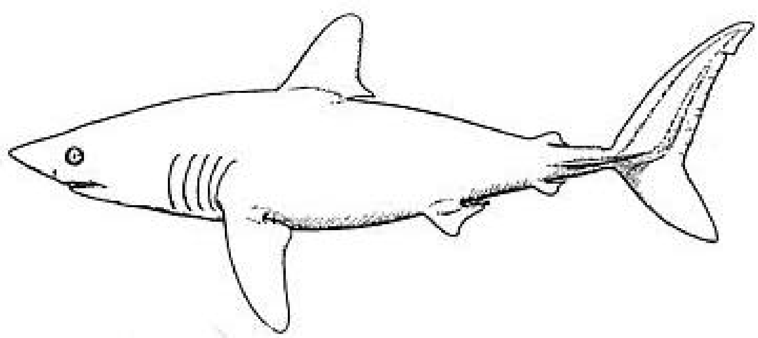
FINAL

UNITED STATES NATIONAL PLAN OF ACTION FOR THE CONSERVATION AND MANAGEMENT OF SHARKS



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CHAPTER 1
INTRODUCTION

1.0 Purpose and Need

Sharks, skates, rays (elasmobranchs) and the chimaeras together comprise the class Chondrichthyes, or cartilaginous fishes.[1] This diverse group of fishes can be distinguished by the possession of a cartilaginous skeleton as opposed to the bony skeleton of the class Osteichthyes, or bony fishes. The great majority of commercially and recreationally important species of chondrichthyans are elasmobranchs. Elasmobranchs, named for their plated gills and 5-7 gill openings, have been important predators in the oceans ever since the first shark-like forms appeared during the Devonian period, over 400 million years ago. As a group, elasmobranchs present an array of problems for fisheries management and conservation. Elasmobranchs are primarily at the top of the food web, often top-level carnivores (Cortes, 1999a), and their abundance is relatively small compared to groups situated in lower trophic levels. Thus, fishing elasmobranchs down to unsustainable levels may occur rapidly, and successful management of elasmobranch fisheries requires a stronger commitment to fishery monitoring, biological research, and proactive management than many teleost fisheries (Walker, 1998).

The life-history characteristics of many elasmobranchs, such as late age of maturity and relatively slow growth rates, make them more susceptible to overfishing than most bony fishes.[2] These characteristics, together with their low fecundity, result in low productivity for most species (Bonfil, 1994; Smith *et al.*, 1998). Recovery of populations from severe depletions (caused either by natural phenomena or human-induced mortality) will probably take many years for most elasmobranch species. In addition, due to these biological traits, the assumptions used in some fisheries models (such as yield per recruit or production models) are not always appropriate and can make stock assessments and management of elasmobranchs difficult. Elasmobranch fisheries assessments are further complicated because of the mobility of many species across political boundaries, even across oceans; a general lack of baseline information about the practices employed in shark fisheries worldwide; incomplete data on catch, effort, landings, and trade; and a lack of information on the biological parameters, importance of specific habitats to productivity, and population dynamics of many species.

Furthermore, the historically low economic value of shark and ray products compared to other fishes has resulted in research and conservation of these species being a lower priority than for traditionally high-value species. However, the growth in demand for some shark products,

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[1] The International Plan of Action for the Conservation and Management of Sharks considers the term “shark” to include all species of sharks, skates, rays, and chimaeras.

[2] For more information on general elasmobranch life history and physiology information, please see marine biology books, identification guides, scientific journals, or the Literature Cited section of this document.

such as fins, continues to drive increased exploitation (Bonfil, 1994; Rose, 1996; Walker, 1998). Modern technology, greater access to distant markets, and the depleted status of many traditionally targeted species have also led to directed fishing effort on previously non-targeted species, including elasmobranchs (FAO, 1998). Increased elasmobranch catches in both directed and incidental fisheries have resulted in growing concern over the fate of some elasmobranch populations in several areas of the world's oceans (Bonfil, 1994; FAO, 1998; Musick, 1999). Many fishery managers must now assess and manage shark fisheries without the benefit of the long-term, high-quality databases available for more traditionally high-value species.

While a few countries (including Canada, New Zealand, Australia, South Africa, and the United States) have specific fishery management plans for certain shark fisheries, international cooperation and coordination of existing shark management plans and development of new shark management plans are needed. Given the wide range of shark distributions (including the high seas) and the extensive migration of many species, bilateral and/or multilateral cooperation, assessments, and agreements are needed to understand and manage shark fisheries sustainably.

At present, there are no international management mechanisms effectively addressing the capture of sharks. However, a number of international bodies, e.g., the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Northwest Atlantic Fisheries Organization (NAFO), and the Inter-American Tropical Tuna Commission (IATTC), have initiated efforts to encourage member countries to collect information about shark catches and, in some cases, develop regional databases for the purpose of stock assessments. In addition, some countries already have laws that facilitate international management. For instance, U.S. participation in international management initiatives is guided by the Atlantic Tunas Convention Act and the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. For more information on international agreements, see Section 1.3.

In recognition of the need for improved international coordination, in 1994, the Ninth Conference of the Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) adopted a Resolution on the Biological and Trade Status of Sharks, requesting that: (1) The United Nations Food and Agriculture Organization (FAO) and other international fisheries management organizations establish programs to collect and assemble the necessary biological and trade data on shark species; and (2) all nations utilizing and trading specimens of shark species cooperate with FAO and other international fisheries management organizations.

In March 1997, a proposal was made at the 22nd Session of the FAO Committee on Fisheries that FAO organize an expert consultation to develop *Guidelines for a Plan of Action* for the improved conservation and management of sharks. This proposal culminated in the decision in February 1998 (FAO, 1998) to prepare an International Plan of Action for the Conservation and Management of Sharks (IPOA) through the meetings of the Technical Working Group on the Conservation and Management of Sharks in Tokyo from April 23 - 27, 1998, a preparatory meeting held in Rome from July 22 - 24, 1998, and the Consultation on Management of Fishing

Capacity, Shark Fisheries, and Incidental Catch of Seabirds in Longline Fisheries, held in Rome from October 26 - 30, 1998.

In February 1999, the FAO Committee on Fisheries (COFI) endorsed the *International Plan of Action for the Conservation and Management of Sharks* (see Appendix 1 for the full text). This plan was commended by the March 1999 FAO Fisheries Ministerial, endorsed by the June 1999 FAO Council, and adopted by the November 1999 FAO Conference. The IPOA builds upon the FAO *Code of Conduct for Responsible Fisheries*, encompasses all elasmobranch fisheries (commercial and recreational), and calls on all member nations to implement, voluntarily, the IPOA through the development of a national plan of action.

1.1 Objectives of the IPOA and the NPOA

The objective of the IPOA is to ensure the conservation and management of sharks and their long-term sustainable use. In the IPOA, member nations have agreed voluntarily to develop, implement, and monitor a national plan of action if their vessels conduct directed fisheries for sharks or if their vessels regularly catch sharks in non-directed fisheries. As stated in paragraph 22 of the IPOA, shark plans should aim to:

1. Ensure that shark catches from directed and non-directed fisheries are sustainable;

2. Assess threats to shark populations, determine and protect critical habitats, and implement harvesting strategies consistent with the principles of biological sustainability and rational long term economic use;

3. Identify and provide special attention in particular to vulnerable or threatened shark stocks;

4. Improve and develop frameworks for establishing and coordinating effective consultation involving stakeholders in research, management, and educational initiatives within and between member Nations;

5. Minimize unutilized incidental catches of sharks;

6. Contribute to the protection of biodiversity and ecosystem structure and function;

7. Minimize waste and discards from shark catches in accordance with article 7.2.2. (g) of the *Code of Conduct for Responsible Fisheries* (for example, requiring the retention of sharks from which fins are removed);

8. Encourage full use of dead sharks;

9. Facilitate improved species-specific catch and landings data and monitoring of shark catches;

10. Facilitate the identification and reporting of species-specific biological and trade data.

Additionally, national plans of action are to be implemented by FAO members in a manner consistent with the FAO (1995) *Code of Conduct for Responsible Fisheries* and any applicable rules of international law, and in conjunction with relevant international organizations.

This U.S. National Plan of Action for the Conservation and Management of Sharks (NPOA) has been developed by the National Marine Fisheries Service (NMFS), in consultation with stakeholders, to fulfill the national responsibility of the United States. Although shark landings do not constitute a large portion of total U.S. landings (see Section 3.1), the sustainability of shark stocks is of international concern. In addition, as described in Section 1.0, overfishing of sharks can occur rapidly with extended periods (often decades) required to rebuild. Furthermore, the depletion of traditionally higher-value species can lead to increased directed fishing on sharks. By participating in the FAO Consultation process and by supporting the adoption of the IPOA, the United States has committed to ensuring that shark fisheries are sustainable.

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) delegates the responsibility for conservation and management of marine fisheries within the Exclusive Economic Zone (EEZ) to the Secretary of Commerce, who in turn, delegates that day-to-day responsibility to NMFS. The Magnuson-Stevens Act requires NMFS and the Regional Fishery Management Councils (Councils) to analyze fisheries under their jurisdiction. If appropriate, management measures ensuring the sustainability of elasmobranch catches should be developed as fishery management plans (FMPs), FMP amendments, and/or regulations. This NPOA also recommends that the Interstate Marine Fisheries Commissions (Commissions) and the appropriate State agencies analyze the fisheries under their jurisdiction to determine if their elasmobranch catches are sustainable. NMFS will continue to work with the Commissions and appropriate State agencies to ensure that those directed and incidental shark catches are sustainable.

To assess properly the current status of elasmobranch resources, address various problems associated with their exploitation, and contribute new ideas to their study and management, it is essential to increase the level of knowledge about the characteristics and diversity of these fisheries, the species exploited, the role of habitat in population growth or depletion, the size of the catches, discards at sea, trade, and past or current management measures adopted for the fisheries. This NPOA furthers this goal by compiling available information about directed and incidental U.S. elasmobranch fisheries and identifying management goals and needs.

This NPOA includes provisions for: assessing levels of directed and incidental catch and bycatch of elasmobranchs, data collection (including collection of habitat and bycatch data), outreach and education of fishermen, exchange of information on shark fisheries and studies, and assessing the effectiveness of management measures. For Federally managed fisheries, the Magnuson-Stevens Act provides the basis and authority for these provisions. As such, these provisions are consistent with the Magnuson-Stevens Act and its National Standards and therefore should already be encompassed in existing FMPs or addressed in the development of FMPs or FMP amendments.

1.2 United States Management Authority

The Magnuson-Stevens Act is the primary domestic legislation governing management of marine fisheries in the U.S. EEZ. The Magnuson-Stevens Act calls for the conservation and management of resources and the marine environment, of which elasmobranchs are a part. In 1996, the U.S. Congress re-authorized the Magnuson-Stevens Act and included new provisions that require fishery managers to halt overfishing; rebuild overfished fisheries; minimize bycatch and bycatch mortality to the extent practicable; and describe, identify, and conserve essential fish habitat (EFH). The Magnuson-Stevens Act contains ten National Standards that fishery managers must consider when determining whether to prepare an FMP or FMP Amendment. These National Standards are:

1. Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the U.S. fishing industry;
2. Conservation and management measures shall be based upon the best scientific information available;
3. To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination;
4. Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various U.S. fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of privileges;
5. Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose;
6. Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches;
7. Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication;
8. Conservation and management measures shall, consistent with the conservation requirements of the Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such

communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities;

9. Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch; and,

10. Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

In addition, Federal fisheries management must also be consistent with the requirements of other legislation including the Marine Mammal Protection Act, the Endangered Species Act (ESA), the National Environmental Policy Act, the Regulatory Flexibility Act, the Paperwork Reduction Act, the Coastal Zone Management Act, the Administrative Procedures Act, and other relevant Federal and State laws.

Development of FMPs is the responsibility of one or more of the eight regional fishery management councils, which were established under the Magnuson-Stevens Act, or the responsibility of the Secretary of Commerce in the case of Atlantic highly migratory species (defined as tuna species, marlin, oceanic sharks, sailfishes, and swordfish). Since 1990, shark fishery management in Federal waters of the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea (excluding dogfishes, skates, and rays) has been the responsibility of the Secretary of Commerce (NMFS, 1993). Dogfish, skates, and rays in the Atlantic Ocean are managed by the New England Fishery Management Council (NEFMC), the Mid-Atlantic Fishery Management Council (MAFMC), the South Atlantic Fishery Management Council (SAFMC), the Gulf of Mexico Fishery Management Council (GMFMC), or the Caribbean Fishery Management Council (CFMC). In the Pacific, three regional councils are responsible for developing fishery management plans for sharks: the Pacific Fishery Management Council (PFMC), the North Pacific Fishery Management Council (NPFMC), and the Western Pacific Fishery Management Council (WPFMC). The PFMC's area of jurisdiction is the EEZ off California, Oregon, and Washington; the NPFMC covers Federal waters off Alaska, including the Gulf of Alaska and the Bering Sea / Aleutian Islands; and the WPFMC's jurisdiction covers Federal waters around Hawaii, Guam, American Samoa, the Northern Mariana Islands, and other U.S. non-self governing insular areas of the Pacific.

In general, waters under the jurisdiction of the individual states extend from the shoreline out to 3 miles (9 nautical miles off Texas, the west coast of Florida, and Puerto Rico), while U.S. waters under Federal management continue from state waters to 200 miles offshore except where intercepted by the EEZ of another nation. Management of elasmobranchs in state waters usually falls under the authority of state regulatory agencies, which are typically the marine division of the state fish and wildlife departments. Each state develops and enforces its own fishing regulations for waters under its jurisdiction (Federally permitted commercial fishermen in the Atlantic are required to follow Federal regulations regardless of where they are fishing as a condition of the permit). Many coastal states promulgate regulations for shark fishing in state waters that complement or are more restrictive than Federal shark regulations for the EEZ. Given that many shark nursery areas are located in waters under state jurisdiction, states play a critical role in effective shark conservation and management.

Cooperative management of the fisheries that occur in the jurisdiction of two or more states and Federal waters may be coordinated by an interstate fishery management commission. These commissions are interstate compacts that work closely with NMFS. Three interstate commissions exist: the Pacific States Marine Fisheries Commission (PSMFC), the Atlantic States Marine Fisheries Commission (ASMFC), and the Gulf States Marine Fisheries Commission (GSMFC). While states set fishery regulations in their own waters, they are encouraged to adopt compatible regulations between state and Federal jurisdictions. The Atlantic Coast Fisheries Cooperative Management Act (ACFCMA) established a special management program between NMFS, the Atlantic coast states, and the ASMFC. Under this legislation, Atlantic states must comply with the management measures approved by this Commission, or risk a Federally mandated closure (by NMFS) of the subject fishery (50 CFR part 697).

In summary, numerous management entities govern fisheries in which sharks are directed catch, incidental catch, and/or bycatch. The Magnuson-Stevens Act forms the basis for management in Federal waters and requires NMFS and the Councils to take specified actions. States agencies and Commissions are bound by state regulations and, in the Atlantic region, by ACFCMA. In preparing this NPOA, NMFS has taken a lead role in compiling relevant information and providing guidance on implementation and prioritization. However, NMFS' authority to require action is limited and does not extend to the Councils, Commissions, or state agencies. Accordingly, much of the language contained in the NPOA is framed in terms of recommendations and suggestions, and not requirements. NMFS will make concerted efforts to assist management entities to implement this NPOA.

1.3 International Initiatives on Science and Management

Several regional and multilateral international agreements collect data on shark catches although no international agreement currently manages those catches. Following are brief descriptions of major international bodies that are actively collecting data on shark catches as well as any initiatives to develop shark management measures.

International Convention for the Conservation of Atlantic Tunas

The International Convention for the Conservation of Atlantic Tunas was established to provide an effective program of international cooperation in research and conservation in recognition of the unique problems related to the highly migratory nature of tunas and tuna-like species. The Convention area is defined as all waters of the Atlantic Ocean, including the adjacent seas. The Commission is responsible for providing internationally coordinated research on the condition of the Atlantic tunas and tuna-like species, and their environment, as well as for the development of regulatory recommendations. The objective of such regulatory recommendations is to conserve and manage species of tuna and tuna-like species throughout their range in a manner that maintains their population at levels that will permit the maximum sustainable catch.

While the Commission does not currently manage sharks, the ICCAT Subcommittee on Bycatch has encouraged contracting parties to collect data on shark catches and landings for several years. In 1995, ICCAT distributed a questionnaire on bycatch of species caught coincidental to ICCAT fisheries. Numerous shark species, including skates, rays, and coastal and pelagic sharks, were reported by member countries as bycatch in their fisheries. Shark species were reported as caught in longline, purse seine, gillnet, and harpoon fisheries. However, the reporting response level was poor and may reflect the relatively low priority various member countries place on monitoring shark bycatch. ICCAT has agreed to act as central storehouse for shark data and intends to conduct a stock assessment on blue, mako, and porbeagle sharks in 2002.

Northwest Atlantic Fisheries Organization

The Northwest Atlantic Fisheries Organization is the successor organization to the International Commission for the Northwest Atlantic Fisheries. Its mission is: (1) to provide for continued multilateral consultation and cooperation with respect to the study, appraisal, and exchange of scientific information and views relating to fisheries of the Convention Area and (2) to conserve and manage fishery resources of the Regulatory Area, i.e., that part of the Convention Area which lies beyond the areas in which coastal states exercise fisheries jurisdiction. The Convention Area is located within the waters of the Northwest Atlantic ocean roughly north of 35° north latitude and west of 42° west longitude.

In 1999, the Fisheries Commission agreed to the following scientific recommendations regarding collection of scientific data and statistics on elasmobranchs: analyses on the distribution and abundance; harmonization of NAFO and FAO catch data; training in identification and reporting of sharks; and an expanded list of elasmobranchs for NAFO reporting. Current catch statistics on elasmobranchs indicates both high level of potential fishing opportunities as well as danger of overfishing if scientific advice is not available.

At the annual meeting in September 2000, the United States proposed and the Scientific Council agreed to convene a symposium on elasmobranch fisheries in 2002 in conjunction with the annual meeting. Additionally, NAFO is developing an identification poster for sharks, skates, and rays of the North Atlantic that complements the deepwater shark identification poster developed in 1998.

International Council for the Exploration of the Sea

The International Council for the Exploration of the Sea (ICES) is the oldest oceanographic organization in the North Atlantic area and is the premier body for giving advice at the international level on scientific and policy matters relating to fisheries, pollution and other marine environmental issues. ICES provides advice on pollution matters to the London, Oslo, and Helsinki Conventions for Marine Pollution, and on fisheries matters to the Convention for the Conservation of Salmon in the North Atlantic Ocean; the United States is a party to all of these conventions. ICES also advises the North-East Atlantic Fisheries Commission and the International Baltic Sea Fishery Commission. ICES also has strong formal ties to the Intergovernmental Oceanographic Commission, to which the United States belongs, and the annual ICES meeting is the major forum for coordinating the planning and execution of research on living marine resources in the North Atlantic.

In 1997, the Study Group on Elasmobranch Fishes met to analyze data on the distribution of species, conduct analytical assessments and evaluate the effects of exploitation, and prepare identification sheets for deepwater sharks, skates, and rays. The Study Group recommended publication of identification guides to sharks, skates, and rays; initiating data collection and biological sampling to improve knowledge on biology and exploitation patterns; exploration of alternative methods to evaluate the status of elasmobranch stocks; sending an ICES representative to FAO and CITES meetings; and keeping a register of available data on shark fisheries.

Inter-American Tropical Tuna Commission

The Inter-American Tropical Tuna Commission was established to "(1) study the biology of the tunas and related species of the eastern Pacific Ocean with a view to determining the effects that fishing and natural factors have on their abundance, and (2) to recommend appropriate conservation measures so that the stocks of fish can be maintained at levels which will afford maximum sustainable catches."

At its 66th meeting in June 2000, the IATTC agreed that minimizing bycatch of non-target species, including sharks, was important to maintaining healthy ecosystems overall and may require modified or new procedures, techniques, or management measures. Specifically, the IATTC agreed to require fishermen on purse-seine vessels to release promptly and unharmed, to the extent practicable, all sharks and other non-target species and to encourage fishermen to develop and use techniques and equipment to facilitate the rapid and safe release of such animals. The IATTC also supported development of a program to research bycatch reduction and evaluate management measures to reduce bycatch such as time and area closures, limits on fishing effort, catch limits, and gear modifications.

Multilateral High Level Conference

The Multilateral High Level Conference (MHLC) is a series of conference negotiations striving to design and implement a conservation and management regime for highly migratory fish stocks in the western and central Pacific Ocean. MHLC2, held in Majuro, Marshall Islands in 1997 adopted by acclamation the Majuro Declaration which expresses the commitment of the participants to negotiate, over a 3-year period, a legally binding conservation and management regime for western and central Pacific highly migratory fish stocks. These stocks support fisheries that produce over 50 percent of the world's tuna catch, and are thus probably the largest and most valuable that are not yet subject to a conservation and management regime. Fortunately, of the tuna stocks likely to be covered, all are believed to be in healthy condition, with the possible exception of bigeye tuna. Achieving the stated goal may be what was called the most significant potential development in that part of the world, given the importance of fish resources to many Pacific island economies.

At the most recent meeting in September 2000, a draft convention and annex entitled "Resolution establishing a preparatory conference for the establishment of the commission for the conservation and management of highly migratory fish stocks in the western and central Pacific Ocean" were adopted. Twenty-four states voted to adopt the resolution, with Japan and Korea opposing and Tonga, China, and France abstaining.

Asia Pacific Economic Cooperation

The Asia Pacific Economic Cooperation (APEC) was established in 1989 to promote open trade and economic cooperation among economies around the Pacific Rim, and, under APEC, the Fisheries Working Group (FWG) was formed in 1991. The FWG meets annually, and deliberates on a broad range of living marine resource issues and specific project proposals. The 21 APEC Economies are invited to these FWG meetings. In recent years, the FWG has concentrated in the areas of management; trade and marketing; seafood inspection training; aquaculture; and the facilitation of the regional implementation of global sustainable fishery initiatives.

The APEC Fisheries Working Group recently approved a project, developed by the United States, that over the next two year will assess regional implementation of the IPOA and explore ways to reduce bycatch and waste. The project will conclude with an APEC-sponsored regional workshop that will bring together scientists, policy makers, and other stakeholders to review shark conservation and management.

Convention on International Trade in Endangered Species of Wild Fauna and Flora

The Convention on International Trade in Endangered Species of Wild Fauna and Flora provides for international co-operation for the protection of certain species of wild fauna and flora against over-exploitation through international trade. Under CITES, species are listed in Appendices according to their conservation status. In addition, listed species must meet the test that trade is at least in part contributing to their decline. Appendix I species, for which there is no international trade permitted, are "threatened with extinction." Appendix II species are "not necessarily threatened with extinction," but may become so unless trade is strictly regulated. This regulation usually takes the form of a requirement for documentation from the country of export, monitoring of imports and, in some cases, export quotas. Imports from countries which are not CITES members still require what is called "CITES-equivalent documentation." Appendix III includes all species which any Party identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation, and as needing the co-operation of other Parties in the control of trade.

At its 10^{th} meeting in 1997, the Conference of the Parties (COP) endorsed several recommendations regarding sharks. Specifically, Parties should: improve methods of accurately identifying species-specific shark catches in directed and non-directed fisheries; establish species-specific reporting on landings, discards, and trade; improve statistics on trade in sharks, shark parts, and derivatives; and reduce the mortality of sharks caught incidentally to other fishing operations. Concerned parties were also encouraged to collect life history and biological data on sharks taken in their fisheries and to initiate management of shark fisheries nationally, regionally, and internationally. However, a U.S. proposal to establish a Marine Species Working Group to study the international trade in marine species subject to large-scale commercial fishing was not adopted.

At the 11th COP, the United States proposed listing the whale shark on Appendix II due to concerns regarding increased trade in whale shark products in the Indo-Pacific, with products destined for Taiwan. The United States also supported listing proposals by the United Kingdom for basking sharks and Australia for white sharks. None of these proposals were adopted.
The U.K. proposal to list the basking shark on Appendix II (Prop. 11.49) was defeated, despite achieving an absolute majority (67 for, 42 against, and 8 abstentions). Opposition to the proposal centered on the debate over whether FAO or CITES should be responsible for managing threatened fish species, with opponents favoring the FAO. However, the United Kingdom recently listed basking sharks on Appendix III and implemented a certification system that requires that exports of that species be accompanied by an export certificate. The United States supports this action to protect basking sharks by monitoring trade.

1.4 International and National Initiatives on Bycatch and Incidental Catch

Bycatch and incidental catch have become a central concern of fishing industries, environmentalists, resource managers, scientists, and the public, both nationally and globally. Because many sharks are caught in directed fisheries for other species, initiatives on incidental catch and bycatch are particularly relevant to shark conservation and management. A 1994 report of FAO estimated that nearly one-quarter (27 million metric tons) of the total world catch by commercial fishing operations was discarded (Alverson *et al.*, 1994). These discards represent a stress upon marine resources without compensating benefits to the general public. Thus, as identified in the IPOA, it is important to minimize waste, especially when so many of the world's fisheries are either fully- or over-exploited. As a source of fishing mortality, excessive discards in commercial fisheries can slow rebuilding of overfished stocks, particularly if most of the discarded catch dies, and imposes direct and indirect costs on commercial fishing operations by increasing sorting time and decreasing the amount of gear available to catch target species.

The FAO *Code of Conduct for Responsible Fisheries*[3] was adopted on October 31, 1995, by the FAO Conference and article 7.6.9 calls for FAO members to

> "take appropriate measures to minimize waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species...and promote, to the extent

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[3] The United Nations Food and Agriculture Organization *Code of Conduct for Responsible Fisheries* can be found at <<http://www.fao.org/fi/agreem/codecond/ficonde.asp>>.

> practicable, the development and use of selective, environmentally safe and cost effective gear and techniques."

While the *Code of Conduct for Responsible Fisheries* does not specifically define bycatch or waste, the concept of reducing bycatch, bycatch mortality, and waste is embodied in the recommended action, consistent with the IPOA. The Magnuson-Stevens Act also requires the reduction of bycatch and bycatch mortality to the extent practicable, and defines bycatch as:

> "fish that are harvested in a fishery, but are not sold or kept for personal use, and includes economic discards and regulatory discards. [Bycatch] does not include fish released alive under a recreational catch and release fishery management program."

Further, fish are defined as:

> "finfish, molluscs, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds."

Incidental catch is frequently described as animals that are harvested in a fishery and that are either kept or discarded but that were not the targeted catch (caught as part as fishing operations for other species). It should be noted that marine mammals and sea birds are considered incidental catch, even though they cannot be retained, and not bycatch because they are not fish.

In 1998, NMFS published a strategic document, *Managing the Nation's Bycatch: Programs, Activities, and Recommendations for the National Marine Fisheries Service* (NMFS Bycatch Plan) (NOAA, 1998), which states the national objectives, goals, and recommendations of the agency, to address current programs and future efforts to reduce bycatch and bycatch mortality of marine resources. The complementary implementation of the *Code of Conduct for Responsible Fisheries*, the Magnuson-Stevens Act, the NMFS Bycatch Plan, the IPOA, and this NPOA should result in a reduction of shark bycatch and/or of shark bycatch mortality in the fisheries of the United States. This will require the cooperative efforts of NMFS, the Councils, the Commissions, appropriate States, affected commercial fishermen and recreational anglers, environmental groups, scientists, non-governmental organizations (NGOs), and other interested parties.

1.5 Development of the U.S. NPOA

The development of the U.S. NPOA was primarily the responsibility of NMFS headquarters. NMFS Regional Offices and Science Centers and Council staff were consulted for comments on two pre-draft documents. These comments were incorporated into the public draft document.

On September 30, 1999 (64 FR 52772), NMFS published a Notice of Availability in the *Federal Register*, which provided a time frame for completion and an outline of the contents of the draft NPOA. The public was invited to provide written comments and suggestions for items to be incorporated and addressed with the NPOA. No public comments were received. On March 27, 2000 (65 FR 16186), NMFS published another notice revising the original time frame for completion of this project. On August 4, 2000 (65 FR 47968), NMFS published a Notice of Availability of the draft NPOA, which established a comment period through September 30, 2000. Numerous comments were received. This final NPOA reflects many of those comments; formal response to comments is provided in the Notice of Availability of the final NPOA.

Written requests for copies of this NPOA may be submitted to Margo Schulze-Haugen, Highly Migratory Species Management Division (F/SF1), National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD, 20910, or via FAX to (301) 713-1917. For further information, contact Margo Schulze-Haugen or Karyl Brewster-Geisz at (301) 713-2347.

CHAPTER 2
IMPLEMENTATION FRAMEWORK

2.0 Role of FAO Members and FAO

In October 1998, the United States was a leading participant in the FAO Consultation on Shark Conservation and Management and successfully negotiated with the world's fishing nations concrete steps to improve shark conservation through the IPOA. The IPOA builds upon the FAO *Code of Conduct for Responsible Fisheries* and encompasses all elasmobranch fisheries. The IPOA encourages action on education of fishermen, exchange of information and studies on elasmobranch fisheries, assessments of levels of non-target catch of elasmobranchs, and assessments of the effectiveness of management measures. Specifically, the IPOA calls for nations, entities, and/or regional management bodies that implement a national plan of action to:

1. Regularly, at least every four years, assess its implementation for the purpose of identifying cost-effective strategies for increasing its effectiveness (paragraph 23);

2. Cooperate through regional and subregional fisheries organizations or arrangements, and other forms of cooperation, with a view to ensuring the sustainability of sharks stocks, including, where appropriate, the development of subregional or regional shark plans (paragraph 25);

3. Ensure effective conservation and management of the stocks where transboundary, straddling, highly migratory, and high seas stocks of sharks are exploited by two or more member nations (paragraph 26);

4. Collaborate through FAO and through international arrangements in research, training, and the production of information and educational material (paragraph 27); and,

5. Report on the progress of the assessment, development, and implementation of the shark plans as part of their biennial reporting to FAO on the *Code of Conduct for Responsible Fisheries* (paragraph 28).

Member nations that determine that a national plan of action is not necessary should review that decision on a regular basis, taking into account changes in their fisheries. At the minimum, these nations should collect data on catches, landings, and trade.

In addition, the IPOA states that the FAO, to the extent directed by its Conference, will:

1. Support member nations in the implementation of the IPOA, including the preparation of the national plan of action (paragraph 29);

2. Support development and implementation of the national plans of action through specific, in-country technical assistance projects with Regular Program funds and by use of extra-budgetary funds made available to the Organization for this purpose (paragraph 30);

3. Provide a list of experts and a mechanism of technical assistance to countries in connection with the development of the national plans of action (paragraph 30); and,

4. Report biennially, through COFI, on the state of progress in the implementation of the IPOA (paragraph 31).

2.1 Implementation of the United States NPOA

As stated in Chapter 1, the authority for implementing the U.S. NPOA comes from the U.S. participation and endorsement of the IPOA as well as through the Magnuson-Stevens Act. For management entities that have jurisdiction of directed shark fisheries or fisheries with regular catches of sharks, the NPOA calls for the following actions to be taken:

1. <u>Data Collection</u>: Data collection programs should collect reliable data to determine the directed and incidental catch, bycatch, and disposition of elasmobranchs by the various fisheries; the effectiveness of existing management measures; the locations and characteristics of nursery and wintering grounds; information on EFH or key habitat for all life stages; and the status of the stocks. These data collections should be species-specific to the maximum extent practicable and may accomplished through incorporating shark species on logbooks and observer forms for other species.

2. <u>Assessment:</u> Assessments of elasmobranchs subject to directed, incidental, or bycatch fishing mortality to determine the sustainable level of fishing mortality should be conducted following the completion of this NPOA by NMFS, the Councils, the Commissions, and appropriate States (management entities) (see Item 7 for policy guidance on time frames for assessments and Section 2.2 for further guidance on prioritization of limited resources).

   Assessments should thereafter be conducted regularly, consistent with the IPOA. Management entities that have already conducted preliminary assessments should continue and expand these wherever possible. Additional work conducted by academic researchers and independent NGOs should be encouraged and incorporated as appropriate. Management entities are encouraged to cooperate and share relevant data with each other.

   The purpose of the assessment is to determine whether the level of total fishing mortality of shark, skate, and ray species is sustainable. To continue to improve upon existing elasmobranch assessments and help make future assessments more effective, the following items should be included for collection and analysis:

A. Species-, size-, region-, and gear-specific catches and landings, including disposition of discards (dead vs. alive);
B. Fishery-independent data on shark distribution, abundance, migratory patterns, habitat utilization, and productivity;
C. Fishing fleet data (commercial and recreational fisheries; e.g., numbers of vessels by size, type of gear used, areas fished, number of fishermen);
D. Fishing catch and effort data (e.g., seasons, target and incidental species, bycatch species, number of trips per year, number of sets per year, catch per unit effort, total effort by appropriate unit of fishing gear);
E. Habitat data including delineation of summer and winter nursery, mating, and feeding habitats;
F. Utilization, price, and trade data (imports and exports) by product form, if possible, and market; and
G. Monitoring of fisheries with directed and incidental catches and bycatch of elasmobranchs (e.g., observer programs).

In addition to the collection and analysis of the above items, the assessment should also consider: (A) the criteria used to evaluate the need for additional elasmobranch management measures: (B) efficacy of existing management measures in controlling total shark mortality to sustainable levels: (C) characterization of necessary habitat and the impact of habitat loss or degradation on sustainable population levels; (D) the need to reduce bycatch and bycatch mortality of sharks; and (E) a statement of conclusions of stock and habitat status and fishery sustainability. In reaching conclusions, the management entities conducting the assessment should take into account biological reference points and potential changes in fisheries, such as the expansion of existing fisheries and/or the development of new or newly directed shark fisheries. At a minimum, the assessment should indicate which fisheries catch sharks and evaluate the catch trends and biological information available at a species-specific level.

Furthermore, consistent with paragraph 23 of the IPOA, management entities should regularly, at least every four years, assess their NPOAs for the purpose of identifying cost-effective strategies for increasing its effectiveness, and modify their management measures as necessary. This assessment should review the sustainability of shark stocks under current levels of mortality as part of assessing the effectiveness of the NPOA.

If, based upon the initial assessment for the purposes of this NPOA, the management entities determine that total fishing mortality on elasmobranchs appears to be sustainable, then the management entities should continue to monitor their fisheries that capture sharks. The management entities should assess their fisheries regularly, consistent with the IPOA, to ensure that changes that could impact shark stock and habitat status and/or the sustainability of shark fisheries have not occurred.

If, based upon the assessment, the management entities conclude that the fishery is not sustainable or if the management entities are unsure if the fishery is sustainable, then the fishery is in need of management measures. Accordingly, an FMP, FMP amendment, or regulations should be developed and implemented in compliance with the Magnuson-Stevens Act, the National Standards, and the National Standard Guidelines, and consistent with the IPOA and this NPOA.

3. Need for Management Measures: If the assessment concludes the stock is overfished, that overfishing is occurring, or that the stock is approaching an overfished state, appropriate management measures (e.g., reduce harvest levels or effort, use of alternative gears, reduce adverse effects on EFH or other habitats, implement minimum sizes, establish time-area closures) should be prescribed to end and/or prevent overfishing, to conserve necessary habitats, and to minimize waste, discards, and unutilized incidental catches of all elasmobranchs harvested. These measures should have a stated benefit and be cost-effective for the fishing industry, to the extent practicable. In addition, these management measures should have a rebuilding time frame and specific guidelines for determining when a species is rebuilt, or alternatively, when a species is overfished, consistent with applicable laws. Management entities are encouraged to include within their provisions all elasmobranch species within their area of jurisdiction, either in an appropriate species group or as individual species. For Federal fisheries, consistent with the Magnuson-Stevens Act, NMFS expects that any necessary management measures will be formally incorporated within an existing FMP or as part of a new FMP, and subsequently incorporated as regulations. Management entities should also monitor the efficacy of these management measures and any impacts on the affected fisheries, and include recommendations on how to implement and monitor the U.S. NPOA

4. Research and Development of Mitigation Measures and Methods: Regardless of the determination of the assessment, management entities should invest in elasmobranch research, fishery monitoring, reduction of bycatch and bycatch mortality, minimization of waste, and enforcement. For example, scientists could investigate specific areas of research including studies on life history to improve species-specific management; gear modification (e.g., circle hooks) or bait modification (e.g., live bait, dead bait, artificial bait) to reduce bycatch and bycatch mortality; methods of species identification (e.g., genetics) to improve species-specific biological, catch, landings, and trade data; post-release mortality estimates to improve stock assessments; identification and characterization of important habitats by life-history stage to understand the impacts of habitat loss and degradation on productivity and the marine ecosystem; and the effectiveness of time-area closures to protect important habitats, as appropriate. Scientists should also study the fishery itself with fishery-dependent and fishery-independent data, as appropriate.

5. Limitation of Fishing Capacity: There are many problems associated with open access fisheries. The greater the number of fishing vessels participating, the more likely it is that individual fishing enterprises will become unprofitable or marginal. As progressively more fisheries come under limited access, pressure on those fisheries that remain open access will increase. Combined with limited quotas, this can lead to greater pressure to catch fish faster. The resulting "race for the fish" or derby fishery produces market gluts, poor

product quality, safety concerns, and high administrative costs. Shortened fishing seasons also mean that fresh fish may not be available to consumers for prolonged periods. Therefore, the limitation of capacity should be investigated as a method for increasing the sustainability of elasmobranch fisheries. NMFS is currently assessing the fishing capacity of Federally managed commercial fisheries in the United States as part of the development of an NPOA on the Management of Fishing Capacity; management entities are urged to participate in this study.

6. Outreach and Education: Each management entity should cooperatively or individually:
   - A. Develop and implement training tools and programs in elasmobranch identification;
   - B. Prescribe means to raise awareness among recreational fishermen, commercial fishermen, fishing associations, and other relevant groups about the need to reduce bycatch mortality and increase survival of released elasmobranchs where bycatch occurs; and,
   - C. Prescribe means to raise awareness among the non-fishing public about the ecological benefits from elasmobranch populations, detrimental effects of habitat destruction (e.g., coastal development, coastal pollution), and appropriate conservation measures to avoid, minimize or mitigate adverse effects on necessary habitats.

7. Reporting and Monitoring: Each management entity should prepare a biennial report on the status of sharks and shark fisheries under its jurisdiction so that NMFS can incorporate that information into biennial reports to COFI. NMFS encourages management entities to conduct an initial assessment (as described above) following completion of this NPOA (if not already done) within two years, and to report to NMFS by September 2002 so that NMFS may incorporate that information into the biennial report to COFI in 2003. If shark conservation and management measures are found to be necessary, NMFS encourages management entities to develop fishery-specific measures within two years from that determination, and to report to NMFS by September 2004 so that NMFS may incorporate that information into the biennial report to COFI in 2005. For any fisheries that are under the authority of the Magnuson-Stevens Act and that are identified as overfished, the development of rebuilding programs must be consistent with Section 304(f) of the Magnuson-Stevens Act.

   For fisheries under Federal FMPs, the annual Stock Assessment and Fishery Evaluation (SAFE) Reports should describe the status of shark stocks under the management entities' jurisdiction, the status of EFH, research efforts, the effectiveness of measures to ensure that mortality is sustainable, the effectiveness of measures to reduce bycatch and bycatch mortality, the need for (additional) management measures, steps taken to implement any necessary management measures, and other factors. SAFE Reports should be submitted to the Assistant Administrator of NMFS and will be made available to the public. Information from the SAFE reports will be compiled and incorporated into the United States' biennial status report to FAO on its implementation of the *Code of Conduct for Responsible Fisheries* (FAO, 1995).

For fisheries under State or Commission management, NMFS will work with the appropriate management entity to conduct the initial assessment of shark stocks under its jurisdiction, develop necessary management measures, and develop similar reports on a biennial basis.

2.2 Management Principles

NMFS believes that strong domestic management of sharks is warranted. Several important shark nursery areas are located within U.S. waters (e.g., Delaware Bay, Chesapeake Bay, Bull's Bay, and Florida Bay in the Atlantic Ocean; Charlotte Harbor/Pine Island Sound and Tampa Bay and St. Andrew Sound in the Gulf of Mexico; and the Southern California Bight in the Pacific Ocean (Castro, 1993; Hanan *et al*., 1993; Pratt and Merson, 1996; Sminkey and Musick, 1996; Carlson, 1999; Carlson and Brusher, 1999; NMFS, 1999a)). These habitats have been identified as EFH under the Magnuson-Stevens Act, which requires NMFS and the Councils to minimize to the extent practicable any adverse impacts to these habitats from fishing activities and requires other Federal agencies to consult with NMFS on ways to conserve these habitats. Additionally, the United States has several directed shark fisheries as well as numerous non-directed fisheries that have regular catches of sharks.

This NPOA should be viewed as an overarching framework within which NMFS, the Councils, the Commissions, and appropriate State agencies should work together to conserve and manage sharks and related fisheries. The NPOA contains guidance on research and management necessary to meet this goal; however, the NPOA does not prescribe specific management measures so that management entities will have flexibility to incorporate measures they consider appropriate.

Adopt the Precautionary Approach

Commercial and recreational fisheries exhibit numerous regional distinctions and differences such as: target species, incidental species, bycatch and bycatch mortality, geographic location, gear used, gear deployment, season, weather, vessel characteristics, and elasmobranch species present. Consequently, each fishery poses different levels of risk to elasmobranch populations with regard to directed or incidental catches or bycatch, and commercial or recreational fisheries. The level of risk to specific populations depends on the life history characteristics of each species and on the level of mortality in the fisheries capturing these species. Because of these differences, each fishery may need its own unique solution to reducing the risk to shark populations.

Because fishing elasmobranchs down to unsustainable levels may occur rapidly and recovery can take decades for many species, successful management of elasmobranch fisheries should be based on the precautionary approach in which measures are implemented proactively before overfishing occurs. NMFS urges the Commissions and appropriate State agencies to initiate or expand the data collection, assessment, and management of shark fisheries and habitats under their jurisdiction, as necessary, to ensure that all shark fisheries in the United States are sustainable. The NPOA calls on management entities at the state, regional, and national levels to initiate, continue, or improve research on elasmobranch catches in their fisheries, address the uniqueness of each fishery, identify key habitats and their impacts on populations, and implement necessary elasmobranch management measures before stock declines are evident.

Protect Vulnerable Life History Stages

NMFS recognizes that some shark species are sensitive to mortality in the juvenile and subadult life history stages (Sminkey and Musick, 1996; Au and Smith 1997; Cortes, 1999b; Brewster-Geisz and Miller, 2000). In addition, the first few reproductive years of adult life history stages may also be important in ensuring the stocks are not overfished (Au *et al.*, 2000). Although these studies have not been done on all shark species, it is a logical assumption that the same conclusions would hold true for many other elasmobranch species. Therefore, proactive domestic management should consider protecting juvenile, subadult, and early adult life history stages and habitat in order to rebuild overfished shark stocks and to prevent overfishing on other shark stocks. Potential measures to increase protection of sensitive life history stages include minimum sizes for retention, enhanced conservation of EFH, and time/area closures of nursery areas. As these stages appear to be critical to rebuilding and sustaining U.S. shark populations, some of which may migrate into international waters, domestic management is a fundamental element for successful international shark management.

Protect Vulnerable Species

Certain shark species are known to be more vulnerable to exploitation than others based due to exceptionally low productivity, restricted ranges, susceptibility to certain fishing gears, international fishing effort, or other relevant factors (Smith *et al.*, 1998). Currently, three shark species are included on the Candidate Species list under ESA because available information indicates that full protection under ESA may be warranted. Additionally, the American Fisheries Society and American Elasmobranch Society have developed policy statements encouraging managers to be particularly sensitive to the vulnerability of less productive species. The American Fisheries Society recently developed (November 2000) a list of marine fish stocks at risk of extinction which included whale, sand tiger, basking, white, dusky, and night sharks, smalltooth and largetooth sawfish, and thorny, big, and barndoor skates. NMFS urges all management entities to consider additional, separate measures to protect species particularly vulnerable to overfishing. Potential measures to increase protection of vulnerable species may include prohibiting possession of that species (e.g., white sharks in California, numerous species in Atlantic Federal waters), time/area closures or marine reserves to protect important habitats or EFH, gear modifications, and precautionary limits on harvest levels.

Minimize Waste

The Shark Finning Prohibition Act (Public Law 106-557) as amending the Magnuson-Stevens Act bans the practice of shark finning (i.e., removing only the fins of a shark and discarding the remainder of the carcass) in Federal fisheries for all species of sharks. Furthermore, the Shark Finning Act specifies a rebuttable presumption that any shark fins landed from a fishing vessel or found on board a fishing vessel were taken, held, or landed in violation of the ban on shark finning if the total weight of shark fins landed or found on board exceeds 5 percent of the total weight of shark carcasses landed or found on board. NMFS is committed to minimizing waste, discards, and unutilized incidental catches in shark fisheries, consistent with the Shark Finning Act and the IPOA. As such, NMFS encourages all non-Federal management entities to develop and implement a consistent or complementary ban on shark finning in fisheries under their jurisdiction. NMFS acknowledges a ban on finning may have considerable economic, cultural, and regional implications, and that different fisheries may warrant different approaches. Nevertheless, NMFS urges all non-Federal management entities to be proactive and precautionary in addressing the conservation and waste aspects of the practice of finning.

Prioritize Limited Resources

NMFS recognizes that funding considerations may limit the resources available to monitor and manage effectively all fisheries (commercial and recreational, directed and incidental) in which sharks are caught. However, the appropriate management entity should determine whether a particular species is overfished, which fisheries should be regulated in regard to shark catches, and make a good faith effort to collect species-specific data in each fishery. The Magnuson-Stevens Act currently requires NMFS, working in partnership with the Councils, to determine the status of stocks and develop rebuilding plans to rebuild overfished species under Federal management. While the ultimate goal is to account fully for all mortality of sharks caught in U.S. fisheries, NMFS recognizes that this may be unrealistic at this time. The appropriate management entity should determine which shark species have higher conservation needs and act appropriately. This approach is consistent with the third aim of paragraph 22 of the IPOA. In cases where the shark species migrate over political boundaries, NMFS will continue to work with the appropriate management entities to implement consistent regulations over the species entire geographic range.

2.3 A Comparison between the IPOA and the United States NPOA

This NPOA builds on the requirements of the Magnuson-Stevens Act and its ten National Standards, which in many cases prescribe stronger measures than those recommended in the IPOA. Table 2.1 compares the goals of the IPOA with the relevant National Standards and highlights some of the steps NMFS has taken or will take to implement these goals.

Table 2.1 A comparison of the goals listed in the IPOA and implementation in the U.S. NPOA through the National Standards of the Magnuson-Stevens Act and ongoing domestic activity.

IPOA goals for NPOAs	Implementation in the U.S. NPOA

1.	Ensure that shark catches from directed and non-directed fisheries are sustainable.	National Standards 1, 2; data collection, stock assessments, identify species as overfished, develop rebuilding plans, establish management measures, observer programs, biennial reports
2.	Assess threats to shark populations, determine and protect critical habitats, and implement harvesting strategies consistent with the principles of biological sustainability and rational long term economic use.	National Standards 1, 2, 3, 4, 5, 8, Section 3(28)(A) (protect marine ecosystems); Sections 303(a)(7) and 305(b) (EFH); data collection, stock assessments, research and monitoring
3.	Identify and provide special attention in particular to vulnerable or threatened shark stocks.	National Standard 1; prioritize species-specific management; list appropriate species on Candidate Species List under ESA, identify species as overfished, develop rebuilding plans, EFH conservation and consultation
4.	Improve and develop frameworks for establishing and co-ordinating effective consultation involving stakeholders in research, management, and educational initiatives within and between member Nations.	National Standards 1, 2, 3, 4; Sections 303(a)(7) and 305(b) (EFH); coordinate regulations and data collection between regions and countries; participate in international scientific and management fora (e.g., ICCAT, IATTC, MHLC)
5.	Minimize unutilized incidental catches of sharks.	National Standards 5, 9; develop and implement a ban on finning, reduce bycatch
6.	Contribute to the protection of biodiversity and ecosystem structure and function.	National Standards 1, 2, 3, 9, Sections 303(a)(7) and 305(b) (EFH)
7.	Minimize waste and discards from shark catches in accordance with article 7.2.2. (g) of the *Code of Conduct for Responsible Fisheries* (for example, requiring the retention of sharks from which fins are removed).	National Standards 5, 9; develop and implement a ban on finning
8.	Encourage full use of dead sharks.	National Standard 5; research and monitoring; market studies
9.	Facilitate improved species-specific catch and landings data and monitoring of shark catches.	National Standards 1, 2; species-specific data collection, observer programs, educational workshops, publish identification guides

10.	Facilitate the identification and reporting of species-specific biological and trade data.	National Standard 2; Outreach and education programs, publish identification guides

Thus, both the IPOA and the Magnuson-Stevens Act require NMFS and the Councils to undertake extensive data collection, analysis, and management measures in order to ensure the long-term sustainability of U.S. shark fisheries. The Commissions and State agencies, though not directly under the authority of the Magnuson-Stevens Act, may participate through the Council process in management of Federal fisheries and, therefore, may already be in partial or full compliance with this NPOA. However, the Commissions and State agencies may need to initiate or expand current data collection, analysis, and management authority for directed shark fisheries or fisheries with regular incidental catches of sharks that are conducted exclusively within state waters. NMFS will work cooperatively with the Councils, Commissions, and States in meeting these objectives.

CHAPTER 3
SYNOPSIS OF FISHERIES AND MANAGEMENT

3.0 General Overview

The United States is the world's fourth largest marine fisheries producer in terms of commercial landings of all species with 4.4 percent, by volume (NMFS, 2000). U.S. commercial marine fishing activities take place within FAO statistical areas 21 (Northwest Atlantic), 31 (Western Central Atlantic), 67 (Northeast Pacific), 77 (Eastern Central Pacific), 71 (Western Central Pacific), 81 (Southwest Pacific), and 87 (Southeast Pacific). In 1999, commercial landings of all marine species totaled approximately 9.3 billion pounds, or 4.2 million metric tons (mt), valued at approximately $3.5 billion in 1999 - an increase of 145.1 million pounds (2 percent) and $338.6 million (11 percent) compared with 1998 (NMFS, 2000). In 1999, recreational harvest of all marine species totaled 135.7 million fish weighing 198.7 million pounds, an increase of approximately 200 thousand fish and 4 million pounds from 1998 harvest levels (NMFS, 2000). The United States imported $17 billion in edible and nonedible fishery products in 1999, and exported products were valued at $10 billion in 1999 (NMFS, 2000).

Elasmobranch fisheries have become increasingly important in the United States, but are still a small share of the total volume and value of U.S. fish production (Tables 3.1 and 3.2). In 1999, total commercial landings of all elasmobranchs were 37.5 thousand mt and were valued at $16.2 million, or less than one percent of total marine fish commercial landings and value (Table 3.1; NMFS, 2000). Recreational landings of elasmobranchs totaled 351 thousand fish weighing approximately 1,410 mt, or about one percent of total marine fish recreational harvest in 1999 (Table 3.2; NMFS, 2000). Even though elasmobranchs are a small share of the total U.S. fisheries, some highly specialized fishermen primarily target these species.

Table 3.1 Recent U.S. commercial landings and value of all fish species and all shark species. Source: NMFS, 2000.

Year	Species	Commercial Landings (mt)	Value (thousands)
1998	**All shark species**	44,558	$19,361
	Dogfish	22,277	$8,139
	Other sharks	7,009	$6,644
	Skates	15,272	$4,578
	All fish species	4,170,357	$3,128,469

1999	**All shark species**	37,559	$16,266
	Dogfish	16,652	$5,951
	Other sharks	6,673	$6,625
	Skates	14,234	$3,690
	All fish species	4,236,158	$3,467,084

Table 3.2 Recent U.S. recreational harvest of all shark species and all fish species. Harvest includes fish that were landed and fish that were released dead. Source: NMFS, 2000.

Year	**Species**	**Metric tons**	**Number of fish (in thousands)**
1998	**All shark species**	1,503	523
	Dogfish	248	167
	Skates/Rays	46	70
	Other sharks	1,209	286
	All fish species	90,580	140,371
1999	**All shark species**	1,410	351
	Dogfish	56	61
	Skates/Rays	88	81
	Other sharks	1,266	209
	All fish species	90,146	135,681

The main elasmobranch fisheries in the United States have traditionally been centered on sharks, although skates and rays have also been fished. The first reported directed fisheries for elasmobranchs in the United States were for the tope or soupfin shark (*Galeorhinus galeus*) in California and for large sharks off Salerno in Florida (Ripley, 1946; NMFS, 1999a). Shark populations have generally proven to be unresilient when subjected to unregulated directed fisheries (Pratt and Casey, 1990). The "boom and bust" pattern of historical fisheries has been attributed to the specialized life-history strategy of sharks, making them particularly vulnerable to over-exploitation (Compagno, 1990; Bonfil, 1994).

Fisheries that catch elasmobranch species in the United States can be divided into four general categories: directed commercial, incidental/bycatch commercial, directed recreational, and incidental/bycatch recreational. Directed fisheries are those that target sharks, skates and rays, whereas incidental fisheries catch sharks secondarily while fishing for other species. In virtually every fishery (e.g., gillnet, longline, trawl, purse seine, pot, handgear), there are varying levels of incidental catches and/or bycatch of sharks. Some of these fisheries both land and discard incidentally caught sharks, depending on market value.

The rest of this chapter will briefly summarize available information on U.S. shark fisheries, including stock assessment results, data on catches, landings and discards, management measures, and research needs. For additional information on specific fisheries, please refer to the contact information in Appendix 3.

3.1 Commercial Skate and Ray Fisheries

3.1.1 Atlantic Fisheries

There are seven species of *Raja* occurring along the North Atlantic coast of the United States that are captured regularly in fisheries: little skate (*Raja erinacea*), winter skate (*R. ocellata*), barndoor skate (*R. laevis*), thorny skate (*R. radiata*), clearnose skate (*R. eglanteria*), rosette skate (*R. garmani*), and smooth skate (*R. senta*) (NEFSC, 2000a). The center of distribution for the little and winter skates is Georges Bank and Southern New England. The thorny, barndoor, and smooth skates are commonly found in the Gulf of Maine. The clearnose and rosette skates are located primarily in Southern New England and the Chesapeake Bight. Skates are known to undertake large-scale migrations, moving seasonally in response to changes in water temperature.

Skates can be caught commercially with trawl, gillnet, longline, handline, and dredge fishing gear. However, the principal commercial fishing method in the Atlantic used to catch skates and rays is otter trawling. Skate landings in the Atlantic peaked in 1969 at 9,500 mt, but declined quickly during the 1970s to 500 mt in 1981. Landings have since increased substantially, partially in response to increased demand for lobster bait, and more significantly, to the increased export market for skate wings taken from winter and thorny skates, the two species currently known to be used for human consumption. Bait landings appear to be primarily from little skate, based on areas fished and known species distribution patterns. Landings in the Atlantic increased to 12,900 mt in 1993 and then declined somewhat to 7,200 mt in 1995; however, the 1996 total was 14,200 mt, the highest on record (NEFSC, 2000a).

The Northeast Region Skate complex was assessed by the Stock Assessment Review Committee (SARC) of the 30th Northeast Regional Stock Assessment Workshop in December, 1999. Terms of reference for the SARC were to: 1) summarize available biological studies (age and growth, maturity, etc.); 2) update commercial and recreational landings and survey indices through 1998/99; 3) summarize, to the extent practicable, fishery discard rates through the use of sea sampling data or other information sources; 4) estimate fishing mortality rates and trends in relative or absolute stock size, and consider appropriate reference points for stock size and fishing mortality rate consistent with the provisions of the Magnuson-Stevens Act; and 5) provide an assessment of the status of species in the complex relative to overfishing criteria, and evaluate the status of the barndoor skate resource relative to listing factors considered in the ESA.

The results of the assessment of the Northeast Region Skate complex and the individual species in the complex were presented in the 30th Northeast Regional Stock Assessment Workshop Advisory Report on Stock Status (NEFSC, 2000a and b). Taken as a group, the biomass for the seven skate species (barndoor, winter, thorny, little, clearnose, rosette, smooth) is at a medium level of abundance. For the aggregate complex, the NEFSC spring survey index of biomass was relatively constant from 1968 to 1980, then increased significantly to peak levels in the mid to late 1980s. The index of skate complex biomass then declined steadily until 1994, but has recently increased again. The large increase in skate biomass in the mid to late 1980s was dominated by winter and little skate. The biomass of large sized skates (>100 cm maximum length; *i.e.*, barndoor, winter, and thorny) has steadily declined since the mid-1980s. The recent increase in aggregate skate biomass has been due to an increase in small sized skates (<100 cm maximum length; *i.e.*, little, clearnose, rosette, and smooth), primarily little skate.

Fishing mortality rates could not be estimated nor could fishing mortality reference points be determined for the barndoor, thorny, smooth, clearnose, or rosette skate stocks due to a lack of data (Table 3.3). Currently, there are no Federal or state regulations governing the harvest of skates and rays in U.S. waters off the northeast Atlantic coast. However, the NEFMC was designated as the Council responsible for developing an FMP for the seven species of skates found in Federal waters off the coast of the New England and Mid-Atlantic states. The NEFMC has one year from March 14, 2000, to develop measures to address overfishing of four species of skates (barndoor, smooth, thorny, and winter skates), consistent with Magnuson-Stevens Act provisions (see 65 FR 15576, March 23, 2000).

Table 3.3 Summary status table for northeast skate species. Source: The 30th Northeast Regional Stock Assessment Workshop (30th SAW) - Draft Advisory Report on Stock Status, page 12.

Species Name	B_{target}	B_{thresh}	Current B	B Status	F_{target}	F_{thresh}	Current F	F Status
Winter	6.46	3.23	2.83	Overfished	0.10	0.10	0.39	Overfishing
Little	6.54	3.27	6.72	Not Overfished	0.40	0.40	0.34	Not Overfishing
Barndoor	1.62	0.81	0.08	Overfished	----	----	----	Unknown
Thorny	4.41	2.20	0.77	Overfished	----	----	----	Unknown
Smooth	0.31	0.16	0.15	Overfished	----	----	----	Unknown
Clearnose	0.56	0.28	0.72	Not Overfished	----	----	----	Unknown
Rosette	0.03	0.01	0.04	Not Overfished	----	----	----	Unknown

Research and Management Needs

The following research and management needs have been identified: (1) adapt the commercial fishery statistics sampling programs to report skate landings by species; (2) collect commercial fishery size composition data by species; (3) increase sea sampling of directed skate landings and skate bycatch, and improve the identification of the species composition of the skate catch; (4) conduct age and growth studies for all seven species in the complex; (5) conduct maturity and fecundity studies for all seven species in the complex (use of life history models requires these data, and may prove useful in establishing biological reference points for the skate species); (6) estimate commercial and recreational fishery discard mortality rates, for different fishing gears and coastal regions and/or bottom types, for all seven species in the complex; (7) conduct studies of the stock structure of the species in the skate complex to identify unit stocks, and stock identification studies, especially for barndoor, thorny, winter, and little skate; (8) explore possible stock-recruitment relationships by examination of NEFSC survey data (a simultaneous examination of the species in the complex may prove a useful first step); (9) investigate trophic interactions between skate species in the complex, and between skates and other groundfish; (10) further consider the validity of NEFSC trawl survey catchability conversion factors for skate species (diel, gear, and vessel); (11) investigate the influences of annual changes in water temperature or other environmental factors on shifts in the range and distribution of the species in the skate complex, and establish the bathymetric distribution of the species in the complex off the U.S. Northeast coast; (12) investigate the SEAMAP survey data for clearnose and rosette skate; (13) investigate historical NEFSC survey data from the *Albatross III* cruise during 1948-1962 when they become readily accessible, as they may provide valuable historical context or long-term trends in skate biomass; and (14) recalculate the error distributions of the survey indices using alternative distributions (NEFSC 2000a).

3.1.2 Pacific Fisheries

Off Alaska, the harvest of sharks and skates in U.S. waters is managed under the Bering Sea/Aleutian Islands (BSAI) Groundfish FMP as components of the "other species complex" category. The harvest of sculpins, octopus, sharks, and skates is managed collectively under a quota which is currently set at or slightly above the average catch levels from the previous few years. Similarly, under the Gulf of Alaska (GOA) Groundfish FMP, sharks and skates are managed as part of an "other species" group (which includes those in the BSAI Groundfish FMP as well as squid). Under this FMP, the total allowable catch is set at 5 percent of the sum of all target species harvest limits.

Skates and sharks are caught in all GOA fisheries, and together represent the majority (50 -80 percent) of estimated "other species" catches between 1990-1998. The skate species group represents the highest proportion of other species catch weight for all years in the domestic fishery (43-65 percent) (Gaichas *et al.*, 1999). While skates are caught in almost all fisheries in the Bering Sea shelf, most of the skate bycatch is in the hook and line fishery for Pacific cod, with trawl fisheries for pollock, rock sole, and yellowfin sole also catching significant amounts. A summary of GOA skate catches by gear for 1990-1998 shows that 39 percent of skates are caught by hook and line gear, 2 percent by pot gear, and 60 percent by trawl gear (NPFMC, 1999). In the hook and line and trawl fisheries, skates are occasionally retained as incidental catch and exvessel prices about $0.15 per pound (NPFMC, 1999). Catches of other species have been small compared to those of target species in the GOA and it appears unlikely that the observed 1990-1998 bycatch of other species has had a negative effect on biomass at the species group level, according to available data (Gaichas *et al.*, 1999).

The State of Alaska has implemented regulations regarding the harvest of skates and rays. A permit must be issued by the Alaska Department of Fish and Game to a fisherman prior to directed fishing for skates and rays. Further, the Alaska State Department of Environmental Conservation prohibits fishermen from delivering less than whole species (i.e., wings intact) without a processors license (NPFMC, 1999).

Off the coasts of California, Oregon and Washington, the Groundfish FMP of the PFMC lists three skates: big skate (*Raja binoculata*), California skate (*R. inornata*), and longnose skate (*R. rhina*) (NPFMC, 1999). Other skates that occur in bottom trawl surveys are Bering skate (*Bathyraja interrupta*) and black skate (*B. trachura*). Most skates are landed as unspecified skate and there is no biological sampling to determine species composition of this catch. Landed catch of all skates off the west coast has increased dramatically from an annual average of 153 mt during 1984-1995 to a level of 1,780 mt during 1996-1999 (Table 3.4). It is not known if this increase is due to increased market acceptance, increased abundance, or increased targeting on one or more species of skates. During 1996-1998, a pilot observer program off the northern coast found that discarded catch of all skates was about 50 percent of the total catch. The nominal abundance of all skates in bottom trawl surveys has averaged 3,700 mt with an upward trend and peak abundance occurring in 1998 (Table 3.5) (Shaw *et al.*, 2000). However, earlier trawl surveys using gear that may be more appropriate for skates produced biomass estimates near 30,000 mt.

Table 3.4 Total skate landings (mt) for California, Oregon, and Washington, 1991-2000, organized by species group. Source: PSMFC, PacFIN database, May 2000, (<<www.psmfc.org/pacfin/data>>).

Species Name	**Year**									
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Bat ray	0	0	0	0	0	0	1.5	3.3	1	0.4
California skate	0	0	0	0	0	0	0	0	0.1	0
Other skates	23.9	18.0	16.5	5.3	8.8	12.6	18.8	24.6	28.4	9.0
Unspecified skate	229.9	186.5	193.3	217.1	485.1	1,556.6	2,604.7	1,285.6	1,675.8	1,384.2

Table 3.5 Abundance (mt) of skates in the NMFS bottom trawl survey conducted off the U.S. west coast from approximately Monterey Bay, California to the U.S.-Canada border in the depth zone 30-200 fathoms. Source: Shaw *et al.*, 2000.

Species Name	Year							
	1977	1980	1983	1986	1989	1992	1995	1998
Unspecified skate	1722	1588	2596	2960	5043	4603	2511	8400

In July 1998, the Alaska Department of Fish and Game submitted a proposal to the NPFMC requesting Federal action to change the management of sharks, skates, and rays to complement the management measures in the territorial waters of Alaska initiated by the Alaska Board of Fisheries. At its October 1998 meeting, the NPFMC initiated analyses of proposed alternatives for plan amendments to the BSAI and GOA groundfish FMPs. In April 1999, the NPFMC released an environmental assessment, regulatory impact review, and initial regulatory flexibility analysis for Amendments 63/63 to the FMPs for the groundfish fisheries of the BSAI and GOA to revise management of sharks and skates.

In December 1999, the NPFMC recommended that all "other species," including sharks and skates, be placed on bycatch status (no directed fishery) as part of its quota specification recommendations. NMFS determined, however, that the FMPs did not authorize that action. Final action on the proposed Plan Amendments 63/63 to the Bering Sea/Aleutian Islands and Gulf of Alaska FMPs to consider prohibiting directed fishing on sharks and skates and finning of sharks will be rescheduled for spring 2001.

Research and Management Needs

While an assessment of the status of skates off the west coast has been conducted, the information on distribution, stock structure, and life history characteristics remains extremely limited for "other species" in the GOA (Gaichas *et al.*, 1999). This assessment relied on life history information from the same or similar species in other geographic areas because region and fishery-specific information is lacking. Further investigation is necessary to ensure that all components of other species are not adversely affected by groundfish fisheries.

3.2 Commercial Shark Fisheries

3.2.1 Atlantic Fisheries (Excluding Spiny Dogfish)

The main directed commercial fisheries that catch sharks in Federal waters along the U.S. Atlantic and Gulf of Mexico coasts include the pelagic longline fishery, the bottom longline fishery, the drift gillnet fishery, and the shark handgear fishery (rod and reel, handline, bandit gear or electronic rod and reel). Other commercial fisheries in the Atlantic Federal waters that catch sharks as incidental catch or bycatch include swordfish handgear, tuna purse seine, tuna handgear, tuna harpoon, coastal gillnet, other net (cast, sink, trammel, pound), shrimp trawl, other trawl (bottom, midwater, otter), menhaden purse seine, other seine (common, haul, Scottish), and trap (floating, lobster, blue crab, conch). Authorized gears for directed and incidental fisheries for Atlantic sharks in Federal waters include longline, gillnet, rod and reel, handline, and bandit gear.

In order to manage sharks effectively in these fisheries, NMFS initially separated 39 shark species into three species groups in the first Secretarial FMP (NMFS, 1993). An additional 34 species (including spiny dogfish) were included in data collection programs but not included in the management unit. These species groups (large coastal, small coastal, and pelagic) were based on the fishery in which the sharks were caught and not on biological factors. In 1999, NMFS added two additional species groups (prohibited species and deepwater/other sharks). Also in 1999, NMFS implemented limited access for the Atlantic commercial shark fishery and has issued 287 directed permits to target sharks and 585 incidental permits to land shark caught during fishing operations for other species (K. Brewster-Geisz, NMFS, personal communication, 2000). Although the management unit is split into several species groups, any fisherman with a permit can land any species of shark (except prohibited species), within the appropriate retention limits. Fishermen without a permit are only authorized to land sharks under the recreational limit and cannot sell any sharks they land.

Large Coastal Sharks

The U.S. Atlantic commercial shark fishery for large coastal sharks is primarily a southern coastal fishery extending from North Carolina to Texas (NMFS, 1998). About 90 percent of recent U.S. Atlantic large coastal shark landings came from the southeastern region (NMFS, 1998). Although the majority of these sharks are taken by longline gear in the bottom longline fishery, they are also caught in the pelagic longline fishery, the drift gillnet fishery, and the shark handgear fishery. Commercial landings of large coastal sharks in all fisheries (including those in state waters) peaked in 1989 at 351,000 fish or approximately 4,600 mt dressed weight (dw) (NMFS, 1998). Pelagic longline dead discards from 1981 to 1998 fluctuated between 900 and 20,900 fish (NMFS, 1998; Cortes, 1999c). Commercial fishermen who target large coastal sharks usually land blacktip (*Carcharhinus limbatus*) and sandbar sharks (*C. plumbeus*) (Table 3.6). The remainder of the catch is generally comprised of dusky (*C. obscurus*), bull (*C. leucas*), bignose (*C. altimus*), tiger (*Galeocerdo cuvieri*), sand tiger (*Odontaspis taurus*), lemon (*Negaprion brevirostris*), spinner (*C. brevipinna*), scalloped hammerhead (*Sphyrna lewini*), and great hammerhead sharks (*S. mokarran*), with catch composition varying by region. These species are less marketable and often released so that they are reflected in the overall catches but not landings.

Large coastal sharks as a group are considered overfished. The most recent stock assessment for the species included in the large coastal sharks management unit was held in June 1998 (NMFS, 1998). The 1998 stock assessment estimated that the large coastal aggregate was between 30 and 36 percent of maximum sustainable yields (MSY) levels in 1998, and the 1997 catch was 218 to 233 percent of MSY (the ranges are defined by the mean values from two alternative catch scenarios). When analyses were disaggregated into sandbar and blacktip sharks, then the sandbar shark current stock size was estimated to be between 58 and 70 percent of MSY levels, and the 1997 catch was estimated to be 85 to 134 percent of MSY. For blacktip sharks, the current stock size was estimated to be between 44 and 50 percent of MSY levels, and the 1997 catch was estimated to be 163 to 184 percent of MSY. Thus, projections indicated that the large coastal aggregate complex and blacktip sharks might still require additional reductions in effective fishing mortality rate in order to ensure increases of this resource toward MSY.

Projections for sandbar sharks were more optimistic, suggesting that current catches are closer to replacement levels.

Based on these and other results, the FMP for Atlantic tunas, swordfish, and sharks developed separate rebuilding schedules for species complexes based on sandbar sharks and blacktip sharks, and did not develop a rebuilding schedule for the large coastal shark aggregate. The rebuilding program for the sandbar shark complex established a 39-year rebuilding time frame, implemented a minimum size for both commercial and recreational fisheries, and reduced the recreational bag limit. The rebuilding program for the blacktip shark complex established a 30-year rebuilding time frame, reduced the commercial quota level, and reduced the bag limit and implemented a minimum size for recreational fisheries.

Current commercial regulations for large coastal sharks include limited access permitting and reporting requirements, quotas for ridgeback and non-ridgeback subgroups, a trip limit of 4,000 pounds dw for directed permits, a trip limit of 5 large coastal sharks for incidental permits, a ban on finning, a minimum size for the ridgeback subgroup of 4.5 feet fork length, prohibited species, and authorized gears. Certain commercial measures for large coastal sharks are not in force pending a litigation settlement agreement.

Table 3.6 Estimated large coastal shark commercial landings (pounds dw) in the Atlantic Ocean and Gulf of Mexico by species. Source: Cortes, 1999c and 2000.

Species Name	1997	1998	1999
Bignose	2,132	50	9,035
Blacktip	1,506,182	1,893,805	1,286,979
Bull	40,247	27,389	25,426
Dusky	80,930	81,124	110,950
Hammerhead	79,685	59,802	53,394
Lemon	20,595	23,232	23,604
Night	33	3,289	4,287
Nurse	8,864	2,846	1,168
Reef	3,548	100	---
Sand tiger	8,425	38,791	6,401
Sandbar	890,881	1,077,161	1,299,987
Silky	13,920	13,615	8,649
Spinner	6,039	16,900	629
Tiger	6,603	12,174	30,274
White	1,315	----	82
Large coastal (unknown)	98,726	172,038	67,197
Unclassified (assumed to be large coastal)	1,078,813	1,085,989	911,115
Unclassified fins (assumed to be large coastal)	140,638	76,588	80,393
Total	3,987,576 (1,809 mt)	4,584,893 (2,080 mt)	3,919,570 (1,778 mt)

Pelagic Sharks

Pelagic sharks are typically caught incidentally in the commercial tuna and swordfish pelagic longline fisheries (NMFS, 1993), in a small directed porbeagle fishery off the coast of New England, and in directed recreational fisheries. Shortfin mako (*Isurus oxyrinchus*), porbeagle (*Lamna nasus*), and thresher sharks (*Alopias vulpinus*) are typically landed due to relatively high ex-vessel prices (Table 3.7), whereas other species are landed as hold space and market prices allow. Some species, particularly blue sharks (*Prionace glauca*), are frequently discarded because of their unpalatable meat. While catches of blue sharks (in numbers) in the Grand Banks and Northeast Coastal areas often approximate or exceed the catch of the targeted swordfish and tuna (Cramer, 1996) and are discarded, many of them are released alive. Estimates of blue sharks discarded alive range from approximately 30 to 100 percent during the period 1992 to 1995 (Cramer, 1996).

Estimates of pelagic sharks discarded dead each year in the tuna and swordfish pelagic longline fisheries ranged from approximately 300 to 1,200 mt whole weight (ww) from 1987 to 1995, of which an estimated 60 to 95 percent (by weight) were blue sharks (about 9,000 to 30,000 fish) (Cramer, 1996; NMFS, 1999a). Estimates of pelagic sharks discarded dead in the pelagic longline fisheries in 1996 and 1997 were 839 and 253 mt ww, respectively, of which approximately 73 percent (by weight) were blue sharks (about 19,000 and 8,000 fish) (Cramer *et al*.,1997; Cramer and Adams, 1998; NMFS, 1999a). Estimates of pelagic sharks discarded dead in other fisheries in 1996 and 1997 were 110 and 56 mt ww, respectively, of which 93 and 58 percent were blue sharks (about 3000 and 1400 fish) (see Cramer *et al*., 1997; Cramer and Adams, 1998; NMFS, 1999a). Thus, when blue sharks are not included, the estimate of pelagic shark dead discards was about 238 and 91 mt ww in 1996 and 1997, respectively.

The status of pelagic sharks, as a group, is currently unknown.[4] While the 1993 FMP concluded that this species group was fully fished, the reference points needed to establish the current status, as outlined in the 1999 FMP for Atlantic tunas, swordfish, and sharks, have not been defined. A formal stock assessment on this species group has not been conducted to establish the status of these stocks and to measure the efficacy of current regulations. The 1993 and 1999 FMPs reviewed catch rates, landing and discard data, and biological information to establish harvest levels for commercial and recreational fisheries.

Current commercial regulations for pelagic sharks include limited access permitting and reporting requirements, separate quotas for porbeagle and blue sharks, a trip limit of 16 pelagic and small coastal sharks for incidental permits, a ban on finning, prohibited species, and authorized gears.

Table 3.7 Estimated pelagic shark commercial landings (pounds dw) in the Atlantic by species. Source: Cortes, 1999c and 2000.

[4] The status of pelagic shark stocks and fisheries for all countries and oceans was discussed at the recent Pelagic Shark Workshop held in Pacific Grove, CA, from February 14-17, 2000; the proceedings of the workshop are being prepared.

Species Name	1997	1998	1999
Bigeye thresher	5,308	1,403	17,759
Blue	904	706	1,111
Shortfin mako	224,362	224,421	170,860
Longfin mako	7,867	4,971	4,619
Mako, unclassified	71,371	79,773	58,344
Oceanic whitetip	2,764	22,049	698
Porbeagle	4,222	19,795	5,362
Thresher	145,253	102,531	96,012
Pelagic sharks, unclassified	694	111	---
Shark, unclassified (assumed pelagic)	74,849	49,515	46,056
Total	537,594 (244 mt)	505,275 (229 mt)	400,821 (182 mt)

Small Coastal Sharks

Historically, small coastal sharks were incidental catch in commercial fisheries, and commonly used for bait. Observer data indicate that small coastal shark landings represent (by number) 2 percent, 19 percent, and 72 percent of the total observed mortality of the small coastal shark catches in the directed shark bottom longline fishery for the North Carolina, west Florida, and south Atlantic Bight regions, respectively, (Branstetter and Burgess, 1997; NMFS, 1999a). These data indicate that approximately 98 percent, 81 percent, and 28 percent, respectively, of the small coastal shark catch in those regions was not landed, but used for bait. Observer data for the North Carolina and west Florida areas suggest that unreported mortality of small coastal sharks is high; however, the volume of small coastal shark catches in those areas is minor. Nevertheless, small coastal shark landings statistics may considerably underestimate mortality in this fishery. Commercial landings of small coastal sharks increased from 9 mt dw in 1994 to 320 mt dw in 1997 (Table 3.8), with Atlantic sharpnose (*Rhizoprionodon terraenovae*), blacknose (*C. acronotus*), and finetooth (*C. isodon*) sharks comprising 90 percent of the landings (NMFS, 1999a; Cortes, 1999c). There is also a small drift gillnet fishery that targets small coastal sharks, particularly when the large coastal shark fishery is closed.

The 1993 FMP defined small coastal sharks as fully fished. A stock assessment for these species has not been conducted since 1993. Thus, despite increases in landings, the 1999 FMP for Atlantic tunas, swordfish, and sharks had to use the reference points defined in the 1993 FMP to determine the current status of small coastal sharks. For this reason, small coastal sharks are considered fully fished. As with pelagic sharks, a stock assessment is needed for these species in order to establish the status of these stocks and to measure the efficacy of current regulations.

Current commercial regulations for small coastal sharks include limited access permitting and reporting requirements, a trip limit of 16 pelagic and small coastal sharks for incidental permits, a ban on finning, prohibited species, and authorized gears. Certain commercial measures for small coastal sharks are currently not in force pending a litigation settlement agreement.

Table 3.8 Estimated small coastal shark commercial landings (pounds dw) in the Atlantic by species. Source: Cortes, 1999c and 2000.

Species Name	1997	1998	1999
Caribbean sharpnose	---	---	2,039
Atlantic sharpnose	256,562	230,920	239,647
Blacknose	202,781	119,689	130,317
Bonnethead	75,787	13,949	53,702
Finetooth	169,733	267,224	246,404
Shark, unclassified (assumed small coastal sharks)	51	82	136
Total	704,914 (320 mt)	631,864 (287 mt)	672,245 (305 mt)

Prohibited Species

In April 1997, NMFS prohibited possession of five species of sharks: whale, basking, sand tiger, bigeye sand tiger, and white sharks. 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. Dusky, night (*C. signatus*), and sand tiger sharks were petitioned and added to Candidate Species List under the ESA in the fall of 1997. However, NMFS had already prohibited possession of sand tiger sharks in the commercial and recreational fisheries, and thereby had already afforded those species the maximum protection possible within its fisheries management jurisdiction.

The 1999 FMP for Atlantic tunas, swordfish, and sharks prohibited the retention of an additional 14 species of sharks, including dusky and night sharks, based on a precautionary approach that prohibits retention of any species unless its stock size can support and sustain fishing mortality sufficiently to meet the FMPs objectives. This action was selected because it helps prevent development of directed fisheries or markets for uncommon or seriously depleted species. This action was selected for dusky and night sharks due to catch rate data that indicate large population declines since the early 1970s, and will allow for faster rebuilding for these species, if bycatch mortality is not too large. All sharks not authorized for retention must be released in a manner that ensures the maximum probability of survival.

Deepwater/Other Sharks

The level of landings and discards, for any fishery, of species in the deepwater and other species group is generally unknown. However, given the nature of the species in this species group and the gear types being used, it is unlikely these species are overfished at this time.

Pelagic Longline Fishery

The U.S. pelagic longline fishery for Atlantic highly migratory species primarily targets swordfish, yellowfin tuna, or bigeye tuna in various areas and seasons. Secondary target species include dolphin, albacore tuna, pelagic sharks (e.g., mako, thresher, blue and porbeagle sharks) as well as several species of large coastal sharks. Although this gear can be modified (i.e., depth of set, hook type, etc.) to target either swordfish or tuna, like other hook and line fisheries, it is a multi-species fishery. These fisheries are opportunistic, switching gear style and making subtle changes to optimize the net returns of each individual trip (NMFS, 1999a).

Pelagic longline gear is composed of several parts. The primary fishing line, or mainline of the longline system, 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. Each individual hook is connected by a leader to the mainline. Lightsticks, which contain chemicals that emit a glowing light, are often used. 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. Fishermen preferentially target swordfish during periods when the moon is full to take advantage of increased densities of pelagic species near the surface.

Reported effort, in terms of number of vessels fishing, has fluctuated in recent years but has not shown obvious trends in the distant water, southeast coastal, and northeast coastal areas. However, there appears to be a trend towards decreasing numbers of vessels fishing in the Caribbean and the Gulf of Mexico. In all areas, the reported number of hooks per set has increased (NMFS, 1999a). Although swordfish appear to have remained the primary target species in the Caribbean, distant water, and southeast coastal fishery areas, the proportion of swordfish in the reported landed catch has decreased in both the distant water and southeast coastal areas. In the case of the distant water fishery, an increasing proportion of the reported landings are tunas (non-bluefin). Coastal shark and dolphin landings have increased in the southeast coastal area.

The pelagic longline fishery sector is comprised of five relatively distinct segments with different fishing practices and strategies: 1) the Gulf of Mexico yellowfin tuna fishery; 2) south Atlantic/ Florida east coast to Cape Hatteras swordfish fishery; 3) the Mid-Atlantic and New England swordfish and bigeye tuna fishery; 4) U.S. Atlantic distant water swordfish fishery; and 5) the Caribbean Island tuna and swordfish fishery . Each vessel type has different range capabilities due to fuel capacity, hold capacity, size, and construction. In addition to geographical area, segments differ by percentage of various target and non-target species, gear characteristics, bait, and deployment techniques. Some vessels fish in more than one fishery segment during the course of the year (NMFS, 1999a).

Bottom Longline Fishery

The Atlantic bottom longline fishery targets large coastal sharks, with landings dominated by sandbar and blacktip sharks. Gear characteristics vary slightly 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 (Branstetter and Burgess, 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.

Commercial shark fishing effort with bottom longline gear is concentrated in the southeastern United States and Gulf of Mexico. 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. In 1996, the greatest number of shark permits was issued in Florida (63 percent), followed by Louisiana and North Carolina (seven percent each). Focusing on the 565 permit holders who landed at least one large coastal shark in 1995 or 1996 ("active" permit holders), Florida is the lead state, with over 61 percent of active permit holders, followed by Louisiana and North Carolina with eight and seven percent, respectively (NMFS, 1999a). Of the 40 vessels that cumulatively caught half the reported landings, 55 percent listed Florida as their home state, followed by North Carolina at 15 percent, and Louisiana at ten percent. As with all HMS fisheries, some shark fishery participants move from their home ports to active fishing areas as the seasons change.

Between 1994 and 1997, the directed shark observer program observed 5.5 million hook hours of effort that caught more than 26,000 sharks (Branstetter and Burgess, 1997). Their observations indicated that average bottom longline sets lasted between 10.1 and 14.9 hours, with longer sets typical of the North Carolina and Florida Gulf fisheries and shorter sets typical of the South Carolina/ Georgia fishery. North Carolina fishermen, on average, set the longest lines (13.7 miles), followed by the Florida Gulf (10.5 miles) and the South Carolina/Georgia fishery (6.9 miles).

Sandbar and blacktip sharks dominated catches of large coastal sharks. Depending on region and year, they constituted 60 to 75 percent of the catch and 75 to 95 percent of the landings during the period 1994 to 1996 (Branstetter and Burgess, 1997). Tiger sharks were the third-most common large coastal sharks caught during the three-year period. However, the tiger shark has little market value and is usually discarded; a few were landed, and some small individuals were used as bait. Other species, such as dusky, bull, and lemon sharks were found to be of local importance. Five species (sandbar, blacktip, dusky, bull, and lemon sharks) constituted 95 percent of the landings. Vessels operating in the South Atlantic Bight caught and landed a greater diversity of species than other regions.

Shark Drift Gillnet Fishery

The shark drift gillnet fishery developed off the east coast of Florida and Georgia in the late 1980s and early 1990s. Based on Trent *et al.* (1997) and Carlson and Lee (2000), vessels operating in the fishery are characterized as being from 12.2-19.8 m in length. The nets (both nylon multifilament and monofilament) used are from 275-1,800 m long and 3.2-4.1 m deep, with stretched mesh from 12.7-29.9 cm. In 1993, the number of vessels operating in the fishery was 5, increased to 11 in 1995 but declined to 7 to 9 in 1999. The annual number of vessel trips is estimated between 150-185. Sharks are landed primarily by two types of gillnet gear (Carlson and Lee, 1999; Carlson, 2000). The most common type is drift gillnet gear, wherein the vessel basically sets a gillnet in a straight line off the stern during the night. The net soaks or fishes at the surface for a period of time, is inspected at various occasions during the soak, and then hauled onto the vessel when the captain/crew feel the catch is adequate. It is usually a nighttime fishery and takes place at least 4.8 km offshore in the EEZ. Mesh size ranges from 12.7-29.9 cm (5-12") stretched. The other type of gear utilized is strike-nets, wherein the vessel takes its gillnet and encircles a school of sharks. This is done usually during daylight hours, using visual sighting of shark schools from the vessel and/or a spotter plane. The gear is encircled around the sharks, but is otherwise hauled back onto the vessel without much soak time.

Based on data from an observer program during 1998-2000, sharks comprised between 89-92 percent of the total observed catch composition (percent of numbers caught). Depending on season, usually the Atlantic sharpnose shark, blacknose shark, blacktip shark, bonnethead (*Sphyrna tiburo*), and finetooth shark make up 90-95 percent by number of the observed shark catch. The discarded portions of the targeted catch (sharks) also varied by season. From 1998-2000, dead discards included scalloped hammerhead shark (21-41 percent), common thresher shark (62 percent), bonnethead (54 percent), and blacktip shark (29 percent).   In most cases, the reason for discarding sharks was the lower quality of flesh and low or no market in the case of the hammerheads and thresher sharks. In the case of the blacktip shark, discards were related to fishing activity that occurred during the large coastal season closure and state size regulations imposed on large coastal species.

Recently a directed fishery for sharks has developed in state waters off the coast of Alabama. Preliminary information indicates that the fishery is operating under 100 percent observer coverage and two fishermen are using gillnets up to 2,300 feet with 8-12" mesh to target blacktip and spinner sharks (W. Ingram, Alabama Department of Coastal Natural Resources, personal communication to J. Carlson).

Menhaden Purse Seine Fishery

The Gulf of Mexico menhaden purse seine fishery operates mainly off Louisiana from the beginning of the third week in April through the end of October each year. Trips typically last one week (7 sea days). Based on the description provided by De Silva *et al.* (in press), sets are made when a school of menhaden is located, with two purse boats, each containing half a purse seine, encircling the school along with any associated species. After encircling the school, the purse line is drawn, resulting in the closing of the net, and the net retrieved back into the purse boats mostly with the use of power blocks. The mother boat then comes alongside and secures the net and purse boats to its port side. The entire set generally lasts 25-60 minutes. For the period 1994-1995, observer data indicated that the mortality rate of sharks caught was 75 percent. Large coastal sharks made up 97 percent of the shark bycatch, of which 35.3 percent were blacktip sharks and 1.8 percent were sandbar sharks, while small coastal sharks made up the remaining 3 percent. The total estimated number of sharks caught in this fishery was about 36,000 in 1994 and 33,000 in 1995, or approximately 26,200 and 24,000 large coastal sharks in 1994 and 1995, respectively (Cortes, 1999c).

Research and Management Needs

Research and management needs in commercial fisheries in the Atlantic Ocean and Gulf of Mexico involve improving scientific assessments, determining bycatch and bycatch mortality levels, assessing the efficacy of current management measures, and improving outreach and cooperation with commercial shark fishermen and their communities. High priority needs include: 1) improving species-specific identification of catches, landings, discards, and trade data; 2) conducting stock assessments on small coastal and pelagic sharks and species-specific assessments on dusky and sand tiger sharks; 3) continued participation in international research and management initiatives, particularly for pelagic sharks; 4) determining and minimizing bycatch mortality rates of sharks, particularly prohibited species and juvenile sharks; and 5) continued research to determine nursery areas and spatial and temporal use of nursery areas for sharks by size/stage and species. Additional research and management needs include continued research on basic life history parameters; increasing observer sampling in all shark fisheries, particularly in the western Gulf of Mexico; and continued development of size and stage-based models for important shark species, including sandbar and blacktip sharks.

3.2.2 Spiny Dogfish Fisheries

The spiny dogfish *(Squalus acanthia*s) is a common small shark that inhabits the temperate and sub-Arctic latitudes of the North Atlantic Ocean. In the Northwest Atlantic, spiny dogfish range from Labrador to Florida, but are most abundant from Nova Scotia to Cape Hatteras. They migrate seasonally, moving north in spring and summer, and south in fall and winter (MAFMC and NEFMC, 1999). Spiny dogfish school by size until they mature and then school by both size and sex. Canadian research surveys indicate that spiny dogfish are distributed throughout the Canadian Maritimes during the summer months. The stock is concentrated in U.S. waters during the fall through spring. Spiny dogfish are considered a unit stock in the Northwest Atlantic Ocean and, as such, represent an interjurisdictional stock (MAFMC and NEFMC, 1999).

The combination of increased fishing mortality, declining biomass of mature females, and low recruitment have contributed to the overfished condition of the stock. The fishing mortality rate (F) has correspondingly risen from below an estimated F=0.1 in the 1980s to the current estimate of F=0.3. Dogfish landings have been primarily composed of females because they attain a larger size than males, and large fish are preferred by the processing sector. The 26th Northeast Regional Stock Assessment Workshop (SAW 26), in 1998, indicated that biomass estimates of mature females (> 80 cm) have declined by over 50 percent since 1989. The removal of a large portion of the female spawning stock since 1989 has reversed the trend of increasing mature biomass since the late 1970s. Recruitment of juvenile spiny dogfish was the lowest on record in 1997. In addition, length frequency data from both U.S. commercial landings and research surveys indicate a pronounced decrease in the average size of females in recent years. For example, the mean length of females landed in the commercial fishery has declined from 38 inches in 1982 to 33 inches in 1996 (MAFMC and NEFMC, 1999).

Total commercial landings of spiny dogfish from 1968 through 1974 increased largely due to the foreign fleet harvest, most notably the former Soviet Union. Foreign landings during the period 1965 to 1977 were about 156, 000 mt. With the advent of the EEZ, the foreign harvest dwindled to a low in 1979, but landings by the United States and Canada have been steadily increasing since then, as export markets for dogfish have been developed (MAFMC and NEFMC, 1999).

A sharp intensification of the U.S. commercial fishery began in 1990. Landings increased six-fold from roughly 4,500 mt in 1989 to 27,000 mt in 1996 (MAFMC and NEFMC, 1999). From 1990 to 1997, U.S. commercial landings averaged about 18,000 mt. Cumulative removals during this eight year period were roughly 154,000 mt; in contrast, cumulative U.S. landings for the period 1962 to 1989 were only 54,000 mt. However, although the reported weights of landings were similar, the recent U.S. fishery generated significant discards and the landings were comprised almost exclusively of mature females. In contrast, the foreign fishery was prosecuted on all sizes of spiny dogfish with minimal discarding (MAFMC and NEFMC, 1999). Virtually all of the spiny dogfish taken as bycatch in the mixed- and multi-species gillnet and otter trawl fisheries in the northwest Atlantic Ocean were discarded based on sea sample data from 1991 to 1993. The primary reason for the discarding of dogfish taken in these fisheries is the small size or lack of market (MAFMC and NEFMC, 1999).

Spiny dogfish are landed in every state from Maine to North Carolina with numerous gear types. However, prior to 1990, Massachusetts was responsible for the vast majority of commercial landings. Beginning in 1989 (as the U.S. fishery expansion began), the states of North Carolina, New Jersey, Maryland, and Maine began to increase in importance. Overall, Massachusetts and North Carolina recorded the highest landings of spiny dogfish during the period 1988 to 1997, followed by Maryland, Maine, New Jersey, Rhode Island, New Hampshire, and Virginia (MAFMC and NEFMC, 1999). Two principal gear types, trawls and gillnets, accounted for roughly equal amounts of spiny dogfish landings from 1988 to 1990. As the fishery expanded in the early 1990s, gillnets increased dramatically in importance. In 1991, gillnets accounted for greater than 60 percent of the dogfish landed, for 75 percent by 1993, and for 80 percent by 1996. Thus, the dramatic increase in spiny dogfish landings in recent years is due largely to an increase in gillnet activity in the fishery (MAFMC and NEFMC, 1999).

The Spiny Dogfish FMP implemented the following measures: 1) A commercial quota; 2) seasonal (semi-annual) allocation of a commercial quota; 3) a prohibition on finning; 4) a framework adjustment process; 5) the establishment of a Spiny Dogfish Monitoring Committee; 6) annual FMP review; 7) permit and reporting requirements for commercial vessels, operators, and dealers; and 8) other measures regarding sea samplers, foreign fishing, and exempted fishing activities.

Research and Management Needs

Research and management needs for the commercial spiny dogfish fishery include: updating age and growth estimates; updating length at maturity estimates; updating/investigating food habits of young-of-year and recruits; improving estimates of discards from non-directed fisheries; investigating potential databases from coastal states regarding estuarine use, particularly in the mid-Atlantic region; and increasing the frequency of sex determination for all surveys and seasons. A number of areas where primary data are lacking include the spatial extent of fishing induced disturbance; the effects of specific gear types, along a gradient of effort, on specific habitat types; and the role of seafloor habitats on the population dynamics of harvested demersal species. These data should allow managers to regulate the amount of fishing that would be sustainable relative to essential fish habitat.

3.2.3 Other Atlantic Fisheries

Other fisheries in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea which may have incidental catches or bycatch of sharks include: northeast multispecies, Atlantic herring, Atlantic mackerel, squid, and butterfish, Atlantic menhaden, weakfish, monkfish, summer flounder, scup, black sea bass, coastal gillnet, south Atlantic snapper-grouper, south Atlantic coastal migratory pelagics, south Atlantic shrimp fisheries. These fisheries are managed under the New England, Mid Atlantic, South Atlantic, and/or Gulf of Mexico Fishery Management Councils.

Research and Management Needs

Research and management needs for these fisheries include assessments of the catch, landings, and disposition of sharks caught as incidental catch and/or bycatch and the impacts of this mortality is having upon the health of the relevant shark species populations.

3.2.4 Pacific Fisheries

Common Thresher Shark

In California, 94 percent of the total thresher shark commercial landings is taken in the driftnet ("drift gillnet") fishery for swordfish, where it is the second most valuable species landed. This fishery began in the Southern California Bight (SCB) in 1977-78, the common thresher being specifically targeted then. From early on and amid signs of population decline, various restrictions were emplaced by the State of California to protect reproducing females, as well as striped marlin, marine mammals, and the swordfish that had become increasingly targeted.

After 1981, the directed fishery for thresher shark was affected by various season and area closures. The spring-season directed fishery originally began February 1, but in 1982 was allowed only after April, then by 1986 only during May, and then essentially closed after 1990, when driftnet fishing was either entirely closed or had to be at greater than 75 miles from shore through mid-August (Hanan *et al.*, 1993). Driftnetting was allowed inshore the rest of the year (August 15 to January 31), but not within various limits depending upon place and month. These closures strongly reduced fishing effort within 20 miles of land where most threshers were caught (the species favors coastal habitats). However, effort expanded offshore and northward beyond the SCB by 1982 (eventually to off Oregon and Washington), and total effort did not decline until after 1986.

Catches peaked early in this fishery with approximately 1,000 mt taken in 1982 (Hanan *et al.*, 1993), declined sharply in 1986, and have been low since. Since 1990 annual catches have averaged 200 mt (1990-1998 period) and appear stable (Holts *et al.*, 1998). Catch per unit effort also declined from initial levels.

The early increase to peak catches followed by strong decline with continuous reductions in fishing effort, and then finally relatively stable catches at much reduced catch per unit effort

(CPUE) levels, are symptomatic of the "fishing-up" effect (Ricker, 1975), i.e., the temporary support of elevated catches from fishing at unsustainable rates and then stock reduction and contraction of fishing effort. This is an expected exploitation pattern for slow-growing, long-lived species that, while of low productivity, eventually accumulate a sizable, fishable biomass.

Exploitation reduced the common thresher population as indicated by decline in CPUE (Hill and Holts, unpublished data; Holts *et al.*, 1998), but the magnitude of the decline as a measure of stock reduction is confounded by the effects of the various area and time closures, the offshore expansion, and the changed emphasis from shark to swordfish among most of the fishermen. The closures reduced annual catches by approximately 50 percent of the peak years (Hanan *et al.*, 1993; Cailliet *et al.*, 1991) and, being area specific, likely altered catchabilities according to age and size.

Present levels of fishing effort are allowing slow stock growth, as seen in the significant rise of CPUE in certain inshore areas (e.g., just south of Pt. Conception (Hill and Holts, unpublished data), and an increase in sustainable catches is to be expected. However, such catches will always be much less than the unsustainable catches of the early years. The common thresher MSY is estimated to be as little as 4-7 percent of the standing population that supplied the early-period fishing-up catches, based on the estimated population rate of increase (Smith *et al.* (*in press*); Au *et al.* (*in press*)).

As a species whose strategy for long-term survivability depends upon steady, rather than strong, recruitment (Stearns, 1992), it is important that some adults survive well to accumulate as a multi-aged breeding pool, at least in certain areas. This appears to be occurring, as the spring-season restrictions on the fishery have provided substantial protection to threshers that are vulnerable during the reproductive season. The PSMFC has set a 340 mt coastwide annual landings guideline for this shark, which since 1991 has not been approached. Further, the California driftnet fishery is a limited entry fishery with permits not being re-issued (Steve Cooke, Calif. Dept. Fish and Game, personal communication).

The common thresher also occurs off British Columbia and Central America. Populations off Baja California may be of the same stock as occur of the U.S. Pacific coast, and transboundary movements of tagged specimens have been observed. Little is known about the fisheries off Mexico since many of the shark landings there are not reported at the species level. During 1989-1993, 5,400 mt of sharks (various spp.) were landed from the states of Baja California (Norte) and Baja California Sur (Holts *et al.*, 1998).

Shortfin Mako Shark

This species is also taken primarily by the California driftnet fishery for swordfish, (82 percent of its commercial landings). Although present catches are only about 80 mt per year, the mako shark is still the second most valuable species taken in the fishery. Like the common thresher, shortfin mako catches have been affected by the changes that occurred in the driftnet fishery. Its catches peaked early (240 mt in 1982) and then declined. Makos are also taken in smaller amounts (less than 10 mt per year) by California-based longliners operating beyond the

EEZ (Vojkovich and Barsky, 1998). During 1988-1991, there was an experimental longline fishery for makos and blue sharks in the SCB.

The fishery takes primarily juveniles and subadults. The SCB is evidently an important nursery and feeding area for immature stages (Hanan *et al.*, 1993). Catch localities are like that of the common thresher, but with nearshore occurrences less frequent. The mako's distribution is affected by temperature, warmer years being associated with more northward movement.

Mako CPUEs between 1982 and 1995 show some decline (Hill and Holts, unpublished data; Holts *et al.*, 1998). A trend of decreasing average size is also seen in the catches. These indications of stock reduction under exploitation are problematical with respect to degree, because of the changes that occurred in the fishery, the effect of warm-water years, and the fact that exploitation extends to only a very small proportion of the adults. Whatever the decline observed, it is unlikely to be representative of change for the entire stock. The adult female fraction is not available to California fishermen (Cailliet *et al.*, 1991).

Considering the mako's tropical to warm-temperate, ocean-wide range, and the low availability of adult females to fishing gears (pregnant females are rarely taken anywhere, and the California driftnet fishery basically takes immature animals), this species is probably not being depleted off the Pacific Coast States. However, its productivity potential is like that of the thresher shark (Smith *et al.*, *in press*), and the SCB is without doubt an important nursery/growing area for the species. A reasonable assumption is that the present time-area restrictions on driftnet fishing does provide valuable protection for the stock's immature life stages. Thus the longline experimental fishing program (1988-1992) that demonstrated high catchability by that gear (taking 109 mt of mako during its first year -- like the species' catch from the entire driftnet fishery) was closed out of concern for the immature sharks (as well as for traditional fishermen).

The shortfin mako also occurs off Mexico, and populations there may of the same stock fished in U.S. waters. Makos tagged in the SCB have been recaptured as far south as Acapulco, Mexico.

Blue Shark

This is probably the most commonly caught shark, but its catches are poorly known because of low market value. Most of the catch is discarded. It is taken in both the driftnet and longline fisheries. Experimental longlining for blue sharks was conducted in California waters during 1979-1980 and 1998-1992 (the latter was the mako-blue shark experiment) in attempts to develop markets for the species. Peak reported landings from all gears were 87 and 92 mt in 1980 and 1981 respectively. Since 1985 landings have averaged less than 5 mt (Holts *et al.*, 1998). There is some evidence for decrease in average size in the catches.

The blue shark is extensively distributed from tropic to temperate seas and is probably the most abundant of all large top-predators. Its reproducing/nursery areas appear to be the subtropic-subarctic transition waters spanning the north Pacific and including southerly extensions along the eastern and western coasts (Nakano, 1994). Comparison of length distributions from the driftnet fishery off California and the longline swordfish fishery operating north of Hawaii indicates that subadult blue sharks move out from EEZ waters to join the oceanic, adult portion of their population as they approach sexual maturity; the females leave at younger ages than the males.

Stevens (1996) estimated that 138,000 mt of blue shark were taken by Pacific international longline fleets in 1994. But while there is some evidence for stock decline in the central Pacific (Nakano, 1996), there is not at yet evidence for overexploitation. There is insufficient information from the PFMC's coastal gillnet and longline fisheries to infer stock status at this time, and the representativeness of the locally available population to the main oceanic stock is unknown. Constraints on the driftnet fishery afford some protection for these sharks, which are mostly juveniles and subadults. No constraints exist for longline operations beyond the EEZ. For a description of the status of the Pacific-wide blue shark stock, see Section 3.3.6.

Pacific Angel Shark

The angel shark is a sedentary bottom species that apparently was abundant locally in the shallow waters of California's Santa Barbara Channel and off the Channel Islands. It is a slow-growing (maturing at 10 years), long-lived species. While no longer important commercially, it once was the object of a directed fishery.

A set-gillnet fishery targeting angel shark began in 1978 off Santa Barbara; it expanded rapidly as its fresh product market grew (Cailliet *et al.*, 1991). The species is relatively lethargic and the population exploited was localized and vulnerable, mainly in waters less than 20 m deep (Holts, 1988). Catches peaked in 1985-1986 at 560 mt but decreased quickly to 120 mt three years later. Minimum retention sizes adopted in 1988 to protect the juveniles and young adults did not halt the decline. Depletion was evident, but not surprising; the shark's productivity, about half that of the pelagic species (Smith *et al.*, 1998), was apparently entirely surpassed. But, in 1994, California voters banned set gillnets in nearshore waters, which terminated this fishery and likely averted population collapse.

For slow-growing species such as angel shark, it is important that there be allowed at least some local concentrations of reproducing adults to serve as replenishing stock for losses to fishing. Presumably, the angel shark stock is now growing, as the directed fishery on it is closed. Recent (1994-1998) catches by set gillnets, where allowed, have been about 18 mt per year.

Soupfin Shark

This species is also slow-growing (maturing at 12 years), and its productivity is also low. But it is wide-ranging and widespread. It has commercial potential, for it apparently can build up to a considerable biomass, as indicated by its infamous, once important fishery.

The fishery for soupfin expanded spectacularly in 1938 with discovery that this shark's liver oil was rich in vitamin A (Ripley, 1946). With set gillnets the preferred gear type, the catch of mainly adults peaked in 1940 at about 4,000 mt. World War II heightened the demand for livers, but the fishery crashed in 1942 and the catch was down to less than 300 mt by 1944. Demand finally dropped after synthetic vitamin A came onto markets in the late 1940s.

The severe catch decline even under unrelented fishing effort clearly demonstrated the overfishing of the soupfin population. It is evident that temporary high catches were obtained at unsustainable rates (the fishing-up effect). The population must have been strongly reduced, though it probably did not itself collapse, because of the short duration of the directed fishery and the long pre-adult age span that delays effects of reduced reproduction (Walker, 1999; Holden, 1977).

The soupfin is no longer important commercially, only about 40 mt per year now being caught in set gillnets. If targeted again, it should be important to recognize that its sustainable yield has to be only a small fraction of its accumulated biomass, about 3 percent (Smith *et al.*, 1998).

Salmon, Pelagic Thresher, and Bigeye Thresher Sharks

The status of these sharks is unknown off the Pacific Coast States. They are minor components of the driftnet catch. Recent catches (1994-1998) averaged less than 1, 8, and 25 mt per year for the salmon and pelagic and bigeye thresher sharks, respectively.

Spiny Dogfish

Off the U.S. west coast, there is a limited commercial market for spiny dogfish (*Squalus acanthias*). At one time, however, sharks were a target species of the liver fishery. Peak landings of 56,000 mt occurred in 1944 but by the late 1950s the fishery had essentially collapsed after synthetic vitamin A was marketed. Today, this fishery is primarily conducted with bottom trawls off the Oregon-Washington coast. The coastwide landed catch in 1999 was 514 mt which is near the 15 year average but below the peak of 1,392 mt in 1994 (see Table 3.9). Spiny dogfish are common in this area and are typically the third most abundant species in bottom trawl surveys on the continental shelf (Table 3.10). The average landed catch of 532 mt is a relatively small fraction of the nominal average biomass from the trawl surveys (43,000 mt) and there is no obvious downward trend in the 1977-1998 era of survey coverage. However, no assessment of the impact of this fishery or the status of the fishery has ever been conducted, and the total catch of dogfish is likely to be significantly greater than the recorded landed catch. Dogfish are a schooling species so are occasionally caught in large numbers by bottom trawls. This fact plus the limited market for dogfish leads to high levels of discard. Although there is no comprehensive observer program on the west coast to determine the total catch of dogfish and other sharks, preliminary examination of a pilot observer program indicates that the landed catch of spiny dogfish may be only 25 percent of the total catch.

Spiny dogfish are one of three shark species listed in the PFMC's groundfish FMP. Knowledge of the other two species (leopard shark, *Triakis semifasciata*, and soupfin shark, *Galeorhinus zyopterus*) is even more limited than that for dogfish. Coastwide catch of these two species averaged 19 and 73 mt, respectively, with a downward trend over the 1984-1999 time period.

Table 3.9 Shark landings (mt) for California, Oregon, and Washington, 1991-2000, organized by species group. Source: PSMFC, PacFIN Database, May 2000, <<www.psmfc.org/pacfin/data>>.

	Year									
Species Name	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Bigeye thresher shark	0	0	0	37.0	0	20.4	31.6	10.9	5.5	3.4
Blue shark	0.7	1.4	0.5	12.2	5.3	0.9	0.6	2.9	0.3	0.8
Common thresher shark	0	0	0	329.7	0	319.5	319.0	325.5	319.9	174.2
Leopard shark	21.8	19.3	23.8	10.7	9.9	7.6	11.3	14.8	14.3	9.4
Other shark	170.1	120.0	72.5	24.9	18.7	17.8	33.4	54.9	54.5	24.5
Pelagic thresher shark	0	0	0	0	0	1.2	34.8	1.8	10.3	0.1
Shortfin mako	218.7	142.0	122.2	127.9	95.4	96.0	131.6	97.6	62.6	28.4
Soupfin shark	50.7	46.0	39.5	55.1	43.9	65.2	62.7	53.7	74.6	31.3
Spiny dogfish	3,450.0	2,992.3	2,559.2	3,057.1	2,261.2	2,053.2	1,417.6	1,358.3	985.2	838.6
Unspecified shark	8.6	5.9	4.8	6.2	15.9	5.0	6.3	6.7	12.8	5.3

Table 3.10 Abundance (mt) of spiny dogfish in the NMFS bottom trawl survey conducted off the U.S. west coast from approximately Monterey Bay, California to the U.S.-Canada border in the depth zone 30-200 fathoms. Source: Shaw *et al.*, 2000

	Year							
Species Name	**1977**	**1980**	**1983**	**1986**	**1989**	**1992**	**1995**	**1998**
Spiny dogfish	32269	34265	68155	25579	97957	37108	15781	33839

The west coast groundfish fishery operates over a broad depth range with significant fishing activities by trawl, longline and pots out to 1,500 m. Trawl surveys in this deeper range encounter brown cat shark, filetail cat shark, and longnose cat shark which indicates that these other species probably are bycatch in this deepwater fishery.

Research and Management Needs

Currently, a highly migratory species FMP is being developed by the PFMC that will bring several of the large shark species (common thresher, pelagic thresher, bigeye thresher, shortfin mako, and blue) under its jurisdiction. Research and management needs include: monitoring increased CPUEs for common thresher sharks and ensuring that some adults survive to accumulate a multi-aged breeding pool; determining transboundary movements of common thresher and shortfin mako sharks; investigating species composition of shark catches in Mexican fisheries; investigating the trend of decreasing average sizes of shortfin mako sharks and the degree to which this trends reflects changes in the entire stock; analyzing the stock status of Pacific angel sharks to assess if rebuilding is occurring; determining the status of salmon sharks, pelagic and bigeye thresher sharks, leopard sharks, spiny dogfish; and determining the status elasmobranchs that are taken incidentally in groundfish fisheries.

3.2.5 North Pacific Fisheries

Off Alaska, the harvest of sharks and skates in U.S. waters is managed under the BSAI Groundfish FMP as components of the "other species complex" category. The harvest of sculpins, octopus, sharks, and skates is managed collectively under a quota which is currently set at or slightly above the average catch levels from the previous few years. Similarly, under the GOA Groundfish FMP, sharks and skates are managed as part of an "other species" group (which includes those in the BSAI Groundfish FMP as well as squid). Under this FMP, the total allowable catch is set at 5 percent of the sum of all target species harvest limits.

Skates and sharks are caught in all GOA fisheries, and together represent the majority (50 -80 percent) of estimated "other species" catches between 1990-1998. Shark catches alone have composed 9-20 percent of estimated other species catches (Gaichas *et al.*, 1999). Spiny dogfish make up 49 percent of estimated shark catches on average, followed by Pacific sleeper sharks (19 percent), unidentified sharks (18 percent), and salmon sharks (12 percent). Blue sharks, sixgill sharks, and brown cat sharks were rarely identified in catches. Salmon sharks are taken as rare bycatch in pollock fisheries (primarily pelagic trawl gear), while Pacific sleeper sharks and spiny dogfish are more often taken by bottom trawl and longline fisheries (Gaichas *et al.*, 1999). Catches of other species have been small compared to those of target species in the GOA and it appears unlikely that the observed 1990-1998 bycatch of other species has had a negative effect on biomass at the species group level, according to available data (Gaichas *et al.*, 1999).

Salmon Shark

The salmon shark, *Lamna ditropis*, and the Pacific sleeper shark, *Somniosus pacificus*, are the predominant large predatory fish species of the boreal north Pacific, yet very little is known of their ecology, or seasonal movements. Throughout the 1990s salmon shark and sleeper shark sightings and catches in Prince William Sound (PWS) and the GOA have increased. Reports of an increasing trend in the abundance of sharks in Prince William Sound and the eastern Gulf of Alaska have come to the attention of biologists, commercial and sport fishermen, and the popular press in recent years. Anecdotal accounts of increasing numbers of sharks in the eastern GOA are supported by a time series of relative abundance (catch per unit of effort) of sharks in the region. A preliminary analysis of shark bycatch from International Pacific Halibut Commission (IPHC) longline survey data indicates that spiny dogfish, sleeper, and salmon sharks have increased in abundance in the region in recent years

Salmon sharks are rarely caught in commercial gear, and information on trends in abundance is largely anecdotal. However, salmon sharks appear to be the predominant large predatory pelagic fish in the coastal GOA. A member of the family Lamnidae, they are the Pacific congener of the porbeagle shark in the Atlantic Ocean and are closely related to white and mako sharks. Throughout the 1990s, salmon shark abundance in the northern GOA has increased. The vast majority of salmon sharks aggregating in surface waters of the GOA are adult females. They have been reported to reach 3 m in length, although normal size range appears to be between 1.8 and 2.4 m. Salmon sharks maintain an elevated body temperature and studies have shown that they may have the highest body temperature of any shark, as much as 13.6° C above ambient water temperatures. Because of this, they likely possess a relatively high metabolic rate and daily ration. Their diet consists primarily of salmon, squid, and groundfish.

As part of the Alaska Predator Ecosystem Experiment project, the NMFS Auke Bay Laboratory conducted a pilot salmon shark study in 1999. Non-lethal stomach contents and tissue samples for fatty acids, stable isotope, and population genetics analyses were collected. The sharks were tagged with Floy tags, and three were released with "pop-up" archival satellite tags. Although large surface aggregations of salmon sharks have become common during summer months in PWS in recent years, data collected from the satellite tags, hydroacoustics, and underwater video indicate that the majority of the sharks present are below the surface at any given time. The pop-up archival satellite tag data from late July to late September indicate that the sharks spend the majority of their time between 10 and 50 m depth and did not have clear diel patterns of depth preference (B. Wright, NMFS, Auke Bay, AK, personal communication).

Spiny Dogfish

Spiny dogfish are commonly taken as bycatch in commercial fishing gear in Alaska. They are particularly well represented in the pelagic trawl pollock fishery and in longline fisheries for sablefish, halibut, Greenland turbot, and Pacific cod. IPHC longline survey data are the only long-term source of spiny dogfish bycatch records available. IPHC grid surveys were expanded in 1996 to include statistical areas east of area 240. The survey data indicate an increasing trend in relative abundance of dogfish along the eastern and central gulf coast of Alaska in the 1990s. A downturn in this trend in 1999 corresponds to a virtual no-show for eulachon in the Copper River, although fishermen in the Yakutat area continued to have problems with dogfish swamping salmon gill-nets. Dogfish bycatch has presented a formidable problem for IPHC statistical analyses of halibut abundance in recent years, a problem that has not been resolved (Dan Randolf, personal communication). The increasing trend of dogfish is supported by NMFS small mesh trawl surveys in the Kodiak Island region (Paul Anderson, NMFS, Kodiak, AK, personal communication).

Sleeper Shark

The Pacific sleeper shark is another shark species that has increased in abundance in recent years. Sleeper sharks are one of the few sharks found in polar waters year-round and are the Pacific congener of the Greenland shark. They are a large demersal species generally inhabiting deep water, although they occasionally come to the surface at high latitudes. NMFS and IPHC researchers in Alaska have caught specimens in the six meter range although they average 1.8 to 2.4 m in length in PWS sablefish surveys. Sleeper sharks are opportunistic predators whose diet consists primarily of groundfish, squid, and salmon. They are also known to prey on marine mammals, including harbor seals and southern right whale dolphins. Alaska Department of Fish and Game sablefish survey data also indicate an increasing trend in sleeper shark abundance since the survey began in 1996. While finding empirical data for relative trends in sleeper shark and dogfish bycatch in Alaska is difficult, they are particularly hard to come by for salmon sharks.

In July 1998, the Alaska Department of Fish and Game submitted a proposal to the NPFMC requesting Federal action to change the management of sharks, skates, and rays to complement the management measures in the territorial waters of Alaska initiated by the Alaska Board of Fisheries. At its October 1998 meeting, the NPFMC initiated analyses of proposed alternatives for plan amendments to the BSAI and GOA groundfish FMPs. In April 1999, the NPFMC released an environmental assessment, regulatory impact review, and initial regulatory flexibility analysis for Amendments 63/63 to the FMPs for the groundfish fisheries of the BSAI and GOA to revise management of sharks and skates.

In December 1999, the NPFMC recommended that all "other species," including sharks and skates, be placed on bycatch status (no directed fishery) as part of its quota specification recommendations. NMFS determined, however, that the FMPs did not authorize that action. Final action on the proposed Plan Amendments 63/63 to the Bering Sea/Aleutian Islands and Gulf of Alaska FMPs to consider prohibiting directed fishing on sharks and skates and finning of sharks will be rescheduled for spring 2001.

Research and Management Needs

While an assessment of the status of sharks off the west coast has been conducted, the information on distribution, stock structure, and life history characteristics remains extremely limited for "other species" in the GOA (Gaichas *et al.*, 1999). This assessment relied on life history information from the same or similar species in other geographic areas because region and fishery-specific information is lacking. Because managing by species groups can result in excessive fishing mortality on less productive species, further investigation is necessary to ensure that all components of the other species group are not adversely affected by groundfish fisheries.

3.2.6 Western, Central, and South Pacific Fisheries

The U.S. Flag Pacific Islands comprise the State of Hawaii, the Territories of American Samoa and Guam, the Commonwealth of the Northern Marianas, and six other US Flag Pacific Island groups under military (Wake Island, Johnson Atoll) or Federal (Howland and Baker, Jarvis, Kingman Reef and Palmyra Atoll, Midway) control. A tuna and swordfish fishery operating out of Hawaii is the largest Federally regulated US domestic fishery in the western and central Pacific. A smaller artisanal longline fishery also operates out of Pago Pago, American Samoa. The balance of pelagic fisheries production is generated by small troll and handline vessels and by a small skipjack pole-and-line fleet in Hawaii. Nearshore fisheries (0 to 3 nautical miles), such as troll and handline, come primarily under the management authority of the state or territorial governments. A U.S. purse seine fleet operates under an international treaty in the Western Pacific. The various US Insular Pacific fisheries are defined by Federal Register notice (dated December 2, 1999, Vol. 64 No. 231 pg. 67511-67524).

The Western Pacific Pelagic FMP includes a variety of sharks within the pelagic management unit species. At the family level, included are Alopiidae- thresher sharks, Carcharhinidae- requiem sharks, Lamnidae- mackerel sharks, and Sphyrnidae- hammerhead sharks. But only a few sharks species represent the preponderance of the catch in pelagic fisheries. In fact, a single species, the blue shark, represents the vast majority of sharks caught in western Pacific fisheries (see Table 3.11) (Ito and Machado, 1999). In Hawaii, the sharks caught most commonly by small-scale gears are the makos (*Isurus* spp) and threshers (*Alopias* spp). In American Samoa, makos and threshers are also a common component of longline shark catch, but the predominant species in the catch is the blue shark. In the Mariana Islands (Guam), silky (*C. falciformes*) and Galapagos (*C. galapagensis*) sharks comprise the majority of shark catches, with a mix of other pelagics and coastal species making up the balance (Haight and Dalzell, 2000). From a broader view, vessels from various Pacific Rim and Island nations also have a significant incidental catch of sharks. With some minor exceptions, sharks are not the target species of fisheries in the central, western and South Pacific. Therefore it is difficult to determine shark catches throughout the region with precision. Nonetheless, Stevens (1996) estimated between 283,000 and 470,400 mt of sharks were landed by all high-seas Pacific fishing in 1994, of which 140,100 mt (30-50 percent of the total) were blue sharks. In comparison, all U.S. Pacific insular fisheries caught less than 3,000 mt of sharks in 1998.

In September 2000, NMFS and Japan's National Research Institute of Far Seas Fisheries conducted a collaborative preliminary Pacific-wide stock assessment of blue sharks; this project is still in progress. Plausible values for MSY and associated fishing mortality at MSY (Fmsy) were calculated. Currently, several estimated scenarios have been generated based on various structural assumptions in setting up the assessment model and given history of abundance, recruitment, fishing mortality, and other parameters (Kleiber and Takeuchi, 2000). As a basis for the MSY calculations, the most conservative, or pessimistic, approach which showed the most impact of fisheries and the least degree of recovery was used to select an example scenario. Under that scenario, the calculated MSY was approximately 2 million blue sharks per year at an Fmsy of approximately four times the current fishing mortality levels. Because of the one-sided nature of the assumptions made, different assumptions would result in higher MSY and Fmsy values. Irrespective of the numerical results, the central conclusion of this work is that, under the current fishing regime in the North Pacific, the blue shark population appears to be under-exploited (Kleiber and Takeuchi, 2000).

Hawaii (Pelagic) Longline Fishery

The Hawaii-based pelagic longline fishery has roots dating back to the turn of the 20th century (Boggs and Ito, 1993). It expanded rapidly in the late 1980s and early 1990s with a more than four-fold increase in vessels in part because of the discovery of swordfish stocks around Hawaiian archipelago and strong export incentives for tuna. Hawaii longliners traditionally targeted bigeye, yellowfin, and albacore tuna but more recently may undertake "mixed trips" where both swordfish and tuna are targeted (He *et al.*, 1997).

Monofilament main lines are typically 30-50 nautical miles long and consist of 800 to 1,700 branch lines and hooks (depending on target species) (Boggs and Ito, 1993). Swordfish and mixed trips set their gear with fewer hooks between floats, which keeps the gear shallow. The gear is set in the evening and hauled the following morning. The main difference between swordfish and mixed-species fishing strategy involves the use of lightsticks, which are placed at more frequent intervals when targeting swordfish (Ito and Machado, 1999). In contrast, when targeting tuna, more hooks are used between floats and the gear is set during the day. The Hawaii-based fleet preserve their catch with ice because the principal market demand is for fresh rather than frozen fish (McCoy and Ishihara, 1999).

Fishing strategy influences shark incidental catch (Bigelow *et al.*, 1999). Swordfish sets are shallow while tuna are caught in deeper sets. In addition, some vessels use stainless steel wire leaders while others use monofilament. Depth of set affects species composition of shark incidental catch and wire leaders result in higher catch rates (because sharks are less likely to bite through the leader and thus escape) (Dahl, unpublished data). Overall, shark CPUE is about ten times higher in sets targeting swordfish compared to tuna trips (Ito and Machado, 1999).

Figure 1 shows the distribution of effort (in hooks set), for the Hawaii-based longline fleet in 1998. These data are compiled from NMFS logbooks which report sharks in four categories: blue, mako, thresher and other. The logbook data indicate 89 percent of shark reported catches consist of the blue shark. Other reported species include the oceanic whitetip (*C. longimanus*), bigeye thresher (*A. superciliosus*), and shortfin mako (comprising more than 1 percent of reported shark catch (Ito and Machado, 1999). In general, the blue, oceanic whitetip and silky shark dominate the pelagic shark community in the tropical and temperate Pacific (Bonfil, 1994). At least 15 other species have been observed, but are caught in modest numbers (NMFS, unpublished data). In 1998, areas of high catch per unit effort for blue sharks were north of the Hawaiian islands between 30º N and 40º N and 150º W and 165º W (Figure 2) (Ito and Machado, 1999).

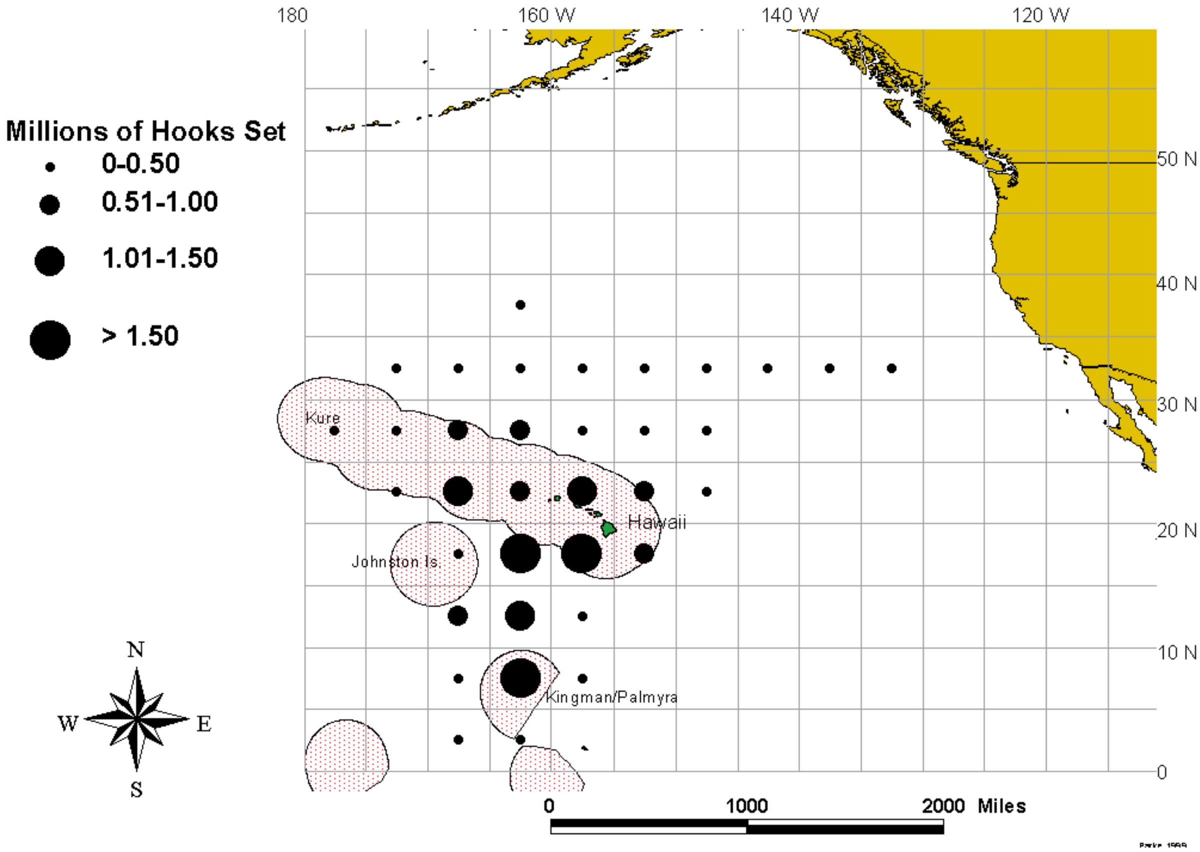

Figure 1 Total number of hooks set by the Hawaii-based longline fishery, by area, 1998. Source: Ito and Machado, 1999.

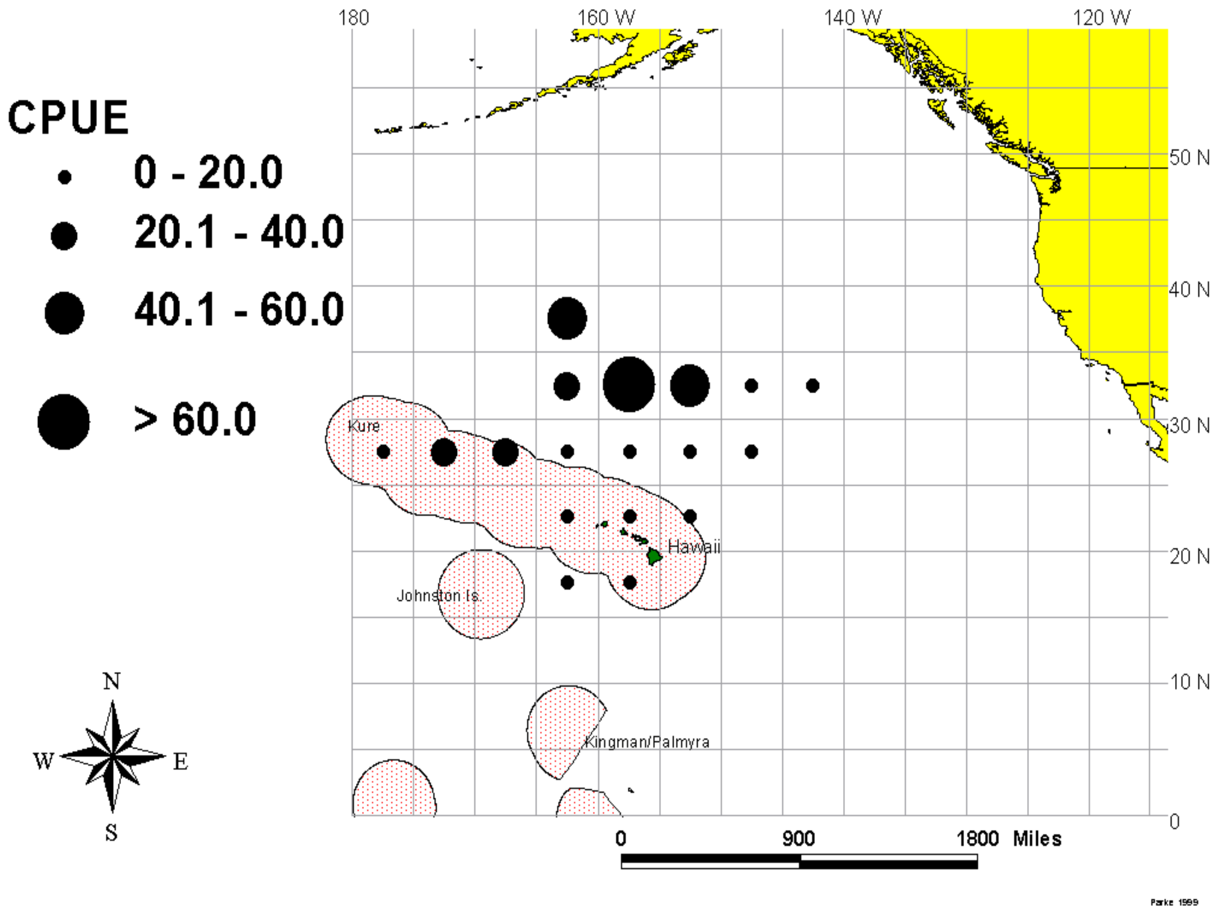

Figure 2 Blue shark CPUE (fish per 1000 hooks) by area for swordfish directed and mixed target trips, 1998. Source: Ito and Machado, 1999.

In 1991, less than 2 percent of all sharks were finned in the Hawaii-based longline fishery (Table 3.11). This figure eventually rises to 65 percent in 1999 (Table 3.12). Whole carcasses have remained a fairly stable yet insignificant component of shark landings, representing 1-2 percent of the catch. Broader market factors--specifically, an increase in demand for shark fins in the early 1990s contributed to the large increase in the number of fins retained. Demand for shark fins is correlated with rising incomes in Asia, particularly in the People's Republic of China. McCoy and Ishihara (1999) suggest that the U.S. mainland is probably an important market for fins landed in Hawaii since there is a significant and growing population of Asian-Americans there who could stimulate demand. Further, those U.S. coastal shark fisheries located on the eastern seaboard have seen significant reduction in shark quotas limiting domestic supply.

Trade figures, or 'exports' of fins from Hawaii to the mainland are not available, but McCoy and Ishihara (1999) note that imports of shark fins into the United States have fallen since the early 1990s despite a robust economy and a presumably growing market. This suggests that domestic supplies, including Hawaii, now contribute a larger share of the domestic market. McCoy and Ishihara (1999) estimate that about 38 mt of dried shark fins are landed by the Hawaii-based longline fleet; 95 percent are blue sharks and the remainder are mako (2 percent) and other sharks (3 percent). Hawaii longliners only retain thresher and mako shark carcasses for sale. According to logbook data, 715 mako and 166 thresher sharks were kept by the fleet in 1999 (NMFS, unpublished data). McCoy and Ishihara (1999) identify four crucial barriers to the retention of blue shark carcasses: (1) short storage life of the flesh in ice, (2) capacity constraints of Hawaii-based longline vessels, (3) limited deck space on these vessels necessary for proper handling, and (4) low value for the landed product.

Table 3.11 Hawaii-based longline incidental shark catch (number of fish), 1991-1998. Source: Ito and Machado, 1999.

Year	Number Caught	Number Released	Number Kept		Percent Retained	Percent Finned
			Finned	Whole		
Blue Sharks						
1991	65,481	65,481	0	0	0	0
1992	89,292	88,315	977	0	1.1	1.1
1993	150,216	135,861	14,355	0	9.6	9.6
1994	110,187	95,783	14,404	0	13.1	13.1
1995	94,881	64,696	30,185	0	31.8	31.8
1996	96,214	54,982	41,149	83	42.9	42.8
1997	80,008	34,087	45,704	217	57.4	57.1
1998	91,228	35,771	55,410	47	60.8	60.7

Total Sharks						
1991	71,183	68,894	1,082	1,207	4.9	1.5
1992	94,897	91,292	2,362	1,243	3.8	2.5
1993	154,608	137,846	15,473	1,289	10.8	10.0
1994	114,656	98,119	15,374	1,163	14.4	13.4
1995	101,292	67,760	32,842	690	33.1	32.4
1996	100,992	57,254	43,109	629	43.3	42.7
1997	85,838	36,496	48,552	790	57.5	56.6
1998	99,919	39,062	60,083	774	60.9	60.1

Table 3.12 Disposition of sharks in 1999. Source: NMFS as reported in Dahl, unpublished.

Species Name	Number Finned	Number Kept as Carcass	Total Number Caught	Percent of Shark Total Catch	Percent of Total Caught that were Finned, by Category	Percent of Total Finned, by Category
Blue	51,915	81	78,091	89.2	66.5	90.6
Mako	624	715	1,625	1.9	38.4	1.1
Thresher	1,857	166	3,716	4.2	50.0	3.2
Other	2,890	20	4,144	4.7	69.7	5.1
Total	57,286	982	87,576	100.0	65.4	100.0

Crews on Hawaii-based longline boats are usually instructed by buyers in shark processing methods (or they already possess this knowledge from experience in other domestic fisheries) (Dahl, unpublished data). Typically the dorsal, two pectoral, and lower caudal fins are removed and strung together as a set. The fins are sun-dried for three or four days and then stored in a warm, dry place such as the engine room (McCoy and Ishihara, 1999). Sometimes other fins such as the small pelvic and anal fins, are also retained, but they command a much lower price (Dahl, unpublished data). Buyers prefer fins in 'sets' consisting of the fins from the same shark.

Estimates of landings and value, made by McCoy and Ishihara (1999) are presented in Table 3.13. These estimates include landings from transshipment by foreign vessels. They estimate fin revenues at about $1 million for the Hawaii longline fleet. Total Hawaii-based longline fleet ex-vessel revenue in 1998 was $46.2 million (Ito and Machado, 1999). Generally, revenue from finning is shared among crew members; the vessel owner and/or captain may not receive a share. McCoy and Ishihara (1999) estimate that crew members each earn $2,375-$2,850 a year from finning; representing about 10 percent of total earnings. Local fin buyers engage in the business on a part-time basis, typically as one of several enterprises. In addition to purchases from the local longline fleet, Hawaii also serves as a transshipment point for a portion of the shark fins produced by foreign longline vessels. Korean longliners tranship the vast majority of fins through Hawaii.[5] McCoy and Ishihara (1999) estimate the economic impact of shark landings and transshipments in the region, summarized in Table 3.14 .

Table 3.13 Estimates of volume and ex-vessel value of shark fins landed in Hawaii, American Samoa and Guam, 1998. Source: McCoy and Ishihara, 1999.

Location and Source Fleet	Estimated Volume (dry fin weight, mt)	Average Price Range ($/kg)	Estimate Range of Ex-vessel Value ($ '000)
Hawaii-based longline	38	25-30	950-1,140
Hawaii transshipments	132	18-20	2,376-2,640
Guam: Taiwan longline transshipments	5-6	20-30	100-180
Guam: Japanese longline	18-28	10-13	180-364
American Samoa: foreign longline	35-47	13-15	455-705
American Samoa: purse seine	9-10	18-23	162-230
Total	237-261		$4,223-$5,259

Table 3.14 Summary of direct economic contribution of sharks to local economies ($ '000). Source: McCoy and Ishihara, 1999.

	Hawaii	Guam	American Samoa	Total
Crew spending from shark fin revenue	950-1,140	180-364	422-653	1,552-2,157
Fresh shark meat sales	42	-0-	-0-	42
Local transshipment expenses	235	53	-0-	288
Trader gross margin	332-399	54-109	123-187	509-695
Direct government revenue	-0-	-0-	7	7
Total	$1,559-1,816	$287-526	$552-847	$2,398-3,189

American Samoa (Pelagic) Longline Fishery

The longline fleet in American Samoa lands a significant number of sharks and is currently actively managed under the WPFMC Pelagic FMP (WPFMC, 1999a). In this fishery small motorized catamarans deploy a short (3 to 5 nautical mile) longline with a hand-powered reel. Trips last one or two days and these boats have a limited range, making this essentially a shore-based fishery. Total fishery landings in 1998 were 401 mt (WPFMC, 1999b). The shark catch consist of blues, makos and threshers. Shark landings from the American Samoa longline fishery

[5] U.S.-flag vessels, including some Hawaii-based longliners, are contracted on a casual basis to transport fins from tankers to Honolulu. Direct landings cannot be made by foreign vessels in Hawaii. Once in Honolulu, the fins are transferred to shipping containers for shipment to Asia.

peaked in 1999 with 510 sharks (all species) caught (Haight and Dalzell, 2000). Like the shark catch in the Hawaii longline fishery, the majority of sharks caught in this fishery are retained for finning (72 percent), with only a relatively small fraction (14.4 percent) landed for consumption (WPFMC, 1999b). Unlike the Hawaii fishery, the American Samoa incidental shark catch is more varied, with less than 50 percent of the catch comprising blue sharks, with larger contributions by thresher (3 percent) and mako sharks (11 percent). A large proportion of the shark catch (41 percent) in this longline fishery remains to be identified (Dahl, unpublished data).

Troll and Handline Fishery (Hawaii, Guam and the Northern Marianas)

Hand troll gear is used by commercial, recreational and charter vessels for pelagic species throughout Hawaii and the Western Pacific Region (WPFMC, 1999b). In American Samoa, Guam and the Northern Mariana Islands trolling with baited hooks and lures is conducted from catamarans and other small commercial, recreational and charter vessels in coastal waters, near seamounts or around fish aggregating devices (Haight and Dalzell, 2000). According to the Hawaii Division of Aquatic Resources (HDAR), commercial catch reports submitted by fishermen indicate that between 1994 and 1998, the quantity of pelagic and coastal sharks caught by troll gear in the waters around Hawaii varied from a low of 1.8 mt to a high of 6.4 mt with a yearly average of 4.1 mt (Haight and Dalzell, 2000). In the same time period, the tuna handline fishery (which includes the nighttime *ika shibi* and daytime *palu ahi* techniques) caught an average of 1.3 mt of sharks per year and the bottomfish handline fishery caught a similar quantity (Haight and Dalzell, 2000). The total number of sharks taken by these fisheries averaged approximately 200 per year from 1988-1995 and peaked in 1996-97 at 300 per year. These figures do not include sharks caught by the recreational sector, as there are no data collection mechanisms for recreational fisheries in Hawaii. Furthermore, HDAR notes that these figures may underestimate the actual amount of sharks caught commercially due to non-reporting by fishermen. Additionally, the Hawaiian charter troll fleet caught an average of 2.5 mt per year from 1990 to 1999. The average catch per year of the charter troll fleet is similar to that of the commercial troll fleet (Haight and Dalzell, 2000). In the Mariana Islands small boats using trolling gear also catch relatively low numbers of sharks. In 1998, small commercial and recreational vessels in Guam landed about 3.6 mt of both coastal and oceanic sharks (WPFMC, 1999b). There are no reports of small-scale commercial fishermen in the Mariana Islands selling shark fins.

U.S. Western Pacific Purse Seine Fishery

This fishery is predominantly conducted on the high seas and within the EEZ's of sovereign insular South Pacific Forum nations in the central, western and south Pacific under a multilateral treaty entitled "Treaty on Fisheries Between the Governments of certain Pacific Island States and the Government of the United States." U.S. purse seine vessels fish throughout the tropical central and western Pacific between 130º E. and 150º W. longitude and may, under certain circumstances, fish within the U.S. non-self governing areas of the south Pacific (Coan *et al.*, 2000). Purse seine vessels target skipjack and yellowfin tuna, which are frozen and delivered to canneries in the region. For the 1999/2000 licensing period, approximately 35 vessels were active. Catch of target species for all U.S. purse seiners operating in the WCPO was 180,000 mt in 1999. Based on logbooks, shark bycatch for 1999 was reported at 48.5 mt (Coan *et al.*, 2000).

Other Fisheries

With one minor exception, available fisheries information do not indicate that shark species are taken in other U.S. western, central and south Pacific fisheries.[6]

Shark Products Landed or Transshipped Through U.S. Insular Pacific Ports

Regional ports also serve as transshipment points for foreign vessels. Under U.S. Federal law foreign vessels may not land fish directly at U.S. ports. However, American Samoa, Guam and the Northern Mariana Islands are exempted from this restriction (Dahl, unpublished data). Taiwanese longline vessels offload frozen catch in both Guam and American Samoa (McCoy and Ishihara, 1999). Taiwanese operators, more than those of other major Pacific fishing nations, see landings of shark products as an integral part of their operations (McCoy and Ishihara, 1999). In the tropical western Pacific, these vessels often retain carcasses from shortfin mako, oceanic whitetip, and silky sharks, depending on the constraints of hold capacity and trip duration (McCoy and Ishihara, 1999). Japanese longline vessels also transship through Guam. In 1999, 50 to 60 vessels, mostly owned by small family-run businesses (owning two or there fishing vessels), were based in Guam (Dahl, unpublished data). These vessels fish in the EEZs of the Republic of Palau and the Federated States of Micronesia, and on the high seas of the western Pacific. Japanese vessel operators put much less emphasis on the retention of shark products, partly because of vessel capacity constraints (McCoy and Ishihara, 1999).

State Government Shark Control Programs and Activities

From 1959 to 1976, the State of Hawaii implemented six shark control programs ostensibly to reduce the number of attacks on humans. A total of 2,849 sharks were killed during the program. The majority of sharks caught were coastal species such as sandbar (51 percent), tiger (19 percent), gray reef (9 percent), and Galapagos (8 percent) (Haight and Dalzell, 2000). Shark control programs were implemented in Hawaii on the premise that fishing could reduce the populations to a point where shark attack risk was decreased. Each of the major control programs referred to continual decreases in catch rates for consecutive fishing circuits as evidence

[6] One vessel operated in the Hawaiian Islands in 1998-99 specifically targeting coastal sharks with bottom longline gear. (The vessel has subsequently ceased operations.) NMFS deployed data collector information from a 1999 trip, indicate that the following sharks were caught: 684 sandbar (70 percent of the total number), 182 Galapagos (19 percent), 85 tiger (8 percent), 20 grey reef (*C. amblyrhynchos*) (2 percent) and 9 blacktip (1 percent) (Vatter, 2000).

that shark populations had been reduced and that these programs had been successful (Wetherbee *et al.*, 1994). It was estimated that nearshore shark populations were reduced by as much as 50 to 90 percent following the control programs. There was also some evidence that the average size of some sharks, such as sandbars, declined during successive circuits of one of the control programs in the mid-1960s. Wetherbee *et al.* (1994), however, suggested that seasonal migrations by sharks between different depths, depending on size and other factors such as weather and bait, may also have had an influence on catch rates and average size of sharks taken by these control programs.

In 1992, the State of Hawaii legislatively established the Shark Task Force to advise the Governor and the Chairman of the Department of Land and Natural Resources (DLNR) on appropriate action to be taken by the State following a series of shark attacks, including two witnessed fatalities. Members of the Task Force consist of personnel from State DLNR, City and County Life Guards, University of Hawaii, Hawaii Visitors Bureau, Native Hawaiian representative, and NMFS. The Task Force was put on inactive status in 1995. However, it was re-activated in 1999 after a series of six shark attacks occurred throughout the Hawaiian Islands.

The Task Force initiated a policy to remove several large tiger sharks from a specific area following a fatal shark attack or series of attacks. All other sharks caught, including tiger sharks under 8 feet in length, are tagged and released. This policy has resulted in the removal of approximately 12 large tiger sharks from 1992 until 1995. Plans are presently being formulated by the State Shark Task Force to tag and track several large, potentially dangerous galapagos sharks and tiger sharks off North Kona, Hawaii.

During its 2000 session, the Hawaii State Legislature passed a bill (HR 1947) stating, among other things that “No person shall knowingly harvest shark fins from the territorial waters of the State, or land shark fins in the State, unless the fins were taken from a shark landed whole in the State.” On June 22, 2000, the Governor of the state signed the bill into law. The law reportedly raises questions as to whether Federal fishery management regulations take precedence over activities in Federal waters (no longline fishing currently takes in State of Hawaii waters). The bill allows the continued importation of fins (as opposed to landings by Hawaii-based vessels). It may be difficult to distinguish between imported and landed fins (Dahl, unpublished data).

U.S. Federal Shark Management in the Western Pacific

The WPFMC recently formulated management policies in relation to shark catches.[7] The sharp increase in finning over the past five years has generated considerable public concern and controversy. For this reason, in October 1999, the Council recommended the Pelagic FMP be amended (Amendment 9) to establish an annual quota for the number of sharks that could be harvested by vessels in the Hawaii-based longline fishery (Dahl, unpublished data; Haight and Dalzell, 2000). Amendment 9, which was submitted to NMFS for review and approval in June 2000, seeks to manage shark catches to achieve optimum yield, ensure that commercial fisheries remain profitable, limit waste, and promote domestic marketing of sharks (Dahl, unpublished data). Amendment 9 proposes two separate annual quotas, one for blue sharks and one for all other shark species. Under the proposal, 50,000 blue sharks, whole carcass or only fins[8], could be landed annually. For all other shark species, a quota of one shark, landed as a whole carcass, is proposed. This distinction recognizes that these other shark species are generally less abundant than blue sharks and that a market exists for their meat. An anticipated difficulty in relation to the annual quota pertains to dock side monitoring.

Although there has been limited implementation of policies specific to sharks, other NMFS regulations applied to the Hawaii-based longline fishery could have an impact on shark landings (Dahl, unpublished data). Perhaps most important is the limited entry program, developed in response to the rapid growth in fleet size during the late 1980s and early 1990s. Longline vessel exclusion zones around the Hawaiian Islands, Guam, and its offshore banks reduce catches of coastal shark species.

In December 1999, a civil suit filed in Federal court and brought against NMFS by a consortium of environmental organizations focusing on the incidental catch of sea turtles resulted in a court order requiring NMFS to impose interim measures closing certain waters to longline fishing, establishing fishing gear restrictions, and requiring increased observer coverage in the Hawaii-based longline fishery. The court-ordered closed/restricted areas cover over 9.8 million square miles, of which about a third encompass the areas of highest blue shark CPUE (see Figure 2). The closure is expected to have a positive impact on the number of fishery-induced shark moralities.

Research and Management Needs

[7] An exception is Amendment 1 to the Pelagic FMP, implemented in 1991. This was drafted in response to guidelines from the Secretary of Commerce based on a then new national standard in the Magnuson Act requiring measurable definitions for recruitment overfishing for each species managed under FMPs (Dahl, unpublished data).

[8] It is estimated that 50,000 pounds of dried fins represent the annual quota of 50,000 sharks (i.e., one pound of dried fin is produced from each blue shark).

Research and management needs in the western Pacific Ocean region include reducing the capture and mortality of sharks not retained in commercial fisheries; improving species-specific catch, landings, disposition, and biological data in small-scale fisheries; improving dockside monitoring of shark landings by volume and species; and more complete collection and exchange of shark catch and landings data by all distant water fishing nations and coastal states both within the EEZ and on the high seas.

3.3 Recreational Skate and Ray Fisheries

Recreationally, skates can be caught with rod and reel. Recreational harvest (landings and dead discards) of skates and rays in the Atlantic region have averaged about 75,000 fish and 37.6 mt between 1995 and 1999 (Table 3.15). The North Atlantic and Mid-Atlantic regions have generally higher skate and ray recreational harvest although the Gulf of Mexico region has the highest harvest in pounds reported (1997). Trends in recreational harvest of skates and rays may be more reflective of trends in effort than population trends. In the Alaska region, the majority of skates caught recreationally are caught incidentally to halibut fishing.

Table 3.15 Estimated total numbers and total pounds in thousands for recreationally caught skates and rays. Source: Marine Recreational Fishery Statistics Survey, 2000.

Year	Harvest	North Atlantic	Mid-Atlantic	South Atlantic	Gulf of Mexico	Total
1995	Number	22	21	8	25	75
	Pounds	2	5	**	7	33
1996	Number	16	35	9	21	89
	Pounds	15	18	20	17	70
1997	Number	35	26	15	19	95
	Pounds	31	42	**	91	164
1998	Number	25	8	13	6	53
	Pounds	32	--	3	--	36
1999	Number	17	24	17	11	70
	Pounds	19	67	7	19	112

**None reported; – Estimate is less than thirty thousand.

Research and Management Needs

Generally, the recreational fishery for these species is fairly small compared to the commercial sector. Research and management needs would include collection of species-specific catch and landings data, species-specific biological data, and post-release survival estimates.

3.4 Recreational Shark Fisheries

3.4.1 Atlantic Fisheries (Excluding Spiny Dogfish)

Recreational fishing for Atlantic sharks occurs in Federal and state waters from New England to the Gulf of Mexico and Caribbean Sea. U.S. Atlantic recreational shark harvests have declined somewhat from the peak recorded catches in 1983 (NMFS, 1999a). For pelagic species, some of which are considered prized gamefish (e.g., makos), recreational harvests have fluctuated from a peak of approximately 93,000 fish in 1985 to a low of about 6,000 fish in 1994. Recreational landings of small coastal sharks have fluctuated around 50,000 to 150,000 fish per year since the mid 1980s, with Atlantic sharpnose comprising about 65 percent of the catches (NMFS, 1999a). Atlantic shark recreational harvest estimates for 1997-1999 are provided in Table 3.15.

Table 3.16 Estimated recreational shark harvests (numbers of fish) in the Atlantic Ocean and Gulf of Mexico by management subgroup and species. Source: Cortes, 1999; NMFS, 1999a; Cortes 2000.

Management Subgroup	Species Name	1997	1998	1999
Large Coastal Sharks	Blacktip	68,284	82,310	30,961
	Bull	1,254	1745	2,832
	Dusky	13,278	4,499	5,186
	Hammerhead	618	389	75
	Hammerhead, great	379	494	346
	Hammerhead, scalloped	3,320	2,575	1,329
	Hammerhead, smooth	2,176	375	---
	Lemon	2,354	2,303	131
	Night	90	133	---
	Nurse	7,859	2,455	1,489
	Reef	10	---	---
	Sandbar	40,929	35,766	18,882
	Silky	240	5,376	3,834
	Spinner	3,342	10,836	5,738
	Tiger	70	1,380	146

	Unclassified	16,298	19,139	12,953
Pelagic Sharks	Blue	4,265	6,085	5,218
	Shortfin mako	2,618	5,633	1,383
	Thresher	1,436	36	4,512
Small Coastal Sharks	Atlantic angel	---	109	---
	Atlantic sharpnose	65,530	129,315	40,291
	Blacknose	10,761	10,523	5,957
	Bonnethead	15,730	29,692	36,664
	Finetooth	5,000	139	69

Shark tournament fishing is usually conducted from vessels that vary in size from small outboards to sportfishing yachts of 15 meters or longer. The number of participants and vessels varies: a two-day Long Island, NY shark tournament has drawn 300 vessels and about 1,500 anglers annually in recent years. More exclusive tournaments charge high entry fees on a first-come, first-served basis, and offer a top prize of $50,000 or more (NMFS, 1999a). Many tournaments establish minimum sizes for species like shortfin mako and blue sharks, and some tournaments encourage catch and release fishing by offering prize points for released sharks. The increase in eastern Gulf Coast shark fishing tournaments since 1973 underscores the popularity of this activity among anglers. Previously, there were only about a half dozen such tournaments in the region, but by the late 1980s there were about 65 each year (NMFS, 1999a).

Fisher and Ditton (1992) surveyed Gulf of Mexico shark fishermen and found that they spent an average of $197 per trip, were willing to spend on average an additional $105 rather than stop fishing for sharks, and that 32 percent of those surveyed said that no other species would be an acceptable substitute for sharks.

Current recreational regulations for sharks include a bag limit of one shark per vessel per trip with a minimum size of 4.5 feet fork length; an allowance for one Atlantic sharpnose shark per person per trip (no minimum size); a requirement that all landed sharks must have heads, tails, and fins attached; a ban on finning; prohibited species; authorized gears; and a no sale provision.

Research and Management Needs

Research and management needs in the recreational fisheries in the Atlantic Ocean and Gulf of Mexico involve increasing species-specific identification of all sharks; improving scientific assessments; determining post-release mortality levels; and improving outreach and cooperation with recreational shark fishermen and their communities. High priority needs include improving species-specific identification of catches and landings data; determining post-release mortality rates and ways to minimize that mortality; conducting a stock assessment on small coastal sharks and species-specific assessments on dusky and sand tiger sharks; and continued participation in international research and management initiatives, particularly for pelagic sharks.

3.4.2 Spiny Dogfish Fisheries

Most of the catch of spiny dogfish in recreational fisheries appears to be incidental to the targeting of other species. The value of spiny dogfish in recreational fisheries in terms of angler expenditures and revenues derived from those expenditures in the targeting of this species appears to be fairly low. Of the total spiny dogfish caught in 1996, 7 percent was caught from beach, shore, or man-made structure; 40 percent was caught from a party or charter boat; and 53 percent was caught from a private or rental boat (MAFMC and NEFMC, 1999). Given the migratory range of spiny dogfish, most were caught in the North Atlantic and Mid-Atlantic regions: 38 percent in the North Atlantic and 61 percent in the Mid-Atlantic regions.

Excluding the recreational estimate for 1981, total recreational catches increased from about 70 mt in 1982-1983 to greater than 408 mt in 1989. Since then the estimates of spiny dogfish recreational catch in weight have declined. The 1993 estimate was about 120 mt. Total catch in weight declined to less than 37 mt in 1996, but increased to 66 mt in 1997 (MAFMC and NEFMC, 1999). Total catches in number increased in nearly five fold from 1982 to 1989. In the North Atlantic subregion (Maine to Connecticut), catches peaked in 1988 at nearly 400,000 fish and declined to fewer than 250,000 in 1993. Peak catches of nearly 500,000 fish occurred in the Mid-Atlantic states (New York to Virginia) in 1990; catches declined to about 250,000 in 1993. Catches of spiny dogfish from North Carolina to Florida increased dramatically after 1979, but are an order of magnitude lower than observed in the Mid-Atlantic and New England states. Most dogfish are released after capture, increasing to more than 90 percent in recent years (MAFMC and NEFMC, 1999).

Research and Management Needs

Research needs in recreational dogfish fisheries includes improving biological information to allow better estimation of mean lengths and weights from recreational fisheries; further investigation of post-release mortality from live bait and handling practices, and monitoring of reporting rates relative to stock size.

3.4.3 Pacific Fisheries

Leopard Shark

This nearshore species is the major recreationally-caught shark. The leopard shark is common in shallow water from the intertidal zone to 15 feet depth, including bays and sloughs.

Tagging studies in central California indicate a population consisting of regional stocks having limited mixing. The leopard shark is fished secondarily by commercial fishermen. Nearly all the U.S. harvest is from off California. The commercial catch, taken by set net, hook and line, and trawl, has averaged about 14 mt since 1991, although it is recognized that some landings may also be lumped under the "shark unspecified" category. The NMFS Marine Recreational Statistics Survey indicates a larger recreational catch consisting 45,000 individual fish per year, averaged over 1993-1997 (range: 34-54,000 fish). This recreational fishing is mainly by angling with baited hooks.

Population studies on exploitation rates and yield potentials (Smith and Abramson, 1990) and comparisons with total catches indicate the population is not presently being depleted. The State of California's impositions of size limits for sport and commercial fishermen and the general curtailment of gillnetting within the leopard shark's nearshore range appear to have halted the increase of fishing mortality, if not reduced it, over the past decade.

The resident stocks near large cities are still vulnerable to local depletion, however, because fishing effort can be locally concentrated and because of limited mixing among stocks and the species' low productivity. The leopard shark is not mature until about 13 years of age (females), and its annual rate of increase is estimated to be only about 2-3 percent per year (Au and Smith, 1997). Furthermore, present size limits do not protect mature adults that come into angler-accessible, nearshore feeding and pupping areas. As in all slow-growing species, it is important that the breeding population be given sufficient protection to provide for steady recruitment to adulthood.

Pelagic Sharks: Shortfin Mako, Thresher, and Blue Shark

Directed recreational angling for pelagic sharks, especially from private boats and skiffs, has become increasingly popular in recent decades in California, especially in coastal waters between San Diego and Santa Barbara. Currently, there are about eight shark fishing tournaments held annually targeting mako shark, thresher shark and also blue shark. The extent of this catch is not fully known, as private boat recreational catches are difficult to estimate with any precision and subject to large sampling variability. The shortfin mako is the most popular species, followed closely by thresher, then blue sharks. Partyboat catches are reported, but are thought to represent a relatively small portion of the total sport catch. An average of 204 mako and 55 thresher sharks were landed per year aboard partyboats during 1990-1998, with peak catches for both species (308 mako, 163 thresher) taken in the 1993 El Niño year. The California Fish and Game Code limits the take to two individuals per day of each of these sharks, although sport anglers may possess more than this limit depending on the length of the fishing trip. Most blue sharks (approximately 93 percent in 1997-98) are released alive by anglers. Recreational catches of pelagic sharks north of Point Conception, California, are thought to be mostly incidental.

Other Sharks

Sharks are a minor target of recreational fishermen in Oregon and Washington. In Oregon and Washington, spiny dogfish and limited numbers of other sharks are caught incidentally by anglers while fishing for Pacific salmon and bottomfish, but the recreational dogfish catch in Washington is large (Camhi, 1999).

Research and Management Needs

In general, the recreational shark fisheries in the Pacific historically account for a low level of the overall harvest of these species when compared to commercial fisheries. Because of this, there is little information concerning the impact of the recreational fishermen. As directed angling for some shark species has increased in some areas of the Pacific, a program to monitor and gather data concerning the catch and effort contributed by this sector should be initiated. The highly migratory species FMP under development will provide recommendations for research on the magnitude and significance of recreational harvests of sharks and for possible management changes to ensure that this fishery does not pose any risk to sustainable shark populations.

3.4.4 North Pacific Fisheries

There is relatively little interest in recreational shark fishing in Alaska and these fish are most often considered a nuisance by anglers (NPFMC, 1999). The majority of sharks caught recreationally in Alaska are caught incidentally to halibut and salmon fishing. Recreational fishing for salmon sharks has increased recently but only a few charter operators or private anglers possess the specialized equipment and knowledge to catch these sharks on hook and line (NPFMC, 1999). The majority of salmon sharks are released (79 percent released state-wide in 1998). In South Central Alaska (includes Cook Inlet and Prince William Sound), spiny dogfish comprise the majority of sharks caught incidentally to recreational halibut and salmon fisheries. Approximately 98 percent of the spiny dogfish are reported released. In addition, there appear to be concentrations of sleeper sharks in the central part of Cook Inlet in the summer which are targeted by recreational fishermen (NPFMC, 1999).

Research and Management Needs

The recreational fishery in this area of the Pacific Ocean accounts for a small percentage of the overall harvest of shark species. As there is little information concerning the levels of catch and effort in this area, a program should be implemented to gather preliminary information for monitoring purposes.

3.4.5 West Pacific Fisheries

In Hawaii, despite the importance of recreational fishing for pelagic fishes, such as marlins and tunas, there still appears to be little interest in recreational shark fishing (Camhi, 1999).

Research and Management Needs

The recreational fishery in this area of the Pacific Ocean accounts for a small percentage of the overall harvest of shark species. As there is little information concerning the levels of catch and effort in this area, a data collection program should be implemented to gather preliminary information for monitoring purposes.

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APPENDIX 1

FAO International Plan of Action for Conservation and Management of Sharks

APPENDIX 2

LIST OF ACRONYMS

ACFCMA	Atlantic Coast Fisheries Cooperative Management Act
APEC	Asia Pacific Economic Cooperation
ASMFC	Atlantic States Marine Fisheries Commission
BSAI	Bering Sea/Aleutian Islands
CFMC	Caribbean Fishery Management Council
CFR	Code of the Federal Register
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COFI	FAO Committee on Fisheries
COP	Conference of the Parties
CPUE	Catch Per Unit Effort
DLNR	Department of Land and Natural Resources
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FAO	United Nations Food and Agriculture Organization
FMP	Fishery Management Plan
FR	Federal Register
FWG	Fisheries Working Group
GMFMC	Gulf of Mexico Fishery Management Council
GOA	Gulf of Alaska
GSMFC	Gulf States Marine Fisheries Commission
HDAR	Hawaii Division of Aquatic Resources
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Seas
IPHC	International Pacific Halibut Commission
IPOA	International Plan of Action for the Conservation and Management of Sharks
MAFMC	Mid-Atlantic Fishery Management Council
MHLC	Multilateral High Level Conference
MSY	Maximum Sustainable Yield

NAFO	Northwest Atlantic Fisheries Organization
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center, NMFS
NGO	Non-Governmental Organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fishery Management Council
NPOA	United States National Plan of Action for the Conservation and Management of Sharks
PFMC	Pacific Fishery Management Council
PSMFC	Pacific States Marine Fisheries Commission
PWS	Prince William Sound
SAFE	Stock Assessment and Fishery Evaluation
SAFMC	South Atlantic Fishery Management Council
SARC	Stock Assessment Review Committee
SAW	Stock Assessment Workshop
SCB	Southern California Bight
SEAMAP	Southeast Area Monitoring and Assessment Program
WPFMC	West Pacific Fishery Management Council

APPENDIX 3

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