3.0 DESCRIPTION OF THE FISHERY

3.1 HISTORY OF EXPLOITATION

Historically, sharks have been an underutilized resource in North America. Small, localized shark fisheries have existed along all U.S. coasts for many years, but organized intensive shark fisheries have been scarce and have lasted only a few years.

A shark longline fishery operated in Salerno, Florida nearly continuously from 1936 to 1950. The maximum number of these shark-fishing boats in use at any one time was five. The greatest number of shark-fishing boats known to have been operating off the Southeastern Coast of the U.S. concurrently was 16 (Springer, 1952). Sharks were fished primarily for their livers and hides. The liver oil was used in the production of vitamin A, and the hides were processed into leather. Production also included fresh and salted meat, fins, and fish meal.

From 1938 to 1946, all shark fishing was done with chain sets, except for one boat known to set nearshore gillnets in summer for nurse sharks. The weight of the chain line normally confined fishing to depths less than 46 m. When currents were not strong, however, sets were made at depths to 91 m. In the last years of the fishery (1947 to 1950), the catch per unit of effort increased. This was due both to expansion of the fishery and to a bonus arrangement that encouraged cooperation among the fishermen. This operation ended in 1950, because of the appearance of low-cost, synthetic vitamin A (Springer, 1950 and Wagner, 1966).

An intensive fishery for soupfin sharks and spiny dogfish existed for a few years off California during the late 1930s and early 1940s. Prior to 1937, shark fishing in California supplied limited demands for fresh shark fillets and fish meal. There was also a substantial ethnic market for dried fins of soupfin sharks. Annual production from 1930 to 1936 averaged 267 mt. In 1937, however, a new market for sharks developed when it was discovered that soupfin shark liver was the richest source of vitamin A available in commercial quantities. Supplies of vitamin A were scarce at the time because of the war in Europe (Butler, 1955). Nominal prices offered to fishermen for soupfin sharks increased dramatically, and the fishery became a bonanza. By 1942, the price of shark liver had risen to $1,653 per metric ton from $11 per metric ton in 1938. In 1939, about 600 boats were fishing for soupfin sharks along the California coast, with state shark landings reaching a maximum of 4,187 mt in 1939 (Ripley, 1946). In the following years, total landings decreased despite the increase in fishing effort encouraged by high prices. By 1946, shark landings had declined to 728 mt (Conner, 1947) due to overfishing, and by 1950, due to the availability of synthetic

vitamin A and imports from Japan (Butler, 1955), and decreased catches to a pre-1937 level of 322 mt.

A soupfin shark fishery also operated in Oregon and Washington from about 1940 to 1949. The development of more efficient gear, and expansion of the fishery, caused a sharp rise in Oregon landings, peaking when 123 mt of livers were landed, but subsequently dropping to a low of 23 mt of livers in 1948. Expansion to new fishing grounds in the Hecate Straits, British Columbia, caused landings to increase slightly in 1949, but by 1950, the synthesis of vitamin A and decreased catches resulted in a total absence of boats fishing for sharks in Oregon (Westrheim, 1950).

Another small shark 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 Faroe Islands. In the late 1940s, these fishermen caught from 1,360 to 2,720 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).

The fishery for thresher sharks is centered off southern California with the common thresher, Alopias vulpinus, as the principal species. This fishery began as a minor operation with only 15 vessels landing sharks caught as a bycatch in the directed fishery for swordfish, Xiphias gladius. Nominal ex-vessel prices for the common thresher increased from $.29 in 1977 to $1.60 per pound in 1986. By 1980, the number of vessels in the fleet reached 200 and entry became limited by California. By 1985, the number of licensed vessel reached 250. Landings increased from 59 mt in 1977, peaked at 1,099 mt in 1982, and declined ever since to 545 mt in 1986. Available information indicates that the local population is not large or capable of reproducing itself and immigration from adjacent waters is not sufficient to sustain a fishery under the current fishing pressure (Holts, 1988). Since 1986, landings have continued to decline and the resource is considered to be depleted in different areas within its range. In 1989, the directed harvest was prohibited as part of a management plan implemented by California, Oregon, and Washington (Holts, 1991).

The fishery for the Pacific angel shark, Squatina californica, started in 1978 near Santa Barbara, California. Prior to 1982, 6-8 vessels from California fished for this shark. After 1982, landings increased to about 144 mt in 1982, doubled by 1984, reached 590 mt in 1985, and declined to 499 mt in 1986 (Holts,

1988). Landings have continued to decline due to overfishing and an influx of lower-price imports from Mexico. (Holts, 1991)

3.1.1 SHARK MEAT AS FOOD FOR HUMANS

There was little consumption of shark meat in the U.S. prior to the 1970s. Since then, shark flesh has become a popular seafood; largely due to improved handling at sea, a Federally assisted marketing program that promoted shark consumption, and a market economy favoring the low-cost shark over more costly fish.

Shark meat is nutritious, boneless, and mild-flavored, and the texture has eye-appeal. Species valued for premium edibility are mako, white, thresher, soupfin, sandbar, and blacktip, but some species, such as blue sharks, are generally considered unpalatable. Shark meat is susceptible to spoilage because of its high urea content. The flavor and quality of the meat depend on effective, timely bleeding of the carcass, and on storage temperature.

3.1.2 SHARK FINS

Chinese use shark fins as the main ingredient of a highly regarded soup; consequently, there is a significant market for shark fins in Asia. Thus, the fins are the highest priced shark product. For the longest white shark fins and tails indicated, 40/up (40-cm and longer), nominal wholesale market prices declined from $44/kg by 1982 to $26-$34/kg in 1984-87 and rose to the range of $45-$50/kg by 1988-91. The prices of 30/40 and 20/30 white shark fins and tails behaved similarly. Prices of the shorter ones, 10/20s and un/10s, increased more sharply since the mid-1980s.

Dried shark fins are processed primarily in Hong Kong and Singapore, soaked and dried repeatedly until the skin peels off and exposes the cartilage and fibers. Careful trimming yields the spaghetti-like fibers, ceratotrichia, used in shark fin soup. The preferred species are those that have large, very fibrous fins. The dorsal and caudal fins have the highest fiber content, although the two pectoral fins can also be used. Generally (in Asia), the larger the fibers, the more expensive the end product (Ross, 1989). Nominal prices in 1991 paid to fishermen in Florida range from $3.30 per kilogram for wet fins, $14.30 per kilogram for partly dry fins, and $22.00 per kilogram for top grade dry fins (O'hop, 1991).

Prices for finished fins vary with degree of processing and other factors. According to the survey of San Francisco fin markets conducted in June 1989, mixed ceratotrichia and basal cartilages sold for a nominal price of $100 per kilogram, while pure ceratotrichia commanded $220 per kilogram or more for select fins

in "matched" sets, i.e., from the same shark, for the most prized species (Cook, 1989).

3.1.3 SHARK HIDES

Shark hides can be processed to produce high-quality leather. Processing only shark skin is not very profitable, however, and participants must combine this operation with additional utilization of the shark (such as fins) or with another fishery. Although there is some demand for skins, the market requires a high-quality product, making it necessary to exercise great care in processing the skin.

3.1.4 SHARK RESEARCH AND MEDICINE

Because of their position in vertebrate evolution, sharks have been studied as anatomical models of primitive vertebrates for many decades. Sharks are currently used in physiological, biochemical, and immunological research.

Sharks are utilized in biomedical research, both as model animals and as sources of medically important compounds. Sharks are being used in cancer research because they rarely develop any malignant tumors (Harshberger, 1968). Ten years of studies have shown that captive nurse sharks exposed to powerful carcinogens never develop the disease (Hueter, 1990a), demonstrating an immunity to tumors. Shark liver oil promotes the activity of white blood cells, potentially contributing to the sharks' natural resistance to cancer (Bliznakov, 1968). Sharks are also being used as a source of cartilage that contains a compound that may be useful in clinical control of tumors in humans (Lee and Langer, 1983; Luer, 1986). Shark cartilage has also been used as a component of artificial skin for burn victims (Maugh, 1982). Shark corneas were once used experimentally for human transplants because of their resistance to osmotic swelling (Payrau, 1969). Other compounds derived from sharks have anti-clotting agents more powerful than the commercially-available products (Ronsivalli, 1978).

Sharks have also been used in the manufacture of pharmaceutical drugs. Shark liver oil was used for many years as a source of vitamin A, until vitamin A was synthesized in the late 1940s. There is concern among some that the synthetic substitute may be inferior to fish liver oil because it lacks minerals, amino acids, and possibly other unidentified nutrients (Ronsivalli, 1978). Shark liver oil currently is used in hemorrhoid remedies and in food supplement capsules.

3.1.5 MISCELLANEOUS SHARK PRODUCTS

Shark jaws and teeth are sold extensively in seaside curio shops. Jewelry made from shark teeth is a popular item. Tiger shark

vertebrae are turned into a white face powder used by Japanese geisha girls.

3.1.6 SHARK ATTACKS

Approximately 20 to 25 shark "attacks" occur in U.S. waters every year (Burgess, 1990). These consist of human-shark interactions where a person may be hurt or, rarely, killed by sharks. The annual attack rate is relatively stable, although the number of people engaged in saltwater activities increases every year. The number of deaths attributed to shark attacks is small, compared to fatalities from bee stings or lightning strikes, but the news media focuses a great deal more attention on shark attacks.

Implementation of the plan is not expected to affect the number of shark attacks on humans, as these events are more dependent on human behavior than on shark abundance. For example, a speared fish in the water produces all the smells, sounds, and sights that attract sharks, with potentially unpleasant consequences to the spear-fisherman. Many other "attacks" stem from people carelessly handling sharks or provoking them. It is suspected that some victims of alleged attacks by tiger sharks, known scavengers as well as predators, actually may have died from unrelated causes. Public education and water safety can reduce the number of yearly shark attacks. Burgess (1989) puts shark attacks into a proper perspective: in Florida, over 100 million human-in-the-water hours annually produce about 15 to 20 attacks, resulting in an average of less than one death per year.

3.2 COMMERCIAL AND RECREATIONAL FISHING ACTIVITIES

3.2.1 PARTICIPATING USER GROUPS

Description of User Groups

Sharks, as both food and gamefish, increased in popularity in the 1970s. In recent years, economic changes in Asia broadened the sharkfin market. The increased demand for shark flesh and the high price of their fins encouraged entry into the shark fishery. Fishermen in other fisheries, such as tuna and swordfish, began to retain sharks for the fins, instead of releasing them alive as was done previously. Both directed and nondirected commercial fisheries, as well as recreational anglers, now exploit shark resources.

Users of shark resources may be divided into two broad categories: recreational and commercial. Recreational users are anglers who pursue sharks for sport; this has become popular in the last 15 years, as evidenced by the increased number of shark tournaments. Commercial fishermen, who derive some portion of their income by selling their shark catch, are grouped as those engaged in directed fisheries (targeting sharks), or those

involved in indirect fisheries (targeting other species with sharks as bycatch).

Recreational Use

In the past, sharks were often called "the poor man's marlin." Now, however, shark fishing is a popular sport at all socioeconomic 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. Makos, white sharks, and large oceanic sharks, on the other hand, are generally available only to those on ocean-going vessels.

Beach or surf fishing for sharks became popular in the early 1970s (Sand, 1982; Schneider, 1972). Pier fishing for sharks was also popular for many years (the largest tiger shark on record was caught from a pier in Cherry Grove, South Carolina in 1964), but has been prohibited by many tourist-dependent communities that did not want to publicize the presence of large sharks near swimming beaches.

Most recreational shark fishing takes place from small to medium-size boats. The increase in eastern Gulf Coast shark fishing tournaments since 1973 underscores the popularity of this activity. Previously, there were only about a half dozen such tournaments in the region, but by 1983, there were more than 40 shark tournaments, and there are currently about 65 each year (Casey, 1989).

Shark tournament fishing is usually conducted from boats that vary in size from small outboards to sportfishing yachts of 15 m or longer. The number of participants and boats varies: a two-day Long Island, New York shark tournament has drawn 300 boats and about 1500 anglers annually in recent years, but some tournaments limit boats to less than 150 because of limited shore facilities. "Exclusive" tournaments charge high entry fees on a "first-come, first-served basis." In the past 10 years, "big money" shark tournaments with a top prize of $50,000 or more have become popular.

As many as 15 different species, depending upon tournament locale, are caught during these events. The most prized catches, with respect to fighting quality, size, or rarity are: mako, thresher, white, dusky, tiger, lemon, blacktip, hammerhead, and bull sharks.

In the 1960s and early 1970s, tournaments often awarded prizes for total weight or number of sharks caught. Unfortunately, the catch then was discarded, although some species, primarily mako, were sold or kept for food. Smaller or less desirable species were routinely killed rather than released; the prevailing

attitude was "the only good shark is a dead shark." Since then, however, attitudes have changed. Currently, most tournament rules include restrictions on minimum size, number of sharks per boat, and/or anglers. Many tournaments encourage tagging and releasing small sharks and discourage landing sharks that will be discarded. At least one shark tournament is strictly a tag-and-release contest, with observers assigned to each boat.

Charter vessel fishing for sharks is becoming increasingly popular, probably due to the decreased abundance of other large gamefish, but the cost of pursuing billfish may be a factor as well. In most U.S. waters, this type of fishing is confined to the warmer months, May to September. In some regions, certain species are heavily targeted: sharpnose and blacktip in the Carolinas, and mako and large white sharks at Montauk, New York. Headboats, on the other hand, may land the smaller shark species caught, but they usually do not target sharks specifically, except for a headboat fishery for sharpnose sharks based in Port Aransas, Texas.

Commercial Use

Directed Fisheries
Commercial fishermen in the directed shark fisheries use either longlines or gillnets. Longliners use modified swordfish lines in coastal waters during a long season, often following stocks as they move north or south along the Atlantic coast. The primary species caught by longline fishermen are sandbar, blacktip, bull, bignose, tiger, sand tiger, lemon, spinner, scalloped hammerhead, and great hammerhead sharks.

Gillnet fishing for sharks in the southeast has existed for many years. These fishermen operate small boats from May to November, when sharks are in shallow water. Some of these estuarine waters, 2 to 5 m deep, are nursery areas for many species of sharks. Gillnet fishermen catch sandbar, blacktip, finetooth, blacknose, bull, spinner, dusky, sharpnose, sand tiger, scalloped hammerhead, and others. Recent legislation in South Carolina essentially terminated the use of commercial gillnets in its waters. This action has forced fishermen into deeper, Federal waters where their gillnets are less effective.

Indirect Fisheries
Tuna and swordfish longline fisheries catch large numbers of sharks as bycatch. Dominant in the tuna fisheries are blue, porbeagle, hammerhead, and "unidentified" sharks; in the domestic swordfish fishery mako, thresher, and "unidentified" sharks are the major species. These unidentified species are probably bignose, dusky, silky, and night sharks. Other fisheries also take sharks as bycatch in the summer months. Shallow-water shrimp trawls catch large quantities of Atlantic sharpnose sharks and the juveniles of several species. Shrimping is common in

areas that serve as nurseries, and many newborn sharks are caught at this time (Castro, 1989). Gillnet vessels in the New England multispecies fishery catch and land sharks during the summer and early fall, with porbeagle and mako the dominant species.

The practice of "finning," i.e., removing the fins and discarding the remainder of the shark to the sea, probably arose in the indirect longline fisheries in order to save freezer space for the more valuable swordfish and tuna. Directed shark fisheries are unlikely to discard the carcasses, unless they are spoiled or unmarketable species. For example, hammerhead sharks are usually not marketed because their flesh is darker than that of other sharks and is commonly (but erroneously) considered spoiled; some processors also claim that it does not keep as well as other sharks.

Over the years, shark discards from both the commercial and recreational fisheries have been extensive. Although accurate information on amounts and species discarded cannot be derived without onboard observers, significant new fishery information was received from fishermen, fish dealers/processors, and several state fishery management agencies during the public comment periods held on the proposed FMP and on the proposed rule. This new information included: (1) data showing higher fishery removals in recent years than those used as a basis for determining MSY and stock conditions in the NMFS 1990 shark stock assessment; (2) records on the size and frequency of shark species caught in commercial fisheries; and (3) information on the commercial fishing fleet. NMFS reviewed this new information and determined that the amount of sharks finned was about the same as was harvested and landed during the years 1987 to 1991 (see Appendix II, Report of the Atlantic Coastal Shark Fishery Analysis Review, November 23, 1992).

3.2.2 LANDINGS AND VALUE INFORMATION

3.2.2.1 COMMERCIAL LANDINGS AND VALUE

Landings data are collected by port agents who routinely record the weight and average ex-vessel price of sharks purchased by seafood dealers. Some landings data may expose information about a single fisherman or dealer and must be treated confidentially, in accordance with the Privacy Act.

Landing statistics are maintained as round weight equivalents of the actual dressed weight or fin weight landed. Dressed carcass weights are converted to round weights before the data are archived. In cases where fins are sold without carcasses, the fin weights are used to estimate round weights.

Most sharks are not identified by species in the commercial landing statistics. There are many similar species, thus

identification of dressed sharks is difficult, and there is no difference in price except for mako sharks (Isurus spp.). Data for some species groups, however, are available through swordfish logbooks which list the weight of each carcass sold by species group: swordfish, tuna, mako, thresher, blacktip, "unidentified sharks," etc.

Commercial shark landings are seasonal. In the Gulf and South Atlantic, lowest landings from 1979 to 1987 occurred in January, with maximum Atlantic landings in March, and maximum Gulf landings in May. In the northeast (Maine through Virginia), commercial landings are lowest in February and March, increase significantly into June, peak and remain steady from July through September, and decrease into the winter months. Most commercial landings (86% for the period 1979 to 1988) come from the EEZ and beyond rather than state waters.

Commercial U.S. shark landings and ex-vessel values have increased significantly for all regions over the past decade (Table 3.1, Figures 3.1 and 3.2). From 1979 to 1986, shark landings from the Atlantic and Gulf of Mexico increased at an almost linear rate of about 130 mt per year. This trend represents a developmental phase in the evolution of the present industry: fins and flesh were supplied by incidental catches from longline, gillnet, and trawl fleets fishing for other species, but fishermen needed a dependable market to cover time and labor expended on the incidental catch. Likewise, wholesalers and retailers required consistent supplies of quality products. The fishery began to flourish as the regional marketing network developed.

U.S. shark landings increased sharply from 1,618 mt in 1986, peaked at 7,122 mt in 1989, and declining by 16% to 5,950 mt in 1990 (Snell, 1991). This growth was largely in the South Atlantic and Gulf of Mexico, attributable to the sharp increase in fin prices and development of directed shark fisheries. Landings data were not available from the Caribbean prior to 1987. Peak landings were 18 mt in 1990. Caribbean landings are included with Gulf of Mexico landings. Since 1985, several longline and gillnet fisheries began to target sharks in response to an established market, availability of the resource, and limited revenues in other fisheries.

Since 1983, the ex-vessel price for sharks has remained relatively stable in constant dollars (Table 3.2), after almost doubling from 1979 to 1983. The market has averaged about $1.00 per kilogram, figured as ex-vessel value divided by round weight. (Note: The actual price paid for dressed carcasses would be higher.) Nonimal fin prices have risen significantly since 1987, however, in response to the demand from Asia. For the longest white shark fins and tails indicated, 40/up (40-cm and longer), the wholesale market prices declined from $44/kg in 1982 to $26-

$34/kg in 1984-87 and rose to the range of $45-$50/kg by 1988-91. The prices of 30/40 and 20/30 white shark fins and tails behaved similarly. Nominal prices of the shorter ones, 10/20s and under/10s, increased more strongly since the mid-1980s. Prices paid to fishermen in Florida range from $3.30 per kilogram for wet fins, $14.30 per kilogram for partly dry fins, and $22.00 per kilogram for top grade dry fins (O'hop, 1991). One effect of this increase has been to encourage finning of sharks that otherwise would be released alive.

3.2.2.2 RECREATIONAL CATCH

Recreational landings are estimated by the Marine Recreational Fishery Statistics Survey (MRFSS) carried out annually by NMFS. The survey consists of two activities: a telephone survey of households and an intercept survey of anglers at fishing sites. Several statistics are estimated: the number of fishing trips, the number of fish caught and/or landed (number and weight), and the number of persons fishing. In addition to the MRFSS, data from the NMFS headboat survey, shark tournaments, and Texas landings (which have been excluded from the MRFSS since 1985) were also used in assessing recreational catch and effort in the FMP. The MRFSS data are extremely variable among years and regions. The data, due to interview sparsity, variances in coding and reporting, and estimation methods and preciseness, have limitations. Sharks in the MRFSS are grouped into one multi-species category that includes some species that are not included in the FMP management unit. MRFSS grouping is not aligned to the three species groups used in the FMP (large coastal, small coastal and pelagic) which limits the usefulness of these data. The MRFSS estimate of total shark landings from 1979-1989 is reflected in Table 3.3. Shark landings by region are shown in Table 3.4. The Caribbean has not been sampled since 1981 under the MRFSS. The level of landings, however, is considered to be quite low.

The MRFSS data on fishing modes for 1979 to 1988 indicate that approximately 10% of the sharks were taken by headboats and charter boats. Analysis of Atlantic charter boat data on the effects of bag limits on shark catch (Isely, 1989) showed that sharks were caught on 5% of all charter boat trips surveyed, with an average of 2.8 sharks per boat per successful shark trip (defined as a trip on which at least one shark was caught). There were an estimated 3.33 anglers per boat for successful shark trips, but only one shark was caught on 37.4% of such trips. On a per angler basis, 76.6% of successful shark trips resulted in catches of one or less sharks per person. About 2% of all charter boat trips yielded one shark per trip, and 3% yielded more than one shark per trip. On a per angler basis, about 4% of charter boat trips caught one or less sharks per person, and about 1% caught more than one shark per person. Table 3.5 shows that the 838 charter boats operating in the Gulf

of Mexico during this period targeted sharks from 0.4 to 5.2% of their fishing time.

For purposes of this section only (because of the way the survey data were gathered), headboats are defined as vessels that carry 15 or more passengers, with the exception of 7 or more passengers in Louisiana. The number of headboats operating in the Gulf of Mexico has ranged from a high of around 100 in 1985 (Huntsman, 1989a) to 69 in 1988, increasing to 91 in 1990 (Cross, 1991). Approximately 110 more operated in the South Atlantic in 1990, from North Carolina to the Florida Keys.

While South Atlantic headboat shark catches are apparently increasing, from about 1 mt in 1986 and 3 mt in 1987 (Huntsman, 1989b and NOAA, 1989) to 24 mt in 1988 and 34 mt in 1989, total angler days (effort) are apparently decreasing: 415,472 in 1986; 446,404 in 1987; 420,663 in 1988; and 410,010 in 1989 (Cross, 1991). The most common shark caught by anglers fishing from headboats in the U.S. South Atlantic in 1989 was the blacktip, with 6 mt landed.

Total Gulf headboat shark catches were 61 mt in 1986, 113 mt in 1987, 135 mt in 1988, and 101 mt in 1989. About 50 to 75% of the Gulf headboat shark catch is landed between June and August (NOAA, 1989). In 1989, Texas headboats accounted for 87% by weight of total Gulf headboat shark landings. Gulf headboat shark catches are mostly attributed to a directed sharpnose shark fishery from Port Aransas, Texas. These headboats landed 26 mt in 1986, 92 mt in 1987, 113 mt in 1988, and 74 mt in 1989. Approximately half of Port Aransas-landed sharks were sharpnose.

Gulf of Mexico headboat effort (angler days) was 302,536 in 1986, 286,774 in 1987, 274,035 in 1988, and 274,581 in 1989. Thus, while it appears that Gulf of Mexico headboat effort (angler days) remained almost constant from 1988 to 1989, Gulf Headboat shark landings decreased 25%.

While Gulf headboats take large numbers of small sharks, especially sharpnose, sharks make up only 1 to 2% of all fish caught. Still, in summer months sharks can make up as much as 25% of total catch weight (NOAA, 1989a). No significant decrease has been noted in the average weight of sharks landed in Port Aransas (all sharks combined) over the last four years. Mean weights have remained fairly constant: 5.3 kg in 1986, 5.9 kg in 1987, 5.6 kg in 1988, and 5.9 kg in 1989.

The majority of sharks taken recreationally are caught in state waters (NOAA, 1979-1988). Combined recreational shark catches (by number) for the Mid-Atlantic, South Atlantic, and Gulf of Mexico inshore regions (from shore to three nautical miles) for 1984 to 1988 were 64% of the total for that period, with offshore (greater than three nautical miles from shore) catches accounting

Table 3.1

U.S. Commercial Shark Landings*

Year	Landings (mts)
1979	135
1980	458
1981	666
1982	590
1983	724
1984	846
1985	969
1986	1618
1987	3603
1988	5276
1989	7122
1990	5950

* All species in the management unit.

Source: National Marine Fisheries Service

Table 3.2

Average Nominal and Constant Dollar U.S. Commercial Shark Values by Region, 1979-1990

	New England		Mid-Atlantic		South Atlantic		Gulf of Mexico		All Areas	
	Nom. $/kg	Const. $/kg	Nom. $/kg	Const. $/kg	Nom. $/kg	Const. $/kg	Nom. $/kg	Const. $/kg	Nom. $/kg	Const. $/kg
1979	.56	.72	.45	.58	.50	.65	.33	.43	.44	.57
1980	.22	.25	.31	.35	.47	.53	.88	.99	.50	.56
1981	.23	.24	.25	.26	.95	.98	.84	.87	.64	.66
1982	.54	.54	1.15	1.15	.71	.71	.89	.89	.80	.80
1983	1.38	1.36	1.30	1.28	.84	.83	1.00	.99	.99	.98
1984	1.27	1.25	1.69	1.67	.85	.84	.88	.87	.94	.91
1985	1.66	1.60	1.77	1.71	1.09	1.05	.90	.87	1.10	1.06
1986	2.05	2.02	2.44	2.41	1.03	1.02	.95	.94	1.14	1.12
1987	2.17	2.09	2.58	2.49	1.08	1.04	1.03	.99	1.17	1.13
1988	2.08	1.96	2.88	2.43	1.05	.99	1.05	1.06	1.10	1.08
1989	1.94	1.83	1.85	1.74	1.04	.98	1.06	1.00	1.10	1.04
1990	1.65	1.40	1.97	1.67	1.04	.88	1.07	.91	1.10	.93

Source: Average nominal values calculated from Request to the Secretary to Collect Information on the Western North Atlantic Shark Fishery, p.11, January 10, 1988, Authority and Amendment to the Magnuson Act, Sec.303(e)(2). Constant dollar values derived deflating nominal values by the producer price index for finished consumer goods (1982=100).

for the remainder. For this period in the Mid-Atlantic, more sharks were caught offshore (58%) than inshore (42%). In the South Atlantic, significantly more sharks were caught inshore (84%) than offshore (16%). Similarly, in the Gulf of Mexico, 70% were taken inshore versus 30% offshore.

No information is available on recreational catches of sharks in the Caribbean. Data are not available to assign a monetary value directly to the recreational shark catch. A study of big-game fishing in New Jersey indicated that the value of catching an additional shark (marginal value) on a given fishing trip ranged from about $40 each for a sandbar, dusky, or blue shark to almost $120 for a mako shark (Brown, 1987). Marginal values assigned in big-game fisheries are not appropriate for more common fisheries. For smaller sharks, these values may be closer to those of similar-sized fishes, such as red drum or king mackerel.

3.2.3 VESSELS, GEAR AND EMPLOYMENT

3.2.3.1 COMMERCIAL FISHERY

Commercial shark fishing gear includes longlines, gillnets, trawls, and to an unknown extent, harpoons. Longlines commonly have a mainline up to 30 km long, along which buoy lines and baited gangions are attached, and are fished as either pelagic or bottom gear, depending on whether the mainline is suspended in the water column or resting on the sea floor. Most Atlantic and Gulf longlines are pelagic gear used by the swordfish and tuna fleets, and capture sharks incidentally. These fisheries often avoid areas of large shark concentrations, to conserve bait and time that might otherwise be spent on more valuable species.

In recent years a directed longline shark fishery has emerged, with many vessels converted from shrimp trawl or snapper-grouper bottom-longline fisheries. A typical shark vessel is 10 to 15 m long and deploys pelagic or bottom longlines baited with bluefish, bonito, mackerel, mullet, or squid. Lines usually have large (3/0 or 3.5/0) shark hooks, with 300 to 500 hooks on gangions of multistrand steel cable. A trip usually lasts one or two days with one to three sets per day (Lawlor, 1985). The number of full-time, year-round longline shark fishing vessels increased from 102 in 1988 to 124 in 1989 and is less now. It is not possible to classify vessels as fishing in the Atlantic versus the Gulf because many, if not most, fish both places. However, it is estimated that in 1988 over half of longline vessels that targeted shark for at least one trip were based in the Gulf (Massey, 1989b). Some longliners probably target sharks during part of the year as demand peaks or catches in alternative fisheries decline (e.g., tuna, swordfish, or reef fish).

The number of vessels with required Federal swordfish permits increased significantly from 1985 to 1989 and then decreased to

655 in 1990 (Table 3.6). This includes virtually all the pelagic longliners, many bottom longline vessels, and all harpoon and drift gillnet boats. An unknown number of harpoon vessels are from Massachusetts. These are all vessels that could potentially fish for sharks.

Drift and anchored gillnets are also used to harvest sharks in the nondirected and directed fisheries. In Florida, monofilament drift gillnets range in size from 18- to 64-cm stretch mesh (Lawlor, 1985). In South Carolina, anchored gillnets are more common, with mesh size from 20 to 33 cm; the state limits gillnet lengths within 5 km of the coastline to 31 m, but offshore the nets may be 246 m long. Virginia has an extensive inshore summer gillnet fishery with a significant shark bycatch, and gillnet vessels in New York and New Jersey that target weakfish, shad, and bluefish also catch sharks. In 1989, two of these vessels fished for shark during the winter months, but it is not known whether this small fishery has continued. An estimated 12 to 15 swordfish gillnet boats in Massachusetts and Rhode Island also have a shark bycatch. Gillnetters targeting groundfish in Maine also take shark, and the multispecies trawl fishery on Georges Bank takes a small shark bycatch.

From 1986-1989, there were 10 to 12 gillnet boats directing at sharks, and 3 to 4 boats using both gillnets and longlines. These boats work the Atlantic and the waters off Key West, Florida.

Some sharks are also landed by the Gulf and South Atlantic shrimp fleet. However, this catch will be reduced through mandatory use of TEDs in shrimp trawls to eliminate the capture and drowning of protected sea turtles. A turtle or large fish entering the trawl is shunted from the net through an escape opening in the TED, although some soft TEDs may not reduce mortality of small sharks because they get caught in the webbing (Seidel, 1990).

3.2.3.2 RECREATIONAL FISHERY

The number of recreational angler-trips that targeted sharks in North Carolina and areas south, including the Gulf of Mexico, averaged 214,682 from 1986-1989. During that same time period, recreational shark fishing trips from Virginia to New York averaged 1,116,000 (Parrack, 1990). The primary recreational gear is rod and reel, fished from boats or, to a lesser extent, from shore, piers, and bridges. In the northeast, there is also a significant handline fishery for sharks centered on Long Island, New York. Although it is considered a recreational fishery, the fish are frequently sold and, therefore, are recorded as commercial landings.

A survey of Atlantic charter boats (Isley, 1989) revealed that 5% of the trips resulted in shark catches. If this proportion

corresponds to targeted trips only, a small number of charter boat trips target sharks. The Gulf of Mexico charter boat data indicate that the 838 charter boats fished for sharks less than 5% of the time.

3.2.4 MARKETING AND DISTRIBUTION

There are five main shark products: fins, meat, skins, teeth/jaws, and oil. Shark fins account for most of the international shark trade. When the meat, skins or jaws are utilized, they are usually processed for sale in the domestic market.

3.2.4.1 DOMESTIC

Domestically, in the last two decades, there has been an increase in trade of shark meat. The new willingness to experiment with unfamiliar species, the high price and scarcity of some more traditional species, and the similarity with swordfish steaks has increased consumption of shark meat (Ross, 1989).

Shark "fillets" (loins or logs for cutting into meal-size steaks or fillets) became the leading shark product of U.S. seafood processing plants during the 1970s. Real prices (expressed in 1982 dollars) were on a downward trend from $1.75/kg (f.o.b., plant) in 1975 to $1.10/kg in 1982, but they increased to $3.60 by 1990. From 62 mt in 1974, output rose to 1,000-1,500 mt in 1976-79, and to 2,000-4,000 mt in 1979-90. Adding smaller amounts of steaks and dressed fish, meat has dominated sales value for two decades. Production of dried shark fins, absent since 1969, was reported again in 1984, and their higher price made them a significant part of sales value by 1988. U.S. imports and exports of shark meat roughly balanced in 1990, and U.S. consumption could have been about 6,000 mt, perhaps twice what it was in 1980 (Vondruska, 1991).

Most shark-meat traders prefer sharks less than 45 kg, selecting especially those from 10 to 30 kg for easier handling and storage, and for a product similar in size to swordfish steaks. In addition, meat from larger sharks is tougher. Shark meat is generally distributed through retail seafood outlets.

3.2.4.2 INTERNATIONAL

International data on processed products and foreign trade specifically for sharks are limited, and the following description is based on available data. In 1989, the world harvest of all sharks was 371,100 mt (U.S., 13,600 mt). This

Table 3.3

U.S. Recreational Shark Landings 1979-1989

Year	Landings (mt)
1979	11512
1980	3210
1981	9431
1982	2599
1983	5527
1984	1975
1985	5305
1986	4243
1987	4175
1988	2728
1989	1666

Source: NMFS, Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1979-1989.

Table 3.4

U.S. Recreational Shark Landings By Region
1979 - 1989

Year	North Atlantic	Mid-Atlantic	South Atlantic	Gulf of Mexico	All Regions
		(In Metric Tons)			
1979	-	10925	218	369	11512
1980	-	240	1966	1005	3210
1981	275	420	1132	7604	9431
1982	-	1252	688	660	2599
1983	1415	1304	2574	234	5527
1984	-	1408	349	115	1975
1985	-	2165	1521	1618	5305
1986	-	2943	692	608	4243
1987	-	3563	451	156	4175
1988	-	1530	318	813	2728
1989	-	1000	231	228	1666
Totals:	1690	26750	10140	13410	52371
Percent of Totals:	.03	.51	.19	.26	1.00[1]

[1]Regional figures do not necessarily add with total figures.

Source: Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, Various Years.

Table 3.5

Number of Vessels with Federal Permits To Fish for Atlantic Swordfish by State of the Owner's Residence 1985-1989

State	1985	1986	1987	1988	1989	1990
AL	2	7	24	19	14	6
CA	1	-	1	-	2	2
CT	14	12	10	6	5	5
DE	4	8	7	5	4	5
FL	166	185	210	211	231	220
GA	1	-	1	2	4	1
LA	-	7	45	104	110	89
MA	135	138	168	139	113	88
MD	4	6	6	6	6	8
ME	8	7	8	5	4	4
MS	-	2	2	5	10	8
NC	5	2	1	4	9	14
NH	-	2	3	4	3	3
NJ	35	41	38	49	55	51
NY	17	14	25	30	39	35
PA	-	-	1	-	-	1
PR	1	1	2	-	-	1
RI	32	34	38	30	38	32
SC	8	6	8	8	9	7
TX	13	11	15	68	89	66
VA	4	2	1	2	4	6
VI	1	2	2	2	3	5
Totals	451	487	616	699	752	655

Source: National Marine Fisheries Service

Table 3.6

Number of Charter Vessels Operating on the Gulf of Mexico U.S. Coast and Mean Percent Time Targeted on Shark

State	Number of Charter Vessels	% Time Sharks Targeted
Alabama	35	0.6
Florida	628	5.2
Louisiana	45	1.1
Mississippi	18	3.3
Texas	112	0.4
Total	838	

Sources: Holland, S.M. and J.W. Milon (1989) and Ditton, R.B. et al. (1989). Gulf of Mexico Fishery Management Council, 1989.

includes 84,300 mt of dogfish shark (U.S., 5,800 mt), much of which is thought to enter international trade as shark meat (FAO, 1991). European imports of shark meat had an estimated value of $75-$127 million in 1988, and U.S. exports (mostly to Europe) had a value of $6 million in 1990. In 1988, Far East imports of dried shark fins amounted to $133 million, and U.S. exports were estimated at $7 million (Vondruska, 1991).

Regarding dried shark fins, the combined imports for several Far East countries rose gradually from 3,703 mt in 1976 to 6,818 mt in 1988, including trade among these countries, and the value in 1988 was $133 million. The real price (average unit value in 1982 dollars) for imports of Hong Kong, the leading buyer, was $10/kg in 1976, $14/kg in 1982 and $24/kg in 1988. Hong Kong imported from the United States some 50-80 mt in 1974, 1979 and 1985-86, 261 mt in 1988, and 229 mt in 1989. Based on the average for all Hong Kong imports in 1988 (about $26/kg), the U.S. shipment in 1988 would have had a value of $6.7 million.

According to the annual NMFS survey of U.S. seafood processing plants, these plants had a small (confidential) output of dried shark fins in 1984-86, and it rose from 11 mt in 1987 to 118 mt in 1989. U.S. imports of dried shark fins rose from 63 mt in 1984 to 220 mt in 1989, falling to 192 mt in 1990. Higher-priced U.S. imports from Hong Kong and other Far East countries are probably for U.S. consumption or shipment to other consuming countries, whereas most U.S. imports from some countries, such as Latin American countries, and U.S. production are probably for export to the Far East. U.S. processors may purchase "wet" (fresh or frozen) shark fins from domestic fishermen, air-dry them, and ship them. Among east coast fisheries, the preferred sharks for sharkfin soup market are, in order of preference: sandbar, bull, hammerhead, blacktip, porbeagle, mako, thresher, and blue, although only the lower caudal lobe from mako and thresher sharks is considered satisfactory.

Regarding shark meat, combined imports by the 12 countries of the European Economic Community (EEC) totaled 35,400 mt in 1988 (FAO, 1991). Of this amount, 18,300 mt was from non-EEC sources and included 9,400 mt of dogfish meat, 7,200 mt of other shark meat, and 1,700 mt of fillets. Based on U.S. processor prices for fillets in 1988-90 ($2.12-$3.60/kg), the 1988 imports of the 12 EEC countries of 35,400 mt would have had a value of some $75-$127 million, and their imports from non-EEC sources of 18,300 mt would have had a value of about $40-$70 million.

U.S. exports of shark meat (mostly dogfish and mostly to Europe) from east coast ports declined from 2,066 mt in 1981 to 305 mt in 1986. For all ports, the exports rose from 517 mt in 1989 to 3,023 mt in 1990 because of a shortfall in Turkish fisheries (Ross, 1991). In 1990, U.S. imports were 2,753 mt with a value of about $5.8 million.

The major market for the small volume of U.S.-exported shark meat has been Europe. Many Europeans, especially in the Mediterranean, traditionally consume shark products, and as local supplies dwindled, imports satisfied local demand. Spain has an extensive shark fishery and a strong demand for shark meat, with total imports averaging about 1,500 mt a year. Spain also exports small quantities of shark meat to other European countries. Italy also imports an average of 3,200 mt annually from other Mediterranean and African countries to supplement domestic landings.

Most U.S. exports of sharks (except spiny dogfish) go to the United Kingdom, France and West Germany. The British market utilizes sharks as fillets or pieces in the traditional fish-and-chips seafood takeout industry. French and German consumers prefer shark steaks, similar to U.S. consumers. U.S. exporters have shipped both fresh and frozen product, in whole, sectioned, and steak form. The preferred sharks in Northern Europe are porbeagle and mako species, historically fished and consumed in this region. Due to the growing U.S. domestic demand and the high cost of air shipment, fresh product has generally proven to be too expensive for the foreign market (Ross, 1989). There is a substantial market for salted shark meat in Central America.

Although Europe is the major shark market for U.S. east coast exporters, small quantities of mako and porbeagle meat have also been shipped to Asia. West Coast exporters of mako sharks have developed the Asian markets because of lower transportation costs and their generally greater trade with Japan.

Shark skin, when combined with fins and meat, offers more complete utilization of the sharks. However, such multiple uses may be incompatible: sharks intended for leather are not gutted or iced, but sharks for meat must be quickly gutted and iced. For a top quality hide, the sharks should be washed in saltwater, skinned, and salted within 24 hours of capture to prevent sour spots (decomposition) or burnt hide (exposure to the hot sun). Full curing of the hide can be tricky and some foreign buyers prefer to purchase frozen, uncured hides. In the U.S., the preferred shark hides are from tiger and sandbar sharks, which are light-skinned and average 1 to 3 m long. Other sharks that have suitable skins are nurse, lemon, and dusky. Less preferred species are blacktip and hammerhead, because of thin skins, and bull shark, whose skin is easily ruined by fresh water. There have also been reports of shark skins exported to Europe (Ross, 1989).