgess, G.H. and K.M. Johns. 1999. Commercial shark fishery observer program: Analysis of the large coastal shark fishery - July and August 1998 season in the southeastern United States, with a review of the 1998 commercial fishery in the region. Final report to the Highly Migratory Species Division, National Marine Fisheries Service, Award No. 40GANF800117. 38 pp.

Burgess, G.H. and A. Morgan. 2003. Commercial shark fishery observer program: Support for an observer program monitoring the directed commercial shark fishery in the eastern Gulf of Mexico and Atlantic Ocean. Final report to the Highly Migratory Species Division, National Marine Fisheries Service, Award No. NA06FM0194. 87 pp.

Carlson, J.K. 2000. Progress report on the directed shark gillnet fishery: right whale season, 2002. NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL. Sustainable Fisheries Division Contribution SFD-99/00-90. 12 pp.

Carlson, J.K. and I. Baremore. 2001. The directed shark gillnet fishery: non-right whale season, 2000 and 2001. NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL. Sustainable Fisheries Division Contribution PCB-01/02-002. 8 pp.

Carlson, J.K. and I. Baremore. 2002a. The directed shark gillnet fishery: right whale season, 2002. NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL. Sustainable Fisheries Division Contribution PCB-01/13. 8 pp.

Carlson, J.K. and I. Baremore. 2002b. The directed shark gillnet fishery: non-right whale season, 2002. NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL. Sustainable Fisheries Division Contribution PCB-02/12. 10 pp.

Carlson, J.K. and D.W. Lee. 1999. Catch and bycatch in the shark drift gillnet fishery off east Florida during the critical right whale season, 1999. NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL. Sustainable Fisheries Division Contribution SFD-98/99-60. 13 pp.

Carocci, F. and J. Majkowski. 1998. Atlas of tuna and billfish catches. CD-ROM version 1.0. FAO, Rome, Italy.

Cortes, E. 2000. 2000 Shark Evaluation Report. NOAA, NOAA Fisheries, Southeast Fisheries Science Center, Panama City, FL. SFD-00/01-119. 23 pp.

Cortes, E. 2002. Stock Assessment of Small Coastal Sharks in the U.S. Atlantic and Gulf of Mexico. NOAA Fisheries, Southeast Fisheries Science Center. Panama City, FL. Sustainable Fisheries Division Contribution SFD-01/02-152. 133 pp.

Cortes, E., L. Brooks, and G. Scott. 2002. Stock Assessment of Large Coastal Sharks in the U.S. Atlantic and Gulf of Mexico: Final Meeting Report of the 2002 Shark Evaluation Workshop. National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City Laboratory. Panama City, FL.

Cramer, J. 1999. Pelagic longline bycatch. ICCAT working document SCRS/99/90.

Cramer, J. and H. Adams. 2000. Large pelagic newsletter: 1998. NOAA Tech. Memo. National Marine Fisheries Service SEFSC-433. 25 pp.

De Silva, J.A., R.E. Condrey, and B.A. Thompson. 2001. Profile of shark bycatch in the U.S. Gulf of Mexico menhaden fishery. North Am. J Fish. Manag. 21: pp. 111-124.

Garrison, L. 2003. Protected species interactions with the directed shark gillnet fishery of Florida and Georgia from 1999-2002. NOAA, NOAA Fisheries, Southeast Fisheries Science Center, Miami, FL. 10 pp.

NOAA. 1998. Managing the Nation's Bycatch: programs, activities and recommendations for the National Marine Fisheries Service. U.S. DOC, NOAA, Washington, D.C. 174 pp.

NOAA Fisheries. 2000. 2000 Stock Assessment and Fishery Evaluation for Atlantic Highly Migratory Species. NOAA, National Marine Fisheries Service, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. 184 pp.

NOAA Fisheries. 2001a. Endangered Species Act Section 7 Consultation: Reinitiation of Consultation on the Highly Migratory Species Fishery Management Plan and its Associated Fisheries. NOAA, National Marine Fisheries Service, Office of Protected Resources, Endangered Species Division, Silver Spring, MD. 128 pp.

NOAA Fisheries. 2001b. 2001 Stock Assessment and Fishery Evaluation for Atlantic Highly Migratory Species. NOAA, National Marine Fisheries Service, Highly Migratory Species Management Division, Silver Spring, MD. Public Document.

NOAA Fisheries. 2002. 2002 Stock Assessment and Fishery Evaluation for Atlantic Highly Migratory Species. NOAA, National Marine Fisheries Service, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. 229 pp. + apps.

NOAA Fisheries. 2003a. Endangered Species Act Section 7 Consultation: Biological Opinion on the continued operation of Atlantic shark fisheries (commercial shark bottom longline and drift gillnet fisheries and recreational shark fisheries) under the Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks (HMS FMP) and the proposed Rule for Draft Amendment 1 to the HMS FMP, July 2003. NOAA Fisheries, Southeast Regional Office, Protected Resources Division, I.D. No. F/SER/2003/00953. 65 pp. + apps.

NOAA Fisheries. 2003b. 2003 Stock Assessment and Fishery Evaluation for Atlantic Highly Migratory Species. NOAA, National Marine Fisheries Service, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. 264 pp.

NOAA Fisheries Southeast Fisheries Science Center. 2001. Stock Assessment of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. U.S. DOC, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL, SEFSC Contribution PRD-00/01-08.

NMFS and USFWS. 1995. Status Review for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, MD.

Rester, C.R. and R.E. Condrey. 1999. Characterization and evaluation of bycatch reduction devices in the gulf menhaden fishery. North American Journal of Fisheries Management. 19: pp. 42-50.

Waring, G., J.M. Quintal and C.P. Fairfield. 2002. U.S. Atlantic And Gulf of Mexico Marine Mammal Stock Assessments. U.S. DOC. NOAA Tech. Mem. NMFS-NE-169. 318 pp.

Yeung, C. 2001. Estimates of Marine Mammal and Marine Turtle Bycatch by the U.S. Atlantic Pelagic Longline Fleet in 1999-2000. U.S. DOC. NOAA Tech. Mem. NOAA-TM-SEFSC-467. 42 pp.