# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

JAN 1 4 2011

IN REPLY REFER TO:
FWS/DMA/TRE 2-06ee

Mr. John Scanlon, Secretary-General
CITES Secretariat
15, chemin des Anémones
CH 1219 CHATELAINE-Genève
Switzerland

*VIA EMAIL*: info@cites.org

Dear Mr. Scanlon:

This letter responds to paragraphs a), c), and d) of Notification to the Parties No. 2010/027 of August 24, 2010. Please note that we have already responded to paragraph e) of the Notification in our letter to you of December 17, 2010.

With regard to the information requested for sharks in paragraph a), we have analyzed current U.S. data regarding international trade in CITES-listed sharks and have also consulted with our colleagues at the National Marine Fisheries Service (NMFS) regarding this issue. The United States' National Plan of Action (NPOA) for the Conservation and Management of Sharks, completed in 2001 and previously reported (www.nmfs.noaa.gov/sfa/Final%20NPOA.February.2001.pdf), is currently being implemented consistent with the FAO's International Plan of Action for the Conservation and Management of Sharks. We have addressed the trade in shark fins pursuant to the United States' Shark Finning Prohibition Act of 2000 (Public Law 106-557) as outlined in the 2009 Shark Finning Report to Congress (in Annex 1 of this document). On January 4, 2011, President Obama signed the Shark Conservation Act of 2010 (Annex 2). This new legislation strengthens the Shark Finning Prohibition Act of 2000 by mandating that a national fins-attached policy applies to shark species caught in all waters of the United States, including both the Atlantic and Pacific Oceans. Lastly, we are submitting a report on the U.S. Trade in CITES-Listed Shark Species for the Years 2000-2009 (Annex 3). This report details all U.S. trade in basking shark (*Cetorhinus maximus*), great white shark (*Carcharodon carcharias*), and whale shark (*Rhincodon typus*). In summary, our response provides current information on the conservation and management of shark species, both CITES-listed and not CITES-listed.

With regard to the information requested in paragraph c), recommendations for additional Appendix-II orchid hybrid exemptions (as per Decision 14.133), we believe it is premature to exempt additional hybrids. Although the current annotation to exempt certain Orchidaceae spp. included in Appendix II has not caused implementation problems for the United States, as either an exporting country or importing country, we note that some Management Authorities continue to issue CITES permits for shipments of orchids that would be covered under the exemption. In fact, in 2010, the U.S. plant inspection authorities noted over 200 instances where shipments of Appendix-II orchids covered under the exemption entered the United States accompanied by foreign CITES documents. The underutilization of this exemption was reported at PC17 (Switzerland; 2008) and impracticalities regarding the conditions in the current exemptions were elucidated at PC18 (Buenos Aires; 2009). The underutilization and impracticalities of the current exemptions have not yet been addressed by the Plants Committee. The United States is of the opinion that any additional exemptions should be deferred until the Plants Committee has addressed the concerns with the current exemptions.

With regard to the information requested in paragraph d), regarding Decisions 15.90 and 15.96 concerning *Aniba rosaeodora* and *Bulnesia sarmientoi*, the United States currently relies primarily on the packaging, markings, or labeling of shipments to determine whether they contain these CITES-regulated species. We have not had enough experience implementing these listings to determine whether any particular methods of identification are superior to others. Because the United States is an importing country of both of these species, we are working with other federal agencies, range countries, the CITES Secretariat, and industry to explore this issue in preparation for the upcoming meeting of the Plants Committee. We look forward to working with the range countries and others to refine methodologies and guidance that will facilitate the implementation of these listings.

If you have questions regarding the information we have provided, please feel free to contact Rosemarie Gnam, at +1-703-358-1708 or via email: rosemarie_gnam@fws.gov; or Roddy Gabel, at +1-703-358-2095 or via email: roddy_gabel@fws.gov.

Sincerely,

Robert R. Gabel, Chief
Division of Management Authority

Rosemarie Gnam, Ph.D., Chief
Division of Scientific Authority

cc: Sra. M. Clemente, Chair of the Plants Committee
Sr. Carlos Ibero Solana, Chair of the Animals Committee

Enclosures

# 2009 Shark Finning Report to Congress

NOAA

Issued Pursuant to the Shark Finning Prohibition Act
(Public Law 106-557)

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

# 2009 Shark Finning Report to Congress

Pursuant to the

## Shark Finning Prohibition Act of 2000

(Public Law 106-557)

U.S. Department of Commerce
National Oceanic and Atmospheric Administration

**Prepared by the**
**National Marine Fisheries Service**

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## Abbreviations and Acronyms

ABC ....allowable biological catch
ABL....Auke Bay Laboratory
ADF&G....Alaska Department of Fish and Game
AFSC....Alaska Fisheries Science Center
ALWTRP ....Atlantic Large Whale Take Reduction Plan
BLL ....bottom longline
BREP....Bycatch Reduction Engineering Program
BSAI ....Bering Sea/Aleutian Islands
C....carbon
CCAMLR....Commission for the Conservation of Antarctic Marine Living Resources
CI....confidence interval
CITES ....Convention on International Trade in Endangered Species of Wild Fauna and Flora
CICESE....Centro de Investigación Científica y de Educación Superior de Ensenada
CFR....*Code of Federal Regulations*
CMS ....Convention on Migratory Species
COASTSPAN ....Cooperative Atlantic States Shark Pupping and Nursery
COFI ....Food and Agriculture Organization's Committee on Fisheries
CPCs ....Parties and cooperating non-parties, cooperating fishing entities, or regional economic integration organizations of the IATTC
CPUE ....catch per unit effort
CRED ....Coral Reef Ecosystem Division
CSTP....Cooperative Shark Tagging Program
dw....dressed weight
EEZ ....Exclusive Economic Zone
EFH....essential fish habitat
EPO....Eastern Pacific Ocean
ERA....ecological risk assessment
FAO....Food and Agriculture Organization of the United Nations
FMP....fishery management plan
FR....*Federal Register*
GCEL ....General Counsel for Enforcement and Litigation
GOA....Gulf of Alaska
GULFSPAN....Gulf of Mexico States shark pupping and nursery
Hg....mercury

HIMB ................................................Hawaii Institute of Marine Biology
HMS..................................................highly migratory species
IATTC...............................................Inter-American Tropical Tuna Commission
ICES..................................................International Council for the Exploration of the Sea
ICCAT...............................................International Commission for the Conservation of Atlantic Tunas
IPOA .................................................International Plan of Action
kg......................................................kilogram
LCS ...................................................large coastal sharks
MAFMC............................................Mid-Atlantic Fishery Management Council
MDMF ..............................................Massachusetts Division of Marine Fisheries
MEP ..................................................Massachusetts Environmental Police
MHI...................................................Main Hawaiian Islands
MSA..................................................Magnuson-Stevens Fishery Conservation and Management Act
MSY ..................................................maximum sustainable yield
mt .....................................................metric tons
N.......................................................nitrogen
n........................................................sample size
NEFSC ..............................................Northeast Fisheries Science Center
NEFMC.............................................New England Fishery Management Council
NMFS................................................National Marine Fisheries Service
NOAA ...............................................National Oceanic and Atmospheric Administration
NAFO................................................Northwest Atlantic Fisheries Organization
NOVA ...............................................Notice of Violation and Assessment
NPFMC.............................................North Pacific Fishery Management Council
NPOA................................................National Plan of Action
NRIFSF.............................................National Research Institute for Far Seas Fisheries
NWFSC.............................................Northwest Fishery Science Center
NWHI................................................Northwestern Hawaiian Islands
OFL ...................................................overfishing levels
OLE...................................................Office of Law Enforcement
OTC...................................................oxytetracyline
PacFIN ..............................................Pacific Fisheries Information Network
PIFSC................................................Pacific Island Fishery Science Center
PSAT.................................................pop-up satellite archival tags
PFMC................................................Pacific Fishery Management Council
PRIA .................................................Pacific remote island areas
RFMO ...............................................regional fishery management organization
SAFE.................................................Stock Assessment and Fishery Evaluation
SCRS.................................................Standing Committee on Research and Statistics

SCS ....................................................small coastal sharks
SEDAR ..............................................Southeast data, assessment, and review
SEFSC................................................Southeast Fisheries Science Center
SFPA..................................................Shark Finning Prohibition Act
SPOT..................................................smart position and temperature transmitting tags
SSL.....................................................sound scattering layer
SSN ....................................................spawning stock number
STAR .................................................stock assessment and review
SWFSC ..............................................Southwest Fisheries Science Center
SWRO................................................Southwest Regional Office
TAC....................................................total allowable catch
TL.......................................................total length
UAF....................................................University of Alaska Fairbanks
UNGA................................................United Nations General Assembly
USCG.................................................United States Coast Guard
USVI ..................................................United States Virgin Islands
VMS...................................................vessel monitoring system
WCPFC..............................................Western and Central Pacific Fisheries Commission
WPacFin.............................................Western Pacific Fishery Information Network
WPFMC.............................................Western Pacific Fishery Management Council

# Executive Summary

Because of their biological and ecological characteristics, sharks present an array of issues and challenges for fisheries management and conservation. Many shark species are characterized by relatively late maturity, slow growth, and low reproductive rates, which can make them particularly vulnerable to overexploitation. Concern has grown about the status of shark stocks and the sustainability of their exploitation in world fisheries, as demand for some shark species and shark products (i.e., fins) has increased.

Shark finning is the practice of taking a shark, removing a fin or fins (whether or not including the tail), and returning the remainder of the shark to the sea. The Shark Finning Prohibition Act of 2000 prohibited the practice of shark finning by any person under U.S. jurisdiction. The Act requires the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) to promulgate regulations to implement the prohibitions of the Act, initiate discussion with other nations to develop international agreements on shark finning and data collection, and establish research programs. This report describes NMFS' efforts to carry out the Shark Finning Prohibition Act during calendar year 2008.

Sharks in Federal waters are currently managed under eight different fishery management plans under authority of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). In the U.S. Atlantic Ocean, sharks and other highly migratory species (HMS) are managed directly by NMFS. In the U.S. Pacific Ocean, three regional fishery management councils—Pacific, North Pacific, and Western Pacific—are responsible for developing fishery management plans. In 2008, domestic management of sharks included the following major actions:

- On June 24, 2008, NMFS published a final rule (73 FR 35778, corrected on July 15, 2008, 73 FR 40658) that amended the 2006 Consolidated Atlantic HMS Fishery Management Plan based on recent stock assessments for Large Coastal Sharks (LCS), dusky sharks, and porbeagle sharks. The rule reduced shark harvests to prevent overfishing and rebuild stocks and required that all sharks be offloaded with their fins naturally attached. In addition, the rule closed eight marine protected areas that were established by the South Atlantic Fishery Management Council to shark bottom longline (BLL) gear.
- NMFS publishes rules each year to adjust quotas based on landings from the previous season. A final rule was published on December 24, 2008 (73 FR 79005), which established the 2009 fishing season for commercial quotas for sandbar sharks, non-sandbar large coastal sharks, small coastal sharks, and pelagic sharks based on overharvests or underharvests from the 2008 fishing year.

Additional information on shark management in the United States can be found in sections 2.1 through 2.3 of this report.

The Department of Commerce and the Department of State have been active in promoting development of international agreements consistent with the Shark Finning Prohibition Act. In 2008, the United States was successful in the following international efforts:

- In 2008, parties to the Western and Central Pacific Fisheries Commission (WCPFC) adopted a U.S. proposal to modify and improve a 2006 measure for the conservation and management

of sharks. The revised measure requires, for all vessels (as opposed to vessels greater than 24 meters in length), that Members take measures to: 1) require full utilization of shark catches; 2) ensure their vessels have on board fins that total no more than 5 percent of the weight of sharks on board up to the first point of landing (or require that vessels land sharks with fins attached, or prohibit the landing of fins without corresponding carcasses); and 3) prohibit vessels from retaining on board, transshipping, landing, or trading in any fins harvested in contravention of the WCPFC measure. The 2008 measure also includes new reporting requirements.

- In 2008, the Food and Agriculture Organization of the United Nations Committee on Fisheries hosted, and the United States chaired, a workshop to bring together fisheries experts from a representative number of main shark fishing and trading countries to discuss and agree upon the main limitations and opportunities for improving the monitoring of shark fisheries and international trade in shark products.
- In 2008, two shark-related measures were adopted at the International Commission for the Conservation of Atlantic Tunas (ICCAT). The first measure called for ICCAT and the International Council for the Exploration of the Sea (ICES) to coordinate an assessment of porbeagle sharks. The second measure requires the release of bigeye thresher sharks caught in fisheries managed by ICCAT and that are still alive when brought to the vessel, as well as the recording and reporting to ICCAT of incidental catches and live releases of this species.

Further information on international efforts to advance the goals of the shark finning prohibition can be found in Section 4 of this report.

Numerous research studies undertaken by NMFS Science Centers have produced valuable information on shark status, survivorship, mobility, migration, habitat, ecology, and age and growth characteristics—all of which will be incorporated into effective shark fishery management decisions. A detailed description of NMFS' research efforts regarding sharks can be found in Section 5 of this report.

Overall, compared to the years before enactment of the Shark Finning Prohibition Act, great strides continue to be made in shark conservation, data gathering, management, research, and education on a national and global scale that will contribute to sustainable management of sharks.

# 1. Introduction

Sharks, skates, and rays are within the class Chondrichthyes—the cartilaginous fishes—and the subclass Elasmobranchii. Sharks are an ancient and diverse group of fishes presenting an array of issues and challenges for fisheries management and conservation due to their biological and ecological characteristics. Most sharks are predators at the top of the food chain, and many shark species are characterized by relatively late maturity, slow growth, and low reproductive rates. Abundance of these top predators is often low compared to organisms at lower trophic levels. The combination of these characteristics makes sharks particularly vulnerable to overexploitation.

Over the past few decades—as demand for some shark species and shark products has increased, and as international fishing effort directed at sharks and evidence of overfishing have increased—concern has grown about the status of shark stocks and the sustainability of their exploitation in world fisheries. This situation has resulted in several international initiatives to promote greater understanding of sharks in the ecosystem and in greater efforts to conserve the many shark species in world fisheries.

In U.S. fisheries in 2008, four shark stocks are subject to overfishing[1] and four shark stocks are overfished[2] (Table 1). Twenty and 21 shark stocks or stock complexes have an unknown or undefined status in terms of their overfishing and overfished status, respectively (Table 1).

Shark finning is the practice of taking a shark, removing a fin or fins (whether or not including the tail), and returning the remainder of the shark to the sea.[3] Because the meat of the shark is usually of low value, the finless sharks are thrown back into the sea and subsequently die. Shark fins are very valuable and are among the most expensive fish products in the world. Shark fins are considered a delicacy in East Asia and are used to make shark fin soup. The growth in demand for some shark products, such as fins, continues to drive increased exploitation of sharks (Bonfil 1994; Rose 1996; Walker 1998).

On December 21, 2000, President Clinton signed into law the Shark Finning Prohibition Act of 2000 out of concern for the status of shark populations and the effects of fishing mortality associated with finning on shark populations. Section 3 of this Act amended the Magnuson-Stevens Fishery Conservation and Management Act (MSA) to prohibit any person under U.S. jurisdiction from: (i) engaging in the finning of sharks, (ii) possessing shark fins aboard a fishing vessel without the corresponding carcass, and (iii) landing shark fins without the

[1] A stock that is subject to overfishing has a fishing mortality (harvest) rate above the level that provides for the maximum sustainable yield.
[2] A stock that is overfished has a biomass level below a biological threshold specified in its fishery management plan.
[3] As defined in Section 9 of the Shark Finning Prohibition Act.

corresponding carcass. Section 3 of the Shark Finning Prohibition Act contains 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 Act 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. This is commonly referred to as the "5 percent rule."

The Shark Finning Prohibition Act requires NMFS to promulgate regulations to implement its prohibitions (Section 4), initiate discussion with other nations to develop international agreements on shark finning and data collection (Section 5), provide Congress with annual reports describing efforts to carry out the Shark Finning Prohibition Act (Section 6), and establish research programs (Sections 7 and 8). Section 9 of the Act defines shark finning.

Consistent with Section 4 of the Act, NMFS published a proposed rule (66 FR 34401; June 28, 2001) and final rule (67 FR 6194; February 11, 2002) to implement the provisions of the Shark Finning Prohibition Act. The final rule prohibits: 1) any person from engaging in shark finning aboard a U.S. fishing vessel; 2) any person from possessing shark fins on board a U.S. fishing vessel without the corresponding shark carcasses; 3) any person from landing from a U.S. fishing vessel shark fins without the corresponding carcasses; 4) any person on a foreign fishing vessel from engaging in shark finning in the U.S. Exclusive Economic Zone (EEZ), from landing shark fins without the corresponding carcass into a U.S. port, and from transshipping shark fins in the U.S. EEZ; and 5) the sale or purchase of shark fins taken in violation of the above prohibitions. In addition, all shark fins and carcasses are required to be landed and weighed at the same time, once a landing of shark fins and/or shark carcasses has begun. On June 24, 2008, NMFS published a final rule (73 FR 35778, corrected on July 15, 2008, 73 FR 40658) that amended the 2006 Consolidated Atlantic HMS Fishery Management Plan (FMP) that, among other things, requires that all sharks in the Atlantic HMS fishery be offloaded with the fins naturally attached.

Section 6 of the Shark Finning Prohibition Act requires that the Secretary of Commerce, in consultation with the Secretary of State, provide Congress with annual reports describing efforts to carry out the Act. The Act specifically states that the report:

(1) includes a list that identifies nations whose vessels conduct shark finning and details the extent of the international trade in shark fins, including estimates of value and information on harvesting of shark fins, and landings or transshipment of shark fins through foreign ports;
(2) describes the efforts taken to carry out this Act, and evaluates the progress of those efforts;
(3) sets forth a plan of action to adopt international measures for the conservation of sharks; and
(4) includes recommendations for measures to ensure that United States actions are consistent with national, international, and regional obligations relating to shark populations, including those listed under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

These four topics are described in this *Report to Congress*. Regarding item 1 above, no reliable information exists to determine those nations whose vessels conduct shark finning. However, information on the international trade of shark fins is available from the Food and Agriculture

Organization of the United Nations (FAO), and information on U.S. import and export of shark fins is available from the U.S. Census Bureau. This information can be found in Section 3 of this report. However, it is important to note that, due to the complexity of the shark fin trade, fins are not necessarily produced in the same country from which they are exported.

Consistent with item 2 above, this *Report to Congress* summarizes all of the recent management (Sections 2.1 to 2.3), enforcement (Section 2.4), international efforts (Section 4), and research activities (Section 5) related to sharks that are in support of the Shark Finning Prohibition Act. This report, prepared in consultation with the Department of State, also provides an update to last year's report and includes complete information for 2008 activities.

Regarding item 3 above, the United States participated in the development of and endorsed the FAO's International Plan of Action (IPOA) for the Conservation and Management of Sharks. Consistent with the IPOA, the United States developed a National Plan of Action (NPOA) for the Conservation and Management of Sharks in February 2001. In addition to meeting the statutory requirement of the Shark Finning Prohibition Act, the annual *Report to Congress* serves as a periodic updating of information called for in the IPOA and NPOA.

Regarding item 4 above, NMFS has no specific recommendations for shark conservation and management at this time. Consistent with the provisions of Section 5 of the Shark Finning Prohibition Act, the Department of Commerce and the Department of State have been active in promoting development of international agreements consistent with the Act. Recommendations are brought forward through bilateral, multilateral, and regional efforts. As agreements are developed, the United States implements those agreements and reports on them in the annual *Report to Congress*. Information on recent international efforts, including CITES, can be found in Section 4 of this report.

Continuing efforts are being made nationally and internationally to increase data collection on shark stock assessments, develop gear modifications and capture/release techniques to minimize lethal shark bycatch, and increase our knowledge of shark ecology. These efforts should lead to improved shark management and are supported through agreements with international fishery management organizations, including: Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Inter-American Tropical Tuna Commission (IATTC), Western and Central Pacific Fisheries Commission (WCPFC), Northwest Atlantic Fisheries Organization (NAFO), International Commission for the Conservation of Atlantic Tunas (ICCAT), United Nations General Assembly (UNGA), CITES, FAO, and FAO's Committee on Fisheries (COFI).

**Table 1 Status of shark stocks and stock complexes in U.S. fisheries in 2008.**
Source: NMFS 2009.

| Status of shark stocks and stock complexes in U.S. fisheries in 2008 | | | |
|---|---|---|---|
| FMP & Jurisdiction | Stock or Stock Complex | Overfishing? | Overfished? |
| Spiny Dogfish FMP — NEFMC & MAFMC | Spiny dogfish – Atlantic coast | No | No - rebuilding |
| Consolidated Atlantic Highly Migratory Species FMP — NMFS Highly Migratory Species Division | Sandbar shark – Atlantic[1] | Yes | Yes |
| | Blacktip shark – Gulf of Mexico[1] | No | No |
| | Blacktip shark – South Atlantic[1] | Unknown | Unknown |
| | Atlantic large coastal shark complex[2] | Unknown | Unknown |
| | Finetooth shark – Atlantic[3] | No | No |
| | Atlantic sharpnose shark[3] | No | No |
| | Blacknose shark – Atlantic[3] | Yes | Yes |
| | Bonnethead – Atlantic[3] | No | No |
| | Atlantic small coastal shark complex[4] | No | No |
| | Shortfin mako – Atlantic[5] | Yes | No |
| | Porbeagle – Atlantic[5] | No | Yes |
| | Blue shark – Atlantic[5] | No | No |
| | Dusky shark – Atlantic | Yes | Yes |
| | Atlantic pelagic shark complex[6] | Unknown | Unknown |
| Pacific Coast Groundfish FMP — PFMC | Leopard shark | Unknown | Unknown |
| | Soupfin shark (also known as tope shark) | Unknown | Unknown |
| | Spiny dogfish | Unknown | Unknown |
| West Coast Highly Migratory Species FMP & Pelagic Fisheries of the Western Pacific Region FMP | Thresher shark – North Pacific | Unknown | Unknown |
| | Shortfin mako shark – North Pacific | Unknown | Unknown |
| | Blue shark – Pacific | No | No |
| | Bigeye thresher shark – North Pacific | Unknown | Unknown |

| | | | |
|---|---|---|---|
| — PFMC & WPFMC | Pelagic thresher shark – North Pacific | Unknown | Unknown |
| Pelagic Fisheries of the Western Pacific Region FMP — WPFMC | Longfin mako shark – North Pacific | Unknown | Unknown |
| | Oceanic whitetip shark – Tropical Pacific | Unknown | Unknown |
| | Silky shark – Tropical Pacific | Unknown | Unknown |
| | Salmon shark – North Pacific | Unknown | Unknown |
| Coral Reef Ecosystems of the Western Pacific Region — WPFMC | Hawaiian Archipelago Coral Reef Ecosystem Multi-Species Complex[7] | Unknown | Unknown |
| | American Samoa Coral Reef Ecosystem Multi-Species Complex[7] | Unknown | Unknown |
| | Guam Coral Reef Ecosystem Multi-Species Complex[7] | Unknown | Unknown |
| | Northern Mariana Islands Coral Reef Ecosystem Multi-Species Complex[7] | Unknown | Unknown |
| | Pacific Island Remote Areas Coral Reef Ecosystem Multi-Species Complex[8] | Unknown | Unknown |
| Gulf of Alaska Groundfish FMP — NPFMC | Other species complex[9] | Undefined | Undefined |
| Bering Sea/Aleutian Island Groundfish FMP — NPFMC | Other species complex[10] | No | Undefined |
| Totals: | | 4 “yes”<br>10 “no”<br>19 “Unknown”<br>1 “Undefined” | 4 “yes”<br>9 “no”<br>19 “Unknown”<br>2 “Undefined” |

[1]This stock is part of the Large Coastal Shark Complex, but it is assessed separately.
[2]In addition to Sandbar Shark, Gulf of Mexico Blacktip Shark, and Atlantic Blacktip Shark, the Large Coastal Shark Complex also consists of additional stocks including Spinner Shark, Silky Shark, Bull Shark, Tiger Shark, Lemon Shark, Nurse Shark, Scalloped Hammerhead Shark, Great Hammerhead Shark, and Smooth Hammerhead Shark. In addition, several LCS species cannot be retained in commercial or recreational fisheries, including Bignose Shark, Galapagos Shark, Night Shark, Caribbean Reef Shark, Narrowtooth Shark, Sand Tiger Shark, Bigeye Sand Tiger Shark, Whale Shark, Basking Shark, White Shark.
[3]This stock is part of the Small Coastal Shark Complex, but is assessed separately.
[4]In addition to Finetooth Shark, Atlantic Sharpnose Shark, Blacknose Shark, and Bonnethead Shark, the Small Coastal Shark Complex also consists of: Atlantic Angel Shark, Caribbean Sharpnose Shark, and Smalltail Shark; these 3 species cannot be retained in recreational or commercial fisheries.
[5]This stock is part of the Pelagic Shark Complex, but is assessed separately.
[6]In addition to Shortfin Mako Shark, Blue Shark, and Porbeagle Shark, the Pelagic Shark Complex also consists of Oceanic Whitetip Shark and Thresher Shark. This complex also consists of stocks that cannot be retained in recreational or commercial fisheries, which include Bigeye Thresher Shark, Bigeye Sixgill Shark, Longfin Mako Shark, Sevengill Shark, and Sixgill Shark.
[7]This complex contains up to 146 "currently harvested coral reef taxa" and innumerable "potentially harvested coral reef taxa."
[8]This complex contains up to 146 "currently harvested coral reef taxa" and innumerable "potentially harvested coral reef taxa." The Pacific remote island areas (PRIA) are U.S. island possessions in the Pacific Ocean that include Palmyra Atoll, Kingman Reef, Jarvis Island, Baker Island, Howland Island, Johnston Atoll, Wake Island, and Midway Atoll. All reefs of the PRIA except Wake Island, which is under the jurisdiction of the Department of Defense, are National Wildlife Refuges. Fishing for coral reef-associated species is prohibited in all these areas except Palmyra Atoll, Johnston Atoll, Wake Island, and Midway Atoll.
[9]The Other Species Complex consists of the following stocks: Pacific Sleeper Shark, Salmon Shark, Spiny Dogfish, and numerous octopi, squid, and sculpins. There is no OFL specified for this complex. The TAC is set at an amount less than or equal to 5 percent of the combined TACs for the remainder of the groundfish fishery.
[10]The Other Species Complex consists of the following stocks: Pacific Sleeper Shark, Salmon Shark, Spiny Dogfish, and numerous skates, octopi, and sculpins. The overfishing determination is based on the OFL, which is computed by using abundance estimates of skates and sculpins and average historical catch for sharks and octopus.

# 2. Management and Enforcement

## 2.1 Management Authority in the United States

The Magnuson-Stevens Fishery Conservation and Management Act forms the basis for fisheries management in Federal waters and requires NMFS and the eight regional fishery management councils to take specified actions. State agencies and interstate fishery management commissions are bound by State regulations and, in the Atlantic region, by the Atlantic Coast Fisheries Cooperative Management Act.

## 2.2 Current Management Authority in the Atlantic Ocean

**Atlantic Highly Migratory Species Management**

Development of FMPs is the responsibility of one or more of the eight regional fishery management councils, except for Atlantic highly migratory species (HMS), which include tunas, swordfish, billfish, and sharks. Since 1990, shark fishery management in Federal waters of the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea (excluding spiny dogfish, skates, and rays) has been the responsibility of the Secretary of Commerce, delegated to NMFS' HMS Division.

In 1993, NMFS implemented the FMP for Sharks of the Atlantic Ocean. Under the FMP, three management units were established for shark species: large coastal sharks (LCS), small coastal sharks (SCS), and pelagic sharks (Table 2.2.1). NMFS identified LCS as overfished, and therefore, among other things, implemented commercial quotas for LCS and established recreational harvest limits for all sharks. At that time, NMFS also banned finning of all sharks in the Atlantic Ocean.

In April 1999, NMFS published the FMP for Atlantic Tunas, Swordfish, and Sharks, which included numerous measures to rebuild or prevent overfishing of Atlantic sharks in commercial and recreational fisheries. The 1999 FMP replaced the 1993 FMP and addressed numerous shark management measures, including: reducing commercial LCS and SCS quotas, establishing a commercial quota for blue sharks and a species-specific quota for porbeagle sharks, expanding the list of prohibited shark species, implementing a limited access permitting system in commercial fisheries, and establishing season-specific overharvest and underharvest adjustment procedures.

On December 24, 2003, the final rule implementing Amendment 1 to the 1999 FMP for Atlantic Tunas, Swordfish, and Sharks was published in the *Federal Register* (68 FR 74746). This final rule revised the shark regulations based on the results of the 2002 stock assessments for SCS and LCS. In Amendment 1 to the 1999 FMP, NMFS revised the rebuilding timeframe for LCS to 26 years from 2004, and implemented several new regulatory changes, including: using maximum sustainable yield as a basis for setting commercial quotas; eliminating the commercial minimum size restrictions; implementing trimester commercial fishing seasons effective January 1, 2005; implementing a time/area closure off the coast of North Carolina effective January 1, 2005; and establishing three regional commercial quotas (Gulf of Mexico, South Atlantic, and North Atlantic) for LCS and SCS management units. In addition, as of November 15, 2004, directed shark vessels with gillnet gear on board, regardless of location, are required to have a Vessel Monitoring System (VMS) installed and operating during right whale calving season (November 15–March 31); and, as of January 1, 2005, directed shark vessels with bottom longline fishing gear on board, located between 33° and 36° 30′ N latitude, were required to have a VMS installed and operating during the mid-Atlantic shark closure period (January 1–July 31).

On October 2, 2006, the 1999 FMP was replaced with the final Consolidated Atlantic HMS FMP, which consolidated management of all Atlantic HMS under one plan, reviewed current information on shark essential fish habitat, required the second dorsal and anal fin to remain on shark carcasses through landing, required shark dealers to attend shark identification workshops, and included measures to address overfishing of finetooth sharks (71 FR 58058). This FMP manages several species of sharks (Table 2.2.1). The 2001–2007 commercial shark landings and the 2008 preliminary commercial shark landings are shown in tables 2.2.2 and 2.2.3, respectively.

On February 7, 2007, NMFS published a final rule (72 FR 5633) to implement additional handling, release, and disentanglement requirements for sea turtles and other non-target species caught in the commercial shark bottom longline (BLL) fishery. These additional handling requirements require the commercial shark BLL fishery to utilize equipment and protocols consistent with the requirements for the pelagic longline fishery (July 6, 2004, 69 FR 40734). On September 23, 2008 (73 FR 54721), NMFS published a final rule that also requires U.S. HMS pelagic longline and BLL vessels to possess an additional sea turtle control device as of January 1, 2009. Additionally, the February 7, 2007, final rule established measures to complement those implemented by the Caribbean Fishery Management Council on October 29, 2005 (70 FR 62073), to prohibit all vessels issued HMS permits with BLL gear onboard from fishing with, or deploying, any fishing gear in six distinct areas off the U.S. Virgin Islands and Puerto Rico, year-round. The intent of these restrictions is to minimize adverse impacts to Essential Fish Habitat and reduce fishing mortality on other fish species.

On June 24, 2008, NMFS published a final rule (73 FR 35778, corrected on July 15, 2008, 73 FR 40658) that amended the 2006 Consolidated Atlantic HMS FMP based on recent stock assessments for LCS, dusky sharks, and porbeagle sharks. The rule included measures to adjust quotas and retention limits, modify authorized species for the commercial shark fishery, establish a shark research fishery, require that all sharks be offloaded with all fins naturally attached, and modify the species that can be landed by recreational fishermen. Final measures were effective on July 24, 2008.

NMFS developed a draft environmental impact statement (DEIS) and proposed rule to amend the 2006 Consolidated Atlantic HMS FMP based on the latest SCS and shortfin mako shark stock assessments. The DEIS and proposed rule published in July 2009 (74 FR 36892; 7/24/2009).

NMFS publishes rules each year to adjust quotas based on landings from the previous fishing year (the fishing year is from January to December of each year; each shark fishery closes when the respective shark species/complex's quota reaches 80 percent with a five-day notice upon filing in the *Federal Register*). A final rule was published on December 24, 2008 (73 FR 79005), which established the 2009 fishing season for commercial quotas for sandbar sharks, non-sandbar LCS, small coastal sharks, and pelagic sharks based on overharvests or underharvests from the 2008 fishing year. The 2009 fishing season opened on January 23, 2009.

**Shark Stock Assessments**

A stock assessment was conducted for North Atlantic porbeagle sharks in 2005 by the Canadian Department of Fisheries and Oceans. This assessment was reviewed by NMFS and determined to be the best available science and appropriate for use in U.S. domestic management. Results indicate that porbeagle sharks are overfished ($SSN_{2004}/SSN_{MSY}$ = 0.15-0.32)[4], however, overfishing is not occurring ($F_{2004}/F_{MSY}$ = 0.83). The assessment recommended that there is a 70-percent probability of rebuilding in 100 years if fishing mortality (F) levels are maintained at or below 0.04 (current F level). Based on this assessment, NMFS determined that porbeagle sharks are overfished, but overfishing is not occurring, and NMFS implemented a rebuilding plan for porbeagle sharks in 2008 and reduced the U.S. Atlantic commercial quota from 92 metric tons dressed weight (mt dw) to 1.7 mt dw per year.

The first individual stock assessment for dusky sharks was completed in May 2006. Due to potential identification problems and catch data originating from a variety of sources, the magnitude of dusky shark catch has previously been difficult to ascertain. Three models were used to ascertain the current status of a single dusky shark stock, the most optimistic of which indicated that the dusky shark population has been depleted by 62 to 80 percent of the unfished virgin biomass. The assessment also summarized the relevant biological data, discussed the fisheries affecting dusky sharks, and detailed the data and methods used to assess shark status. Some recommendations were also made regarding future avenues of research and issues to consider in future stock assessments.

The latest stock assessment on LCS, which followed the Southeast Data Assessment and Review (SEDAR) process, was completed in June 2006. During the Review Workshop, an official recommendation was made to alter the current regime for conducting LCS complex-based assessments to species-specific assessments. During the 2006 LCS assessment, the Atlantic stock of sandbar sharks was individually assessed and found to be overfished with overfishing occurring. Regulatory actions were put into place in 2008 to adjust the commercial quota of

[4]Note: SSN refers to spawning stock number and MSY refers to maximum sustainable yield. MSY is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological, environmental conditions and fishery technological characteristics (e.g., gear selectivity), and the distribution of catch among fleets.

sandbar sharks, which as a result can now only be harvested within a shark research fishery, as necessary to achieve rebuilding by the target year of 2070. Blacktip sharks were divided into two stocks, a Gulf of Mexico stock and an Atlantic stock. Due to an absence of reliable estimates of abundance, biomass, and exploitation rates, the current status of blacktips in the Atlantic is unknown. The Gulf of Mexico blacktip shark stock is not overfished and overfishing is not occurring; however, it was recommended that current catch rates of this stock be maintained.

The latest stock assessments for the SCS complex—and for Atlantic sharpnose, bonnethead, blacknose, and finetooth sharks individually—were conducted in 2007. The Review Panel for the 2007 SCS SEDAR concluded that, although the assessment of the status of the complex was adequate based on the available data, given that species-specific assessments were also conducted, any conclusions should be based on the results of the individual species assessments. Results of the finetooth shark assessment indicated the stock was not overfished and overfishing was not occurring, in contrast to the findings of the 2002 SCS assessment, which found that overfishing was occurring. However, because of the general level of uncertainty in the data, the Review Panel suggested cautious management of this resource. For blacknose sharks, the assessment indicated the stock was overfished and overfishing was occurring both in 2005 and in the preceding 2001–2004 period. However, due to uncertainty in life history parameters, catches, and indices of relative abundance, the Review Panel cautioned that stock status could change substantially in an unpredictable direction in future assessments. In contrast, the assessments for Atlantic sharpnose and bonnethead sharks determined the stocks were not overfished and that overfishing was not occurring.

In 2008, an updated stock assessment for blue and shortfin mako sharks was conducted by the International Commission for the Conservation of Atlantic Tunas (ICCAT) Standing Committee on Research and Statistics (SCRS). The results of these stock assessments are described in section 4.2 of this report.

**Observer Coverage**

Observer coverage in the shark BLL fishery began in 1994 on a voluntary basis. Since 2002, observer coverage has been mandatory for selected BLL and gillnet vessels. NMFS aims to obtain 4 to 6 percent observer coverage of the commercial effort and deploys approximately five to seven observers to monitor 300 to 400 commercial fishing trips per year. The data collected through the observer program are critical to the monitoring of takes and mortality estimates for protected sea turtles, sea birds, marine mammals, and smalltooth sawfish. Data obtained through the observer program are also vital for conducting stock assessments of sharks and for use in the development of fishery management measures for Atlantic sharks. Gillnet observer coverage is also contingent upon requirements implemented by the Atlantic Large Whale Take Reduction Plan (ALWTRP). The most recent regulations amending the ALWTRP were published in the *Federal Register* on June 25, 2007 (72 FR 34632), and on October 5, 2007 (72 FR 57104). The ALWTRP, as amended, implements specific regulations for the shark gillnet component of the HMS fisheries.

**Shark Management by the Regional Fishery Management Councils and States**

The Mid-Atlantic Fishery Management Council has the lead in consultations with the New England Fishery Management Council for the management of spiny dogfish in Federal waters of the Atlantic Coast pursuant to the Spiny Dogfish FMP, which became effective in February 2000. The FMP incorporates the MSA regulations governing the harvest, possession, landing, purchase, and sale of shark fins from 50 CFR Part 600, Subpart N. The management program establishes a restrictive spiny dogfish possession limit of 600 pounds per trip and a coastwide commercial quota further split into two seasonal quotas (Period I and Period II). Upon attainment of the coastwide quota, the fishery is closed to further landings by Federally permitted vessels.

Coordinated State management of sharks is vital to ensuring healthy populations of Atlantic coastal sharks. The Atlantic States Marine Fisheries Commission has developed and individual states are in the process of implementing an Interstate Coastal Shark FMP. A goal of this FMP is to improve consistency between Federal and State management of sharks in the Atlantic Ocean.

**Table 2.2.1 U.S. Atlantic shark management units, shark species for which retention is prohibited, and data collection-only species.**

| Sharks in the Consolidated Atlantic HMS FMP | | | |
|---|---|---|---|
| **Large Coastal Sharks (LCS)** | | **Small Coastal Sharks (SCS)** | |
| Sandbar* | *Carcharhinus plumbeus* | Atlantic sharpnose | *Rhizoprionodon terraenovae* |
| Silky** | *Carcharhinus falciformis* | Finetooth | *Carcharhinus isodon* |
| Tiger | *Galeocerdo cuvier* | Blacknose | *Carcharhinus acronotus* |
| Blacktip | *Carcharhinus limbatus* | Bonnethead | *Sphyrna tiburo* |
| Spinner | *Carcharhinus brevipinna* | | |
| Bull | *Carcharhinus leucas* | **Pelagic Sharks** | |
| Lemon | *Negaprion brevirostris* | Shortfin mako | *Isurus oxyrinchus* |
| Nurse | *Ginglymostoma cirratum* | Common thresher | *Alopias vulpinus* |
| Scalloped hammerhead | *Sphyrna lewini* | Porbeagle | *Lamna nasus* |
| Great hammerhead | *Sphyrna mokarran* | Oceanic whitetip | *Carcharhinus longimanus* |
| Smooth hammerhead | *Sphyrna zygaena* | Blue | *Prionace glauca* |
| **Prohibited Species** | | | |
| Sand tiger | *Carcharias taurus* | Caribbean reef | *Carcharhinus perezi* |
| Bigeye sand tiger | *Odontaspis noronhai* | Narrowtooth | *Carcharhinus brachyurus* |
| Whale | *Rhincodon typus* | Caribbean sharpnose | *Rhizoprionodon porosus* |
| Basking | *Cetorhinus maximus* | Smalltail | *Carcharhinus porosus* |
| White | *Carcharodon carcharias* | Atlantic angel | *Squatina dumeril* |
| Dusky | *Carcharhinus obscurus* | Longfin mako | *Isurus paucus* |
| Bignose | *Carcharhinus altimus* | Bigeye thresher | *Alopias superciliosus* |
| Galapagos | *Carcharhinus galapagensis* | Sevengill | *Heptranchias perlo* |
| Night | *Carcharhinus signatus* | Sixgill | *Hexanchus griseus* |
| | | Bigeye sixgill | *Hexanchus vitulus* |
| **Deepwater and Other Species (Data Collection Only)** | | | |
| Iceland catshark | *Apristurus laurussoni* | Great lanternshark | *Etmopterus princeps* |
| Smallfin catshark | *Apristurus parvipinnis* | Smooth lanternshark | *Etmopterus pusillus* |
| Deepwater catshark | *Apristurus profundorum* | Fringefin lanternshark | *Etmopterus schultzi* |
| Broadgill catshark | *Apristurus riveri* | Green lanternshark | *Etmopterus virens* |
| Marbled catshark | *Galeus arae* | Cookiecutter shark | *Isistius brasiliensis* |
| Blotched catshark | *Scyliorhinus meadi* | Bigtooth cookiecutter | *Isistius plutodus* |
| Chain dogfish | *Scyliorhinus retifer* | Smallmouth velvet dogfish | *Scymnodon obscurus* |
| Dwarf catshark | *Scyliorhinus torrei* | Pygmy shark | *Squaliolus laticaudus* |
| Japanese gulper shark | *Centrophorus acus* | Roughskin spiny dogfish | *Squalus asper* |
| Gulper shark | *Centrophorus granulosus* | Blainville's dogfish | *Squalus blainvillei* |
| Little gulper shark | *Centrophorus uyato* | Cuban dogfish | *Squalus cubensis* |
| Kitefin shark | *Dalatias licha* | Bramble shark | *Echinorhinus brucus* |
| Flatnose gulper shark | *Deania profundorum* | American sawshark | *Pristiophorus schroederi* |
| Portuguese shark | *Centroscymnus coelolepis* | Florida smoothhound | *Mustelus norrisi* |
| Greenland shark | *Somniosus microcephalus* | Smooth dogfish | *Mustelus canis* |
| Lined lanternshark | *Etmopterus bullisi* | | |
| Broadband dogfish | *Etmopterus gracilispinnis* | | |
| Caribbean lanternshark | *Etmopterus hillianus* | | |

***can only be harvested within a shark research fishery, and not allowed for recreational harvest**
****not allowed for recreational harvest**

**Table 2.2.2 Commercial landings for Atlantic large coastal, small coastal, and pelagic sharks in metric tons dressed weight,[5] 2001–2007.**
Source: Cortés and Neer (2002, 2005); Cortés (2003); Cortés pers. comm. (2008).

| 2001–2007 Commercial Shark Landings | | | | | | | |
|---|---|---|---|---|---|---|---|
| Species Group | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
| **Large coastal sharks** | 1,549 | 1,883 | 1,947 | 1,458 | 1,500 | 1,747 | 1,047 |
| **Small coastal sharks** | 329 | 279 | 242 | 205 | 295 | 373 | 297 |
| **Pelagic sharks** | 157 | 212 | 289 | 308 | 107 | 84 | 120 |
| **Total** | 2,035 | 2,374 | 2,478 | 1,971 | 1,902 | 2,204 | 1,464 |

[5] Dressed weight is the weight of fish after the gills, guts, head, and fins have been removed and discarded (usually at sea).

**Table 2.2.3 Preliminary landings estimates in metric tons (mt) and dressed weight (dw) for the 2008 Atlantic shark commercial fisheries.** Landings are based on the quota monitoring system.

| 2008 Preliminary Commercial Shark Landings | | | | |
|---|---|---|---|---|
| Species Group | Region | 2008 Quota | Estimated Total Landings | % of Quota |
| **Non-Sandbar Large Coastal Sharks (LCS)** (i.e., silky, tiger, blacktip, spinner, bull, lemon, nurse, and hammerheads) | Gulf of Mexico | 390.5 mt dw (860,896 lb dw) | 302.8 mt dw (667,608 lb dw) | 78% |
| | Atlantic | 187.8 mt dw (414,024 lb dw) | 164.4 mt dw (362,453 lb dw) | 88% |
| Shark Research Fishery (Non-Sandbar LCS) | No Regional Quotas | 37.5 mt dw (82,673 lb dw) | 17.1 mt dw (37,781 lb dw) | 46% |
| Shark Research Fishery (SRF) (Sandbar Only) | | 87.9 mt dw (193,784 lb dw) | Inside SRF 13.9 mt dw (30,558 lb dw | 78% |
| | | | Outside SRF* 54.9 mt dw (120,939 lb dw) | |
| **Small Coastal Sharks** (SCS) | No Regional Quotas | 454 mt dw (1,000,888 lb dw) | 282.2 mt dw (622,193 lb dw) | 62% |
| Blue Sharks | No Regional Quotas | 273 mt dw (601,856 lb dw) | 1.5 mt dw (3,229 lb dw) | 0.5% |
| Porbeagle Sharks | No Regional Quotas | 1.7 mt dw (3,748 lb dw) | 2.2 mt dw (4,771 lb dw) | 127% |
| Pelagic Sharks Other Than Porbeagle or Blue | No Regional Quotas | 488 mt dw (1,075,856 lb dw) | 108.2 mt dw (238,469 lb dw) | 22% |

* These landings are from state landings.

## 2.3 Current Management of Sharks in the Pacific Ocean

**Pacific Fishery Management Council (PFMC)**

The PFMC's area of jurisdiction is the Exclusive Economic Zone (EEZ) off the coasts of California, Oregon, and Washington. In late October 2002, the PFMC adopted the U.S. West Coast Highly Migratory Species (HMS) Fisheries FMP. This FMP's management area also covers adjacent high-seas waters for fishing activity under the jurisdiction of the HMS FMP. The HMS FMP is implemented by the NMFS Southwest Regional Office in Long Beach, California. The final rule implementing the HMS FMP was published in the *Federal Register* on April 7, 2004 (69 FR 18443). This FMP manages several sharks as part of the management unit complex (Table 2.3.1), including the common thresher and shortfin mako (sharks commercially valued but not primarily targeted in the West Coast-based fisheries), as well as blue sharks (a frequent bycatch species), bigeye thresher, and pelagic thresher (incidental catch) sharks. The HMS FMP also includes some shark species which have been identified for monitoring purposes (Table 2.3.1). These species, which often comprise a fishery's bycatch, are monitored on a consistent and routine basis to the extent practicable. Lastly, the HMS FMP also designated some shark species as prohibited because of their special status (Table 2.3.1). If intercepted during HMS fishing operations, these species—including great white, megamouth, and basking sharks—must be released immediately, unless other provisions for their disposition are established consistent with State and Federal regulations.

The FMP proposed precautionary annual harvest guidelines for common thresher and shortfin mako sharks in order to prevent localized depletion given the level of exploitation in some HMS fisheries at the time the FMP was adopted (e.g., large mesh drift gill net), and the uncertainty about catch in Mexico of these straddling stocks. These high exploitation rates and their impact on HMS shark stocks, if not checked, could take decades to correct given the vulnerable life history characteristics of the species. The common thresher shark and the shortfin mako shark are considered vulnerable to overexploitation due to their low fecundity, long gestation periods, and relatively old age at maturation. The FMP also establishes a formal requirement for fishery monitoring and annual Stock Assessment and Fishery Evaluation (SAFE) reports, as well as a full FMP effectiveness review every 2 years. This should ensure new information will be collected and analyzed so additional conservation action can be taken if any species is determined to need further protection. The Pacific Council's Highly Migratory Species Management Team is currently addressing the required elements of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, including the need to set annual catch limits (ACLs) and accountability measures (AMs) for actively managed HMS sharks.

The Pacific Coast Groundfish FMP includes three shark species (leopard, soupfin, and spiny dogfish) in the groundfish management unit (Table 2.3.2). The FMP is implemented by the NMFS Northwest Regional Office in Seattle, Washington. Beginning in 2003, NMFS established a "rockfish conservation area" closing large areas to fishing for groundfish, including sharks, by most gear types that catch groundfish. In addition, the Pacific Coast Groundfish FMP manages its shark species with a combined annual optimal yield for all "other fish," which includes sharks, skates, ratfish, morids, grenadiers, kelp greenling, and some other groundfish species. This optimal yield is reduced by a precautionary adjustment of 50 percent from the acceptable biological catch. Beginning in 2006, NMFS implemented 2-month cumulative trip limits for spiny dogfish for both open access and limited entry fisheries to control the harvest of dogfish and associated overfished groundfish species. Table 2.3.3 lists landings (round weight[6] equivalent in metric tons) for various sharks from fisheries off California, Oregon, and Washington.

**Table 2.3.1 Shark species in the West Coast Highly Migratory Species Fishery Management Plan.**

| West Coast Highly Migratory Species FMP | |
|---|---|
| Sharks listed as management unit species | |
| Common thresher | *Alopias vulpinus* |
| Shortfin mako | *Isurus oxyrinchus* |
| Blue shark | *Prionace glauca* |
| Bigeye thresher | *Alopias superciliosus* |
| Pelagic thresher | *Alopias pelagicus* |
| Sharks included in the FMP for monitoring purposes | |
| Whale shark | *Rincodon typus* |
| Prickly shark | *Echinorhinus cookei* |
| Salmon shark | *Lamma ditropis* |
| Leopard shark | *Triakis semifasciata* |
| Hammerhead sharks | Sphyrnidae |
| Soupfin shark | *Galeorhinus galeus* |
| Silky shark | *Carcharhinus falciformis* |
| Oceanic whitetip shark | *Carcharhinus longimanus* |
| Blacktip shark | *Carcharhinus limbatus* |
| Dusky shark | *Carcharhinus obscurus* |
| Sixgill shark | *Hexanchus griseus* |
| Spiny dogfish | *Squalus acanthias* |
| Prohibited species | |
| Great white | *Carcharodon carcharias* |
| Megamouth | *Megachasma pelagios* |
| Basking shark | *Cetorhinus maximus* |

[6] Round weight is the weight of the whole fish before processing or removal of any part.

**Table 2.3.2 Shark species in the groundfish management unit of the Pacific Coast Groundfish Fishery Management Plan.**

| Pacific Coast Groundfish FMP | |
|---|---|
| Sharks listed as management unit species | |
| Leopard shark | *Triakis semifasciata* |
| Soupfin shark | *Galeorhinus galeus* |
| Spiny dogfish | *Squalus acanthias* |

**Table 2.3.3 Shark landings (round weight equivalent in metric tons) for California, Oregon, and Washington, 1998–2008, organized by species group.**[7]
Source: PacFIN Database, the Washington, Oregon, and California All Species Reports (Report # 307) and the PFMC Groundfish Management Team Reports, as of May 2009, http://pacfin.psmfc.org/pacfin_pub/data.php

| Shark Landings (mt) for California, Oregon, and Washington | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Species Name | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008[8] |
| Bigeye thresher shark | 11 | 6 | 5 | 2 | -- | 5 | 5 | 10 | 4 | 5 | 7 |
| Blue shark | 3 | < 1 | 1 | 2 | 42 | 1 | < 1 | 1 | < 1 | 10 | <1 |
| Common thresher shark | 361 | 320 | 295 | 373 | 301 | 294 | 115 | 179 | 160 | 204 | 144 |
| Leopard shark | 15 | 14 | 13 | 12 | 13 | 10 | 11 | 13 | 11 | 11 | 3 |
| Other shark | 5 | 6 | 5 | 38 | 4 | 20 | 3 | 5 | 4 | 2 | 2 |
| Pelagic thresher shark | 2 | 10 | 3 | 2 | 2 | 4 | 2 | < 1 | < 1 | 2 | -- |
| Shortfin mako | 100 | 63 | 80 | 46 | 82 | 69 | 54 | 33 | 46 | 45 | 35 |
| Soupfin shark | 54 | 75 | 48 | 45 | 32 | 35 | 27 | 26 | 30 | 17 | 8 |
| Spiny dogfish[9] | 462 | 515 | 647 | 565 | 876 | 450 | 412 | 495 | 431 | 472 | 723 |
| Unspecified shark | 7 | 13 | 6 | 3 | 4 | 3 | 6 | 5 | 5 | 5 | 2 |
| Pacific angel shark | 50 | 48 | 34 | 28 | 22 | 17 | 13 | 12 | 15 | 8 | 12 |
| **Total** | **1,070** | **1,070** | **1,134** | **1,116** | **1,378** | **908** | **648** | **779** | **706** | **781** | **936** |

[7] This report includes all annual landings into the States of Washington, Oregon, and California for all marine species. This report was generated using the fish-ticket-line table and includes all catch areas including Puget Sound, Alaska, and possibly Canadian catch areas.
[8] For the most up-to-date report of shark landings, check the PacFIN website: http://pacfin.psmfc.org/pacfin_pub/data.php, as the data may continue to be updated.
[9] Spiny dogfish are sharks primarily caught in the groundfish fishery and some of the catch landed in Washington, Oregon, and California may have been made outside of the jurisdiction of the PFMC (i.e., Puget Sound, Alaska, and Canadian waters); therefore, the PFMC groundfish management team reports were used to report these landings.

**North Pacific Fishery Management Council (NPFMC)**

The NPFMC manages fisheries in Federal waters off Alaska, and the NMFS Alaska Regional Office in Juneau, Alaska implements the fishing regulations. Sharks are managed under the "other species" category in the Gulf of Alaska (GOA) Groundfish FMP and the Bering Sea/Aleutian Island (BSAI) Groundfish FMP. "Other species" comprises taxonomic groups of slight economic value and are not generally targeted. The category includes sharks, skates, octopi, and sculpins in the BSAI and sharks, octopi, squid, and sculpins in the GOA. These species have limited economic potential and are important components of the ecosystem, but sufficient data are lacking to manage each separately; therefore, an aggregate annual quota limits their catch. Catch of "other species" must be recorded and reported at the individual species level, such as spiny dogfish, or at a broader taxonomic level, such as sculpins.

In the BSAI and GOA, a survey is conducted biannually for groundfish including the "other species" category. The most recent surveys were conducted in 2008 in the BSAI and in 2007 in the GOA. These survey results were incorporated into the SAFE reports for "other species" in the BSAI and GOA (available from the NPFMC). A NMFS survey of "other species" is scheduled for 2009 in the GOA and in 2010 in the BSAI, and the results will be incorporated in the 2009 and 2010 SAFE reports.

Each year the BSAI Plan Team recommends to the Council an overfishing level (OFL) and an Allowable Biological Catch (ABC) amount for the "other species" category based on the best available and most recent scientific information. The Council recommends a total allowable catch (TAC) level for "other species" in the BSAI. In recent years the NPFMC has recommended a TAC for these species estimated as sufficient to meet incidental catch amounts in other directed groundfish fisheries but not sufficient to allow for a directed fishery on these species. The NPFMC has initiated analysis of alternative management measures for the "other species" category in the BSAI and GOA. Specifically, the analysis will examine the feasibility of breaking out the major taxonomic components of the "other species" and setting separate OFLs and ABCs for each component: sharks, skates, sculpins, and octopus.

Beginning in 2008, with the implementation of Amendment 79 to the GOA Groundfish FMP, the GOA Plan Team recommended aggregate OFL and ABC levels for the "other species" category in the GOA. The Alaska Fisheries Science Center (AFSC) prepared stock assessments for "other species" category in the GOA in 2008 for the 2009 and 2010 groundfish fishing years. Amendment 79 requires the NPFMC to set aggregate OFL and ABC levels for the "other species" category each year as part of the annual groundfish harvest specification process. This amendment allows the Council to incorporate the best and most recent scientific and socio-economic information as well as public testimony in its recommendation for an annual "other species" TAC. The purpose of the amendment is to provide a sound biological basis for the setting of "other species" TAC and to provide for an annual review of the stock status of the "other species" category to further reduce the risk of overfishing these species. Previously, the Council only recommended an annual TAC for the "other species" category in the GOA at a level less than or equal to 5 percent of the sum of all other TACs established for assessed species. Since 2006, the Council has recommended an annual TAC of 4,500 mt for the "other species" category. The NPFMC's recommendation was based on the GOA Plan Team's estimate of incidental catch needs in other directed groundfish and Pacific halibut fisheries (4,000 mt) and comments from the Scientific and Statistical Committee (SSC), Advisory Panel (AP), and the public. An annual TAC of 4,500 mt would meet incidental catch needs in the directed groundfish and halibut fisheries and allow for a modest directed fishery for the "other species" category of approximately 500 mt each year and the development of markets for these species.

Seven shark species have been identified during fishery surveys or observed during groundfish fishing in the Alaskan waters (Table 2.3.4). The brown cat, basking, sixgill, and blue sharks are very rarely taken in any sport or commercial fishery and are not targeted for harvest. Pacific sleeper, salmon, and spiny dogfish sharks are taken incidentally in groundfish fisheries and are monitored in season by NMFS. Sharks are the only group in the complex consistently identified to species in catches by fishery observers. Most of the shark incidental catch occurs in the midwater trawl pollock fishery and in the hook and line fisheries for sablefish, Greenland turbot, and Pacific cod along the outer continental shelf and upper slope areas. The most recent estimates of the incidental catch of sharks in the GOA and BSAI are from 2008. These data are included in Chapter 18 in the 2008 BSAI SAFE report and Chapter 18d in the 2008 GOA SAFE report and the NMFS catch accounting system. Estimates of the incidental catch of sharks in the GOA and BSAI groundfish fisheries from 2000 through 2008 have ranged from 418-2,333 metric tons (mt) and 188-1,362 mt, respectively (Table 2.3.5). Due to limited catch reports on individual species and larger taxonomic groups in the "other species" category, estimates of the incidental catch of sharks in the BSAI and GOA in the earlier years (2000 to 2002) are largely based on NMFS survey results and observer data. In the later years (2003 and onward), incidental catch is largely based on the NMFS Catch Accounting System.

**Table 2.3.4 Shark species identified during fishery surveys or observed during groundfish fishing in Alaskan waters.**

| Common Name | Species Name |
|---|---|
| Pacific sleeper shark | *Somniosus pacificus* |
| Salmon shark | *Lamna ditropis* |
| Spiny dogfish shark | *Squalus acanthias* |
| Brown cat shark | *Apristurus brunneus* |
| Basking shark | *Cetorhinus maximus* |
| Sixgill shark | *Hexanchus griseus* |
| Blue shark | *Prionace glauca* |

**Table 2.3.5 Incidental catch (in metric tons) of sharks in the Gulf of Alaska and Bering Sea/Aleutian Islands commercial groundfish fisheries, 2000–2008.**
Source: NMFS Survey, Observer Data, and NMFS Catch Accounting System Data

| Incidental Catch of Sharks (mt) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fishery | Species | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Gulf of Alaska groundfish fishery | **Spiny dogfish** | 397.6 | 494.0 | 117.0 | 361.5 | 1965.5 | 485.2 | 1232.1 | 848.9 | 328.4 |
| | **Pacific sleeper shark** | 608.2 | 249.0 | 225.6 | 297.8 | 286.4 | 485.6 | 253.7 | 297.2 | 65.6 |
| | **Salmon shark** | 37.8 | 32.8 | 58.2 | 37.2 | 40.8 | 60.3 | 34.3 | 134.7 | 3.4 |
| | **Unidentified shark** | 73.6 | 77.0 | 16.8 | 54.3 | 40.1 | 69.8 | 83.3 | 107.3 | 12.1 |
| | **Total** | 1,117.2 | 852.8 | 417.6 | 750.8 | 2332.7 | 1101.0 | 1,603.4 | 1388.1 | 409.5 |
| Bering Sea and Aleutian Islands groundfish fishery | **Spiny dogfish** | 8.9 | 17.3 | 9.4 | 11.3 | 8.6 | 11.4 | 7.0 | 3.0 | 16.2 |
| | **Pacific sleeper shark** | 490.4 | 687.3 | 838.5 | 279.7 | 420.4 | 333.2 | 313.1 | 255.8 | 119.8 |
| | **Salmon shark** | 23.3 | 24.4 | 46.6 | 196.3 | 25.6 | 46.7 | 65.3 | 44.5 | 44.8 |
| | **Unidentified shark** | 67.6 | 35.0 | 467.8 | 32.9 | 60.1 | 26.2 | 305.4 | 27.8 | 60.8 |
| | **Total** | 590.2 | 764.0 | 1,362.3 | 520.1 | 514.7 | 417.5 | 688.8 | 331.1 | 187.5 |

Very few of the sharks incidentally taken in the groundfish fisheries in the BSAI and GOA are retained. Table 2.3.6 lists the amounts of sharks discarded and retained between 2003 and 2008 in the GOA and BSAI. The amount of sharks retained during the period range from 1.8 to 9.9 percent of the total incidental catch in the BSAI, and 0.4 to 10.2 percent in the GOA. In 2006, two vessels targeted sharks using hook and line gear in the GOA, one vessel using a Federal Fishing Permit and another vessel using a permit issued by the Commissioner of the Alaska Department of Fish and Game (ADF&G) for use in State waters. The catches of these vessels is confidential but catches of sharks were very low in amount, effort was very short-lived, and deemed unsuccessful by the participants. Since 2006, there has been no effort targeting sharks in the GOA or BSAI.

**Table 2.3.6 Utilization (in metric tons) of sharks incidentally caught in the Gulf of Alaska and Bering Sea/Aleutian Islands commercial groundfish fisheries, 2003–2008.**
Source: Observer Data and NMFS Catch Accounting System Data

| Utilization of Sharks (mt) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Gulf of Alaska groundfish fishery | Species | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| | **Retained** | 10.8 | 9.9 | 35.5 | 62.1 | 45.4 | 41.9 |
| | **Discarded** | 739.9 | 2322.8 | 1065.4 | 1541.3 | 1342.7 | 367.6 |
| | **Total** | 750.8 | 2332.7 | 1101.0 | 1603.4 | 1388.1 | 409.5 |
| | **Percent Retained** | 1.4 | 0.4 | 3.2 | 3.9 | 3.3 | 10.2 |
| Bering Sea and Aleutian Islands groundfish fishery | **Retained** | 9.5 | 13.3 | 20.3 | 26.6 | 32.6 | 13.0 |
| | **Discarded** | 510.6 | 501.4 | 397.1 | 662.2 | 298.5 | 174.5 |
| | **Total** | 520.1 | 514.7 | 417.5 | 688.8 | 331.1 | 187.5 |
| | **Percent Retained** | 1.8 | 2.6 | 4.9 | 3.9 | 9.9 | 6.9 |

***Recreational shark fisheries***

The ADF&G manages the recreational shark fishery in State and Federal waters with a daily bag limit of one shark of any species per person per day, and an annual limit of two sharks of any species per person. These regulations have been in effect since 1998. In December 2008, the Alaska Board of Fisheries rejected a proposal to establish a vessel trip limit for salmon sharks in Prince William Sound. There have been no reported incidents of sport-caught sharks being finned and discarded, and State regulations prohibit the intentional waste or destruction of any sport-caught species.

Recreational harvest of all shark species combined is estimated through a mail survey of sport fishing license holders. About 1,122 sharks of all species were harvested by the sport fishery in State and Federal waters of Southeast and Southcentral Alaska in 2007 (most recent mail survey estimate). The highest harvests were in the Prince William Sound area, and no sport harvest of sharks was reported in western Alaska. The catch consists almost entirely of spiny dogfish and salmon shark. Although most spiny dogfish are released, they are believed to be the primary species harvested. There is a directed recreational fishery for salmon sharks in Prince William Sound involving a small number of charter boats.

Harvest of salmon sharks by guided anglers is required to be reported in mandatory charter logbooks. Charter boats reported harvests of 284 salmon sharks statewide in 2006, 244 fish in 2007 and 94 fish in 2008. The decrease in harvest is believed to be due mostly to a drop in effort. Although estimates of salmon shark harvest are not available for unguided anglers, the charter fleet is believed to account for the majority of salmon shark harvest. In addition to the mail survey and logbook, shark fisheries are monitored in Southcentral Alaska through biological sampling for species, size, age, and sex composition, as well as spatial distribution of the harvest.

***Commerical shark fishing in State waters***

State of Alaska regulations prohibit directed commercial fishing of sharks statewide except for a spiny dogfish permit fishery (5 AAC 28.379) adopted by the Alaska Board of Fisheries for the Cook Inlet area in 2005. Sharks taken incidentally to commercial groundfish and salmon fisheries may be retained and sold provided that the fish are fully utilized as described in 5 AAC 28.084. The State limits the amount of incidentally taken sharks that may be retained to 20 percent of the round weight of the directed species on board a vessel except in the Southeast District where a vessel using longline or troll gear may retain up to 35 percent round weight of sharks to round weight of the target species on board (5AAC 28.174 (1) and (2)). In the East Yakutat Section and the Icy Bay Subdistrict, salmon gillnetters may retain all spiny dogfish taken as bycatch during salmon gillnet operations (5AAC 28.174 (3)). All sharks landed must be recorded on an ADF&G fish ticket. To date, a single permit was issued in 2006 for the Cook Inlet spiny dogfish fishery and there was a single landing of incidentally taken sharks from southcentral Alaska waters. Since 2006, no permits have been issued.

**Western Pacific Fishery Management Council (WPFMC)**

The WPFMC manages fisheries in Federal waters in the western Pacific region and the NMFS Pacific Island Regional Office in Honolulu, Hawaii, implements the fishing regulations. In the western Pacific region the conservation of sharks is governed under the provisions of the Shark Finning Prohibition Act and the MSA. The MSA (Section 317) makes it unlawful for any person to chum for sharks, except for harvesting purposes. The WPFMC's Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region identifies nine sharks as management unit species (Table 2.3.6). Five species of coastal sharks are listed in the Coral Reef Fisheries Management Plan (Table 2.3.7) as currently harvested.

The longline fisheries in the Western Pacific, in Hawaii and American Samoa, were responsible for the vast majority of the sharks landed. Shark landings (estimated whole weight) by the Hawaii-based longline fisheries peaked at about 2,870 mt in 1999, due largely to the finning of blue sharks (Table 2.3.9). A State of Hawaii law prohibiting landing shark fins without an associated carcass passed in mid-2000 (Hawaii Revised Statutes 188.40-5). This law apparently decreased shark landings by almost 50 percent in 2000. With the subsequent enactment of the Federal Shark Finning Prohibition Act, shark landings from 2001 to 2008 were down by more then 93 percent from their peak. Landings in 2008 (preliminary data) were 159 mt; about the same as in the past eight years. Today, sharks are marketed as fresh shark fillets and steaks in Hawaii supermarkets and restaurants and are also exported to the U.S. mainland.

The American Samoa longline fishery lands a small amount of sharks compared to Hawaii's longline fishery (Table 2.3.9). The pattern of shark landings by the American Samoa longline fishery was similar to shark landings by the Hawaii-based longline fishery. Landings increased from 1 mt in 1995 to 13 mt in 1999, followed by a decline. The decline in shark landings by the American Samoa longline fishery is attributed to the Shark Finning Prohibition Act.

**Table 2.3.7 Pacific sharks in the pelagic management unit in the Pelagic Fisheries of the Western Pacific Region Fisheries Management Plan (as amended in March 2004).**

| Pelagic Fisheries of the Western Pacific Region FMP | |
|---|---|
| Shark species in the pelagic management unit | |
| Blue shark | *Prionace glauca* |
| Shortfin mako shark | *Isurus oxyrinchus* |
| Longfin mako shark | *Isurus paucus* |
| Oceanic whitetip shark | *Carcharhinus longimanus* |
| Common thresher shark | *Alopias vulpinus* |
| Pelagic thresher shark | *Alopias pelagicus* |
| Bigeye thresher shark | *Alopias superciliosus* |
| Silky shark | *Carcharhinus falciformis* |
| Salmon shark | *Lamna ditropis* |

**Table 2.3.8 Five coastal sharks listed as management unit species in the Coral Reef Ecosystems of the Western Pacific Fishery Management Plan and designated as currently harvested coral reef taxa.** Other coastal sharks in the management unit of the FMP belonging to the families Carcharhinidae and Sphyrnidae are designated as potentially harvested coral reef taxa.

| Coral Reef Ecosystems of the Western Pacific Fishery Management Plan | |
|---|---|
| Sharks listed as management unit species and designated as currently harvested coral reef taxa | |
| Grey reef shark | *Carcharhinus amblyrhynchos* |
| Silvertip shark | *Carcharhinus albimarginatus* |
| Galapagos shark | *Carcharhinus galapagenis* |
| Blacktip reef shark | *Carcharhinus melanopterus* |
| Whitetip reef shark | *Triaenodon obesus* |

**Table 2.3.9 Shark landings (mt) from the Hawaii-based longline fishery and the American Samoa longline fishery, 1998–2008.**
Source: Pacific Islands Fisheries Science Center's Fisheries Monitoring and Analysis Program and Western Pacific Fisheries Information Network (WPacFin)

| Shark Landings (mt) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fishery | Species | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Hawaii-based longline fishery | Blue shark | 2,500 | 2,400 | 1,200 | 30 | 30 | 20 | 60 | 30 | 12 | 6 | 7 |
| | Mako shark | 90 | 110 | 80 | 60 | 80 | 90 | 70 | 110 | 95 | 119 | 109 |
| | Thresher shark | 120 | 190 | 100 | 50 | 50 | 50 | 60 | 30 | 33 | 42 | 39 |
| | Miscellaneous shark | 110 | 170 | 70 | 10 | 20 | 10 | 10 | - | 11 | 7 | 4 |
| | Total shark landings | 2,820 | 2,870 | 1,450 | 150 | 180 | 170 | 200 | 170 | 151 | 174 | 159 |
| American Samoa longline fishery | Total shark landings | 11 | 13 | 4 | 1 | 3 | 4 | 1 | <1 | 1 | 2 | 1 |

## 2.4 NOAA Enforcement of the Shark Finning Prohibition Act

NOAA Office for Law Enforcement (OLE) has responsibility for enforcing the Shark Finning Prohibition Act (SFPA) and its implementing regulations. During calendar year 2008, most violations of the SFPA were detected, investigated, and prosecuted in the Northeast, Southeast, Alaska and Pacific Islands Enforcement Divisions. In general, the most common violations were the illegal finning of sharks and failure to maintain sharks in proper form. Additional "non-finning" violations that were investigated included possession of prohibited shark species, and failure to possess or display required permits. During this reporting period, the NOAA Office of General Counsel for Enforcement and Litigation (GCEL) has initiated several enforcement actions for violations of the SFPA.

- In May 2008, an enforcement officer from NOAA OLE's Pacific Islands Division boarded and inspected a Hawaii-based pelagic longline fishing vessel in response to a complaint concerning crewmembers finning sharks. During the boarding, the enforcement officer determined that crewmembers removed the tail fin from a dead blue shark and threw the carcass overboard while at sea. Subsequently, a written warning citation was issued to the vessel operator.

- In June 2008, two enforcement officers from the NOAA OLE Alaska Division performed a routine boarding of a longline vessel. During the inspection, the officers found the tail fin from a sleeper shark in the fish hold; however, the shark carcass had not been retained. The responding officers explained the requirements of the SFPA and gave a warning to the captain of the vessel.

- In August 2008, personnel from USCG Station Grand Isle, LA boarded a commercial fishing vessel at sea. During the inspection, four shark fins were located in the vessel's galley. No corresponding carcasses were onboard. NOAA GCEL issued a Notice of Violation and Assessment (NOVA) in the amount of $500.00 to the vessel owner.

- Also, in August 2008, USCG officers conducted an at-sea boarding and inspection of a commercial fishing vessel and discovered seven shark fins in the vessel's hold with no corresponding carcasses. The vessel operator was issued a Summary Settlement citation in the amount of $200.00 by the NOAA OLE Southeast Enforcement Division.

- In October 2008, a USCG cutter intercepted a Hawaii-based pelagic longline fishing vessel in the Foreign Exclusive Economic Zone of the Cook Islands. A subsequent boarding and inspection revealed that 31 shark fins, weighing approximately 15 pounds in total, were retained onboard the vessel without the corresponding carcasses. The shark fins were seized by the USCG boarding team and were eventually transferred to the NOAA OLE Pacific Islands Enforcement Division, which initiated an investigation. Subsequently, the NOAA GCEL issued a NOVA, which was paid in the amount of $5,000.00.

- Also in October 2008, USCG personnel boarded and inspected a commercial fishing vessel at sea near St. Petersburg, Florida. During the boarding and inspection, officers located one black tipped shark that was finned. The vessel operator was issued a Summary Settlement citation in the amount of $1,600.00 for the incident offense, and for not possessing a shark permit.

- In November 2008, and pursuant to a Federal enforcement agreement with the NOAA OLE, officers from the Florida Fish and Wildlife Commission boarded a commercial fishing vessel upon returning to port. During the dockside inspection, the boarding team located one mako shark carcass that was landed without fins attached to the body. The vessel operator was issued a Written Warning citation for the violation.

## 2.5 Education and Outreach

The U.S. National Plan of Action for the Conservation and Management of Sharks states that each U.S. management entity—i.e., NMFS, Regional Fishery Management Councils, Interstate Marine Fisheries Commissions, and States—should cooperate with regard to education and outreach activities associated with shark conservation and management. As part of the effort to implement the U.S. National Plan of Action, NMFS and other U.S. shark management entities have:

1. Developed training tools and programs in elasmobranch identification (such as identification posters and color guidebooks). For example, the Consolidated Highly Migratory Species Fishery Management Plan requires that all Federally permitted shark dealers in the Atlantic Ocean and Gulf of Mexico attend Atlantic Shark Identification Workshops. The objective of these workshops is to reduce the number of unknown and improperly identified sharks reported in the dealer reporting form and increase the accuracy of species-specific dealer-reported information.
2. Developed information and materials to raise awareness among recreational fishermen, commercial fishermen, fishing associations, and other relevant groups about the need and methods to reduce bycatch mortality and increase survival of released elasmobranchs where bycatch occurs. For example:
   - Starting in 2007, all Atlantic commercial shark fishermen using gillnet and/or longline gear were required to attend a mandatory handling and release workshop on protected resources and non-target bycatch prior to renewing their permits. In addition, in 2008, in conjunction with Amendment 2 to the Consolidated HMS FMP, NMFS distributed recreational placards that showed recreational fishermen which Atlantic sharks could be retained.
   - Also, staff from NMFS' Southwest Region Sustainable Fisheries Division appeared as an in-studio guest on the popular Southern California fishing radio show "Lets Talk Hook-up" to discuss and answer questions on current research, best angling practices to minimize catch and release mortality, and conservation measures in place for common thresher sharks captured by recreational fishermen in the southern California area. In addition, the NMFS Southwest Region Sustainable Fisheries Division, Southwest Fisheries Science Center, and the Pfleger Institute of Environmental Research sponsored three informational thresher shark seminar series

in Southern California during 2008. The primary goal of the seminars was to bring together fishermen, scientists, and resource managers to discuss current research findings, innovative fishing tactics to increase post-release survival, and measures to promote a sustainable recreational thresher shark fishery. An outreach brochure (see figure 2.5.1) was developed and distributed at the seminars and at various fishing shows in 2008 (e.g., at the Fred Hall Fishing and Tackle Shows in Long Beach and Del Mar, California, which annually attracts in excess of 50,000 participants).

- Dr. Michael Musyl, staff at NMFS Pacific Island Fisheries Science Center (PIFSC), was recently highlighted on an episode of *Pacific Expeditions* television series on the VS network where he was filmed placing electronic tags on blue marlin in the Marshall Island in February 2009. On the episode, Dr. Musyl discussed his overall research which includes documenting the excellent post-release survival rate of marlins (virtually 100%) and pelagic sharks (>95%) released from sports fishing gear and longline gear, respectively. Dr. Musyl and colleagues from PIFSC also annually present results on their research activities on pelagic fishes and sharks to the Hawaiian International Billfish Symposium.

3. Attempted to raise awareness among the non-fishing public about the ecological benefits from elasmobranch populations, detrimental effects of habitat destruction (e.g., coastal development and coastal pollution), and appropriate conservation measures to avoid, minimize, or mitigate adverse effects on necessary habitats.
    - As part of the joint relationship between NMFS and the Shelby Center for Ecosystem based Management in Dauphin Island, Alabama, three scientists from the Southeast Fisheries Center taught a 2-week summer course on the biology of sharks for the second year in a row. The course is open to upper level undergraduates from a number of Alabama Universities. The course is a comprehensive, interdisciplinary introduction to the evolution, biology, ecology, and conservation of elasmobranch fishes. Subsequent focus is considered from both an organismal (form and function), and an ecological (population dynamics, their habitats and interactions with each other and their environment) perspective. The impact of fisheries on elasmobranchs from a population and conservation standpoint is also considered. The course consists of lectures, laboratories, and field trips.

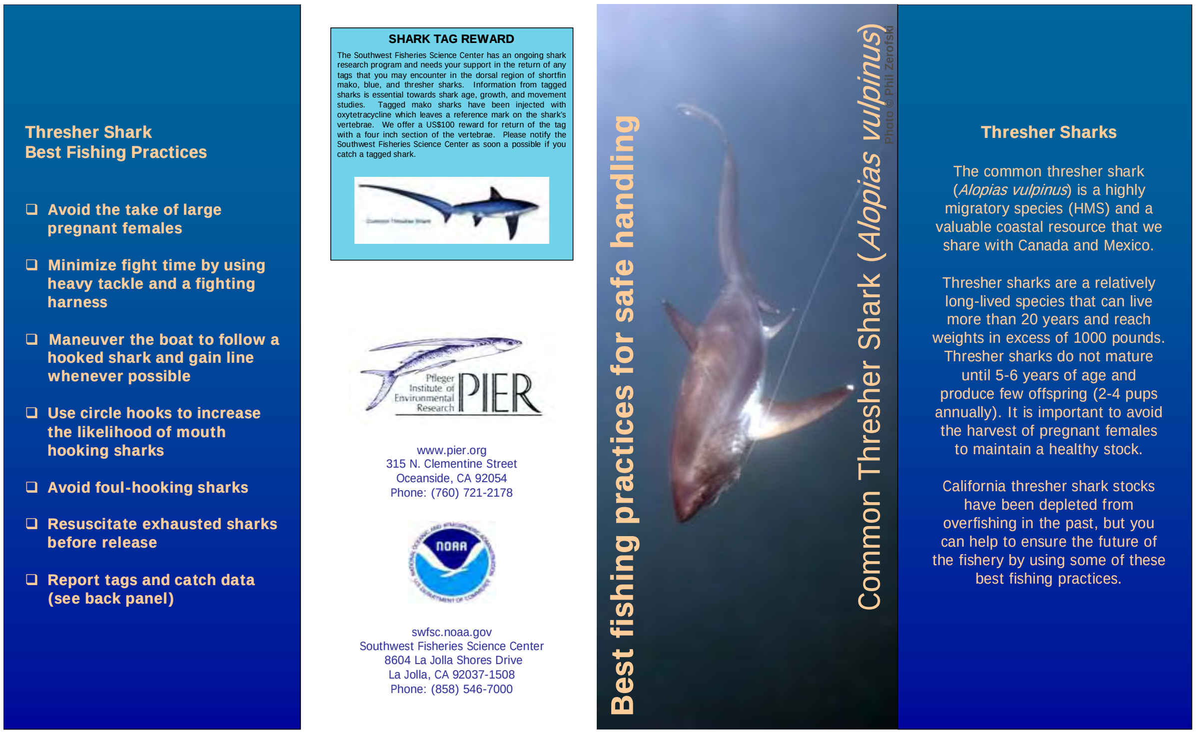


**Fig. 2.5.1. Page 1 of informational brochure on best fishing practices for safe release of common thresher shark captured in the southern California recreational fishery.**

## 2.6 Fishing Capacity

Numerous management tools are used in U.S. fisheries to reduce capacity, including limited entry, vessel and permit buybacks, and exclusive quota programs (e.g., individual fishing quotas, community development quotas, and cooperatives). A limited access permit program for Atlantic sharks has been in place since 1999 that has capped the number of commercial shark permits in the fishery. This limited access permit program includes both directed and incidental commercial shark permits. The directed shark permit, which allows a vessel to target sharks using any authorized gear, also has vessel-upgrading restrictions, further restricting capacity growth. A limited entry program for the U.S. West Coast Swordfish/Thresher Shark Drift Gillnet Fishery has been in place since 1980. Permits that are not renewed on an annual basis are retired with no replacements allowed into the fishery. In addition, a Pacific Leatherback Conservation Area was established in 2001 that closed off a substantial portion of the historic U.S. West Coast Swordfish/Thresher Shark Drift Gillnet fishing grounds (north of Point Conception to an area near the Columbia River, Oregon) during the months of August-November. As a result, fishing efforts and associated shark catch levels (target common threshers and non-target short-finned mako and blue sharks) have been decreasing in this fishery. Additional capacity reduction measures are still being investigated as an effective method for increasing the sustainability of elasmobranch fisheries.

Some participants in the Atlantic shark fishery expressed interest in reducing fishing capacity for sharks via some form of buyout program, and thus requested that an industry “business plan” be developed. The business plan was drafted under a cooperative agreement with the Gulf & South Atlantic Fishery Development Foundation. NMFS received the final report on September 12, 2006. The report concluded, “An evaluation of the Buyout Business Plan options, and comments received by commercial fishermen, indicates that the TAC of the shark fishery cannot adequately support a buyback which industry would support.” The report also concluded that a buyout program within the shark fishery could still be feasible if issues surrounding latent effort and additional financial resources outside of the shark fishery fleet could be addressed.

Pursuant to both an ongoing analytical program and to provisions in the recently reauthorized MSA, NMFS continues to assess levels of capacity in Federally managed fisheries, including fisheries for sharks, skates, and rays that are managed by fishery management plans. NMFS completed its congressionally mandated report on excess harvesting in May 2008, and included in its analysis two fishery management plans (FMPs) that have components targeting sharks: 1) the Atlantic Consolidated HMS FMP targets tunas, sharks, and billfish; and 2) the West Coast HMS FMP mainly targets tuna, swordfish, and sharks. Notably, both the Atlantic and West Coast HMS FMPs were included in the list of 20 Federally managed fisheries that exhibit the “most severe examples of excess harvesting capacity,” and overcapacity levels for both FMPs were estimated at almost 50 percent. In the Atlantic Consolidated HMS FMP, the capacity problem seems to be most serious in the fleets that fish large coastal sharks. The West Coast HMS FMP has relatively low overcapacity in the shark fisheries and declining levels of capacity in the swordfish and thresher shark large mesh drift gill net fishery along with stabilized or slightly declining albacore and coastal purse seine tuna fisheries. The conclusion seems to be that there are fairly high rates of excess capacity and overcapacity in the Federally managed fisheries for shark species, in particular for Atlantic fleets that target large coastal sharks. Note that excess capacity is the ratio of capacity to harvests, and overcapacity is the ratio of capacity to a management target (usually a catch quota). In part to address catch quotas being exceeded in the Atlantic large coast shark fishery, NMFS finalized a rule on June 24, 2008 (73 FR 35778, corrected on July 15, 2008, 73 FR 40658), amending the Consolidated Atlantic HMS FMP as discussed previously in Section 2.2.

# 3. Imports and Exports of Shark Fins

The summaries of annual U.S. imports and exports of shark fins in Tables 3.1.1 and 3.2.1 are based on information submitted by importers and exporters to U.S. Customs and Border Protection and to the U.S. Census Bureau as reported in the NMFS Trade database. In recent years, exports of shark fins exceed imports in both weight and value, although the gap was smaller in 2008 than in previous years. The total weight and value of imports has increased every year since 2003 but with very small increases from 2006 to 2008. The total weight of exports showed a slight increase in 2008 after three years of decreases.

## 3.1 U.S. Imports of Shark Fins

During 2008, imports of shark fins entered through the following U.S. Customs and Border Protection districts: Los Angeles, New York City, San Francisco, and Miami. In 2008, countries of origin (in order of importance based on quantity) were Hong Kong, South Korea, Japan, China, New Zealand, Canada, Indonesia, Panama, Colombia, and Vietnam (Table 3.1.1). The mean value of imports per metric ton (mt) increased from $10,000/mt in 2003 to $60,000/mt in 2008. It should be noted that, due to the complexity of the shark fin trade, fins are not necessarily produced in the same country from which they are exported. In the United States, factors such as availability of labor, overseas contacts, and astute trading can all play a role in determining the locale from which exports are sent.

## 3.2 U.S. Exports of Shark Fins

The vast majority of shark fins exported in 2008 were sent from the United States to Hong Kong and Japan, with small amounts going to Canada, China, Australia, and China, Taipei (Table 3.2.1). The mean value of exports per metric ton (mt) has decreased from $81,000/mt in 2006 to $56,000/mt in 2008. Using data from Table 3.2.1, mean values of dried shark fins for all countries combined has fluctuated between $52,000/mt and $84,000/mt from 2003 to 2008.

## 3.3 International Trade of Shark Fins

The Food and Agriculture Organization of the United Nations (FAO) compiles data on the international trade of fish. The summaries of imports, exports, and production of shark fins in tables 3.3.1, 3.3.2, and 3.3.3 are based on information provided in FAO's FishStat database. The quantities and values in those tables are totals for all dried, dried and salted, fresh, or frozen shark fins. Reported global imports of shark fins have fluctuated between 13,800 mt and 17,126 mt from 2004 to 2007, while the reported global exports of shark fins have fluctuated between 9,911 mt and 15,598 mt from 2004 to 2007. The level of both imports and exports was lower in 2007 than in any other year in the period 2004-2006. Hong Kong remains the largest importer and exporter of shark fins.

**Table 3.1.1 Weight and value of dried shark fins imported into the United States, by country of origin.**
Note: Weight is rounded to the nearest metric ton and value is rounded to thousands of dollars. (1) means that the weight was less than 500 kilograms.
Source: U.S. Census Bureau

| Country | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | 2008 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) |
| Argentina | (1) | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Australia | (1) | 10 | (1) | 3 | (1) | 11 | 0 | 0 | 1 | 13 | 0 | 0 |
| Brazil | (1) | 2 | 0 | 0 | 2 | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canada | 0 | 0 | 0 | 0 | 0 | 0 | (1) | 5 | 2 | 11 | (1) | 20 |
| China | 0 | 0 | 2 | 19 | (1) | 8 | 4 | 132 | 5 | 656 | 1 | 59 |
| China, Hong Kong | 1 | 41 | 5 | 107 | 7 | 524 | 16 | 1053 | 20 | 954 | 23 | 1522 |
| China, Taipei | (1) | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colombia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (1) | 4 |
| Guatemala | 0 | 0 | 0 | 0 | (1) | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| India | 6 | 30 | 3 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Indonesia | 0 | 0 | 0 | 0 | 1 | 12 | 0 | 0 | (1) | 7 | (1) | 8 |
| Japan | 0 | 0 | (1) | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 82 |
| Mexico | 0 | 0 | 0 | 0 | 0 | 0 | (1) | 4 | 0 | 0 | 0 | 0 |
| New Zealand | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 26 | 0 | 0 | 1 | 14 |
| Nicaragua | 0 | 0 | 0 | 0 | 1 | 23 | (1) | 22 | 0 | 0 | 0 | 0 |
| Panama | 0 | 0 | 4 | 160 | 1 | 73 | 7 | 139 | 0 | 0 | (1) | 4 |
| Peru | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 36 | 0 | 0 |
| Philippines | 1 | 3 | 0 | 0 | 16 | 67 | 0 | 0 | 0 | 0 | 0 | 0 |
| South Korea | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 19 |
| Vietnam | 2 | 12 | 1 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | (1) | 6 |
| Total | 11 | 110 | 14 | 344 | 27 | 752 | 29 | 1382 | 29 | 1677 | 29 | 1738 |
| Mean value | $10,000/mt | | $25,000/mt | | $28,000/mt | | $48,000/mt | | $58,000/mt | | $60,000/mt | |

**Table 3.2.1 Weight and value of dried shark fins exported from the United States, by country of destination.**
Note: Data in table are "total exports" which is a combination of domestic exports (this may include products of both domestic and foreign origin) and re-exports. Re-exports of "foreign" products are commodities that have entered the United States as imports and not sold, which, at the time of re-export, are in substantially the same condition as when imported. Weight is rounded to the nearest metric ton and value is rounded to thousands of dollars. (1) means that the weight was less than 500 kilograms.
Source: U.S. Census Bureau

| Country | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | 2008 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) |
| Australia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 13 |
| Canada | 5 | 525 | 2 | 270 | 2 | 217 | 2 | 246 | 3 | 238 | 1 | 164 |
| China | 0 | 0 | 16 | 150 | 2 | 118 | 0 | 0 | 0 | 0 | 1 | 112 |
| China, Hong Kong | 38 | 3441 | 61 | 4179 | 57 | 3390 | 42 | 3536 | 32 | 2347 | 30 | 1531 |
| China,Taipei | 1 | 53 | 1 | 69 | 0 | 0 | 0 | 0 | 0 | 0 | (1) | 35 |
| Colombia | 0 | 0 | (1) | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denmark | 0 | 0 | 0 | 0 | 3 | 133 | 0 | 0 | 0 | 0 | 0 | 0 |
| Finland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 33 | 0 | 0 |
| Germany | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 91 | 0 | 0 | 0 | 0 |
| Japan | 2 | 42 | 0 | 0 | 0 | 0 | 2 | 35 | 0 | 0 | 4 | 204 |
| Mexico | 1 | 10 | 2 | 86 | 1 | 37 | (1) | 17 | (1) | 21 | 0 | 0 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 22 | 0 | 0 | 0 | 0 |
| Portugal | (1) | 3 | (1) | 3 | (1) | 3 | 0 | 0 | (1) | 3 | 0 | 0 |
| South Korea | 1 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Thailand | 0 | 0 | 9 | 107 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 49 | 4096 | 93 | 4868 | 65 | 3898 | 49 | 3945 | 36 | 2642 | 37 | 2059 |
| Mean value per mt | $84,000/mt | | $52,000/mt | | $60,000/mt | | $81,000/mt | | $73,000/mt | | $56,000/mt | |

**Table 3.3.1 Weight and value of shark fins imported by countries other than the United States.**
Source: Food and Agriculture Organization of the United Nations, FishStat database, www.fao.org
Note: Weight is rounded to the nearest metric ton and value is rounded to thousands of dollars. (1) means that the weight was less than 500 kilograms.

| Country | 2004 | | 2005 | | 2006 | | 2007 | |
|---|---|---|---|---|---|---|---|---|
| | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) |
| Angola | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Australia | 0 | 0 | 9 | 1,056 | 7 | 891 | 11 | 1182 |
| Brazil | 4 | 20 | 2 | 8 | 0 | 0 | 0 | 0 |
| Brunei Darussalam | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cambodia | 0 | 0 | 1 | 12 | 4 | 186 | 1 | 38 |
| Canada | 69 | 5,134 | 112 | 5,261 | 110 | 5,480 | 94 | 4,994 |
| Chile | (1) | 11 | 0 | 0 | 0 | 0 | 0 | 0 |
| China | 4,776 | 27,523 | 3,338 | 17,758 | 2,662 | 13,882 | 2,542 | 11,991 |
| China, Hong Kong | 11,040 | 329,778 | 10,348 | 306,968 | 9,363 | 253,427 | 10,183 | 276,302 |
| China, Macao | 96 | 2,831 | 59 | 3,368 | 1,060 | 3,728 | 66 | 3,943 |
| China, Taipei | 525 | 4,052 | 434 | 4,658 | 708 | 4,141 | 564 | 6,223 |
| Djibouti | 0 | 0 | (1) | 15 | 0 | 0 | 0 | 0 |
| India | 0 | 0 | 2 | 8 | 0 | 0 | 0 | 0 |
| Indonesia | 193 | 2,407 | 332 | 2,486 | 293 | 1,274 | 84 | 366 |
| Laos | 0 | 0 | (1) | 5 | (1) | 6 | 0 | 0 |
| Malaysia | 293 | 480 | 93 | 311 | 145 | 585 | 163 | 653 |
| Maldives | (1) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| North Korea | 1 | 268 | 1 | 331 | 2 | 1,222 | 2 | 1,084 |
| Peru | 1 | 4 | 1 | 4 | 8 | 52 | 2 | 12 |
| South Africa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| South Korea | 5 | 268 | 2 | 109 | 6 | 157 | 2 | 82 |
| Sri Lanka | 0 | 0 | 0 | 0 | 16 | 84 | 4 | 9 |
| Thailand | 121 | 1,256 | 113 | 1,317 | 102 | 1,141 | 82 | 877 |
| Turkmenistan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| United Arab Emirates | 0 | 0 | 0 | 0 | (1) | 15 | 0 | 0 |
| Venezuela | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **17,126** | **374,036** | **14,847** | **343,675** | **14,486** | **286,271** | **13,800** | **307,756** |
| **Mean value per metric ton** | **$21,840/mt** | | **$23,148/mt** | | **$19,762/mt** | | **$22,301/mt** | |

**Table 3.3.2 Weight and value of shark fins exported by countries other than the United States.**

Source: Food and Agriculture Organization of the United Nations, FishStat database, www.fao.org

Note: Data in table are for "total exports," which is a combination of domestic exports (this may include products of both domestic and foreign origin) and re-exports. Re-exports of "foreign" products are commodities that have entered into a country as imports and not sold, which, at the time of re-export, are in substantially the same conditions as when imported. Weight is rounded to the nearest metric ton and value is rounded to thousands of dollars. (1) means that the weight was less than 500 kilograms.

| Country | 2004 | | 2005 | | 2006 | | 2007 | |
|---|---|---|---|---|---|---|---|---|
| | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) | Metric ton | Value ($1000) |
| Angola | 5 | 249 | 4 | 265 | 4 | 224 | 3 | 179 |
| Argentina | 4 | 133 | 9 | 504 | 9 | 656 | 11 | 503 |
| Bangladesh | 166 | 689 | 0 | 0 | 195 | 623 | 351 | 1407 |
| Brazil | 179 | 2,405 | 157 | 2,292 | 118 | 1,894 | 131 | 2,313 |
| Brunei Darussalam | 0 | 0 | 12 | 82 | 0 | 0 | 4 | 21 |
| Burma | 0 | 0 | 2 | 23 | 0 | 0 | 0 | 0 |
| Cambodia | 0 | 0 | (1) | 5 | 0 | 0 | 0 | 0 |
| Chile | 54 | 2,474 | 39 | 1,639 | 13 | 570 | 4 | 158 |
| China | 2,476 | 40,966 | 1,349 | 20,753 | 381 | 5,306 | 409 | 6,712 |
| China, Hong Kong | 8,560 | 138,005 | 7,134 | 127,102 | 5,962 | 103,818 | 5,670 | 97,074 |
| China, Macao | 0 | 0 | 24 | 674 | 29 | 800 | 15 | 463 |
| China, Taipei | 1,241 | 4,259 | 1,141 | 8,875 | 974 | 9,514 | 903 | 8,082 |
| Colombia | 17 | 1,130 | 14 | 1,034 | 17 | 1,132 | 19 | 1,146 |
| Congo, Dem. Rep. of the | 0 | 0 | 1 | 53 | (1) | 20 | 0 | 0 |
| Congo, Republic of | 14 | 430 | 18 | 848 | 10 | 246 | 10 | 314 |
| Costa Rica | 6 | 123 | 0 | 0 | 0 | 0 | 10 | 69 |
| Côte d'Ivoire | (1) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Djibouti | 0 | 0 | 0 | 0 | 2 | 47 | 0 | 0 |
| Gabon | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 298 |
| Guinea | (1) | 4 | 47 | 2,163 | 47 | 1,872 | 35 | 1,613 |
| Guinea-Bissau | 0 | 0 | 3 | 110 | 0 | 0 | 5 | 276 |
| India | 218 | 4,513 | 104 | 3,663 | 145 | 5,037 | 96 | 3,879 |
| Indonesia | 943 | 10,936 | 1,554 | 8,065 | 1,073 | 9,174 | 801 | 7,303 |
| Iran | 0 | 0 | 0 | 0 | 0 | 0 | (1) | 2 |
| Japan | 205 | 10,262 | 168 | 8,140 | 181 | 9,091 | 197 | 8,735 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Kiribati | (1) | 25 | 1 | 70 | 1 | 111 | 1 | 69 |
| Kuwait | 0 | 0 | 0 | 0 | (1) | 9 | 1 | 91 |
| Liberia | 0 | 0 | 3 | 296 | 3 | 271 | 3 | 253 |
| Libya | 1 | 27 | 1 | 59 | 1 | 52 | 0 | 0 |
| Malaysia | 463 | 565 | 37 | 196 | 50 | 239 | 107 | 554 |
| Maldives | 57 | 647 | 43 | 598 | 16 | 192 | 15 | 107 |
| Marshall Islands | 1 | 52 | 0 | 0 | 0 | 0 | 55 | 825 |
| Nigeria | 0 | 0 | 1 | 25 | 4 | 92 | 0 | 0 |
| Oman | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pakistan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Panama | 103 | 3,860 | 97 | 3,544 | 78 | 2,600 | 66 | 4,836 |
| Papua New Guinea | 12 | 271 | 9 | 652 | 10 | 495 | 17 | 1412 |
| Philippines | 54 | 411 | 0 | 0 | 0 | 0 | 0 | 0 |
| Saint Pierre and Miquelon | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10 |
| Samoa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Senegal | 72 | 2,537 | 2 | 8 | 48 | 2,678 | 2 | 14 |
| Seychelles | 5 | 33 | 7 | 56 | 6 | 67 | 9 | 86 |
| Solomon Islands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Somalia | 0 | 0 | 0 | 0 | 0 | 0 | (1) | 3 |
| South Africa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| South Korea | 5 | 293 | 7 | 357 | 9 | 438 | 7 | 224 |
| Sri Lanka | 0 | 0 | 0 | 0 | 70 | 2,293 | 43 | 1,540 |
| Suriname | 6 | 218 | 7 | 312 | 8 | 487 | 4 | 260 |
| Thailand | 29 | 1,036 | 44 | 1,916 | 18 | 772 | 74 | 763 |
| Togo | 0 | 0 | 0 | 0 | 24 | 207 | 0 | 0 |
| Tonga | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tunisia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| United Arab Emirates | 468 | 10,149 | 539 | 14,381 | 427 | 13,592 | 472 | 13,965 |
| Uruguay | 38 | 977 | 39 | 570 | 27 | 509 | 21 | 324 |
| Vanuatu | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Venezuela | 40 | 874 | 20 | 351 | 7 | 21 | 2 | 21 |
| Yemen | 156 | 5,434 | 179 | 5,846 | 284 | 8,442 | 331 | 8,977 |
| **Total** | **15,598** | **243,988** | **12,816** | **215,527** | **10,251** | **183,591** | **9,911** | **174,881** |
| **Mean value per metric ton** | **$15,642/mt** | | **$16,817/mt** | | **$17,910/mt** | | **$17,645/mt** | |

**Table 3.3.3 Production of shark fins in metric tons by country.**
Note: The production of shark fins represents the amount that a country processed at the fin level (not the whole animal level). NA = data not available.
Source: Food and Agriculture Organization of the United Nations, FishStat database, www.fao.org

| Country | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|
| **Bangladesh** | 172 | 4 | 1 | 4 | 0 |
| **Brazil** | 82 | 179 | 157 | 118 | 131 |
| **China, Hong Kong SAR** | NA | NA | NA | NA | NA |
| **Côte d'Ivoire** | 0 | 0 | 0 | 0 | 0 |
| **Ecuador** | 77 | 59 | NA | NA | NA |
| **El Salvador** | NA | 136 | 149 | 194 | 44 |
| **Fiji Islands** | 180 | 175 | 160 | 160 | 0 |
| **Guyana** | 45 | 82 | 151 | 123 | 125 |
| **India** | 455 | 827 | 1,926 | 270 | 300 |
| **Indonesia** | 1,288 | 943 | 1,554 | 1,073 | 1,360 |
| **Japan** | 0 | 0 | 0 | 0 | 0 |
| **Korea, Republic of** | 25 | 5 | 7 | 33 | 7 |
| **Madagascar** | NA | NA | NA | NA | NA |
| **Maldives** | 19 | 20 | 13 | 15 | 15 |
| **Pakistan** | 52 | 68 | 81 | 62 | 69 |
| **Philippines** | 78 | 54 | 84 | 71 | 78 |
| **Senegal** | 109 | 33 | 34 | 27 | 16 |
| **Singapore** | 1,021 | 246 | 320 | 120 | 170 |
| **South Africa** | 14 | 0 | 0 | 0 | 0 |
| **Sri Lanka** | 83 | 110 | 80 | 80 | 70 |
| **Taiwan Province of China** | 137 | 134 | 137 | 117 | 36 |
| **Uruguay** | 39 | 35 | 43 | 0 | 7 |
| **Yemen** | 142 | 156 | 179 | 284 | 330 |
| TOTAL (mt) | 4,018 | 3,266 | 5,076 | 2,751 | 2,758 |

# 4. International Efforts to Advance the Goals of the Shark Finning Prohibition Act

Consistent with the provisions of Section 5 of the Shark Finning Prohibition Act, the Department of Commerce and the Department of State have initiated ongoing consultations regarding the development of international agreements consistent with the Act. Discussions have focused on possible bilateral, multilateral, and regional agreements with other nations. The law calls for the United States to pursue an international ban on shark finning and to advocate improved data collection (including biological data, stock abundance, bycatch levels, and information on the nature and extent of shark finning and trade). Determining the nature and extent of shark finning is the first step toward reaching agreements to decrease the incidence of finning worldwide.

## 4.1 Bilateral Efforts

In 2007, NMFS participated in bilateral discussions with a number of entities (including Canada, Chile, Taiwan, and the European Union), which included issues relating to international shark conservation and management. Recent emphasis in these bilateral contacts has been on the collection and exchange of information, including requests for data such as shark and shark fin landings, transshipping activities, and the value of trade. In addition, the United States continues to encourage other countries to implement the FAO's IPOA for the Conservation and Management of Sharks by finalizing their own National Plans of Action.

## 4.2 Regional Efforts

The U.S. Government continues to work within regional fishery management bodies to facilitate shark research, data collection, monitoring, and management initiatives, as appropriate. In recent years, the United States has successfully led efforts to ban shark finning and implement shark conservation and management measures within a number of such organizations. Table 4.2.1 lists regional fishery management organizations (RFMOs) and regional/multilateral programs in which the United States has worked to address shark conservation and management. Of the list in Table 4.2.1, ICCAT, NAFO, WCPFC, and the IATTC have adopted finning prohibitions.

Further activities or planning of five organizations are discussed below as a supplement to last year's *Report to Congress.*

**Table 4.2.1 Regional Fishery Management Organizations and Programs.**

| Regional Fishery Management Organizations and Programs |
| --- |
| • Northwest Atlantic Fisheries Organization (NAFO) |
| • Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) |
| • Inter-American Tropical Tuna Commission (IATTC) |
| • International Commission for the Conservation of Atlantic Tunas (ICCAT) |
| • Western and Central Pacific Fisheries Commission (WCPFC) |
| • International Council for the Exploration of the Sea (ICES) |
| • Asia Pacific Economic Cooperation Forum and the Convention on Migratory Species |
| • South East Atlantic Fisheries Organization |
| • Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America (South Pacific Tuna Treaty) |
| • International Scientific Committee for Tuna and Tuna-like Species in the North Pacific |
| • Department of State Regional Environmental Hub Program |

**North Atlantic Fisheries Organization (NAFO)**
At its 26th Annual Meeting in September 2004, the NAFO Fisheries Commission became the first regional fisheries management organization in the world to establish a catch limit for a directed elasmobranch fishery. The total allowable catch for skates in Division 3LNO (the "nose" and "tail" of the Grand Bank) was set at 13,500 metric tons, for each of the years 2005–2007 and subsequently set at the same level for 2009. This total allowable catch was higher than the United States had initially sought, but the U.S. delegation ultimately joined the consensus of which this measure was a part. In addition to this catch limit, NAFO adopted a U.S.-proposed resolution regarding data collection and reporting relative to elasmobranchs in the NAFO Regulatory Area. At its 27th Annual Meeting in September 2005, the NAFO Fisheries Commission adopted a ban on shark finning in all NAFO-managed fisheries and mandated the collection of information on shark catches. At the 2006 NAFO Annual Meeting, a U.S. proposal for improving elasmobranch data collection was also adopted.

**Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)**

Five shark species—*Lamna nasus*, *Somniosus antarcticus*, *Etmopterus cf. granulosus*, *Centroscymnus coelolpis*, and *Squalus acanthias*—are known to occur in the northern part of the area addressed by CCAMLR. Only the first three species appear to be abundant enough to have the potential to attract commercial interest. The identification of a sixth species, *Halaelurus canescens*, from observer reports at South Georgia has yet to be confirmed.

In 2006, CCAMLR adopted a conservation measure prohibiting directed fishing on shark species in the Convention Area, other than for scientific research purposes. The Commission agreed that the prohibition shall apply until such time as the CCAMLR Scientific Committee has investigated and reported on the potential impacts of this fishing activity and the Commission has agreed on the basis of advice from the Scientific Committee that such fishing may occur in the Convention Area. It also agreed that any bycatch of shark, especially juveniles and gravid females, taken accidentally in other fisheries, shall, as far as possible, be released alive.

During the discussion of the conservation measure at CCAMLR, the United States stated that the issue of management of shark-related fisheries, with a particular focus on the practice of shark finning, is an important one for CCAMLR to consider. The United States noted that it has enacted legislation and regulations banning the practice of shark finning, and has been using educational efforts and enforcement actions to ensure that U.S.-flagged vessels and foreign vessels making U.S. port calls comply with the statutory ban on retaining shark fins without retention of the shark carcasses to the first point of landing.

The United States expressed hope that the investigations of the Scientific Committee would yield analysis of the stock abundance, shark bycatch levels, and other important biological data of the shark species of the Southern Ocean. It is believed that this conservation measure is an important first step to an eventual ban on the practice of shark finning. The United States also mentioned the need for future efforts to collect information on the extent of shark finning in the Convention Area and the amount of trade/transshipment through ports of Contracting and non-Contracting parties. The United States urged all Contracting Parties to prepare and submit their respective National Plans of Action for the Conservation and Management of Sharks to the FAO Committee on Fisheries, as set forth in the IPOA for the Conservation and Management of Sharks, if they have not already done so.

**Inter-American Tropical Tuna Commission (IATTC)**

In 2005, IATTC adopted a measure (Resolution C-05-03) on the conservation of sharks caught in association with fisheries in the eastern Pacific Ocean (EPO). Resolution C-05-03 requires that each Party and cooperating non-party, cooperating fishing entity, or regional economic integration organization (collectively, CPCs) establish and implement a national plan of action for conservation and management of shark stocks, in accordance with the FAO IPOA for the Conservation and Management of Sharks. CPCs must take the necessary measures to ensure that fishermen utilize any retained catches of sharks, retaining all parts of the shark except the head, guts, and skin to the first point of landing. In addition, CPCs must ensure that vessels never have shark fins on board that total more than 5 percent of the total weight of shark carcasses on board, up to the first point of landing. The resolution also encourages: 1) the release of live sharks, especially juveniles, to the extent practicable, that are caught incidentally and are not used for food and/or subsistence in fisheries for tunas and tuna-like species that are not directed at sharks; and 2) further research on making fishing gears more selective, identifying shark nursery areas, and data collection on shark catches, landings, and stock assessments.

In May 2006, the IATTC Working Group on Stock Assessment provided advice on the stock status of key shark species and a proposal for a research plan for a comprehensive assessment of these stocks as required by Resolution C-05-03. The proposal for a research plan for a comprehensive assessment of key shark stocks includes: 1) identification of key species, 2) compilation of available life-history data, 3) compilation and standardization of catch per unit effort (CPUE) data and length frequency data, and 4) population dynamics modeling. A series of actions was proposed, along with the required funding and resources; these included salary for a 14-month research position, catch and effort data for fisheries that take sharks in the EPO, and unpublished life history data. The study is intended as a Pacific-wide study, and it is hoped that the Western and Central Pacific Fisheries Commission would be involved, as would the national observer programs in the EPO.

The IATTC Working Group on Stock Assessment also reviewed the ratio of fins to body weight at their May 2006 meeting, as required by Resolution C-05-03. The Working Group identified several problems with the 5 percent ratio of fins to body weight. For example, it was not specified whether the standard applies to the wet or dry weight of shark fins (the length of the trip determines how dry the fins are), the dressed weight or whole weight of the shark, the whole fin or just what is sold in the market, how the fin was cut (“L” or straight cut), and the size of the shark. It was also recommended that there should be different weight ratios for different species because the ratios of fins to body weight can differ dramatically by species.

In 2007, the IATTC Working Group on Stock Assessment met again and further refined their recommendations to the Commission. These recommendations included using demographic methods and investigating outside funding sources as a part of the comprehensive research plan, and clarifying Resolution C-05-03 to reflect that the 5 percent ratio of fins to body weight only applies to the dressed weight, rather than the whole weight of the shark. The working group’s recommendations have not yet been discussed by the Commission as of the last Commission meeting in June 2008, presumably because the Commission has been primarily focused on establishing tuna conservation and management measures for 2008 and beyond.

**International Commission for the Conservation of Atlantic Tunas (ICCAT)**

In 2004, ICCAT adopted a significant agreement on sharks that requires full utilization of shark catches and mandates fishermen to retain all parts of the shark except the head, guts, and skin to the point of first landing. Countries are required to ensure their vessels retain onboard fins totaling no more than 5 percent of the weight of sharks on board up to the first point of landing. Parties not requiring fins and carcasses to be offloaded together at the point of first landing must ensure compliance with the ratio through certification, monitoring, or other means. These requirements, which parallel current U.S. law, are significant because they provide the means to enforce the prohibition on finning even when no fishery observers are aboard the vessel. The 2004 agreement also: 1) established requirements for data collection on catches of sharks; 2) called for research on shark nursery areas; and 3) encouraged the release of live sharks, especially juvenile sharks.

In 2005, the SCRS reviewed the stock assessment of shortfin mako sharks that was completed in 2004, as well as the appropriateness of the 5 percent fin-to-carcass ratio. The SCRS concluded that the 5 percent ratio is not inappropriate with respect to mixed species shark fisheries that keep the primary fin set (first dorsal, two pectoral, and lower lobe of the caudal fin). The fin-to-carcass ratios are, however, highly variable depending on the species, fin set used, and fin cutting techniques. Other variables relate to how sharks are dressed and whether fins are dried on board. SCRS recommended that conversion factors between fins and body weights be developed and implemented on a species-specific and/or fleet-specific basis. The Commission did not consider alterations to the 5 percent fin-to-carcass ratio at its 2005 meeting. The SCRS also concluded that the shortfin mako biomass in the North Atlantic was probably below the biomass that can support maximum sustainable yield (MSY), as trends in catch per unit effort suggested depletions of 50 percent or more. The SCRS, therefore, recommended the Commission take actions to reduce fishing mortality if ICCAT wanted to improve the status of the stock. SCRS noted that reductions in fleet capacity and effective effort could provide the most direct benefit to the stock. In 2007, the Commission adopted a measure proposed by the United States requiring a reduction in porbeagle and shortfin mako shark fishing mortality in fisheries targeting these species until such time as sustainable levels of harvest can be determined. The measure called for a stock assessment of porbeagle sharks, which will be conducted jointly with the International Council for the Exploration of the Sea (ICES), to be completed in 2009.

Shortfin mako and blue sharks were reassessed in 2008 by the SCRS. The assessment findings, characterized by high levels of uncertainty due to data limitations, indicated that blue sharks in the North and South Atlantic are not overfished and overfishing is not occurring. Separate assessments were conducted for North and South Atlantic shortfin mako sharks. With respect to North Atlantic shortfin mako sharks, assessment results indicated that there is a non-negligible probability that this stock could be below the biomass that could support MSY and above the fishing mortality rate associated with MSY. Recent biological data show decreased productivity for this species. Therefore, given the results of this assessment, NMFS has determined that North Atlantic shortfin mako is not overfished, but is approaching an overfished status and is experiencing overfishing. The status of South Atlantic shortfin mako sharks remains unknown as the SCRS was unable to obtain plausible estimates of stock abundance.

In 2008, the SCRS also conducted productivity-susceptibility analyses (ecological risk assessments) for ten shark species and one stingray species based on biological productivity and potential susceptibility to ICCAT longline fisheries. The results of these analyses indicated that most Atlantic pelagic sharks have exceptionally limited biological productivity and can be overfished even at very low levels of fishing mortality. The bigeye thresher, longfin mako, and shortfin mako sharks have the highest biological vulnerability of the shark species examined. The SCRS asserted that all species considered in the ecological risk assessments are in need of improved biological data to evaluate biological productivity more accurately. The SCRS recommended that precautionary measures be considered for shark stocks with the greatest biological vulnerability and for which there is limited data and that management measures be species-specific whenever possible.

At the 2008 annual meeting, several shark-related proposals were presented and two were adopted. The first proposal called for ICCAT and ICES to coordinate the assessment of porbeagle sharks, which occurred in June 2009, in Copenhagen, Denmark. The measure also contemplated that a meeting of concerned RFMO Chairs be convened just after the joint assessment to consider compatible management measures for the species. At the time of this writing, this meeting had not yet been scheduled. The second measure adopted by ICCAT in 2008 requires the release of bigeye thresher sharks caught in fisheries managed by ICCAT and that are still alive when brought to the vessel, as well as the recording and reporting to ICCAT of incidental catches and live releases of this species.

**Western and Central Pacific Fisheries Commission (WCPFC)**

In December 2006, the WCPFC adopted a binding measure for the conservation and management of sharks. The measure went into effect January 1, 2008. The measure includes provisions for WCPFC members to report on their implementation of the IPOA for the Conservation and Management of Sharks and to report catch and effort statistics for key shark species. The measure also requires, for vessels greater than 24 meters in length, that Members take measures to: 1) require full utilization of shark catches; 2) ensure their vessels have on board fins that total no more than 5 percent of the weight of sharks on board up to the first point of landing (or require that vessels land sharks with fins attached, or prohibit the landing of fins without corresponding carcasses); and 3) prohibit vessels from retaining on board, transshipping, landing, or trading in any fins harvested in contravention of the WCPFC measure.

The WCPFC's Scientific Committee reviewed the 5 percent ratio of fin weight to shark weight at its regular annual session in 2007. The Committee found that the ratio was reasonable, and based on that recommendation, the WCPFC, at its regular annual session in 2007, decided not to revise it.

The WCPFC continued to work on the identification of "key" shark species for the purpose of catch reporting by its Members. Members have been encouraged to provide information on shark catches to the lowest possible taxonomic level in order to assist the Scientific Committee with this task.

At its regular annual session in 2007, the WCPFC considered the recent developments at the UN General Assembly regarding shark conservation and management, and acknowledged that States and RFMOs will increasingly be called upon to adopt measures to manage both directed and non-directed shark fisheries.

At its 5th Regular Session in December 2008, the Parties to WCPFC adopted a U.S. proposal to modify and improve the 2006 measure. The revised measure would apply to all vessels regardless of size or gear type. The 2008 measure also includes new reporting requirements. Commission Members, Cooperating non-Members, and participating Territories (CMMs) must now report their annual catch and effort by gear type for five key shark species: blue shark, oceanic whitetip shark, mako shark, silky, and thresher shark. CMMs must also report annually regarding their retention and discards of shark catches.

## 4.3 Multilateral Efforts

The U.S. Government continued work within other multilateral fora to facilitate shark research, data collection, monitoring, and management initiatives, as appropriate. Table 4.3.1 lists these multilateral fora. Of the list in Table 4.3.1, the activities or planning of four organizations are discussed below as a supplement to last year's *Report to Congress.*

**Table 4.3.1 Other multilateral fora.**

| Other Multilateral Fora |
|---|
| • Food and Agriculture Organization of the United Nations (FAO) Committee on Fisheries (COFI) |
| • International Union for Conservation of Nature and Natural Resources |
| • Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) |
| • World Summit on Sustainable Development |
| • United Nations General Assembly (UNGA) |
| • Convention of Migratory Species (CMS) |

**<u>Food and Agriculture Organization of the United Nations (FAO) Committee on Fisheries (COFI)</u>**

In 1999, the FAO adopted the IPOA for the Conservation and Management of Sharks, which is understood to include all species of sharks, skates, rays, and chimaeras (Class Chondrichthyes). The IPOA calls on all FAO members to adopt a corresponding National Plan of Action if their vessels conduct directed fisheries for sharks or if their vessels regularly catch sharks in non-directed fisheries. The United States was one of the first countries to prepare a National Plan, which was publicly released in 2001. At the time this report was written, the following entities had developed National Plans of Action for the Conservation and Management of Sharks: Argentina, Australia, Canada, Ecuador, Japan, Malaysia, Mexico, Seychelles, Taiwan, the United Kingdom, the United States, and Uruguay.

The FAO hosted a workshop in November 2008 to bring together fisheries experts from a representative number of main shark fishing and trading countries to discuss and agree upon the main limitations and opportunities for improving the monitoring of shark fisheries and international trade in shark products. The workshop, chaired by the United States, identified that the first priority step towards a NPOA, especially for those countries who struggle with low monitoring and management capacity, is to improve information about catches and life history parameters on the limited number of their main species. Regarding trade in shark products, it was noted that the main limitation is that the codes used at customs aggregate all shark species and lack clear separation of processed commodities.

**Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)**

CITES has addressed the issue of sharks on several recent occasions. Whale sharks, great white sharks, and basking sharks have been listed in Appendix II of CITES as species that may become threatened with extinction unless trade is subject to regulation. In June 2007, at the 14th Conference of the Parties, the United States successfully proposed that sawfishes (Pristidae) be listed in Appendix I, thus banning commercial trade in sawfish and sawfish products. Proposals to list spiny dogfish and porbeagle sharks in Appendix II were well supported, including by the United States, but were rejected. In addition, CITES adopted a resolution that urges parties to implement the IPOA for the Conservation and Management of Sharks as a matter of priority, establish systems for verification of catch, and improve monitoring and reporting in cooperation with FAO and fisheries management bodies. It also calls on parties that are members of fisheries management bodies to urge those bodies to develop shark management plans. It asks Parties that are landing and exporting products from shark species to improve communication between their CITES and fisheries authorities and to ensure that levels of international trade are not detrimental to the status of the species. Parties are also encouraged to continue developing manuals and guides for the identification of sharks and shark products in international trade. The CITES Secretariat is directed to liaise with FAO/RFMOs to organize a capacity-building workshop on the conservation and management of sharks. Finally, the resolution urges parties, when developing proposals to include shark species in CITES appendices, to consider factors affecting implementation and effectiveness, including monitoring and enforcement practicalities, given that sharks are generally traded in parts (meat, fins, etc.).

In CITES Resolution Conf. 12.6 on conservation and management of sharks, the Animals Committee is directed to examine information provided by range states in shark assessment reports and other available relevant documents, with a view to identifying key species and examining these for consideration and possible listing under CITES. The Animals Committee made species-specific recommendations at the 13th and 14th meetings of the Conference of the Parties for improving the conservation status of sharks and the regulation of international trade in these species. Decision 14.107 states that the Animals Committee shall continue activities specified under Resolution Conf. 12.6, including refinement of the list of shark species of concern, in collaboration with FAO, taking account of those referenced in Annex 3 to document CoP14 Doc. 59.1, and shall report on these activities at the 15th meeting of the Conference of the Parties. At the 23rd Animals Committee in 2008, a working group was established with the mandate to examine information in document AC23 Doc.15.2 and other available relevant documents, with a view to identifying key species and examining these for consideration and possible listing under CITES. The United States led an intersessional group on the implementation of Decision 14.107 and presented a paper for discussion at the 24th Animals Committee, which included progress on previous recommendations and prioritized future actions for species of concern.

**United Nations General Assembly (UNGA)**

In December 2005, the UNGA adopted by consensus a resolution on Oceans and the Law of the Sea: "Sustainable Fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments." The resolution, strongly supported by the United States, recognizes the importance and vulnerability of sharks and the need for measures to promote long-term sustainability of shark populations and fisheries. It confirms the role of relevant regional and subregional fisheries management organizations and arrangements in the conservation and management of sharks and encourages the implementation of the FAO IPOA for the Conservation and Management of Sharks. It further encourages the international community to increase the capacity of developing States to implement the IPOA.

In 2007, the United States developed and proposed new language on shark conservation and management for inclusion in the annual UNGA Sustainable Fisheries Resolution. The resolution, which was adopted by consensus in December 2007, included language based on the U.S. proposal aimed at strengthening protections for vulnerable and endangered shark populations around the world, and called on States and RFMOs to take *immediate and concerted actions* to improve shark conservation and management. Specifically, the resolution calls upon States, including through RFMOs, to adopt measures to fully implement the IPOA for the Conservation and Management of Sharks for directed and non-directed shark fisheries, based on the best available scientific information, through, among other things, establishing limits on shark catches, undertaking improved assessment of the health of shark stocks, reducing shark bycatch in other fisheries, and limiting shark fisheries until management measures are adopted. The resolution also calls on States to improve the implementation of and compliance with existing RFMO and national measures that regulate shark fisheries, *"in particular those measures which prohibit or restrict fisheries conducted solely for the purpose of harvesting shark fins, and, where necessary, to consider taking other measures, as appropriate, such as requiring that all sharks be landed with each fin naturally attached."* The United States intends to build on the success achieved at the UNGA by promoting shark conservation in other appropriate multilateral fora. No new language was added to the resolution in 2008.

**Convention on Migratory Species (CMS)**

Also known as the Bonn Convention, the CMS aims to conserve terrestrial, marine, and avian migratory species throughout their range. An intergovernmental treaty, the CMS was concluded under the aegis of the United Nations Environment Programme and currently has 109 parties. The United States is not a party to the CMS. However, non-parties are able to participate in the negotiation of and can sign onto individual instruments concluded under the CMS umbrella, including a possible new global shark instrument.

Conference of the Parties

The United Nations Environment Programme Secretariat of the Convention on Migratory Species (CMS) convened the Ninth Meeting of the Conference of the Parties (COP) to the Convention from 1-5 December 2008 in Rome, Italy. The COP considered proposals for listing four new shark species under Appendix II of the CMS. The European Commission put forward proposals for the inclusion of *Squalus acanthias* (spiny dogfish) and *Lamna nasus* (porbeagle shark) and Croatia put forward proposals for the inclusion of *Isurus oxyrinchus* and *Isurus paucus* (longfin and shortfin mako sharks). Since the United States is not party to CMS, we are not able to vote in favor or against listing any new species under the Convention, however, we were able to participate in the discussions in our Observer status at the meeting. These proposals were hotly debated due to many Southern Hemisphere countries opposing the listings based on southern populations of the stocks being in better shape than northern populations. Migratory species that have an unfavorable conservation status or would benefit significantly from international cooperation are listed in Appendix II to the Convention. Further, CMS encourages State parties to conclude global or regional instruments for the listed species. The COP agreed to list longfin and shortfin mako sharks, porbeagle shark, and Northern Hemisphere populations of spiny dogfish on Appendix II. These listings will have implications on the species considered for listing under the new global shark instrument, which to date, had only tentatively agreed to focus on the already listed species of whale sharks, basking shark, and great white shark.

Intergovernmental Meeting for a New Global Shark Instrument

Following on from the first intergovernmental meeting held in December 2007 to identify and elaborate on an option for international cooperation on migratory sharks under CMS, the Secretariat of the Convention on Migratory Species (CMS) convened the second meeting on International Cooperation on Migratory Sharks under the CMS (SHARKS II) from 6-8 December 2008. The SHARKS II meeting participants discussed a range of options for a potential CMS instrument, including the type of instrument desired, the species to be covered, the desired geographical scope and issues that should be addressed in an associated plan of action.

Regarding the type of instrument desired, participants centered their discussions around two drafts texts, one of a legally binding instrument or Agreement (Agreement) and one of a non-legally binding instrument or Memorandum of Understanding (MOU), prepared by the CMS Secretariat, in consultation with an Intersessional Steering Group on Migratory Sharks (ISGMS), on which the United States participated. Meeting participants agreed to develop a non-legally binding MOU that would be global in scope. The MOU will have effect as an action plan that sets out activities that the signatories will progressively strive to undertake in relation to sharks, and assign priority to these activities.

Among the meeting's most contentious issues was species to be covered by the MOU. The discussion centered on whether to limit the scope of the MOU to the basking, great white, and whale sharks that initially triggered interest in the instrument in 2005 or to include the Northern Hemisphere populations of the spiny dogfish, porbeagle, shortfin mako, and longfin mako sharks that were recently listed on the CMS appendex II at its ninth Conference of the Parties the week prior to SHARKS II. No final decisions were made on what species would be listed initially nor a mechanism for adding additional species in the future.

Contact groups were established during the meeting to revise and further develop the provisions on both fundamental principles and conservation and management measures. The Chair of the Conservation Measures Contact Group proposed holding an intersessional drafting group comprised of SHARKS II participants, key countries, and experts to begin developing a draft Annex containing the MOU's plan of action. The Annex would consist of both the organized framework of conservation and management measures. An informal intersessional drafting group was formed, which would work by correspondence in a process to develop successive iterations of a draft annex based on the discussions of the contact group and drawing on key core documents such as the International Union for Conservation of Nature (IUCN) report discussed at this meeting and other recent reports released to the international community that could be available to the drafting group. It was suggested that the CMS Secretariat consider scheduling a meeting to use the output of the informal intercessional drafting group to further elaborate and work toward concluding the Annex for adoption with the MOU text. Such a meeting could be held consecutively with the next meeting to negotiate the MOU or at some other time, as appropriate.

The U.S. approach at SHARKS II meeting was to explore ways that CMS may be able to add value to existing international efforts aimed at the conservation and management of sharks, including the FAO IPOA for the Conservation and Management of Sharks and work underway in various Regional Fisheries Management Organizations. The U.S. primary areas of focus included: 1) strengthening shark management in U.S. waters; 2) working with other nations, particularly developing nations to build capacity of shark conservation and management; 3) working through RFMOs to fulfill their mandates for sharks; and 4) improve enforcement of shark finning bans. The United States also expressed frustration that although most of the major RFMOs adopted measures banning finning, promoted the collection of shark-related data and research, and encouraged the live release of sharks caught as bycatch, the measures are not well-enforced and shark-related data continue to be seriously lacking.

The Philippines offered to host SHARKS III in late 2009/early 2010. In the interim, the United States agreed to chair the intersessional drafting group to prepare the provisions for the section on Conservation and Management measures to be integrated with the action plan.

# 5. NOAA Research on Sharks

## 5.1 Data Collection and Quality Control, Biological Research, and Stock Assessments

**Pacific Islands Fisheries Science Center (PIFSC)**

***Fishery Data Collection***

Market data from the PIFSC shoreside sampling program contain detailed biological and economic information on sharks in the Hawaii-based longline fishery dating from 1987. These data are primarily collected from fish dealers who are required to submit sales/transaction data to the State of Hawaii. The Western Pacific Fishery Information Network (WPacFIN) is a Federal-State partnership collecting, processing, analyzing, sharing, and managing fisheries data on sharks and other species from American island territories and states in the Western Pacific. The WPacFIN program has also assisted other U.S. islands' fisheries agencies in American Samoa, Guam, and the Northern Mariana Islands to modify their data-collecting procedures to collect bycatch information. These modifications have improved the documentation of shark interactions with fishing gear. Shark catches in the Hawaii-based longline fishery have been monitored by a logbook program since 1990, and by an observer program since 1994.

***Biometrical Research on Catch Statistics***

Biometrical research on shark bycatch issues funded by the Pelagic Fisheries Research Program (University of Hawaii) has led to the acceptance for publication of a paper titled "Decreases in Shark Catches and Mortality in the Hawaii-based Longline Fishery as Documented by Fishery Observers", (Walsh et al. in press) by the journal *Marine and Coastal Fisheries*. This work was based on analyses of shark catch data from the Pacific Islands Regional Observer Program. The results included a detailed description of the taxonomic composition of the shark catch, as well as additional information pertinent to either the management (e.g., nominal catch rates; disposition of caught sharks; distributions of shark catches relative to those of target species) or basic biology (e.g., mean sizes; sex ratios) of the common species. The results indicated that blue shark in particular, which comprises approximately 85 percent of the shark bycatch, exhibits a high rate of survival (about 95 percent) to the time of release. On the basis of these very low minimum mortality estimates, it was concluded that this fishery has made substantial progress in reducing bycatch mortality compared to the period before the shark finning ban.

***Insular Shark Surveys***

Densities of insular sharks (Table 5.1.1) have been estimated at most of the U.S. island possessions within the Tropical Central, Northern, and Equatorial Pacific on annual or biennial surveys conducted by the Coral Reef Ecosystem Division (CRED) since 2000.

These estimates include surveys of:

- 10 major shallow reefs in the Northwestern Hawaiian Islands (2000, 2001, 2002, 2003, 2004, 2006, 2008).
- The Main Hawaiian Islands (2005, 2006, 2008).
- The Pacific Remote Island Areas of Howland and Baker in the U.S. Phoenix Islands and Jarvis Island, and Palmyra and Kingman Atolls in the U.S. Line Islands (2000, 2001, 2002, 2004, 2006, 2008).
- American Samoa including Rose Atoll and Swains Island (2002, 2004, 2006, 2008).
- Guam, and the Commonwealth of the Northern Marianas Islands (2003, 2005, 2007, 2009), Johnston Atoll (2004, 2006, 2008), and at Wake Atoll (2005, 2007, 2009).

To date, these surveys suggest that shallow (<30m) inshore water shark populations appear to be relatively abundant at most reefs in the Northwestern Hawaiian Islands (NWHI), Pacific Remote Island Areas, and the Northern Mariana Islands, but are noticeably sparse and/or small-bodied at most reefs in the Main Hawaiian Islands (MHI), American Samoa, and the Southern Mariana Islands. CRED is currently working on a scientific article pertaining to these observations. Preliminary results were presented at the 11th International Coral Reefs Symposium in Ft. Lauderdale, Florida in July 2008.

In brief, five species of sharks are typically recorded in sufficient frequency by towed-divers to allow meaningful statistical analyses: grey reef shark (*Carcharhinus amblyrhynchos*), Galapagos shark (*Carcharhinus galapagensis*), whitetip reef shark (*Triaenodon obesus*), blacktip reef shark (*Carcharhinus melanopterus*), and tawny nurse shark (*Nebrius ferrugineus*). Analyses show a highly significant negative relationship between grey reef and Galapagos shark densities and proximity to human population centers (e.g., proxy for potential fishing pressure and other human impacts). Average combined numerical density for these two species near population centers is less than 1 percent of densities recorded at the most isolated islands (e.g., no human population, very low present or historical fishing pressure or other human activity). Even around islands with no human habitation but within reach of populated areas, grey reef and Galapagos shark densities are only between 15 and 40 percent of the population densities around the most isolated near-pristine reefs. Trends in whitetip and blacktip reef shark numbers are similar, but less dramatic. Tawny nurse shark densities are low around most islands. From our preliminary results we infer that some insular shark populations near human population centers are severely depressed.

Although the CRED time series is still relatively short (<9 years), certain temporal trends in reef shark densities are starting to appear. In brief, CRED has noticed apparent declines in reef shark densities in the Northwestern Hawaiian Islands and in the Northern Mariana Islands. Possible explanations for these patterns are currently being investigated.

**Table 5.1.1 Shark species observed in PIFSC-CRED Reef Assessment and Monitoring Program surveys around U.S. Pacific Islands.**

| Shark species observed | | |
|---|---|---|
| Common Name | Species | Family |
| Gray reef shark | *Carcharhinus amblyrhynchos* | Carcharhinidae |
| Silvertip shark | *Carcharhinus albimarginatus* | Carcharhinidae |
| Galapagos shark | *Carcharhinus galapagensis* | Carcharhinidae |
| Blacktip reef shark | *Carcharhinus melanopterus* | Carcharhinidae |
| Tiger shark | *Galeocerdo cuvier* | Carcharhinidae |
| Whitetip reef shark | *Triaenodon obesus* | Carcharhinidae |
| Tawny nurse shark | *Nebrius ferrugineus* | Ginglymostomatidae |
| Whale shark | *Rhincodon typus* | Rhincodontidae |
| Scalloped hammerhead shark | *Sphyrna lewini* | Sphyrnidae |
| Great hammerhead shark | *Sphyrna mokarran* | Sphyrnidae |
| Zebra shark | *Stegostoma varium* | Stegostomatidae |

***Shark Predation Mitigation on Hawaiian Monk Seals at French Frigate Shoals***

Galapagos shark predation has become the dominant mortality source for nursing and recently weaned endangered Hawaiian monk seal pups at French Frigate Shoals (FFS), the most important breeding site in the NWHI. Intense predation by a relatively small number of sharks (~20) on preweaned pups was first detected in the late 1990s, when 19 to 31 mortalities were documented each year from 1997 to 1999. This equated to 17–32 percent of the annual cohort. Subsequent mitigation efforts resulted in the removal of 12 sharks known to be preying on monk seal pups and the ensuing predation losses dropped to 8–12 pups from 2000 to 2008 (12–21 percent of the annual cohort born at FFS). Sharks were removed using a combination of shore-based handline fishing, boat fishing, and hand-held harpoon. Removal attempts were unsuccessful in 2005 and 2007, as sharks have become progressively more wary and are now conducting their predation at times when they are least likely to encounter humans. Most predation occurred at Trig Island, but it has increased at other sites in the atoll over time. We attribute these results in part to shark displacement away from Trig Island due to applied fishing, harassment, and deterrence efforts at Trig during the monk seal pupping season in late spring and summer. The decision framework for implementing the shark removal experiment was evaluated in terms of expected costs and benefits (to both monk seals and sharks), uncertainties in the predation data, and concerns about the acceptability of a removal project within a refuge. Given the declining status of endangered monk seals and the probable minimal effect of the shark removals, we concluded that available data were sufficient to support the removal experiment. However, we elected to place a temporary moratorium on shark removals in 2008 as we investigate the efficacy and feasibility of non-lethal shark deterrents. Deterrents deployed in 2008 included: visual deterrents (boat anchored offshore near Trig Island, assorted visual stimuli in the water column); auditory deterrents (boat noise broadcast by an underwater loudspeaker); magnetic deterrent (permanent magnets deployed in association with the visual stimuli); and electromagnetic deterrents (powered *Shark Shield*–type device deployed at strategic access points near Trig Island). For the 2009 pupping season, an expanded deterrent study is being conducted, which includes a comparison of deterrents versus increased human presence at pupping sites. Also, a remote camera system is currently in place at Trig with the aim of capturing shark activity and incidents on pups this season. Results from the 2008-2009 deterrent research will be used to determine which, if any, of these deterrent methods are effective in reducing predation levels, and to assess whether shark removals will be necessary in future years.

NOAA's Hawaiian Monk Seal Research Program is also financially and logistically supporting a shark movement research project being conducted by the Hawaiian Institute of Marine Biology (HIMB). To date, 46 Galapagos and 19 tiger sharks were captured using 10-hook bottom-set long lines and fitted with acoustic transmitters. With 18 deployed underwater receivers, the activity of these tagged sharks are detectable around four major pupping sites within the FFS atoll, as well as deep water locations outside of the FFS breaking reef. The research will help characterize the segment of the Galapagos shark population likely involved in predation of pre-weaned monk seal pups.

***Stock Assessment of Pelagic Sharks***

Work was initiated in 2000 as a collaborative effort with scientists at the National Research Institute for Far Seas Fisheries (NRIFSF). A report was produced (Kleiber et al. 2001) but was not published in the peer-reviewed literature. The 2001 report indicated the blue shark stock was not being overfished. PIFSC and NRIFSF subsequently renewed this collaboration, along with scientists from the Government of Japan's Fisheries Research Agency, to update the blue shark assessment with the latest Japanese and Hawaiian longline fishery data, as well as with better estimates of Taiwanese and Korean catch and effort data.

Objectives were to determine the degree to which the blue shark population has been affected by fishing activity and whether current fishing practices need to be managed to ensure continued viability and utilization of the resource. In addition to re-estimating catch and effort data based on a longer time series of data (Nakano and Clarke 2005, 2006), this study incorporated several new features: 1) effort data were obtained from the Fisheries Administration of Taiwan, 2) catches for the Japanese inshore longline fleet were included, 3) catch estimates were contrasted with estimates from the shark fin trade, 4) catch per unit effort was standardized using both a generalized linear model and a statistical habitat model, and 5) two different stock assessment models were applied.

The two shark assessment models—a surplus production model and an integrated age and spatially structured model—represent opposite ends of the spectrum in terms of data needs. The results were recently published as a NOAA Technical Memorandum (Kleiber et al. 2009), and the two models were found to be in general agreement. The trends in abundance in the production model and all alternate runs of the integrated model show the same pattern of stock decline in the 1980s followed by recovery to a biomass that was greater than that at the start of the time series. One of the several alternate analyses indicated some probability (around 30 percent) that the population is overfished and a lower probability that overfishing may be occurring. There was an increasing trend in total effort expanded by longline fisheries toward the end of the time series, and this trend may have continued thereafter. The uncertainty could well be reduced by a vigorous campaign of tagging and by continuous, faithful reporting of catches and details of fishing gear.

***Electronic Tagging Studies and Movement Patterns***

PIFSC scientists are using acoustic, archival, and pop-up satellite archival tags (PSATs)[10] to study vertical and horizontal movement patterns in commercially and ecologically important tuna, billfish, and shark species, as well as sea turtles. The work is part of a larger effort to determine the relationship of oceanographic conditions to fish and sea turtle behavior patterns. This information is intended for incorporation into population assessments, addressing fisheries interactions and allocation issues, as well as improving the overall management and conservation of commercially and recreationally important tuna and billfish species, sharks, and sea turtles. The research, sponsored by the Pelagic Fisheries Research Program and PIFSC, has shown that some large pelagic fishes have much greater vertical mobility than others. More specifically, we have found that swordfish, bigeye tuna, and bigeye thresher sharks remain in the vicinity of prey organisms comprising the deep Sound Scattering Layer (SSL) during their extensive diel vertical migrations. In contrast, other billfish, tuna, and shark species stay in the upper 200 m of the water column both night and day. The SSL comprises various species of squids, mesopelagic fish, and euphausiids that undertake extensive diurnal vertical migrations. This composition of organisms is referred to as the SSL because the migration of these organisms was first discovered by the sound waves that reflect off gas-filled swim bladders or fat droplets within the migrating organisms. Organisms in the SSL feed in surface waters at night to avoid being seen and eaten by their predators and then return during the day to depths of 500 m or deeper. Pelagic fishes able to mirror movements of the SSL can better exploit these organisms as prey. Also, the ability of swordfish, bigeye tuna, and bigeye thresher sharks to access great depths permits them to effectively exploit the SSL for prey even after they descend to deeper water at dawn. Certainly, the ability to mirror the movements of vertically migrating prey confers selective advantages. However, other pelagic species—such as yellowfin tuna, silky sharks, oceanic white-tip sharks, blue marlin, and striped marlin—do not make extensive regular vertical excursions. PIFSC scientists have also found one of the most ubiquitous large-vertebrate species in the pelagic environment—the blue shark—occasionally displays vertical movement behaviors similar to those of swordfish, bigeye tuna, and bigeye thresher sharks. Lastly, it appears that pelagic species follow a very similar search strategy (e.g., Levy flight) in the open ocean, which allows them to find patchily distributed food resources (Sims et al. 2008). PIFSC is finishing manuscripts detailing the movements of pelagic sharks in relation to oceanographic conditions (Musyl et al. in prep). In a review paper, Bernal et al. (in press) summarizes the eco-physiology of large pelagic sharks while Sibert et al. (in press) report on the error structure of light-based geolocation estimates afforded by PSATs and Nielsen et al. (in press) show how reconstructed PSAT tracks can be optimized. A figure from Bernal et al. (in press) [Figure 5.1.1], indicates a possible vertical niche pelagic fish structure based on physiology and thermal biology.

The PIFSC, in collaboration with Australian Institute for Marine Science and the Commonwealth Scientific and Industrial Research Organization, has for the past several years been deploying electronic tags on whale sharks at Ningaloo Reef, Western Australia, to describe their vertical and horizontal movements. The work has documented that whale sharks dive below 1000 m,

[10] PSAT tags record measurements such as temperature, pressure (depth), and ambient light-level irradiance (some model tags also have the ability to measure salinity). At a preset time, an electronic link is activated that dissolves the tag's nosecone attachment, allowing the tag to float to the surface where it sends its broadcast of data to satellites under three conditions: (1) meets set pop-up date, (2) exceeds threshold depth (~1200-1500 m; can tell shed tag from mortality), and (3) remains stationary at a depth above the threshold depth for (usually) 4 consecutive days.

deeper than previously thought. After the whale sharks leave Ningaloo Reef, some travel to Indonesia while others head across the Indian Ocean (Wilson et al. 2006).

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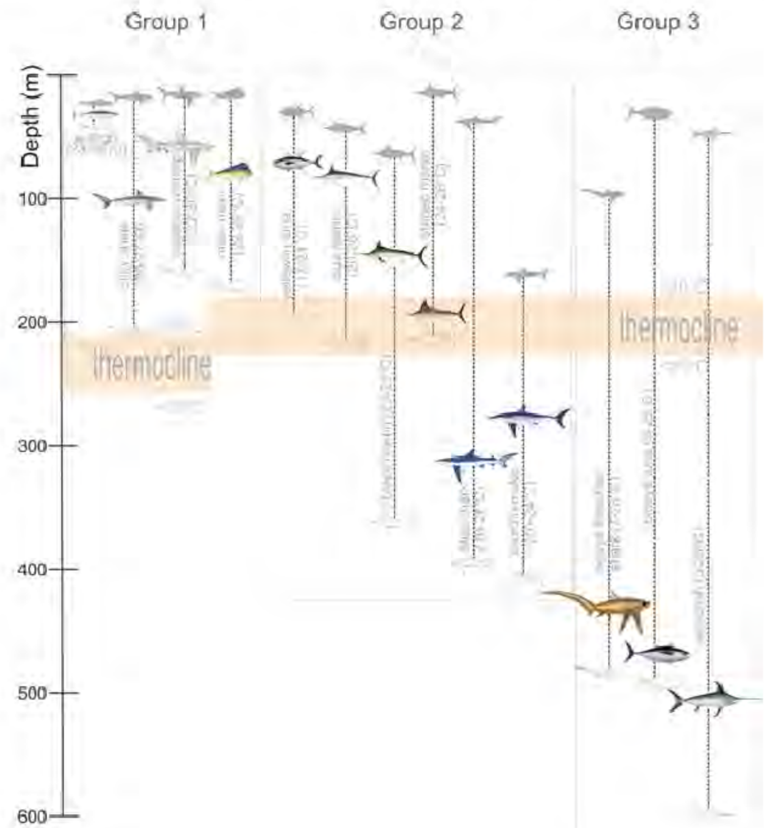


**Fig. 14.1** Representative vertical movement patterns for pelagic fishes. Fish images represent the average depth (combined night and day) for each species. Gray-filled fish outlines represent the depth at which each species spent 95% of the time during the night. Open outlines represent the depth at which each species spent 95% of the time during the day. Values next to the common name show the temperature ranges encountered by each species. Orange shaded bar represents the thermocline, defined as depth range in which the water column is separated into the upper uniformed-temperature surface layer (i.e., water above 20°C) and the cooler deeper waters (i.e., below 20°C). Group 1: Fishes that spend the majority of their time in the upper uniformed-temperature surface layer. Group 2: Fishes that undertake short excursions below the thermocline. Group 3: Fishes that make frequent excursions below the thermocline. Fig. modified from Musyl *et al.* (2004). Wahoo[1] (*Acanthocybium solandri)*, silky shark[2] (*Carcharhinus falciformis*), oceanic whitetip[2] (*Carcharhinus longimanus*), mahimahi[2] (*Coryphaena hippurus*), yellowfin tuna[3] (*Thunnus albacares*), blue marlin[4] (*Makaira nigricans*), black marlin[5] (*M. indica*), striped marlin[6] (*Tetrapturus audax*), blue shark[7] (*Prionace glauca*), shortfin mako shark[8] (*Isurus oxyrinchus*), bigeye thresher shark[9] (*Alopias superciliosus*), the bigeye tuna[10] (*Thunnus obesus*), and swordfish[11] (*Xiphias gladius*).
[1]C. Sepulveda, S. Aalbers, D. Bernal, unpublished; [2]M. Musyl and R. Brill, unpublished; [3]Schaefer *et al.* (2007); [4] Block *et al.* (1992); [5]Gunn *et al.* (2003), Pepperell and Davies (1999); [6]Brill *et al.* (1993), Holts and Bedford (1990); [7]Carey and Scharold (1990); [8]Holts and Bedford (1993), Sepulveda *et al.* (2004); [9]Nakano *et al.* (2003), Weng and Block (2004); [10]Schaefer and Fuller (2002), Holland *et al.* (1992); [11]Carey and Robinson (1981), Carey (1990).

**Figure 5.1.1: Possible vertical niches of pelagic fishes. Source: Bernal et al. (in press)**

## Southwest Fisheries Science Center (SWFSC)

***Abundance Surveys***

The blue, shortfin mako, and thresher sharks are all taken in regional commercial and recreational fisheries. Common thresher and mako sharks have the greatest commercial value and are also specifically targeted by sport fishers, especially off highly populous Southern California. Although the blue shark is targeted in Mexico, it has little market importance in the United States but is a leading bycatch species in the U.S. West Coast drift gillnet and high-seas longline fisheries. Although catches of adult blue, thresher, and shortfin mako sharks do occur, the commercial and sport catch of these species off Southern California consists largely of juvenile sharks. To track trends in the abundance of juvenile and sub-adult blue, shortfin mako, and common thresher shark, surveys are carried out in the Southern California Bight each summer.

Juvenile Pelagic Shark Survey

The Southern California Bight is a known nursery area for shortfin mako and blue sharks. The SWFSC has been monitoring the relative abundance of juvenile mako and blue sharks since 1994 using a fishery-independent longline survey. The annual survey was conducted during June and July of 2008 aboard the F/V *Ventura II*. One to two fishing sets were completed daily and a total of 6,007 hooks were fished during 29 sets. Catch included 40 shortfin mako sharks, 233 blue sharks, one common thresher shark, five pelagic rays (*Pteroplatytrygon violacea)*, and one bat ray (*Myliobatis californica)*. The cruise was conducted in two legs with 85 percent of the shortfin mako sharks caught during the second leg when higher water temperatures were encountered. The overall survey catch rate was 0.184 per 100 hook-hours for shortfin mako and 1.090 per 100 hook-hours for blue sharks. The nominal CPUE for blue sharks was somewhat higher than in 2007; however, there is a declining trend in nominal CPUE for both species over the time series of the survey.

**Table 5.1.2 Nominal catch per unit effort of sharks caught in SWFSC's juvenile shark survey.**

| Nominal Catch per unit effort on the juvenile shark survey (units are per 100 hook-hours) | | | | | |
|---|---|---|---|---|---|
| Species | 2004 | 2005 | 2006 | 2007 | 2008 |
| Shortfin mako<br>*Isurus oxyrinchus* | 0.399 | 0.369 | 0.445 | 0.556 | 0.184 |
| Blue shark<br>*Prionace glauca* | 0.499 | 0.443 | 1.350 | 0.666 | 1.090 |

In conjunction with the fisheries-independent survey, additional biological studies were also conducted during the 2008 cruise. Most mako and blue sharks caught were tagged with conventional tags, marked with oxytetracyline (OTC) for age validation and growth studies, and DNA samples were taken for studies of population dynamics. In addition, to obtain more detailed information on movements and define the habitat of Pacific sharks, satellite tags were deployed on both blue and mako sharks (see below).

Essential Fish Habitat (EFH) and Pup Abundance Survey of Common Thresher Sharks
Like many other sharks, the pups of the common thresher are found in near-shore waters of the Southern California Bight. These waters are considered Essential Fish Habitat (EFH) for thresher shark pups, but the extent of this habitat is poorly defined. In 2003, the SWFSC began a survey to develop a pup abundance index and determine the continuity of thresher pup distribution along the coast of the Southern California Bight. In 2008, the sixth year of sampling took place. The SWFSC team worked with the F/V *Outer Banks* to sample in the Southern California Bight from Point Conception to the Mexican border. Forty-eight longline sets were made in relatively shallow, near-shore waters. Over the 18-day cruise, 300 common thresher sharks, two spiny dogfish (*Squalus acanthias*), 28 soupfin sharks (*Galeorhinus galeus*), two leopard sharks (*Triakis semifasciata*), and five brown smoothhound (*Mustelus henlei*) were caught. Nearly all of the thresher sharks caught were injected with OTC for age and growth studies, tagged with conventional tags, and released. In addition, satellite tags were deployed on three thresher sharks.

While it is still too early to develop a pre-recruit index, a number of interesting patterns are emerging. Depth-stratified sampling revealed that over half of the neonates[11] were caught in shallow waters from 0 to 46 m and almost all individuals are caught shallower than 90 m. The distribution of thresher sharks is very patchy and areas of high abundance are not consistent across years. In all years a large percentage of the catch has been neonates, which were found in all areas surveyed.

Currently, the SWFSC Fisheries Resources Division is collaborating with Drs. Jeffrey Graham of Scripps Institution of Oceanography and Oscar Sosa-Nishizaki of Mexico's Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE) to examine the movements, essential fish habitat, and fisheries for thresher sharks off Baja California, Mexico. Based on tag recoveries and satellite tracks, it is clear that the thresher shark nursery spans the waters of both countries.

***Pelagic Shark Migration Studies***
As mentioned above, the SWFSC has been using electronic tags to study the movements and behaviors of blue, shortfin mako, and common thresher sharks. Use of satellite technology started in 1999 and more recently has been conducted in collaboration with the Tagging of Pacific Pelagics program (www.toppcensus.org), Mexican colleagues at CICESE, and Canadian colleagues at the Department of Fisheries and Oceans Pacific Biological Station in Nanaimo, British Columbia. Overall, during the juvenile shark abundance surveys conducted in the summer of 2008, nine makos, three threshers, and four blue sharks were tagged with PSAT tags and/or Smart Position and Temperature Transmitting (SPOT)[12] tags. This brings the total to 77 makos, 66 blue sharks, and 27 common threshers tagged through these collaborative projects. The specific goals of the satellite tagging program are to document and compare the movements and behaviors of these species in the California Current, and to link these data to physical and biological oceanography. This approach will allow us to characterize the habitats sharks most

[11] newborn
[12] SPOT tags record measurements such as temperature, salinity, and depth. SPOT tags regularly send their recorded data to satellites that relay the information to researchers.

frequently utilize or prefer and, subsequently, to better understand how populations might shift in response to changes in environmental conditions.

SPOT tag deployments went particularly well in 2008. Five of six SPOT tags deployed on blue and mako sharks in 2008 were still transmitting in early 2009 after more than 200 days. In addition, three satellite tags deployed in 2007 on mako sharks were also transmitting a year and a half after being deployed. These longer-term and multi-year records provide an incredible opportunity to examine seasonal movement patterns and regional fidelity (Figure 5.1.2). The longer tracks reveal that some mako sharks make an annual migration to the North Equatorial Current and interestingly, animals returned to the same general regions as in the previous year. The migrations are relatively directed with animals spending an average of four weeks south of 18°N before returning to the waters off Mexico and California. The exact reason for this migration remains to be determined. Analysis of the data on blue sharks tagged by CICESE in 2006 was recently completed by a master's degree student at CICESE in Ensenada, Mexico.

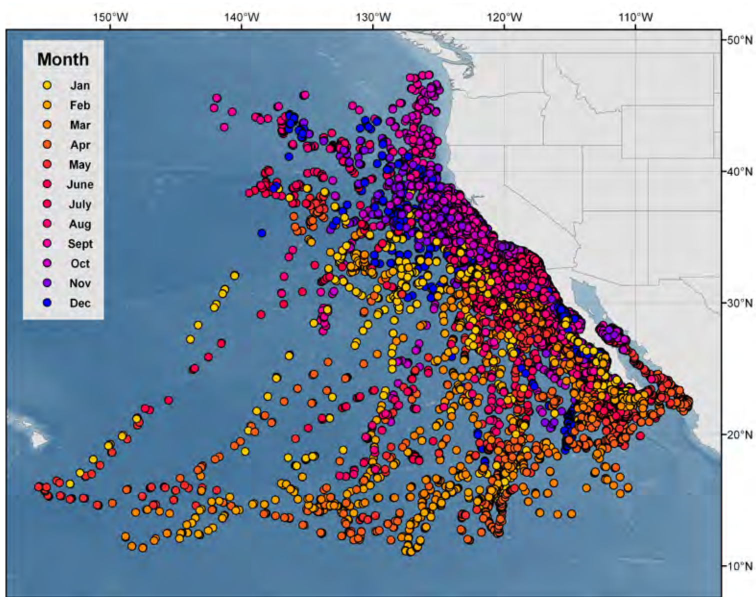


**Figure 5.1.2. Mako shark movements recorded by radio position transmitting tags (SPOT) from 2002 through 2009 (n = 42). The colors indicate monthly shifts in location.**

### *Pelagic Shark Feeding Ecology*

With the recent reauthorization of the MSA, there is a move towards ecosystems management. This approach requires information on ecological relationships among species, one of the most important being trophic links. To determine the trophic relationships in the Southern California Bight, the SWFSC has been investigating the foraging ecology of a range of shark species since 1999. Species examined include blue, shortfin mako, common thresher, and bigeye thresher sharks. Techniques include analyses of stomach contents, stable carbon and nitrogen isotopes, and mercury levels. Mercury levels also provide insights into potential human toxicity. While analyses of stomach contents are ongoing and an additional 36 stomachs were collected this year, no new results are available. Results for the other studies are provided.

Trophic Status of the Common Thresher and Shortfin Mako Shark Inferred from Stable Isotope Analysis

While the common thresher and shortfin mako shark are suspected of undergoing shifts in diet during their development, there is no quantitative evidence to support this conclusion. Stomach content analyses of these two shark species are ongoing; however, stomach contents provide only a snapshot of feeding history unless sampling is exhaustive in time and space and sample sizes are large. In contrast, stable isotope[13] analyses can give an integrated view of feeding over time and provide an important complement to studies of stomach contents. Nitrogen isotope ratios ($^{15}N/^{14}N$) fractionate at predictable increments with each increase in trophic position because of differences in how the two isotopes are metabolized. Thus, if one can measure the difference in $^{15}N/^{14}N$ between the base of the food web and the predator being studied, one can estimate the trophic[14] position of the predator. In contrast, the carbon isotope ratio ($^{13}C/^{12}C$) only fractionates slightly with increasing trophic position and provides insight into different carbon sources at the base of the food web, providing some insights into foraging location. For example, $^{13}C$ decreases as one moves from near-shore to offshore environments.

The stable C and N isotope ratios of muscle and liver from 50 common thresher [81 - 226 cm fork length (FL)] and 42 shortfin mako (77 -317 cm FL) have been characterized over a broad size range. These two tissues were selected because they have different isotope turnover rates; liver turns over much more quickly than muscle and thus reflects the more recent diet. Common thresher soft tissues showed an increase in $\delta^{15}N$ with increasing size reaching an asymptote at the approximate size at sexual maturity, suggesting a gradual trophic increase from 3.0 to 4.3 with ontogeny.[15] (Note that the symbol "δ" refers to delta units relative to International standards of limestone and N gas.) An observed enrichment of muscle $\delta^{15}N$ relative to liver suggests that there may be seasonal shifts in trophic level, although most samples in this study were collected in the late summer and fall. Common thresher muscle $\delta^{13}C$ was also enriched relative to liver, suggesting potential shifts from near-shore to offshore habitats.

In contrast to the thresher shark, the shortfin mako did not show any discernable pattern in $\delta^{15}N$ with size. This suggests that there is no clear ontogenetic trophic shift over a size range from 77 to 317 cm FL. Trophic positions for the mako ranged from 3.4 to 4.8. Similar to the thresher, muscle $\delta^{15}N$ was enriched relative to the liver in smaller sharks, although the reverse was true for all females greater than 250 cm FL, the approximate size at sexual maturity. This could also reflect seasonal diet shifts or perhaps changes in their physiology as female shortfin mako become sexually mature. The high variability in the shortfin mako $\delta^{13}C$ suggests high plasticity in their feeding ecology, with some individuals showing very near-shore signals while others

[13] Isotopes are any of the several different forms of an element each having different atomic mass. For example, most carbon in nature is present as $^{12}C$, with approximately 1 percent being $^{13}C$. Stable isotopes are isotopes that do not degrade measurably over the lifetime of an animal.
[14] The higher the trophic level, the higher the organism is on the food chain. Trophic levels typically range from 1 to 5.
[15] Ontogeny refers to the development of an organism.

show offshore signals. This research was recently completed as part of a San Diego State University student's masters thesis.

Bio-Accumulation of Mercury in Shortfin Mako and Common Thresher Sharks

In recent years there has been considerable concern about the bio-accumulation of mercury (Hg) in top marine predators posing a public health risk. Off the West Coast, the two shark species that are regularly consumed and have the potential to have high Hg concentrations are the common thresher shark and the mako shark. In 2004, NMFS initiated a study to test overall Hg levels in mako and thresher sharks as well as to examine potential ontogenetic shifts in Hg concentration.

Over the course of the study, 38 common thresher sharks (63 to 241 cm FL) and 33 mako sharks (75 to 330 cm FL) were sampled. For both species, we found detectable levels of Hg in the white muscle, but not in the liver and no differences in Hg levels between the sexes suggesting similar bio-accumulation patterns. There were, however, significant interspecific differences with the shortfin mako having considerably higher Hg levels than the common thresher (averages: mako 1.13 µg/g, common thresher 0.13 µg/g). This likely reflects the shortfin mako foraging at higher trophic levels, and thus accumulating greater levels of Hg than the common thresher, which primarily targets small schooling fish. We found strong linear relationships between body size and Hg level for both species with a significantly greater rate of increase for the shortfin mako. In all common thresher sharks tested, Hg levels were well below the U.S. Food and Drug Administration's established action level of 1.0 µg/g for commercial fish. Nearly all shortfin mako muscle samples from sharks ≤ 150 cm FL (FL) had Hg levels below 1.0 µg/g, but all shortfin makos >150 cm FL had muscle Hg levels exceeding this level. The largest mako shark had a concentration of 2.90 µg/g. This research is currently in press in the California Cooperative Oceanic Fisheries Investigations Reports.

***Genetic Population Structure***

Shortfin Mako Shark

The shortfin mako is a wide-ranging pelagic shark caught globally in temperate and tropical waters. The stock structure within their broad range is poorly understood, especially in the Pacific. In the North Atlantic, thousands of conventional tags have been deployed, and although 608 have been returned, not a single shark was recaptured south of 10°N. This suggests, at a minimum, a northern and southern stock. Although the more limited conventional tag returns in the Pacific reveal movement across the North Pacific from California to as far as Japan, the potential for separation between the North and South Pacific is not known. A study is being conducted using mitochondrial DNA analyses from samples gathered around the Pacific to test the hypothesis that shortfin makos from the North and South Pacific are genetically distinct. In addition, this study will examine corridors of gene flow for shortfin mako sharks in the Pacific Ocean.

To date, 410 samples from seven sites in the Pacific (southern California, Hawaii, Japan, New Zealand, Australia, NW South America, and Chile) and one site in the North Atlantic have been analyzed. The North Atlantic site is significantly different from all Pacific sites. Within the Pacific, analyses reveal that sharks in locations in closest proximity—California/Hawaii, NW South America/Chile, and Australia/New Zealand—show no population subdivision.

Divergence was apparent between the Northern and Southern Hemispheres as well as across the North Pacific between California/Hawaii and Japan. After performing isolation by distance analyses, it appears that the corridors of gene flow are following a stepping stone model. With concern about global shark populations, a better understanding of stock structure is critical to developing accurate stock assessments and ensuring effective management. This research is being completed as a part of a master's thesis project at the University of San Diego.

Silky Sharks

Silky sharks (*Carcharhinus falciformis*) are an abundant pan-tropical species and comprise the bulk of the shark bycatch in global tuna fisheries. Despite their ubiquitous nature and relative abundance, little is known about their movement patterns, stock structure, and abundance trends. There is some evidence of declining abundance in both the Atlantic and Pacific, suggesting a need to take a closer look at this species. The SWFSC has been working with the IATTC, PIFSC, and other collaborators to collect samples throughout the Pacific in order to learn more about this poorly understood species.

To investigate whether distinct stocks exist within the Pacific Ocean, DNA sequence data from the mitochondrial control region and size polymorphisms at amplified fragment lengths, and microsatellite loci have been examined. Preliminary results suggest the existence of separate stocks north and south of the relatively cool zone of upwelling along the equator in the eastern Pacific. Obtaining samples from the western Pacific has been difficult, but what samples we currently have suggest another stock exists in the southwest Pacific. Additional samples from the western Pacific are anticipated in the next few months. The results of this research will be incorporated into the upcoming IATTC stock assessment for silky sharks.

***Pelagic Shark Age, Growth, and Maturity***

Age and growth of mako, common thresher, and blue sharks are being estimated from ring formation in vertebrae. Critical to this method is validation with OTC, which lays down a mark at the time of injection. When the shark is recaptured and the vertebrae recovered, the number of rings laid down over a known time period can be counted. In 2008, we continued OTC validation studies on blue, mako, and thresher sharks.

Since the beginning of the program in 1997, 1,959 OTC-marked individuals have been released during juvenile shark surveys. In 2008, 32 mako, 232 blue, and 253 common thresher sharks were tagged and marked with OTC. As of April 2009, recaptured OTC-marked sharks included 71 mako, 31 blue, and 40 common thresher sharks; however, vertebrae were returned for only about half of the recaptures. Time at liberty ranged from 6 to 1,938 days, with net movements of individual sharks as high as 3,410 nautical miles. Examination of the band periodicity based on the OTC mark is ongoing.

In addition to the work with OTC-marked individuals, age and growth studies are being conducted with non-marked vertebrae using various visualization techniques to identify bands, and by length frequency analysis of the fisheries and survey catch data. The purpose is to expand and refine previous ageing studies using a larger sample size with accompanying information on sex and maturity stage.

***Other International Collaboration***

The SWFSC provides guidance to RFMO's on the conservation and management of sharks throughout the Pacific. As an example, SWFSC scientists participate in the Bycatch Working Group of the International Scientific Committee and work collaboratively with the IATTC on the development of shark bycatch reductions techniques. SWFSC staff also work collaboratively with scientists of the Instituto Nacional de la Pesca through the bilateral partnership, MexUS-Pacifico. While no collaborative activities were carried out during 2008 through MexUS-Pacifico, planned projects include joint abundance surveys and tagging of large pelagic sharks and collaborative shark assessment efforts. The group met early in 2009 and reiterated their commitments to the projects. In addition, SWFSC staff participate in the Northeast Pacific IUCN shark specialist group and have provided input regarding shark conservation and management through a number of other international fora.

## Northwest Fisheries Science Center (NWFSC)

***Monitoring and assessment activities***

The NWFSC conducts and supports several activities addressing the monitoring and assessment of sharks along the West Coast of the United States and in Puget Sound. The Pacific Fishery Information Network serves as a clearinghouse for commercial landings data, including sharks. In addition, the At-Sea Hake and West Coast Groundfish Observer Programs collect data on shark species caught on vessels selected for observer coverage.

The NWFSC conducts annual trawl surveys of the West Coast, designed primarily to acquire abundance data for West Coast groundfish stocks. The tonnages of all shark species collected during these surveys are documented. In addition, the survey program has conducted numerous special projects in recent years to help researchers acquire data and samples necessary for research on various shark species. Since 2002, the survey has collected biological data and tissue samples from spiny dogfish, including dorsal spines, which can be used to age the fish. Biological data and tissue samples were also collected from leopard sharks and cat sharks during the bottom trawl surveys.

In addition to these monitoring activities, the NWFSC conducted the first assessment for longnose skate in 2007. This assessment was reviewed during the 2007 stock assessment review (STAR) process, and was adopted by the PFMC for use in management. The NWFSC coordinates the STAR panel review process for all such groundfish stock assessments provided as scientific advice to the PFMC.

***Movement studies***

The NWFSC, in collaboration with Washington Department of Fish and Wildlife and the Seattle Aquarium, has been estimating movement parameters of sixgill and sevengill sharks in Puget Sound and Willipa Bay. Vemco ultrasonic tags were surgically implanted into the body cavity of each shark and released fish at their capture site. Automated listening stations were used to detect fish tagged with ultrasonic transmitters, thus allowing shark movement to be monitored. In addition, movement was monitored with active, boat-based tracking. These data have allowed estimation of movement parameters (e.g., move length and turning angles) that allow home ranges to be estimated; daily, seasonal, and interannual movements to be described; and important habitats to be quantified. Also, models based on habitat-specific movement parameters allow for inference of relative abundance in different habitats. In addition, upon capture, biological data (e.g., genetic samples, blood samples, gut contents, and length/weight) are collected and used by the Washington Department of Fish and Wildlife to support management of these species.

## Alaska Fishery Science Center (AFSC)

### *Shark research and assessments*

Research efforts at the Alaska Fishery Science Center's Auke Bay Laboratory (ABL) are focused on:

1. Collection of data to support stock assessments of shark species subject to incidental harvest in Alaskan waters.
2. Abundance and tagging of Pacific sleeper sharks.
3. Migration and habitat use of spiny dogfish in the Gulf of Alaska.
4. Estimation of shark bycatch from unobserved fisheries.
5. Collaborative research with the University of Alaska Fairbanks (UAF), the University of Washington (UW), and the Alaska Department of Fish and Game (ADF&G) on:
    a. Life history, reproduction, and general ecology,
    b. Age and growth,
    c. Demography,
    d. Indices of abundance and bycatch modeling, and
    e. Feeding ecology and stable isotopes

### *Stock assessments of shark species subject to incidental harvest in Alaskan waters*

Species currently assessed include Pacific sleeper sharks (*Somniosus pacificus)*, spiny dogfish (*Squalus acanthias)*, and salmon sharks (*Lamna ditropis)* which are the shark species most commonly encountered as bycatch in Alaskan waters. The shark stock assessment is currently limited to an analysis of commercial bycatch relative to biomass, which is estimated from NMFS fishery-independent bottom trawl surveys in the Gulf of Alaska, Eastern Bering Sea, and Aleutian Islands. Stock assessments are summarized annually in an appendix to the NPFMC Stock Assessment and Fishery Evaluation (SAFE) Report available online (i.e., see Tribuzio et al. 2008a and 2008b).

### *Pacific sleeper sharks*

During the summers of 2003–2006, scientists from the ABL deployed 138 numerical Floy tags, 91 electronic archival tags, 24 electronic acoustic tags, and 17 electronic satellite pop-up tags on Pacific sleeper sharks in the upper Chatham Strait region of Southeast Alaska (Courtney and Hulbert 2007). Two numerical tags and 10 satellite tags have been recovered. The recovery of temperature, depth, and movement data from the electronic archival and acoustic tags will aid in the identification of Pacific sleeper shark habitat utilization and distribution in Southeast Alaska, and identify the potential for interactions between Pacific sleeper sharks and other species in this region.

Collaborative research is being conducted by the AFCS's ABL and UAF on ecosystem considerations of Pacific sleeper shark bycatch in the northeast Pacific Ocean. Specific topics being addressed include the determination of Pacific sleeper shark relative abundance trends, distribution, habitat, and trophic level in Alaskan marine waters. Historical trends in area-weighted CPUE of Pacific sleeper sharks in the northeast Pacific Ocean between 1979 and 2003 were determined from sablefish longline surveys (Courtney and Sigler 2007). There are no directed fisheries or surveys for Pacific sleeper sharks in Alaskan marine waters; consequently, abundance estimation is limited to indirect methods. We analyzed Pacific sleeper shark incidental catch (bycatch) from sablefish longline surveys conducted on the upper continental slope of the eastern Bering Sea, Aleutian Islands, and Gulf of Alaska between 1979 and 2003. Our objectives were to estimate trends in Pacific sleeper shark relative abundance and their statistical significance. A total of 1,565 Pacific sleeper sharks were captured by sablefish longline surveys between 1979 and 2003, with a sample effort of 19.7 million hooks. Area ($km^2$) weighted CPUE of Pacific sleeper sharks was analyzed from standardized sablefish longline surveys between 1982 and 2003 with bootstrap 95 percent confidence intervals[16] (CI) as an index of relative abundance in numbers. Within the limited time series available for hypothesis testing, area-weighted CPUE of Pacific sleeper sharks increased significantly in the eastern Bering Sea between 1988 and 1994 and in the Gulf of Alaska between 1989 and 2003, but also decreased significantly in the Gulf of Alaska in 1997. The increasing trend in the Gulf of Alaska was driven entirely by one region, Shelikof Trough, where most (54 percent) Pacific sleeper sharks were captured. Increasing trends in area-weighted CPUE of Pacific sleeper sharks in the eastern Bering Sea and Shelikof Trough are consistent with previous analyses of fishery-dependent and fishery-independent data from the northeast Pacific Ocean and with evidence of a climatic regime shift that began in 1976 and 1977. Whether increasing trends in area-weighted CPUE of Pacific sleeper sharks from sablefish longline surveys represent an increase in the relative abundance of Pacific sleeper sharks at the population level or just reflect changes in local densities is unknown, because of caveats associated with computing area-weighted CPUE of Pacific sleeper sharks from sablefish longline surveys and because of a lack of information on the life history and distribution of Pacific sleeper sharks.

***Spiny dogfish***

Migration and habitat use in the Gulf of Alaska

In the summer of 2009, scientists from ABL will deploy 15 pop-up archival tags on spiny dogfish. These tags will be programmed to pop-up after one year at which time the data will be recovered via satellite. Data will include depth and temperature as well as a geolocation. These first 15 tags will be the preliminary study, and we expect to deploy more tags in following years. Results will indicate habitat preference with respect to depth and temperature, which may play a role in examining the effects of climate changes in the North Pacific. Further, the geolocation data will elucidate the degree to which Gulf of Alaska spiny dogfish populations mix with those populations in British Columbia, Canada, and the U.S. Pacific Coast.

Estimation of shark bycatch from unobserved fisheries

In the Gulf of Alaska, some fisheries fall outside of the groundfish observer program (eg., halibut individual fishing quota fishery) and data on the bycatch of shark and skate species from those

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[16] A 95 percent confidence interval means that the probability that the true population mean falls within the confidence interval is 0.95.

fisheries does not exist. Scientists at ABL are working with others from the AFSC, ADF&G, and the International Pacific Halibut Commission to determine a method for using existing survey data to estimate the bycatch of elasmobranch species. This project will build off work completed by a University of Washington student (described below) and work conducted by ABL scientists (Courtney et al. 2006).

Collaborative research in the Gulf of Alaska

The AFSC's ABL has collaborated with the Juneau Center of the UAF, School of Fisheries and Ocean Sciences, the University of Washington, and the ADF&G during 2004–2008 to investigate the population dynamics, life history, and ecological role of spiny dogfish in the Gulf of Alaska. As part of this study, ABL scientists deployed 167 electronic archival tags, 617 numerical tags, and one satellite pop-up tag on spiny dogfish in Yakutat Bay, Alaska. One satellite tag and one archival tag have been recovered. Data from tag recoveries will provide insights into the seasonal residency and movement patterns of spiny dogfish in Yakutat Bay and the northeast Pacific Ocean. The ABL has also provided shark bycatch data, biomass estimates, field and technical support, and a graduate student committee member in support of graduate student research. Results from graduate student research will be incorporated into annual stock assessments.

Age and growth

A total of 1,599 spiny dogfish spines have been collected and aged, ranging across the continental shelf from Southeast Alaska to Kodiak Island (NMFS surveys and commercial bycatch), Cook Inlet (ADF&G surveys and commercial fishery sampling), Prince William Sound (ADF&G surveys), Yakutat Bay (from UAF/UW and NMFS surveys and commercial bycatch) and Southeast Alaska (from ADF&G surveys). Unworn spines were used to create an algorithm for estimating the number of worn band pairs so that worn spines could be included. Male and female length-at-age data was used to compare a variety of growth models and determine the most appropriate model for the species. Results suggest that a two-phase growth model is the best fit for both sexes. Parameter results indicate that the spiny dogfish is amongst the slowest growing shark species, as well as the longest lived. Differences in growth models and parameters with neighboring areas (British Columbia and the U.S. west coast) suggest that Gulf of Alaska (GOA) spiny dogfish are biologically distinct. A manuscript detailing this research has been submitted and is under review (Tribuzio et al. in review).

Life history, reproduction and ecology

Through the collaborative work described above, scientists were able to collect dogfish data from many regions within the Gulf of Alaska, using multiple gear types and throughout most of the year. The data is being examined for trends in seasonal abundance; gear biases; sex, size and age distributions; and reproductive information. Preliminary results suggest that the species has a low fecundity and slow reproductive cycle. They mature at a large size relative to the overall maximum size and at a late age. All of which are indicators of species are susceptible to overfishing. This project is also examining historical commercial and survey data for abundance trends by regions. One goal is to determine if seasonal abundances coincide with abundances of other species (i.e., prey availability) or environmental factors.

Demographics

The growth model results were used to construct two demographic models of spiny dogfish in the Gulf of Alaska: an age-based and a stage-based model. The stage-based model had five categories, based on biologically significant life stages: neonates, juveniles, sub-adults, pregnant adults, and non-pregnant adults; whereas the age-based model had 120 individual age classes. The purpose of this project was to define the natural state of the population, or the population's natural growth rate, age distribution, and reproductive values in the absence of fishing pressure, and to perturb that population with simulated levels of fishing pressure. The secondary purpose was to determine if the simpler stage-based model produced comparable results to the fully age structured model, and if it may be used in place of the age model. Results of both models suggest that spiny dogfish can only tolerate low levels of fishing mortality ($F<0.03$) and that the ability of the population to rebound is also low. Both models were projected forward with varying levels of fishing pressure, and at $F\geq0.3$, all simulated populations went extinct in 20 years or less. A manuscript detailing this research is under review (Tribuzio and Kruse, in review).

Indices of abundance and bycatch modeling

In the Gulf of Alaska, dogfish occur frequently as bycatch (non-target catch) in commercial fisheries. Preliminary estimates of dogfish bycatch in the Gulf of Alaska exist, however the overall impacts of fishing on dogfish populations in Alaska are unknown and no stock assessment has been conducted. Research conducted by a University of Washington student compiled available bycatch data from commercial longline fisheries as well as State and Federal surveys. This data was standardized using Generalized Linear Models to construct an index of abundance based solely on bycatch data. A preliminary stock assessment (using Bayesian and Classical methods) was then completed, which showed that although the potential for overfishing of dogfish is high, they are not currently overfished. Two manuscripts are in preparation detailing this study (Rice and Gallucci, in prep a and b).

Feeding ecology and stable isotopes

The stomach contents from over 900 spiny dogfish have been identified. The spiny dogfish is believed to be a generalist feeder, with no particular prey species. The purpose of this study is to determine the seasonal feeding habits of this species and to examine any regional variation in diets. This study is in the data analysis phase. Diets will be compared across sex and size, region, time of year, and prey availability. Early results suggest that the species feeds broadly, but may have seasonal and regional tendencies toward certain prey groups. A manuscript detailing the diet analysis is in preparation (Tribuzio et al. in prep)

An additional collaboration between NMFS and UAF used stable isotope analysis to investigate the feeding ecology of spiny dogfish in the GOA. The stable isotopes of carbon and nitrogen were used to examine trophic variation in relation to length, sex, and geographic region. White muscle tissue was analyzed from male and female spiny dogfish collected in the GOA (n=412) ranging from 61 to 113 cm in TL. Based on a preliminary analysis, spiny dogfish increase in trophic position with length and display differences in trophic position among geographical areas in the GOA. Examining variations of the trophic position using stable isotope analysis will provide more accurate estimates of trophic position and will lead to a better understanding of the role in the GOA of different size classes of spiny dogfish have in the GOA.

## Northeast Fisheries Science Center (NEFSC)

***Fishery Independent Surveys and Recreational Monitoring of Coastal and Pelagic Sharks***

Juvenile Shark Survey for Monitoring and Assessing Delaware Bay Sandbar Sharks (*Carcharhinus plumbeus*)

The juvenile sandbar shark population in Delaware Bay is surveyed by NEFSC staff as part of the Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) program. A random stratified longline sampling plan, based on depth and geographic location, was developed in 2001 to assess and monitor the juvenile sandbar shark population during the nursery season. The juvenile index of abundance from this standardized survey has been used as an input into various stock assessment models. In addition, the mark-recapture data from this project are being used to examine the temporal and spatial relative abundance and distribution of sandbar sharks in Delaware Bay. In 2008, a total of 95 sandbar sharks were caught, with 90 of the sharks (95 percent) released with tags. In addition, data obtained from this survey were used in a cooperative genetic study on sandbar sharks with researchers from the Virginia Institute of Marine Science (Portnoy et al. 2008). Results of this study provided a calculation for the effective number of breeders and effective population size for adults of Delaware Bay and the Eastern Shore of Virginia by genotyping 902 animals across five cohorts at eight microsatellite loci. Estimates of the effective number of breeders and effective population size were compared to estimates of Delaware Bay census size. The estimated ratios were 0.45 or higher, which is in contrast to estimated ratios in other exploited marine fishes that are several orders of magnitude smaller. Instead, the estimated ratio of effective population size to census size for sandbar sharks is similar to that found in marine and terrestrial mammals.

Delaware Bay Sand Tiger (*Carcharias taurus*) Survey

A survey, initiated in 2006 targeting the sand tiger shark for identifying EFH and for future stock assessment purposes, continued in 2008 (see Figure 5.1.3). This study incorporates historical NEFSC sampling stations for comparison to pre-management abundance. Preliminary results indicate that this survey will be a successful monitoring tool for the Delaware Bay sand tiger population and for evaluating long-term changes in abundance and size composition. In 2008, a total of 26 sand tigers were caught, with all 26 sharks released with conventional tags and two with PSATs (in conjunction with researchers from Massachusetts Division of Marine Fisheries [MDMF]).

**Figure 5.1.3. Measuring a sand tiger during the NEFSC Delaware Bay Sand Tiger Survey. Souce: Corey Eddy/NMFS photo.**

Collection of Recreational Shark Fishing Data and Samples

Historically, species-specific landings data from recreational fisheries is lacking for sharks. In an effort to augment these data, the NEFSC has been attending recreational shark tournaments continuously since 1961 collecting data on species, sex, and size composition from individual events; in some cases, for over 45 years. In addition, these tournaments provide a source of samples for pelagic and some coastal sharks to aid in our biological research. Analysis of these tournament landings data was initiated by creating a database of historic information (1961-2008) and producing preliminary summaries of one long-term tournament. The collection and analysis of these data are critical for input into species and age specific population and demographic models for shark management. In 2008, biological samples for life history studies and catch and morphometric data for more than 200 pelagic sharks were collected at 10 recreational fishing tournaments in the northeastern United States. Participation at recreational shark tournaments and the resultant information is very valuable as a monitoring tool to provide long-term data that can detect trends in species and size composition, provide valuable specimens and tissue for life history and genetic studies, provide outreach opportunities for recreational fishermen and the public, and finally, to provide additional information on movements that complement the NMFS Cooperative Shark Tagging Program (CSTP).

NEFSC Historical Longline Survey Database
The NEFSC recently recovered the shark species catch per set data from the exploratory shark longline surveys conducted by the Sandy Hook and Narragansett Laboratories from 1961 to 1991. In addition to the fishery-independent surveys conducted by the NEFSC, scientific staff have been working with the University of North Carolina (UNC) to electronically recover the data from an ongoing coastal shark survey in Onslow Bay that began in 1972. These surveys provide a valuable historical perspective for evaluating the stock status of Atlantic sharks. This data recovery process is part of a larger, systematic effort to electronically recover and archive historical longline surveys and biological observations of large marine predators (swordfish, sharks, tunas, and billfishes) in the North Atlantic. When completed, these efforts will include reconstructing the historic catch, size composition, and biological sampling data into a standardized format for time series analysis of CPUE and size. Standardized indices of abundance developed for sharks caught during these longline surveys have been and will continue to be used in stock assessments as part of the SEDAR process. Recently, analyses of trends in night shark abundance from the NEFSC exploratory shark longline surveys were an integral part of a study using all currently available information to determine the status of the United States population of this species (Carlson et al. 2008). As a result of this study, the night shark was removed from the Species of Concern list, but retained as a prohibited species until a more comprehensive stock assessment can be conducted. Work on the recovery of environmental data for both the NEFSC and the UNC time series, as well as the associated individual shark data, is ongoing to further refine these indices and to develop indices of abundance for other shark species, and for future use in shark EFH designations.

Fishery Independent Survey for Coastal Sharks
The fishery independent survey of Atlantic large and small coastal sharks is conducted bi-annually in U.S. waters. Its primary objective is to conduct a standardized, systematic survey of the shark populations off the U.S. Atlantic coast to provide unbiased indices of relative abundance for species inhabiting the waters from Florida to the Mid-Atlantic. It also provides an opportunity to tag sharks with conventional and electronic tags as part of the NEFSC CSTP and to collect biological samples and data used in analyses of life history characteristics (age, growth, reproductive biology, trophic ecology, etc.) and other research of sharks in U.S. coastal waters including the collection of morphometric data for size conversions.

***Essential Fish Habitat***

Pelagic Nursery Grounds

Pelagic shark biology, movements, and abundance studies continued in 2008 with further investigations of pelagic nursery grounds in conjunction with the high seas commercial longline fleet. This collaborative work offers a unique opportunity to sample and tag blue sharks (*Prionace glauca*) and shortfin makos (*Isurus oxyrinchus*) in a potential nursery area, to collect length-frequency data and biological samples, and to conduct conventional and electronic tagging of these species. Sampling took place from September 15 to November 7, 2008, on board a commercial longline vessel targeting swordfish on the Grand Banks off Newfoundland. In 23 sets, 985 sharks, primarily juvenile blue sharks (967), shortfin makos (11), and porbeagles (*Lamna nasus*) (7), were tagged with conventional tags with 535 of these injected with oxytetracycline for age and growth studies. Dissections were accomplished on over 90 sharks. The majority of these fish were measured and used for length-frequency analysis. In addition, two real-time satellite (SPOT) tags and five PSAT tags were deployed on shortfin makos in 2006 and 2008, respectively, and one PSAT tag was deployed on a blue shark. All the PSAT's are programmed to pop-up in 2009.

Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Program

The NEFSC manages and coordinates this program, which surveys Atlantic coastal waters from Florida to Massachusetts and in the U.S. Virgin Islands (USVI) by conducting cooperative, comprehensive, and standardized investigations of coastal shark nursery habitat. COASTSPAN surveys are used to describe the species composition of shark nursery habitat, to describe habitat preferences, and to determine the relative abundance, distribution, and migration of those species through longline and gillnet sampling and mark-recapture data (see Figure 5.1.4). In 2008, COASTSPAN participants were the Georgia Department of Natural Resources, the South Carolina Department of Natural Resources, Coastal Carolina University, and the North Carolina Division of Marine Fisheries. The NEFSC staff conducts the survey in Narragansett and Delaware Bays and additional sampling in the USVI and Massachusetts in conjunction with the MDMF. Standardized indices of abundance from several COASTPAN surveys are used in the stock assessments for large and small coastal sharks and data from all surveys are used to update and refine EFH designations for juvenile life stages of managed coastal shark species.

**Figure 5.1.4. Tagging a juvenile sandbar shark during the NEFSC COASTSPAN Program Survey. Source: W. David McElroy / NMFS photo.**

In collaboration with MDMF and NMFS (Galveston, TX; Silver Spring, MD), a study was initiated to investigate the spatial and temporal use of nursery habitat by neonatal blacktip (*Carcharhinus limbatus*) and lemon (*Negaprion brevirostris*) sharks in St. John, USVI. In December 2005, active acoustic tracking of lemon and blacktip sharks was conducted in Fish Bay, a productive shark nursery, for 10 days with students from the Boston University Marine Program. This cooperative USVI survey is the first comprehensive survey of elasmobranchs in the USVI and has resulted in the identification of critical shark nursery habitat for blacktip and lemon sharks in Fish Bay (DeAngelis et al. 2008). Building on this work, 33 acoustic transmitters were surgically implanted in 20 blacktip and 13 lemon sharks from 2006 to 2008; their long-term movements are currently being monitored using passive acoustic telemetry. Additional tags will be deployed in 2009.

<u>Habitat Utilization and Essential Fish Habitat of Delaware Bay Sand Tiger Sharks</u>
Funding was received through the NOAA Living Marine Resources Cooperative Science Center to support a multi-year cooperative research project with staff from Delaware State University and the University of Rhode Island on habitat use, depth selection, and the timing of residency for sand tigers in Delaware Bay. Sand tigers were implanted with 69 standard acoustic or depth-sensing transmitters to monitor their movements and habitat use of Delaware Bay during the summer months from 2006–2008. Males and females were segregated, with males more commonly found in the lower salinity middle portion of the bay and in shallower waters, whereas females were more common in deeper, higher salinity waters near the mouth of the Bay. Habitat use varied between years with significantly shallower depths used in 2007 than in 2008. The importance of Delaware Bay as summer habitat for sand tigers is demonstrated by relatively high interannual site fidelity with 50 percent of sharks tagged in 2006 returning in 2007, and 60 percent tagged in 2007 were detected in the Bay the following summer of 2008.

<u>EFH Designations</u>
NEFSC staff participate on a working group with others from the NMFS HMS Division and SEFSC to update and refine the EFH designations for managed shark species. This process was ongoing in 2008 and entailed refining the methodology used to determine EFH, providing data for pelagic sharks caught outside the EEZ from the CSTP and NEFSC surveys for use in delineating EFH, and a detailed review of resulting EFH designations from the refined methodology.

***Elasmobranch Life History Studies***
NEFSC life history studies are conducted on Atlantic species of elasmobranchs to address identified priority knowledge gaps and focus on species of concern because of declines and management issues. Biological samples are obtained on research surveys and cruises, on commercial vessels, at recreational fishing tournaments, and opportunistically from observers on commercial fishing vessels and from strandings. In recent years, studies have concentrated on a complete life history for a species to obtain a total picture for management. This comprehensive life-history approach encompasses studies on age and growth rates and validation, diet and trophic ecology, and reproductive biology essential to estimate parameters for demographic, fisheries, and ecosystem models.

<u>Atlantic Blue Shark and Shortfin Mako Life History and Assessment Studies</u>
Collaborative programs to examine the biology and population dynamics of the blue shark and shortfin mako in the North Atlantic are ongoing. These studies—critical for use in stock assessment—have resulted in the publication of research that provides fishery-independent demographic and risk analysis results for the blue shark for use in conservation and management with the construction of an age-structured matrix population model in which the vital rates are stochastic. Demographic analyses confirm the importance of juvenile survival for population growth. The risk analysis is proposed as a supplement to the data-limited stock assessment to

better evaluate the probability that a given management strategy will put the population at risk of decline.

Shortfin mako survival was estimated from NMFS CSTP mark-recapture data. Estimates of survival were generated with the computer software MARK and provided a means for estimating parameters from the 6,309 tagged animals when they were recaptured (n = 730). The results of several models were presented with various combinations of constant and time-specific survival and recovery rates and gave a range of survival for the shortfin mako from 0.705–0.873 per year. An estimate of survival is a key variable for stock assessments and subsequent demographic analyses, and is crucial when it comes to directly managing exploited or commercially viable species.

A genetic approach for identifying pelagic shark tissues was streamlined and simplified by researchers at NOVA Southeastern University, facilitating rapid and unambiguous species identification (Shivji et al. 2008). The result is a rapid, accurate, and relatively inexpensive genetic assay for identifying tissues and body parts from the shortfin mako and four other shark species (silky, dusky, sandbar, and longfin mako).

Efforts were initiated in 2005 with MDMF researchers to tag shortfin makos and blue sharks with PSAT and SPOT tags. In October 2005, two blue sharks were tagged and released south of Massachusetts; both fish were blood sampled for stress physiology studies. The tags detached from the sharks in February 2006 and data analysis is ongoing. Two real-time satellite (SPOT) tags and five PSAT tags were deployed on shortfin makos in 2006 and 2008, respectively, from a longliner while fishing on the Grand Banks. In addition, one PSAT tag was deployed on a blue shark. All the PSATs are programmed to pop-up in 2009.

In 2008, regional sizes, sex ratios, maturation, and movement patterns were analyzed for 91,450 blue sharks tagged by members of the NMFS CSTP in the North Atlantic Ocean from 1962-2000 (Kohler and Turner 2008). Of these, 5,410 were recaptured for an overall recapture rate of 5.9 percent. Blue sharks made frequent trans-Atlantic crossings from the western to eastern regions, and were shown to move between most areas; the mean distance traveled was 857 km, and the mean time at liberty between tagging and recapture was 0.9 year. North Atlantic blue sharks are believed to constitute a single stock, and a better understanding of their complex movements, life-history strategies, and population structure is needed to develop informed management of this open ocean species.

The blue shark has been subject to bycatch fishing mortality in the western North Atlantic for almost a half-century. Nevertheless, stock status is ambiguous and improved input data are needed for stock assessments. It is particularly important to obtain reliable indices of abundance because of the uncertainty in estimates of bycatch. An index of relative abundance (catch-per-unit effort, CPUE) was developed for western North Atlantic blue sharks, starting from the mid-1950s, when industrial pelagic longline tuna fisheries began (Aires-da-Silva et al. 2008). Longline catch and effort records from recent observer programs (1980–1990s) were linked with longline survey records from both historical archives and recent cruises (1950–1990s). Generalized linear models were used to remove the effects of diverse fishing target practices, and geographical and seasonal variability that affect blue shark catch rates. The analysis revealed a decline in blue shark CPUE of approximately 30 percent in the western North Atlantic from 1957 to 2000. The magnitude of this CPUE decline was less than other recently published estimates and seems reasonable in light of the high productivity of the blue shark revealed by life-history studies and preliminary stock assessments.

Biology of the Thresher Shark (*Alopias vulpinus*)

Life-history studies of the thresher shark in the western North Atlantic continued with analysis of age and reproductive parameters. Age and growth estimates were generated using vertebral centra from 173 females, 135 males, and 11 individuals of unknown sex ranging in size from 56 to 264 centimeters fork length. In addition, further collection of food habits and reproductive samples were accomplished primarily at recreational fishing tournaments. Reproductive tissues were processed and sectioned using histological techniques; these results were combined with the morphological reproductive data to determine sexual sizes at maturity for this species.

Biology of the Atlantic Torpedo (*Torpedo nobiliana*)

Atlantic torpedo samples for age and growth, reproduction, and food habits were obtained from the bycatch of bottom trawl, trap net and gillnet fisheries operating primarily out of Pt. Judith, Rhode Island. A total of 170 rays (124 female, 46 male) were collected from February 2006 through March 2008. Males ranged in size from 60.4 cm to 111.2 cm TL while females ranged in size from 69.1 cm to 151.7 cm TL. Reproductive tissues have been processed and sectioned using histological techniques and examined. Morphological data on organ measurements have been plotted and will be compared to the histological results. Vertebrae from 45 males and 122 females were also processed using histology and image analysis. Criteria for the identification of bands was unable to be defined due to the variety of banding patterns throughout the vertebral samples and attempts to calibrate the band pair readings using a subsample of vertebrae were unsuccessful. Because the precision of the counts was low and the bias was high, the readers did not continue counting the band pairs for the rest of the samples. Due to these difficulties with ageing using the vertebral centra, this work is still in progress. Electric rays (family Torpedinidae) are distinguished from other batoids by the possession of kidney-shaped electric organs along the anterior-lateral portion of their disks. There are approximately 21 validated species in the genus *Torpedo*, of which only the Atlantic torpedo, *Torpedo nobiliana,* is believed to be found in the Northwest Atlantic Ocean. However, as an indirect result of this study, the population of electric rays off the coast of Rhode Island is being examined to determine if the rays may be of the species *Torpedo occidentalis* rather than, or in addition to, *Torpedo nobiliana*. This research is part of a University of Rhode Island graduate student master's thesis.

Biology of the Smooth Skate (*Malacoraja senta*)

The smooth skate is one of the smallest (<70 cm TL; <2.0 kg wet weight) species of skate endemic to the western North Atlantic and has a relatively broad geographic distribution, ranging from Newfoundland and southern Gulf of St. Lawrence in Canada to New Jersey in the United States. Age and growth estimates for the smooth skate were derived from 306 vertebral centra from skates caught in the North Atlantic off the coast of New Hampshire and Massachusetts. Male and female growth diverged at both ends of the data range and the sexes required different growth functions to describe them. Males and females were aged to 15 and 14 years, respectively. Research is ongoing to determine the size and age at sexual maturity for this species in the Gulf of Maine.

Northeast Skate Complex
The goal of this research is to sample the skate complex landed for use in the Rhode Island lobster bait industry. Sampling includes identification to species level, collection of data on size, sex, and reproductive condition, recording catch locations, and collection of vertebrae and stomach samples for subsequent analysis. These data will contribute to the FMP objectives to collect information critical for improving knowledge of skate fisheries by species and for monitoring the status of skate fisheries, resources, and related markets, as well as improve the effectiveness of skate management approaches.

***Age and Growth of Elasmobranchs***
Tiger Shark (*Galeocerdo cuvier*)
Age and growth estimates for the tiger shark in the western North Atlantic were derived from band counts of 238 sectioned vertebral centra (Kneebone et al. 2008). Two- and three-parameter von Bertalanffy and Gompertz growth functions fit to length-at-age data demonstrated that growth rates were similar for males and females up to approximately 200 cm fork length after which male growth slowed. Both sexes appear to reach maturity at age 10. Males and females were aged to 20 and 22 years, respectively, although longevity estimates predict maximum ages of 27 and 29 years, respectively. Bomb radiocarbon analysis of ten band pairs extracted from four vertebral sections suggested that band pairs are deposited annually up to age 20. This study provides a rigorous description of tiger shark age and growth in the western North Atlantic and further demonstrates the utility of bomb radiocarbon as an age validation tool for elasmobranch fishes.

Basking Shark (*Cetorhinus maximus*)
Age and growth of the basking shark was examined using vertebral samples from 13 females (261 to 856 cm TL), 16 males (311 to 840 cm TL) and 11 specimens of unknown sex (376 to 853 cm TL) (Natanson et al. 2008). Vertebral samples were obtained worldwide from museums and institutional and private collections. Examination of multiple vertebrae from along the vertebral column of 10 specimens indicated that vertebral morphology and band pair (alternating opaque and translucent bands) counts changed dramatically along an individual column. Smaller sharks had similar band pair counts along the length of the vertebral column while large sharks had a difference of up to 24 band pairs between the highest and lowest count along the column. Evidence indicates that band pair deposition may be related to growth and not time in this species and thus the basking shark cannot be directly aged using vertebral band pair counts.

Basking Shark Isotope Analysis
Researchers at the Woods Hole Oceanographic Institution, MDMF, and the NEFSC are using isotopic analysis on vertebrae to determine the trophic position of the basking shark as well as to learn more about their migratory behavior and ocean connectivity. This type of retrospective trophic-level reconstruction has broad applications in future studies on the ecology of this shark species to determine lifelong feeding and migratory patterns and to augment electronic tag data.

***Elasmobranch Feeding Ecology***
Diet, Feeding Ecology, and Gastric Evacuation Studies of Delaware Bay Sandbar and Smooth Dogfish (*Mustelus canis*) Sharks

The diet and feeding ecology of sandbar sharks and smooth dogfish are being investigated within Delaware Bay. These species are the two most abundant shark species in the Bay ecosystem, so their role as top predators within the Bay could be substantial. Several multivariate statistical methods as well as standard dietary analyses were applied to the data. These techniques, along with the large sample size and high dietary resolution, enabled detailed feeding patterns to be examined. This study also successfully developed a non-lethal stomach eversion sampling technique which worked effectively to obtain the stomach contents. The dietary results for these species are for the most part consistent with earlier studies in other locales, although this study provides a greater level of detail and comparisons not previously performed. Gastric evacuation experiments have been concluded for the sandbar sharks and early results indicate a faster digestion rate then formerly thought. Further analysis of ecological patterns as well as potential competition between the species is being examined. This includes further characterization of specific monthly patterns, and comparisons to ecological data on prey species for evaluating the role of these large predators in the Delaware Bay nursery. The dietary results will be compared with morphometric data being compiled to evaluate changes in growth and condition. This will provide insight into the quality and importance of the nursery habitat, and potentially information regarding physiological changes in condition, survival, and the impact of migration and winter habitat.

Smooth Dogfish (*Mustelus canis*)
In collaboration with MDMF and the University of Massachusetts, staff are working to examine the feeding ecology of smooth dogfish in Massachusetts waters. In 2008, 70 longline sets were conducted over 18 days from May through October, resulting in the capture of 242 smooth dogfish; samples were also collected from the MDMF spring and fall trawl surveys (n=28). Stomach contents of all dogfish were everted and analyzed. Major prey items included lobster, American rock crab, spider crab and mantis shrimp. Over the two years of the study, 370 dogfish have been collected. It is anticipated that the project will be completed in 2009 as part of a graduate student masters thesis.

Sable Island Seal Predation
An investigation into shark predation on five species of seals on Sable Island, Nova Scotia, Canada, is ongoing. Flesh wound patterns, tooth fragments, and bone markings are being analyzed to determine the identification of the predator. This work is being completed in conjunction with Sable Island researcher Zoe Lucas.

Food Habits of the Scalloped Hammerhead (*Sphryna lewini*)
The role of the scalloped hammerhead in the western North Atlantic food web is being examined by quantitatively characterizing the stomach contents from sharks caught by research and commercial vessels, and at recreational fishing tournaments. A total of 308 samples were collected from 1975 to 2008. The diet composition will be described and impacts caused by biotic and abiotic factors will be evaluated including differences between shark size and sex, and sampling season, gear, and area.

***Movements and Migrations using conventional and electronic tag technology***
Cooperative Shark Tagging Program (CSTP)

The CSTP provides information on distribution, movements, and essential fish habitat for shark species in U.S. Atlantic and Gulf of Mexico waters. This program has involved more than 7,000 volunteer recreational and commercial fishermen, scientists, and fisheries observers since 1962. In 2008, information was received on 5,300 tagged and 425 recaptured fish bringing the total numbers tagged to 211,000 sharks of more than 50 species and 12,850 sharks recaptured of 33 species. To improve the quality of data collected through the CSTP, the Guide to Sharks, Tunas, & Billfishes of the US Atlantic and Gulf of Mexico was reprinted and made available to recreational and commercial fishermen through Rhode Island Sea Grant as well as identification placards for coastal and pelagic shark species.

Integrated Mark-Recapture Database Management System (I-MARK)
Substantial progress was made on the NEFSC I-MARK with data modules for tagging, recapture, and contact information brought online and reports (letters to constituents) finalized including location maps and data. A toll-free number has been established as well as online reporting to collect information on recaptures for all species. In 2008, over 45 years of CSTP shark mark-recapture data was migrated to this new Oracle database system, which creates a centralized tagging infrastructure for the more than 50 species of sharks in the CSTP and other NEFSC teleost tagging programs including cod, black sea bass, yellowtail flounder, and scup.

Alternative tag testing is underway utilizing recreational tag and release tournaments. These events offer an opportunity to investigate the use of two new dart tags on pelagic sharks. Many of these events have 100 percent observer coverage on the recreational boats and observers alternatively tag using each tag type and record tag data, release condition, and total catch and effort. This will allow an initial evaluation of these tags by getting feedback from the participants on how easy each tag is to handle, how well they stay on the tagging needle, how easily the dart head penetrates the shark skin, as well as gathering data on the return rate of each tag type.

Porbeagle Movement Patterns
A study on the movement patterns, habitat utilization, and post-release survivorship of porbeagles captured on longline gear in the North Atlantic was funded by the University of New Hampshire Large Pelagics Research Center’s External Grants Program. This work is in conjunction with scientists from MDMF and the University of Massachusetts. The primary objective of this research is to deploy PSAT tags to examine the migratory routes, potential nursery areas, swimming behavior, and environmental associations that characterize habitat utilization by porbeagles. In addition, information will be obtained to validate the assessment of the physiological effects of capture stress and post-release recovery in longline-captured porbeagles, which will increase our understanding of capture-related stress and the potential long-term effects on survival. Moreover, these efforts will potentially allow the quantification of the stress cascade for this shark species captured using commercial gear, thereby providing fishery managers with data showing the minimum standards for capturing (e.g., longline soak time) and releasing these fishes to ensure post-release survival. To date, 17 of the 20 PSATs deployed in 2006 released in 2007. The tags were programmed to release in March (n=7), July (n=7), and November (n=6) of 2007 and 17 (85 percent) successfully reported. The sharks, ten males and ten females ranging from 128-154 cm fork length, were tagged and released from a commercial longliner on the northwestern edge of Georges Bank, about 150 km east of Cape

Cod, MA. Based on known and derived geopositions, the porbeagles exhibited broad seasonally-dependent horizontal (77-870 km) and vertical (surface to 1300 m) movements. All of the sharks remained in the western North Atlantic from the Gulf of St. Lawrence and the coast of Nova Scotia to Georges Bank and oceanic and shelf waters south to North Carolina. In general, the population appears to contract during the summer and fall with more expansive radiation in the winter and spring. Although sharks moved through temperatures ranging from 2-26 °C, the bulk of their time (77 percent) was spent in water ranging from 8-16 °C. In the spring and summer months, the sharks remained epipelagic in the upper 200 m of the water column. In the late fall and winter months, some of the porbeagles (n=10) moved to mesopelagic depths (200-1000 m). Temperature records indicate that these fish were likely associated with the Gulf Stream. Additional analyses, which include the integration of these data with those from the long-term conventional tag-recapture database, are ongoing.

Two summary articles on porbeagle biology and management were published in 2008 (Campana et al. 2008; Francis et al. 2008) in which the primary authors were from Canada and New Zealand, respectively. These studies include published NEFSC porbeagle life history results and offer a comprehensive overview of the population dynamics and life history information for this species, to date.

Tiger Shark Movement Patterns

In cooperation with researchers from the Monterey Bay Aquarium and MDMF, three tiger sharks were tagged with PSAT's off the coast of North Carolina during the NEFSC fishery independent bottom longline survey in April 2007. The tags reported in July (n=1) and August (n=2) and provided viable data on the horizontal and vertical movements of these fish. Given that these sharks were also blood sampled at capture, these tags generate additional information on post-release survivorship and behavior of longline-stressed tiger sharks. Data analyses was ongoing in 2008 and additional tags will be deployed in 2009 off the coast of New England.

## Southeast Fisheries Science Center (SEFSC)

***Stock Assessments of Pelagic and Prohibited Sharks***

SEFSC scientists actively participated in the ICCAT intersessional assessment of blue and shortfin mako stocks described in section 4.2. Specifically, SEFSC staff prepared 4 documents for the data preparatory meeting held in Uruguay in 2007 and 5 documents for the stock assessment workshop held in Spain in 2008, in addition to being centrally involved in conducting the actual stock assessments (ICCAT 2008). SEFSC staff also developed two Ecological Risk Assessments (ERAs) of pelagic sharks for the 2008 ICCAT stock assessment meeting (see ERA section below).

Funds from the NMFS Protected Resources Species of Concern Program were provided in 2007 to provide an assessment of the sand tiger shark as it pertains to the species of concern criterion. Productivity, abundance trends, and endemism were assessed (Carlson et al. 2009). Little evidence was found to support the conclusion that sand tigers are endemic to any discrete location in U.S. Atlantic waters. Sand tigers have very low productivity but examination of trends in size suggests that sand tigers were not heavily exploited. An analysis of trends in abundance from multiple data sources indicated the lack of a considerable decline in abundance for any series examined. Most series showed low to moderate declines in abundance, from 0.2 to 6.2 percent. However, the very high levels of uncertainty in relative abundance trends suggest that results should be viewed with caution. Owing to the exceptionally low productivity of sand tigers and the relatively low sample sizes on which trend analyses were based, the study recommended that sand tigers be retained on the species of concern list as a precautionary approach.

***Ecological Risk Assessments of Atlantic sharks***

SEFSC staff conducted several ERAs of Atlantic sharks in 2008. These analyses evaluate the productivity of a stock and its susceptibility to the fisheries exploiting it, which combined allow for an assessment of the potential vulnerability of the stock in question. Two ERAs were carried out for stocks in the Atlantic shark complex, one as part of activities by the NMFS Vulnerability Evaluation Working Group (see Patrick et al. 2009 and http://www.nmfs.noaa.gov/msa2007/vulnerability.htm for more information), the other for presentation at the American Elasmobranch Society 24th annual meeting (Cortés et al. 2008a). Additionally, two ERAs were conducted in support of ICCAT's 2008 assessment activities for pelagic sharks (Cortés et al. 2008b; Simpfendorfer et al. 2008). Results of these analyses provided categorizations of the relative vulnerability and associated risk of the different stocks to being overfished.

***Observer Programs***

<u>Shark Longline Program</u>

From 1994 to 2004, the southeastern United States commercial shark bottom longline fishery was monitored by the University of Florida Commercial Shark Fishery Observer Program. In 2005, the responsibilities of the program were moved to NMFS' Panama City Laboratory Shark Population Assessment Group in Panama City, Florida. This program is designed to meet the intent of the Endangered Species Act and the Consolidated Atlantic HMS FMP. It was created to obtain better data on catch, bycatch, and discards in the shark bottom longline fishery. All observers are required to attend a 1-week safety training and species identification course before being dispatched to the fishery. While on board the vessel, the observer records information on gear characteristics and all species caught, condition of the catch (e.g., alive, dead, damaged, or unknown), and the final disposition of the catch (e.g., kept, released, finned, etc.). Recent amendments to the Consolidated Atlantic HMS FMP based on updated stock assessments have eliminated the major directed shark fishery in the U.S. Atlantic. The amendments implement a shark research fishery, which allows NMFS to select a limited number of commercial shark vessels on an annual basis to collect life history data and catch data for future stock assessments. Furthermore, the revised measures drastically reduce quotas and retention limits, and modify the authorized species in commercial shark fisheries. Specifically, commercial shark fishers not participating in the research fishery are no longer allowed to land sandbar sharks, *Carcharhinus plumbeus*, which have been the main target species for most fishermen. Outside the research fishery, fishers are permitted to land 33 non-sandbar large coastal sharks. In June 2008, NMFS announced its request for applications for the shark research fishery from commercial shark fishers with a directed or incidental permit. Commercial shark fishers submitted applications to the Highly Migratory Species (HMS) Management Division. The HMS Management Division provided a list of qualified applicants to the Panama City Laboratory and based on the temporal and spatial needs of the research objectives, the availability of qualified applicants, and the available quota, 11 qualified applicants were selected for observer coverage. These vessels carried observers on 100 percent of trips. Outside the research fishery, vessels targeting shark and possessing current valid directed shark fishing permits were randomly selected for coverage with a target coverage level of 4-6 percent. From January to December 2008, a total of 50 trips (defined as from the time a vessel leaves the port until the vessel returns to port and lands catch, including multiple hauls therein) on 17 vessels with a total of 214 hauls (defined as setting gear, soaking gear for some duration of time, and retrieving gear) were observed.

Shark Gillnet Program

Since 1993, an observer program has been underway to estimate catch and bycatch in the directed shark gillnet fisheries along the southeastern U.S. Atlantic coast. This program was designed to meet the intent of the Marine Mammal Protection Act, the Endangered Species Act, and the 1999 revised FMP for HMS. It was also created to obtain better data on catch, bycatch, and discards in the shark fishery. Historically, the Atlantic Large Whale Take Reduction Plan and the Biological Opinion issued under Section 7 of the Endangered Species Act mandated 100 percent observer coverage during the right whale calving season (November 15 to April 1). Outside the right whale calving season (i.e., April 1 to November 14), observer coverage equivalent to 38 percent of all trips is maintained. In 2007, the regulations implementing the Atlantic Large Whale Take Reduction Plan were amended and included the removal of the mandatory 100 percent observer coverage for drift gillnet vessels during the right whale calving season, but now prohibit all gillnets in an expanded southeast U.S. restricted area that covers an area from Cape Canaveral, Florida, to the North Carolina-South Carolina border, from November 15 through April 15. The rule has limited exemptions, only in waters south of 29 degrees N latitude, for shark strikenet fishing[17] during this same period and for Spanish mackerel gillnet fishing in December and March. Based on these regulations and on current funding levels, the shark gillnet observer program now covers all anchored (sink, stab, set), strike, or drift gillnet fishing by vessels that fish from Florida to the North Carolina year-round. Similar to the shark longline observer program, all observers are required to attend a 1-week safety training and species identification course and while on board the vessel they must record information on gear characteristics and all species caught, condition of the catch, and the final disposition of the catch. A total of 5 drift gillnet vessels were observed making 68 sets on 9 trips in 2008. No vessels that targeted sharks were observed fishing gillnets in a strike fashion in 2008. A total of 41 trips making 134 sink net sets on 14 vessels were observed in 2008. Trips were made targeting one or more of the following: shark, Spanish mackerel, king mackerel, Southern kingfish, and goosefish (monkfish).

***Determination of critical habitat for the conservation of dusky shark (Carcharhinus obscurus) using satellite archival tags***

In an attempt to improve the conservation status of dusky shark, NMFS established a time-area closure off North Carolina from January to July to reduce bycatch of neonate and juvenile dusky sharks. Although neonate and juvenile dusky sharks have been documented in abundance in this locality during the winter months, current knowledge of the overwintering area of this population

[17] When a vessel fishes for sharks with strikenets, the vessel encircles a school of sharks with a gillnet. This is usually done during daylight hours, to allow visual observation of schooling sharks from the vessel or by using a spotter plane.

is derived entirely from fishery-dependent data (tag returns and commercial fishery longline data; NMFS 2003). Thus, these data may be a more accurate reflection of the distribution of the fishery rather than the distribution of the population. To examine the utility of the closed area on the conservation and recovery of dusky shark, satellite archival tags are being used to examine habitat utilization and movement patterns of juvenile dusky shark. Information gathered through this study will verify the utilization of the closed area by dusky shark and also provide information on daily and seasonal movement patterns such as migration corridors that could aid in developing additional critical habitat information. Data are also being obtained on preferred depth and habitat, which may help reduce further fishery interactions through bycatch mitigation. To date, 2 dusky sharks have been tagged with PSAT tags.

***Shark depredation rates in pelagic longline fisheries***

A suite of modelling approaches was employed to analyze shark depredation rates from the U.S. Atlantic pelagic longline fishery. As depredation events are relatively rare, there is a large number of zeroes in pelagic longline data, and conventional generalized linear models (GLMs) may be ineffective as tools for statistical inference. GLMs (Poisson and negative-binomial), two-part (delta-lognormal and truncated negative binomial, T-NB), and mixture models (zero-inflated Poisson, ZIP, and zero-inflated negative binomial, ZINB) were used to understand the factors that contributed most to the occurrence of depredation events that included a small proportion of whale damage. Of the six distribution forms used, only the ZIP and T-NB models performed adequately in describing depredation data, and the T-NB and ZINB models outperformed the ZIP models in bootstrap cross-validation estimates of prediction error. Candidate T-NB and ZINB model results showed that encounter probabilities were more strongly related to large-scale covariates (space, season) and that depredation counts were correlated with small-scale characteristics of the fishery (temperature, catch composition). Moreover, there was little evidence of historical trends in depredation rates. The results show that the factors contributing to most depredation events are those already controlled by ships' captains and, beyond novel technologies to repel sharks, there may be little more to do to reduce depredation loss in the fishery within current economic and operational constraints (MacNeil et al. 2009).

***Ecosystem-Based Analysis and Management of Apex Predators: A Hierarchical-Bayesian Approach***

Defining a trophic role for sharks in a given ecosystem is routinely accomplished through analysis of stomach contents or, increasingly, using ecological tracers. An alternative, statistical approach is to quantify relationships between predators and potential prey through time, where strong negative correlations between predator and prey indicate significant top-down effect. A major difficulty in implementing these methods, however, is the frequent mismatch between available data sets; sampling of predators and prey often occur on different occasions using different gear types. Research began in 2007 to estimate the effects of predator density on local fish communities using robust, hierarchical Bayesian-based methods. These results are expected to quantify the effect of apex predators in shaping fish community structure in the Gulf of Mexico and to be highly publishable. The conclusions will be of broad interest to fisheries managers trying to rebuild depleted fish stocks should the role of apex predators be substantial.

***Elasmobranch Feeding Ecology and Shark Diet Database***

The current Consolidated Atlantic HMS FMP gives little consideration to ecosystem function because there are little quantitative species-specific data on diet, competition, predator-prey interactions, and habitat requirements of sharks. Therefore, several studies are currently under way describing the diet and foraging ecology, habitat use, and predator-prey interactions of elasmobranchs in various communities. A study on prey selection by the Atlantic angel shark in the northeastern Gulf of Mexico was recently published (Baremore et al. 2008). The diet of the roundel skate (*Raja texana*) from the northern Gulf of Mexico is also being examined (Bethea and Hale in prep.). A database containing information on quantitative food and feeding studies of sharks conducted around the world has been in development for several years and currently includes over 400 studies. This fully searchable database will continue to be updated and fine-tuned in 2009, and is being used as part of a collaborative study on ecosystem effects of fishing large pelagic predatory fish with researchers from the University of Washington, University of Wisconsin, and the Inter-American Tropical Tuna Commission. It is also expected that this shark trophic database will be very useful for other ecosystem-level studies using Ecopath/Ecosim or similar approaches and ultimately for population assessments.

***Cooperative Gulf of Mexico States Shark Pupping and Nursery Survey (GULFSPAN) and Tagging Database***

The SEFSC Panama City Shark Population Assessment Group manages and coordinates a survey of coastal bays and estuaries from Cedar Key, Florida, to Terrebonne Bay, Louisiana. Surveys identify the presence or absence of neonate (newborn) and juvenile sharks and attempt to quantify the relative importance of each area as it pertains to essential fish habitat (EFH) requirements for sharks. The Group also initiated a juvenile shark abundance index survey in 1996. The index is based on random, depth-stratified gillnet sets conducted throughout coastal bays and estuaries in northwest Florida monthly from April to October. The species targeted in the index of abundance survey are juvenile sharks in the large and small coastal management groups. This index has been used as an input to various stock assessment models. A database containing tag and recapture information on elasmobranchs tagged by GULFSPAN participants and NMFS Mississippi Laboratories is in development and currently includes over 11,000 tagged animals and 134 recaptured animals from 1993 to present for both the Gulf of Mexico and U.S. southeast Atlantic Ocean. This fully searchable database was updated and fine-tuned in fiscal year 2008 with hopes to have it online and searchable by all participants in fiscal year 2010.

***Monitoring the Recovery of Smalltooth Sawfish***

The smalltooth sawfish *Pristis pectinata* was listed as Endangered under the Endangered Species Act (ESA) in 2003. Smalltooth sawfish are the first marine fish and first elasmobranch listed under the ESA. Smalltooth sawfish were once common in the Gulf of Mexico and off the southeast coast of the United States. Decades of fishing pressure, both commercial and recreational, and habitat loss caused the population to decline by up to 95 percent during the second half of the twentieth century. Today they exist mostly in southern Florida.

The completion of the Smalltooth Sawfish Recovery Plan in early 2007 brought about a new phase of research and management for the U.S. population of smalltooth sawfish. Research and monitoring priorities identified in the Recovery Plan are now being implemented. Field work is underway to gather information on determining critical habitat and monitoring the population.

This information will evaluate the effectiveness of protective and recovery measures and help determine if the population is rebounding or, at the very least, stabilizing.

One of the high priority research areas is monitoring of the number of juvenile sawfish in various regions throughout Florida to provide a baseline and time series of abundance. One of the more important regions for smalltooth sawfish identified in previous research is the section of coast from Marco Island to Florida Bay, FL. This region encompasses the coast of the Ten Thousand Islands National Wildlife Refuge and Everglades National Park. Scientists from the Panama City Laboratory conduct monthly surveys in southwest Florida to capture, collect biological information, tag and then release smalltooth sawfish. Some results from research to date indicate that juvenile sawfish are highly specific to certain areas and that they may not only return to the same natal estuarine system but the same specific mangrove habitat. Genetic identification of recaptured individuals indicates that sawfish caught on the same mudflat, for example, are siblings and a single adult female sawfish may give birth on that same mudflat year after year. Determination of critical habitat and movement and migration corridors for larger juvenile and adult sawfish is being undertaken using state of the art PSAT and SPOT tags. Individuals are tagged during surveys in waters off the southeast United States. Preliminary results indicate sawfish are found at greater depths than originally anticipated and may be found in offshore aggregations in specific areas of the Gulf of Mexico.

***Life History Studies of Elasmobranchs***
Biological samples of elasmobranchs are obtained through research surveys and cruises, recreational and commercial fishermen, and collection by onboard observers on commercial fishing vessels. Age and growth rates and other life-history aspects of selected species are processed and the data analyzed following standard methodology. This information is vital as input to population models used to predict the productivity of the stocks and to ensure they are harvested at sustainable levels. Several methods were used in an attempt to develop an age and growth model for the Atlantic angel shark (*Squatina dumeril*). Band counts from vertebral sections were fit to the traditional growth equations but did not produce realistic parameter estimates. In addition a length-based Bayesian model was applied to fishery-independent length-frequency data, and a full Bayesian model was fit to length-at-age data to estimate parameters for the von Bertalanffy growth equation. This study provides research guidelines for future research initiatives for species for which growth models are difficult to develop. Additional collaborative efforts are underway to determine age, growth and maturity for night, silky and great hammerhead sharks. Following recommendations of the 2006 Large Coastal Shark SEDAR (SEDAR 11), research is continuing to reevaluate the life history of sandbar and blacktip sharks, especially age at maturity.

***Bomb radiocarbon validation***
To estimate age of great hammerhead sharks, bomb carbon validation and isotope analysis are underway. This technique focuses on the well-documented increase in radiocarbon ($C^{14}$) in the world's oceans, caused by the atmospheric testing of atomic bombs in the 1960s. The increase in atmospheric and oceanic radiocarbon was found to be synchronous with marine organisms containing carbonate, such as bivalves, corals, and fish bones. This synchrony allows the period of increase to be used as a dated marker in calcified structures exhibiting growth bands, such as teleost otoliths and shark vertebrae.

***Cooperative Research—Brazil-U.S. pelagic shark research project***

The main goal of this cooperative project between Brazil (Universidade Federal Rural de Pernambuco) and the United States (SEFSC and the University of Florida's Museum of Natural History) is to conduct simultaneous research on pelagic sharks in the North and South Atlantic Ocean. Central to this project is also the development of fisheries research capacity in Brazil through graduate student training and stronger scientific cooperation between Brazil and the United States. The main research objectives include: 1) development of bycatch reduction and habitat models, 2) investigation of movement and migratory patterns, and 3) ancillary life history studies. Bycatch reduction will be investigated with the placement of hook timers and temperature-depth recorders on fishing gear to gain information on preferential feeding times, fishing depths, and temperatures of pelagic sharks and associated fauna. This information can be used in the future for development of habitat-based models. Movement and migratory patterns are being investigated through the deployment of PSATs on pelagic species that are frequently caught in fishing operations or are of special importance to conservation interests in both countries. Information gathered will provide insight into geographical and vertical distribution patterns, which in turn will provide data on catchability that can be used if bycatch reduction measures are implemented in the future. Data obtained from hook timers, temperature-depth recorders, and archival tags can also be used to estimate the susceptibility of pelagic shark species to surface longline fisheries under ERA approaches. To date, an oceanic whitetip, a longfin mako, and 3 bigeye thresher sharks have been tagged with satellite tags off U.S. waters and two blue sharks have been tagged off Brazilian waters as part of this project. The ancillary studies include genetic, age and growth, reproduction, and trophic ecology analysis.

***Shark Assessment Research Surveys***

The SEFSC Mississippi Laboratories have conducted bottom longline surveys in the Gulf of Mexico, Caribbean, and Southern North Atlantic since 1995 (27 surveys have been completed through 2009). The primary objective is assessment of the distribution and abundance of large and small coastal sharks across their known ranges in order to develop a time series for trend analysis. The surveys, which are conducted at depths between 5 and 200 fathoms, were designed to satisfy five important assessment principles: stockwide survey, synopticity, well-defined sampling universe, controlled biases, and useful precision. The bottom longline surveys are the only long-term, nearly stock-wide, fishery-independent surveys of Western North Atlantic Ocean sharks conducted in U.S. waters and neighboring waters. Recently, survey effort has been extended into depths shallower than 5 fathoms to examine seasonality and abundance of sharks in inshore waters of the northern Gulf of Mexico and to determine what species and size classes are outside of the range of the sampling regime of the long-term survey. This work is being done in cooperation with the Dauphin Island Sea Lab and Gulf Coast Research Laboratory. For all surveys, ancillary objectives are to collect

**Scalloped hammerhead captured in the Gulf of Mexico during a bottom longline survey. Source: NMFS Mississippi Laboratories, Shark Team**

biological and environmental data, and to tag-and-release sharks. The surveys continue to address expanding fisheries management requirements for both elasmobranchs and teleosts.

**NOAA Center for Coastal Environmental Health and Biomolecular Research**

***Ongoing sample collection and methods-development for molecular shark species identification***

The Marine Forensics program at the National Ocean Service's (NOS) Center for Coastal Environmental Health and Biomolecular Research (CCEHBR) in Charleston, South Carolina, conducts research on suitable molecular markers for identification of shark species. DNA identifications can be used to determine whether the species of landed fins match the corresponding bodies, whether prohibited species are found among fish that are not landed intact, and even the identity of dried, processed fins. The Marine Forensics program uses a method developed in-house that is based on sequencing a ~1,400-base-pair fragment of 12s/16s mitochondrial DNA (Greig et al. 2005) to identify the species of suspected sharks seized by agents of Federal and State law enforcement agencies. The published method focuses on 35 species from the U.S. Atlantic shark fishery, but sample collection and research to expand the number and range of shark species sequenced for the diagnostic DNA fragment is ongoing.

## 5.2 Incidental Catch Reduction

**Pacific Islands Fisheries Science Center (PIFSC)**

***Reducing Longline Shark Bycatch***

The resumption of the previously closed Hawaii shallow-set longline fishery for swordfish in late 2004 and continuing through 2007 was anticipated to increase blue shark catches, as in the past blue sharks made up about 50 percent of the total catch in this fishery. With the ban on shark finning, these sharks are not retained and are categorized as regulatory bycatch. Although the anticipated increase in shark bycatch has been less than expected (perhaps due to the requirement to use fish bait instead of squid, or because of a shift toward an earlier fishing season in the reopened swordfish fishery), researchers at PIFSC have undertaken several projects to address shark bycatch on longlines.

***Chemical and Electromagnetic Deterrents to Bycatch***

One study under way since 2005 with funding from the National Bycatch Program seeks to test the use of chemical and electromagnetic deterrents to reduce shark bycatch. Previous research by Eric Stroud of SharkDefense LLC, Oak Ridge, New Jersey, was conducted to identify and isolate possible semiochemical compounds from decayed shark carcasses. Semiochemicals are chemical messengers that sharks use to orient, survive, and reproduce in their specific environments. Certain semiochemicals have the ability to trigger a flight reaction in sharks. Initial tests showed chemical repellents administered by dosing a "cloud" of the repellent into a feeding school of sharks caused favorable behavioral shifts, and teleost fishes such as pilot fish and remora accompanying the sharks were not repelled and continued to feed. This suggested other teleosts, such as longline target species (tunas or billfish), would not be repelled. Longline field testing of these chemicals was conducted in early 2006 with demersal longline sets in South Bimini using the chemicals, and similar testing of magnets, and were quite successful.

Beginning in early 2007, the PIFSC began testing the ability of electropositive metals (lanthanide series) to repel sharks from longline hooks. Electropositive metals release electrons and generate large oxidation potentials when placed in seawater. It is thought that these large oxidation reactions perturb the electrosensory system in sharks and rays, causing the animals to exhibit aversion behaviors. Since commercially targeted pelagic teleosts do not have an electrosensory sense, this method of perturbing the electric field around baited hooks may selectively reduce the bycatch of sharks and other elasmobranchs.

Feeding behavior experiments were conducted to determine whether the presence of these metals would deter sharks from biting fish bait. Experiments were conducted with Galapagos sharks and sandbar sharks off the coasts of the North Shore of Oahu. Results indicate that sharks significantly reduced their biting of bait associated with electropositive metals. In addition, sharks exhibited significantly more aversion behaviors as they approached bait associated with these metals. Further studies on captive sandbar sharks in tanks indicated sharks would not get any closer than 40 cm to bait in the presence of the metal (metal approximately the same size as a 60g lead fishing weight).

Initial experiments to examine the effects on shark catch rates on modified longlines are also being conducted. This is being accomplished through a collaboration with Dr. Kim Holland of the University of Hawaii's Hawaii Institute of Marine Biology (HIMB) located on Coconut Island in Kaneohe Bay. We have initiated two experiments, one focusing on the effects of Nd/Pr (Neodymiun/Praseodymium) alloy on the catch rates of sharks on bottom set longline gear and the other examining the effects of Nd/Pr alloy and other lanthanide alloys on the feeding and swimming behavior of scalloped hammerhead (*Sphyrna lewini)* and sandbar *(Carcharhinus plumbeus)* sharks. Preliminary results from longline field trials in Kaneohe Bay, Hawaii suggest that catch rates of juvenile scalloped hammerhead sharks are reduced by 63 percent on branchlines with the Nd/Pr alloy attached as compared to lead weight-controls (Figure 5.2.1). Sharks for behavioral experiments are being collected, experimental observation arenas are being prepared for behavioral experiments, and initial behavioral experiments examining effects on swimming behavior have been initiated.

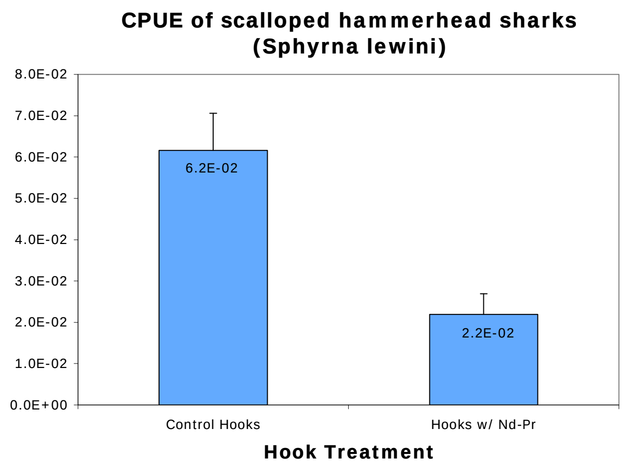


**Figure 5.2.1: Catch per unit effort of scalloped hammerhead sharks on longlines with Nd/Pr alloy attached versus control hooks.**

In addition, field trials on pelagic sharks are being initiated. Collaborating with the SWFSC, experiments examining the effects of the metals on the catch rates of mako and blue sharks are being planned during the annual SWFSC pelagic shark surveys. Experiments in the Ecuadorian mahi-mahi longline fisheries are also being planned.

***Longline Gear Effects on Shark Bycatch***

To explore operational differences in the longline fishery that might reduce shark bycatch, the observer database is being used to compare bycatch rates under different operational factors (e.g., hook type, branch line material, bait type, the presence of light sticks, soak time, etc.). A preliminary analysis was completed that compared the catches of vessels using traditional tuna hooks to vessels voluntarily using size 14/0 to 16/0 circle hooks in the Hawaii-based tuna fleet. The study was inconclusive due to the small number of vessels using the circle hooks. Subsequently, 19 contracted vessels were used to test large (size 18/0) circle hooks versus tuna hooks in controlled comparisons. Preliminary analysis does not indicate these large circle hooks increase the catch rate of sharks, in contrast to findings of increased shark catch on circle hooks in studies comparing smaller circle hooks with J hooks in other fisheries.

***Testing Deeper Sets***

An experiment with deeper-set longline gear conducted in 2006 has been analyzed and has been published (Beverley et al. 2009). The experiment altered current commercial tuna longline setting techniques by eliminating all shallow set hooks (less than 100 m depth) from tuna longline sets. The objective was to maximize target catch of deeper dwelling species such as bigeye tuna, and reduce incidental catch of many marketable but less desired species (e.g., billfish and sharks). The deep setting technique was easily integrated into daily fishing activities with only minor adjustments in methodology. The main drawback for the crew was increased time to deploy and retrieve the gear. Catch totals of bigeye tuna and sickle pomfret were greater on the deep set gear than on the controlled sets; but the bigeye results were not statistically significant. Catch of several less valuable incidental fish (e.g., blue marlin, striped marlin, shortbill spearfish, dolphinfish, and wahoo) was significantly lower on the deep set gear than the controlled sets. Unfortunately, no significant results were found for sharks.

Results from several of the bycatch studies suggest combining methods to avoid bycatch. Perhaps a combination of electropositive metals fashioned into weights attached to longline gear and setting the gear deeper might avoid bycatch of sharks and marlins. Research is also being initiated to develop safer weights, such as weights that do not spring back toward fishermen when branch lines holding large fish break during retrieval.

## Southeast Fisheries Science Center (SEFSC)

***Cooperative Research—The Capture Depth, Time, and Hooked Survival Rate for Bottom Longline–Caught Large Coastal Sharks***

The field aspect of a project funded through the NMFS Cooperative Research Program to examine alternative measures (such as reduced soak time, restrictions on gear length, and fishing depth restrictions) in the shark bottom longline fishery to reduce mortality on prohibited sharks was completed in 2007. Preliminary analysis has begun to analyze the data.

***Temporal and Spatial Distribution of Bycatch in the U.S. Atlantic Bottom Longline Shark Fishery***

A project to evaluate the composition of bycatch from the shark bottom longline fishery began in 2007. The project examines the temporal and spatial distribution of bycatch as well as factors that may influence the rate at which bycatch is caught. This information has important implications for management actions such as marine protected areas, time area closures, and gear modifications. A three-way analysis of variance (ANOVA) was performed for each taxonomic group using the number of individuals as the dependent variable and year, region, and hook type as the independent variables. Three subregions (eastern Gulf of Mexico, south Atlantic, and Mid-Atlantic Bight), 5 years (2002–2006), four hook types (small, medium, large, and other), and eight broad taxonomic categories were used in the analyses. The results indicated that the majority of bycatch was caught in the eastern Gulf of Mexico and that the Selachimorpha taxon category made up over 90 percent of the total bycatch. All three factors were significant ($p<0.1$) for this group, as were the interactions between hook type and year and hook type and region.

***Depth, capture time, and hooking mortality of bottom longline-caught sharks***

The primary gear type used to harvest coastal sharks in the U.S. Atlantic shark fishery is bottom longline. Recent stock assessments have found several species of coastal sharks in U.S. Atlantic Ocean waters have declined from 60-80 percent of virgin levels. To aid in stock rebuilding, alternative gear restriction measures such as reduced soak time, restrictions on the length of gear, and fishing depth restrictions have been considered but not implemented. In order for such management measures to be enacted, controlled experiments were performed using hook timers and time depth recorders. Our results indicate that hook time increased mortality rates for the blacknose and blacktip sharks, but not for the sandbar, bull or Atlantic sharpnose sharks. Mortality rates for both species increased significantly after more than four hours on the hook and mortality also increased with increased bottom water temperature for blacknose shark. Significantly more sharks bit the hook within the first four hours of the set and individual shark species were commonly caught at different temperature and depth ranges. These results could be used by fisheries management to implement restrictions of fishing depth and soak time to aid in the recovery of coastal sharks species.

## 5.3 Post-Release Survival

**Pacific Islands Fisheries Science Center (PIFSC)**

***Improved Release Technology***

The recently resumed Hawaii-based swordfish longline fishery, as well as the tuna longline fishery, is required to carry and use dehookers for removing hooks from sea turtles. These dehookers can also be used to remove external hooks and ingested hooks from the mouth and upper digestive tract of fish, and could improve post-release survival and condition of released sharks. Sharks are generally released from the gear by one of the following methods: 1) severing the branchline; 2) hauling the shark to the vessel to slice the hook free; or 3) dragging the shark from the stern until the hook pulls free. Fishermen are encouraged to use dehooking devices to minimize trauma and stress of bycatch by reducing handling time and to mitigate post-hooking mortality.

Testing of the dehookers on sharks during research cruises has indicated that removal of circle hooks from shark jaws with the dehookers can be quite difficult. PIFSC is looking into the feasibility of barbless circle hooks for use on longlines, which would make it easier to dehook unwanted catch with less harm. Preliminary research in the Hawaii shore fishery has indicated that barbless circle hooks catch as much as barbed hooks, but the situation could be different with more passive gear such as longlines, where bait must soak unattended for much of the day and fish have an extended period in which to try to throw the hook. Initial results from very limited longline testing of barbless hooks on research cruises in American Samoa, and in collaboration with the Narragansett Laboratory, indicated a substantial increase in bait loss using barbless hooks. Subsequent testing used rubber retainers to prevent bait loss. Summary information from before and after the use of bait retainers showed no difference between barbed and barbless hooks in the catch and catch rates of targeted species and sharks, although catches have so far been too few to provide much statistical power. Also in this study, the efficacy of the pigtail dehooker, the device required by U.S. regulations for releasing sea turtles, showed a 67 percent success rate in dehooking and releasing live sharks on barbless hooks, compared to a 0 percent success rate when used with sharks caught on barbed hooks. In 2007, PIFSC and PIRO personnel conducted longline trials along the eastern shore of Virginia to compare catches of sharks and rays on barbed and barbless circle hooks. In a randomization test, difference in the catches between the hook types was not significant. Circle hook removal trials were also conducted simultaneously and resulting effectiveness of removing hooks from sharks were 27 percent with barbed hooks and 72 percent with barbless hooks. During the study a new dehooker was developed and tested. Preliminary results were >90 percent effective in removing both barbed and barbless circle hooks from sharks; however, the prototype appears to be more efficient on smaller sized animals.

***Post-release Survival***

Many large marine animals (sharks, turtles, and marine mammals) are accidentally caught in commercial fisheries. While conservationists and fisheries managers encourage release of these non-target species, the long-term fate of released animals is uncertain. Successful management strategies in both sport and commercial fisheries require information about long-term survival of released fish. Catch-and-release sport fishing and non-retention of commercially caught fish are justifiable management options only if there is a reasonable likelihood that released fish will survive for long periods. All recreational anglers and commercial fisherman who practice catch-and-release fishing hope the released fish will survive. Although it is safe to say that 100 percent of retained fish will die, it is not known what proportion of released fish will survive. Many factors—such as fish size, water temperature, fight time, and fishing gear—could influence survival.

Post-release survival, which is not well established for any marine species, is typically estimated using tagging programs. Historically, large-scale conventional tagging programs were used. These programs yielded low return rates, consistent with a high post-release mortality. For example, in a 30-year study of Atlantic blue sharks, only 5 percent of tags were recovered. Short-duration studies using ultrasonic telemetry have shown that large pelagic fish usually survive for at least 24 to 48 hours following release from sport fishing or longline gear. PIFSC researchers and collaborators from other agencies, academia, and industry have been developing alternative tools to study longer-term post-release mortality. Whereas tagging studies assess how many fish survive, new approaches are being used to understand why fish die. A set of diagnostic tools is being developed to assess the biochemical and physiological status of fish captured on various gear. These diagnostics are being examined in relation to survival data obtained from a comprehensive PSAT program. Once established as an indicator of survival probability, such biochemical and physiological profiling could provide an alternative means of assessing consequences of fishery release practices.

PIFSC scientists have been developing biochemical and physiological profiling techniques for use in estimating post-release survival of blue sharks, which are frequently caught as bycatch of Pacific longliners. Using NOAA research vessels, they captured 211 sharks, of which 172 were blue sharks. Using blue sharks, PIFSC scientists and collaborators developed a model to predict long-term survival of released animals (verified by PSAT data) based on analysis of small blood samples. Five parameters distinguished survivors from moribund sharks: plasma $Mg2+$, plasma lactate, erythrocyte Hsp70 mRNA, plasma $Ca2+$, and plasma $K+$. A logistic regression model incorporating a combination of $Mg2+$ and lactate successfully categorized 19 of 20 (95 percent) fish of known fate and predicted that 21 of 22 (96 percent) sharks of unknown fate would have survived upon release. These data suggest that a shark captured without obvious physical damage or physiological stress (the condition of 95 percent of the sharks they captured) would have a high probability of surviving upon release (Moyes et al. 2006).

In the second approach, five species of pelagic sharks (bigeye thresher, n=8; blue shark, n=32; oceanic whitetip, n=16; short fin mako, n=5; and silky shark, n=10) released from longline gear were tagged with PSATs. Of 44 PSATs reporting (62 percent reporting rate, 95% CI, 50 to 73 percent), there was definitive data for post-release mortality in only 2 cases (male blue shark after 7days, female oceanic whitetip after 9 days) for an overall mortality estimate of 4.5 percent (95 percent bootstrap CI, 0 to 11 percent). Non-reporting tags are not synonymous with mortality as Musyl et al. (in prep) can demonstrate that species' depth patterns (pressure/temperature), tag manufacturer and pop-up year significantly influence PSAT reporting rates in logistic regression models. Other researchers have similarly surmised that you can not make the assumption that non-reporting tags are cases of mortality due to many factors that could cause electronic tag failure in the marine environment. The case for mortality in the blue shark sample (1 mortality in 16 tags, 95 percent bootstrap CI, 0 to 19 percent) must be viewed with skepticism. For example, morbidity in this case was perhaps unwittingly influenced by scientific sampling (see Moyes et al. 2006). This was the first shark hauled and tagged on board in the study and there were problems obtaining a blood sample (i.e., no blood sample was taken after repeated trials). In the second case (1 mortality in 13 tags, 95% bootstrap CI, 0 to 23 percent), the oceanic whitetip shark did not make any notable descents after release and languished near the surface before it apparently succumbed and sank, thereby jettisoning the tag to the surface about 9 days after capture. Antecedent stress variables to explain mortality have been examined (i.e., capture temperature, soak time, etc.) but we could not conclusively demonstrate association with any of the variables and mortality in these two instances. These combined biochemical and PSAT analyses suggest that sharks landed in an apparently healthy condition are likely to survive long term if released (95 percent survival based on biochemical analyses [blue shark]; >95 percent based on PSATs [all sharks studied]). In summary, our studies demonstrate a high rate of post-release survival of pelagic sharks captured and released from longline gear fished with circle hooks. These tagging results are also used to chronicle these pelagic species in terms of migration routes, distribution patterns and habitat association as well as developing bycatch mitigation methods (Beverley et al. 2009).

***Pop-up Satellite Archival Tags (PSAT) Performance and Metadata Analysis Project***
Satellite tagging studies have been used to investigate post-release mortality of animals, either as indicated by signal failure, early pop-up, or depth data indicating rapid descent to abnormal depth before pop-up. However, these signals, or the lack thereof, may have other origins besides mortality. The purpose of this study is to explore failure (or success) scenarios in PSATs attached to pelagic fish, sharks, and turtles. We quantify these issues by analyzing reporting rates, retention times, and data return from 27 pelagic species from 2164 deployments [731 PSAT deployments from 19 species in the authors' database, and in 1433 PSAT deployments from 24 species summarized from 53 published articles]. Shark species in the database include bigeye thresher, blue, shortfin mako, silky, oceanic whitetip, great white, and basking sharks. Other species include: black, blue, and striped marlins; broadbill swordfish; bigeye, yellowfin, and bluefin tunas; tarpon; and green, loggerhead, and olive ridley turtles. To date, of 731 PSATs attached to sharks, billfish, tunas, and turtles, 577 (79 percent) reported data. Of the tags that recorded data, 106 (18 percent) hit their programmed pop-off date and 471 tags popped off earlier than their program date. The 154 (21 percent) non-reporting tags are not assumed to reflect fish mortality. The metadata study is designed to look for explanatory variables related to tag performance by analyzing PSAT retention rates, percentage of satellite data (i.e., depth, temperature, geolocations) retrieved, and tag failure. By examining these factors and other information about PSATs attached to vastly different pelagic species, it is anticipated certain patterns/commonalties may emerge to help improve attachment methodologies, selection of target species, and experimental designs, particularly with respect to post-release survival studies. PSATs in the database had an overall reporting rate of 0.79 which was not significantly different ($p = 0.13$) from the PSAT reporting rate of 0.76 in the meta-analysis. Logistic regression models showed that reporting rates have improved significantly over recent years, are lower in species undertaking large vertical excursions with a significant interaction between species' depth class (i.e., littoral, epi-pelagic, meso-pelagic, bathy-pelagic) and tag manufacturer. Information derived from this study should allow an unprecedented and critical appraisal of the overall efficacy of the technology.

## <u>Southwest Fisheries Science Center</u>

***Post-release Survival of Pelagic Sharks***
Common thresher, mako, and blue sharks are captured in a number of West Coast commercial fisheries. The drift gillnet fishery is the commercial fishery that catches the greatest number of each of these species. While thresher and mako sharks are landed, almost all blue sharks are discarded. Mako and thresher sharks are also targeted in the expanding recreational fisheries in the southern California Bight. Many recreational fishermen are only interested in the challenge of the fight and will frequently release their catch. The survival rate of sharks released both from the drift gillnet fishery and by recreational anglers is unknown. Reliable estimates of removals

(i.e., mortalities) are necessary in order to adequately assess the status of the stocks and determine the effects of the fisheries on their abundance.

Survival of Blue Sharks Released from the Drift Gillnet Fishery
The SWFSC and Southwest Region have been working on a project to determine the survivability of blue sharks caught and released alive by the California drift gillnet fishery. Blue sharks are the second greatest bycatch species in number (behind the common mola) in this fishery. Roughly 35 percent of the blue sharks caught are released alive, but their fate is unknown. During the 2007-2008 fishing season, seven sharks in various conditions at time of release were tagged with PSAT tags. During the 2008-2009 season, three additional blue sharks were tagged. The tagged sharks were tracked and results indicate that survivability is high; nine of the 10 sharks survived for at least 30 days following tagging and the tenth shark survived for at least 17 days, after which it appears the tag was ingested by another animal. Final tagging efforts of smaller sharks and those in the poorest condition will be conducted during the 2009-2010 season to conclude the study. Ultimately, blue shark mortality will be estimated based on condition and size at release. Recent changes to the observer instructions request that the condition of all released sharks be recorded on observed trips so that the mortality estimates can be appropriately estimated for all discarded sharks.

Survival of Common Thresher Sharks Released from the Recreational Fishery
In spring 2007, a collaborative Bycatch Reduction and Engineering Program (BREP) project was initiated by the SWFSC, Southwest Region Sustainable Fisheries Division, and Pfleger Institute of Environmental Research to determine the survivability of the common thresher shark, *Alopias vulpinus*, caught and released by recreational fishermen in southern California. Anglers often foul-hook thresher sharks in the tail and pull them backwards during the fight which creates respiratory difficulties in these obligate ram ventilators. When the fight time is long, the fish may be exhausted by the time it reaches the boat for release and may not survive. To assess the survivorship of recreationally caught thresher sharks, PSATs were deployed on sharks that were captured using rod and reel gear and subsequently released. Blood samples were also drawn to assess several blood bio-chemistry readings such as percent hematocrit, heat stress proteins, lactate, and blood plasma levels that are indicative of stress. As of December 31, 2008, a total of 12 thresher sharks ranging in size from 170 to 330 pounds were captured and fitted with PSAT tags (see Figure 5.3.1). Of these 12 tagged sharks, two did not survive the catch-and-release event. Those two had fight times in excess of 85 minutes and appeared exhausted. The remaining tagged sharks with fight times under 85 minutes survived based on established PSAT transmission protocols. Preliminary analysis of blood biochemistry levels in tail-hooked sharks showed elevated levels that were correlated with fight times. An additional eight PSAT tags will be deployed in 2009 to complete the first phase of the BREP funded project including the collection of additional blood biochemistry samples. The second phase of the research plan will concentrate on developing alternatives to tail-hooking methods (mouth-hooking) and conducting outreach with the angling community to foster greater use of these alternatives. An informational brochure has been prepared and distributed to meet these goals. Once the mouth-hooking techniques have been perfected, the third and final phase of the research plan will take place with additional PSAT studies to assess the rate of survival of mouth-hooked sharks along with collection and analysis of blood biochemistry samples from mouth-hooked sharks to compare the relative stress indicator levels.


**Figure 5.3.1. One of twelve common thresher sharks captured and tagged with a PSAT tag to assess catch-and-release survivorship**

## Northeast Fisheries Science Center

### *Post-release Recovery and Survivorship Studies in Sharks—Physiological Effects of Capture Stress*

This ongoing cooperative research is directed toward coastal and pelagic shark species caught on recreational and commercial fishing gear. This work is collaborative with researchers from MDMF and many other state and academic institutions. These studies use blood and muscle sampling methods, including hematocrit, plasma ion levels, and red blood cell counts, coupled with acoustic tracking and PSAT data to quantify the magnitude and impacts of capture stress. The primary objectives of the new technology tag studies are to examine shark migratory routes, potential nursery areas, swimming behavior, and environmental associations. Secondarily, these studies can assess the physiological effects of capture stress and post-release recovery in commercially- and recreationally-captured sharks. These electronic tagging studies include: 1) acoustic tagging and bottom monitoring studies for coastal shark species in Delaware Bay and the USVI as part of COASTSPAN; 2) tracking of porbeagle sharks with acoustic and PSATs in conjunction with the MDMF; 3) placing SPOT and PSAT tags on shortfin makos and blue sharks in the Northeast U.S. and on their pelagic nursery grounds; 4) placing PSAT tags on sand tigers in Delaware Bay as part of a fishery independent survey and habitat study; and 5) placing PSAT and SPOT tags on dusky and tiger sharks in conjunction with Monterey Bay Aquarium, University of California Long Beach, and MDMF. Integration of data from new-technology tags and conventional tags from the CSTP is necessary to provide a comprehensive picture of the movements and migrations of sharks along with possible reasons for the use of particular migratory routes, swimming behavior, and environmental associations. In addition, the results of this research will be critical to evaluate the extensive current catch-and-release management strategies for sharks.

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# Appendix 1: Internet Information Sources

**Atlantic Ocean Shark Management**

Copies of the 2006 Consolidated Atlantic HMS FMP and its Amendments and Atlantic commercial and recreational shark fishing regulations and brochures can be found on the Highly Migratory Species (HMS) Management Division website at http://www.nmfs.noaa.gov/sfa/hms/. Information on Atlantic shark fisheries is updated annually in the Stock Assessment and Fishery Evaluation (SAFE) Report for Atlantic HMS, which are also available on the website. The website includes links to current fishery regulations (50 CFR 635), shark landings updates, and the U.S. National Plan of Action for Sharks.

**Pacific Ocean Shark Management**

The U.S. West Coast Highly Migratory Species FMP and the Pacific Coast Groundfish FMP are currently available on the Pacific Fishery Management Council website: http://www.pcouncil.org/.

Data reported in Table 2.3.3 (Shark landings (round weight equivalent in metric tons) for California, Oregon, and Washington, 1998–2008) was obtained from the Pacific States Marine Fisheries Commission's PacFIN Database, which may be found on their website at: http://pacfin.psmfc.org/pacfin_pub/data.php.

Information about pelagic fisheries of the Western Pacific Region FMP is available on the Western Pacific Fishery Management Council's website: http://www.wpcouncil.org/pelagic.htm.

Data reported in Table 2.3.9 (Shark landings (mt) from the Hawaii-based longline fishery and the American Samoa longline fishery, 1998-2008) was partially obtained from the Western Pacific Fisheries Information Network (WPacFIN). WPacFIN is a Federal-State partnership collecting, processing, analyzing, sharing, and managing fisheries data from American island territories and States in the Western Pacific. More information is available on their website at: http://www.pifsc.noaa.gov/wpacfin/.

The Bering Sea/Aleutian Islands Groundfish FMP and the Groundfish of the Gulf of Alaska FMP are available on the North Pacific Fishery Management Council's (NPFMC) website: http://www.fakr.noaa.gov/npfmc/fmp/fmp.htm.

Stock assessments and other scientific information for sharks are summarized annually in an appendix to the NPFMC SAFE Reports that are available online: http://www.fakr.noaa.gov/npfmc/SAFE/SAFE.htm.

**International Efforts to Advance the Goals of the Shark Finning Prohibition Act**
NOAA Fisheries Office of International Affairs
http://www.nmfs.noaa.gov/ia/

FAO International Plan of Action for the Conservation and Management of Sharks
http://www.fao.org/figis/servlet/static?dom=org&xml=ipoa_sharks.xml

U.S. NPOA for the Conservation and Management of Sharks
http://www.nmfs.noaa.gov/sfa/hms/Final%20NPOA.February.2001.htm

NAFO Conservation and Enforcement Measures
http://www.nafo.int/fisheries/frames/regulations.html

IATTC
http://iattc.org/HomeENG.htm

ICCAT
http://www.iccat.int/en/

WCPFC
http://www.wcpfc.int/

UNGA
http://www.un.org/en/law/

**U.S. Imports and Exports of Shark Fins**
Summaries of U.S. imports and exports of shark fins are based on information submitted by importers and exporters to the U.S. Customs and Border Protection. This information is compiled by the U.S. Census Bureau and is reported in the NMFS Trade database: http://www.st.nmfs.gov/st1/trade/index.html

**U.S. Secretary of Commerce**
**Gary Locke**

**Under Secretary of Commerce for Oceans and Atmosphere**
**and**
**NOAA Administrator**
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**U.S. Government - 2010**

H. R. 81

# One Hundred Eleventh Congress of the United States of America

**AT THE SECOND SESSION**

***Begun and held at the City of Washington on Tuesday, the fifth day of January, two thousand and ten***

## An Act

To amend the High Seas Driftnet Fishing Moratorium Protection Act and the Magnuson-Stevens Fishery Conservation and Management Act to improve the conservation of sharks.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

**SECTION 1. TABLE OF CONTENTS.**

The table of contents for this Act is as follows:



## TITLE I—SHARK CONSERVATION ACT OF 2010

**SEC. 101. SHORT TITLE.**

This title may be cited as the “Shark Conservation Act of 2010”.

**SEC. 102. AMENDMENT OF HIGH SEAS DRIFTNET FISHING MORATORIUM PROTECTION ACT.**

(a) ACTIONS TO STRENGTHEN INTERNATIONAL FISHERY MANAGEMENT ORGANIZATIONS.—Section 608 of the High Seas Driftnet Fishing Moratorium Protection Act (16 U.S.C. 1826i) is amended—

(1) in paragraph (1)—

(A) in subparagraph (D), by striking “and” at the end;

(B) in subparagraph (E), by inserting “and” after the semicolon; and

(C) by adding at the end the following:

"(F) to adopt shark conservation measures, including measures to prohibit removal of any of the fins of a shark (including the tail) and discarding the carcass of the shark at sea;";

(2) in paragraph (2), by striking "and" at the end;

(3) by redesignating paragraph (3) as paragraph (4); and

(4) by inserting after paragraph (2) the following:

"(3) seeking to enter into international agreements that require measures for the conservation of sharks, including measures to prohibit removal of any of the fins of a shark (including the tail) and discarding the carcass of the shark at sea, that are comparable to those of the United States, taking into account different conditions; and".

(b) ILLEGAL, UNREPORTED, OR UNREGULATED FISHING.—Subparagraph (A) of section 609(e)(3) of the High Seas Driftnet Fishing Moratorium Protection Act (16 U.S.C. 1826j(e)(3)) is amended—

(1) by striking the "and" before "bycatch reduction requirements"; and

(2) by striking the semicolon at the end and inserting ", and shark conservation measures;".

(c) EQUIVALENT CONSERVATION MEASURES.—

(1) IDENTIFICATION.—Subsection (a) of section 610 of the High Seas Driftnet Fishing Moratorium Protection Act (16 U.S.C. 1826k) is amended—

(A) in the matter preceding paragraph (1), by striking "607, a nation if—" and inserting "607—";

(B) in paragraph (1)—

(i) by redesignating subparagraphs (A) and (B) as clauses (i) and (ii), respectively; and

(ii) by moving clauses (i) and (ii) (as so redesignated) 2 ems to the right;

(C) by redesignating paragraphs (1) through (3) as subparagraphs (A) through (C), respectively;

(D) by moving subparagraphs (A) through (C) (as so redesignated) 2 ems to the right;

(E) by inserting before subparagraph (A) (as so redesignated) the following:

"(1) a nation if—";

(F) in subparagraph (C) (as so redesignated) by striking the period at the end and inserting "; and"; and

(G) by adding at the end the following:

"(2) a nation if—

"(A) fishing vessels of that nation are engaged, or have been engaged during the preceding calendar year, in fishing activities or practices in waters beyond any national jurisdiction that target or incidentally catch sharks; and

"(B) the nation has not adopted a regulatory program to provide for the conservation of sharks, including measures to prohibit removal of any of the fins of a shark (including the tail) and discarding the carcass of the shark at sea, that is comparable to that of the United States, taking into account different conditions.".

(2) INITIAL IDENTIFICATIONS.—The Secretary of Commerce shall begin making identifications under paragraph (2) of section 610(a) of the High Seas Driftnet Fishing Moratorium

Protection Act (16 U.S.C. 1826k(a)), as added by paragraph (1)(G), not later than 1 year after the date of the enactment of this Act.

**SEC. 103. AMENDMENT OF MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT.**

(a) IN GENERAL.—Paragraph (1) of section 307 of Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1857) is amended—

(1) by amending subparagraph (P) to read as follows:

"(P)(i) to remove any of the fins of a shark (including the tail) at sea;

"(ii) to have custody, control, or possession of any such fin aboard a fishing vessel unless it is naturally attached to the corresponding carcass;

"(iii) to transfer any such fin from one vessel to another vessel at sea, or to receive any such fin in such transfer, without the fin naturally attached to the corresponding carcass; or

"(iv) to land any such fin that is not naturally attached to the corresponding carcass, or to land any shark carcass without such fins naturally attached;"; and

(2) by striking the matter following subparagraph (R) and inserting the following:

"For purposes of subparagraph (P), there shall be a rebuttable presumption that if any shark fin (including the tail) is found aboard a vessel, other than a fishing vessel, without being naturally attached to the corresponding carcass, such fin was transferred in violation of subparagraph (P)(iii) or that if, after landing, the total weight of shark fins (including the tail) landed from any vessel exceeds five percent of the total weight of shark carcasses landed, such fins were taken, held, or landed in violation of subparagraph (P). In such subparagraph, the term 'naturally attached', with respect to a shark fin, means attached to the corresponding shark carcass through some portion of uncut skin.".

(b) SAVINGS CLAUSE.—

"(1) IN GENERAL.—The amendments made by subsection (a) do not apply to an individual engaged in commercial fishing for smooth dogfish (*Mustelus canis*) in that area of the waters of the United States located shoreward of a line drawn in such a manner that each point on it is 50 nautical miles from the baseline of a State from which the territorial sea is measured, if the individual holds a valid State commercial fishing license, unless the total weight of smooth dogfish fins landed or found on board a vessel to which this subsection applies exceeds 12 percent of the total weight of smooth dogfish carcasses landed or found on board.

(2) DEFINITIONS.—In this subsection:

(A) COMMERCIAL FISHING.—The term "commercial fishing" has the meaning given that term in section 3 of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1802).

(B) STATE.—The term "State" has the meaning given that term in section 803 of Public Law 103–206 (16 U.S.C. 5102).

**SEC. 104. OFFSET OF IMPLEMENTATION COST.**

Section 308(a) of the Interjurisdictional Fisheries Act of 1986 (16 U.S.C. 4107(a)) is amended by striking "2012." and inserting "2010, and $2,500,000 for each of fiscal years 2011 and 2012.".

# TITLE II—INTERNATIONAL FISHERIES AGREEMENT

**SEC. 201. SHORT TITLE.**

This title may be cited as the "International Fisheries Agreement Clarification Act".

**SEC. 202. INTERNATIONAL FISHERY AGREEMENT.**

Consistent with the intent of provisions of the Magnuson-Stevens Fishery and Conservation and Management Act relating to international agreements, the Secretary of Commerce and the New England Fishery Management Council may, for the purpose of rebuilding those portions of fish stocks covered by the United States-Canada Transboundary Resource Sharing Understanding on the date of enactment of this Act—

(1) take into account the Understanding and decisions made under that Understanding in the application of section 304(e)(4)(A)(i) of the Act (16 U.S.C. 1854(e)(4)(A)(i));

(2) consider decisions made under that Understanding as "management measures under an international agreement" that "dictate otherwise" for purposes of section 304(e)(4)(A)(ii) of the Act (16 U.S.C. 1854(e)(4)(A)(ii); and

(3) establish catch levels for those portions of fish stocks within their respective geographic areas covered by the Understanding on the date of enactment of this Act that exceed the catch levels otherwise required under the Northeast Multispecies Fishery Management Plan if—

(A) overfishing is ended immediately;

(B) the fishing mortality level ensures rebuilding within a time period for rebuilding specified taking into account the Understanding pursuant to paragraphs (1) and (2) of this subsection; and

(C) such catch levels are consistent with that Understanding.

**SEC. 203. APPLICATION WITH OTHER LAWS.**

Nothing in this title shall be construed to amend the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1851 et seq.) or to limit or otherwise alter the authority of the Secretary of Commerce under that Act concerning other species.

**SEC. 204. EFFECTIVE DATE.**

(a) IN GENERAL.—Except as provided in subsection (b), section 202 shall apply with respect to fishing years beginning after April 30, 2010.

(b) SPECIAL RULE.—Section 202(3)(B) shall only apply with respect to fishing years beginning after April 30, 2012.

# TITLE III—MISCELLANEOUS

**SEC. 301. TECHNICAL CORRECTIONS TO THE WESTERN AND CENTRAL PACIFIC FISHERIES CONVENTION IMPLEMENTATION ACT.**

Section 503 of the Western and Central Pacific Fisheries Convention Implementation Act (16 U.S.C. 6902) is amended—

(1) by striking "Management Council and" in subsection (a) and inserting "Management Council, and one of whom shall be the chairman or a member of";

(2) by striking subsection (c)(1) and inserting the following:

"(1) EMPLOYMENT STATUS.—Individuals serving as such Commissioners, other than officers or employees of the United States Government, shall not be considered Federal employees except for the purposes of injury compensation or tort claims liability as provided in chapter 81 of title 5, United States Code, and chapter 171 of title 28, United States Code."; and

(3) by striking subsection (d)(2)(B)(ii) and inserting the following:

"(ii) shall not be considered Federal employees except for the purposes of injury compensation or tort claims liability as provided in chapter 81 of title 5, United States Code, and chapter 171 of title 28, United States Code.".

**SEC. 302. PACIFIC WHITING ACT OF 2006.**

(a) SCIENTIFIC EXPERTS.—Section 605(a)(1) of the Pacific Whiting Act of 2006 (16 U.S.C. 7004(a)(1)) is amended by striking "at least 6 but not more than 12" inserting "no more than 2".

(b) EMPLOYMENT STATUS.—Section 609(a) of the Pacific Whiting Act of 2006 (16 U.S.C. 7008(a)) is amended to read as follows:

"(a) EMPLOYMENT STATUS.—Individuals appointed under section 603, 604, 605, or 606 of this title, other than officers or employees of the United States Government, shall not be considered to be Federal employees while performing such service, except for purposes of injury compensation or tort claims liability as provided in chapter 81 of title 5, United States Code, and chapter 171 of title 28, United States Code.".

**SEC. 303. REPLACEMENT VESSEL.**

Notwithstanding any other provision of law, the Secretary of Commerce may promulgate regulations that allow for the replacement or rebuilding of a vessel qualified under subsections (a)(7) and (g)(1)(A) of section 219 of the Department of Commerce and

Related Agencies Appropriations Act, 2005 (Public Law 108–447; 188 Stat. 886–891).

*Speaker of the House of Representatives.*

*Vice President of the United States and President of the Senate.*

# U.S. TRADE IN CITES-LISTED SHARK SPECIES

## 2000-2009

**Prepared by:**

**Division of Management Authority**
**U.S. Fish and Wildlife Service**
**Department of the Interior**

*Prepared on January 10, 2011*

# U.S. TRADE IN CITES-LISTED BASKING SHARK (*CETORHINUS MAXIMUS*) 2000-2009

(Data taken from U.S. CITES Annual Report data)
*Report compiled on 01/10/2011*

NOTE: The basking shark was listed in Appendix III by the United Kingdom on 09/13/2000 and uplisted to Appendix II on 02/13/2003

**I. U.S. imports of CITES-listed basking shark, 2000-2009, by country of origin**

| YEAR | CTRY ORIGIN | CTRY REEXPORT | QUANTITY | UNIT | TYPE SPECIMEN | PURPOSE | SOURCE | STATUS | NO. SHIPMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | None | | | | | | | | |
| 2001 | None | | | | | | | | |
| 2002 | None | | | | | | | | |
| 2003 | None | | | | | | | | |
| 2004 | United Kingdom | None | 1 | no | Skin piece | Commercial | Wild | Cleared | 1 |
| 2004 | Unknown | China | 1 | no | Skin piece | Educational | Pre-CITES | Cleared | 1 |
| 2004 | Unknown | United Kingdom | 1 | no | Leather product | Personal | Pre-CITES | Cleared | 1 |
| 2004 | Unknown | United Kingdom | 1 | no | Skin piece | Exhibition | Pre-CITES | Cleared | 1 |
| 2005 | None | | | | | | | | |
| 2006 | Unknown | United Kingdom | 1 | no | Skin | Commercial | Unknown | Cleared | 1 |
| 2006 | Unknown | United Kingdom | 1 | no | Skin piece | Commercial | Unknown | Cleared | 1 |
| 2007 | None | | | | | | | | |
| 2008 | None | | | | | | | | |
| 2009 | China | None | 20 | gm | Medicinals | Commercial | Wild | Not cleared | 1 |
| 2009 | United Kingdom | None | 30 | no | Scientific spec. | Scientific | Wild | Cleared | 1 |
| TOTALS | | | 1 | no | Leather product | | | | 1 |
| | | | 20 | gm | Medicinals | | | | 1 |
| | | | 30 | gm | Scientific spec. | | | | 1 |
| | | | 1 | no | Skin | | | | 1 |
| | | | 4 | no | Skin pieces | | | | 4 |

**II. U.S. exports/reexports of CITES-listed basking shark, 2000-2009, by country of origin**

| YEAR | CTRY ORIGIN | CTRY REEXPORT | QUANTITY | UNIT | TYPE SPECIMEN | PURPOSE | SOURCE | STATUS | NO. SHIPMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | None | | | | | | | | |
| 2001 | None | | | | | | | | |
| 2002 | None | | | | | | | | |
| 2003 | None | | | | | | | | |
| 2004 | None | | | | | | | | |
| 2005 | Unknown | United States | 2 | no | Skin pieces | Educational | Unknown | Cleared | 1 |
| 2006 | None | | | | | | | | |
| 2007 | None | | | | | | | | |
| 2008 | None | | | | | | | | |
| 2009 | None | | | | | | | | |
| TOTALS | | | 2 | no | Skin pieces | | | | 1 |

# U.S. TRADE IN CITES-LISTED GREAT WHITE SHARK (*CARCHARODON CARCHARIAS*) 2001-2009

(Data taken from U.S. CITES Annual Report data)

*Report compiled on 01/10/2011*

NOTE: The great white shark was listed in Appendix III by Austalia on 10/29/2001 and uplisted to Appendix II on 01/12/2005

**I. U.S. imports of CITES-listed great white shark, 2001-2009, by country of origin**

| YEAR | CTRY ORIGIN | CTRY REEXPORT | QUANTITY | UNIT | TYPE SPECIMEN | PURPOSE | SOURCE | STATUS | NO. SHIPMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | None | | | | | | | | |
| 2002 | Australia | None | 1 | no | Bone | Commercial | Wild | Cleared | 1 |
| 2002 | Australia | None | 1 | no | Skull | Commercial | Wild | Cleared | 1 |
| 2002 | Australia | None | 300 | no | Teeth | Commercial | Wild | Cleared | 1 |
| 2002 | South Africa | None | 13 | kg | Bones | Scientific | Wild | Cleared | 1 |
| 2002 | Taiwan | None | 5 | no | Bones | Commercial | Wild | Cleared | 1 |
| 2003 | Australia | None | 1 | no | Tooth | Personal | Wild | Not cleared | 1 |
| 2004 | Taiwan | None | 12,519 | no | Bones | Commercial | Wild | Cleared | 1 |
| 2005 | New Zealand | None | 1 | no | Bone | Personal | Pre-CITES | Cleared | 1 |
| 2005 | South Africa | None | 24 | no | Teeth | Scientific | Wild | Cleared | 1 |
| 2006 | Australia | None | 1 | no | Trophy | Personal | Wild | Not cleared | 1 |
| 2006 | Mexico | None | 1 | no | Trophy | Personal | Wild | Not cleared | 1 |
| 2006 | New Zealand | None | 1 | no | Bone | Personal | Wild | Cleared | 1 |
| 2007 | South Africa | None | 1 | no | Scientific spec. | Educational | Wild | Cleared | 1 |
| 2007 | Unknown | China | 5 | no | Teeth | Commercial | Wild | Not cleared | 1 |
| 2008 | Philippines | None | 383 | no | Bones | Commercial | Wild | Cleared | 1 |
| 2009 | Australia | None | 3 | no | Bones | Exhibition | Wild | Cleared | 1 |
| 2009 | Australia | None | 300 | no | Teeth | Exhibition | Wild | Cleared | 1 |
| 2009 | Philippines | None | 15 | no | Teeth | Commercial | Wild | Not cleared | 1 |
| 2009 | South Africa | None | 750 | no | Teeth | Scientific | Wild | Cleared | 1 |
| 2009 | Unknown | China | 4 | no | Teeth | Personal | Wild | Not cleared | 2 |
| 2009 | Unknown | Taiwan | 1 | no | Jewelry | Personal | Wild | Not cleared | 1 |
| 2009 | Unknown | Thailand | 1 | no | Teeth | Personal | Wild | Not cleared | 1 |

| | | | | |
|---|---|---|---|---|
| TOTALS | 13 | kg | Bones | 1 |
| | 12,913 | no | Bones | 7 |
| | 1 | no | Jewelry | 1 |
| | 1 | no | Scientific spec. | 1 |
| | 1 | no | Skull | 1 |
| | 1,400 | no | Teeth | 10 |
| | 2 | no | Trophies | 2 |

**II. U.S. exports/reexports of CITES-listed great white shark, 2001-2009, by country of origin**

| YEAR | CTRY ORIGIN | CTRY EXPORT | QUANTITY | UNIT | TYPE SPECIMEN | PURPOSE | SOURCE | STATUS | NO. SHIPMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | None | | | | | | | | |
| 2002 | None | | | | | | | | |
| 2003 | None | | | | | | | | |
| 2004 | None | | | | | | | | |
| 2005 | None | | | | | | | | |
| 2006 | None | | | | | | | | |
| 2007 | None | | | | | | | | |
| 2008 | Unknown | United States | 1 | no | Tooth | Commercial | Wild | Cleared | 1 |
| 2009 | None | | | | | | | | |
| TOTALS | | | 1 | no | Tooth | | | | 1 |

# U.S. TRADE IN CITES-LISTED WHALE SHARK (*RHINCODON TYPUS*)
# 2003-2009

(Data taken from U.S. CITES Annual Report data)
*Report compiled on 01/10/2011*

NOTE: The whale shark was listed in Appendix II on 02/13/2003

**I. U.S. imports of CITES-listed whale shark, 2003-2009, by country of origin**

| YEAR | CTRY ORIGIN | CTRY REEXPORT | QUANTITY | UNIT | TYPE SPECIMEN | PURPOSE | SOURCE | STATUS | NO. SHIPMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 2003 | None | | | | | | | | |
| 2004 | Malaysia | None | 6 | no | Soup | Commercial | Wild | Not cleared | 1 |
| 2005 | Taiwan | None | 2 | no | Live | Zoos | Wild | Cleared | 1 |
| 2006 | Taiwan | None | 2 | no | Live | Zoos | Wild | Cleared | 1 |
| 2007 | Taiwan | None | 2 | no | Live | Zoos | Wild | Cleared | 1 |
| 2008 | None | | | | | | | | |
| 2009 | Taiwan | Canada | 2 | no | Bones | Scientific | Wild | Not cleared | 1 |
| TOTALS | | | 2 | no | Bones | | | | 1 |
| | | | 6 | no | Live | | | | 3 |
| | | | 6 | no | Soup | | | | 1 |

**II. U.S. exports/reexports of CITES-listed whale shark, 2003-2009, by country of origin**

| YEAR | CTRY ORIGIN | CTRY REEXPORT | QUANTITY | UNIT | TYPE SPECIMEN | PURPOSE | SOURCE | STATUS | NO. SHIPMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 2003 | None | | | | | | | | |
| 2004 | None | | | | | | | | |
| 2005 | None | | | | | | | | |
| 2006 | None | | | | | | | | |
| 2007 | None | | | | | | | | |
| 2008 | None | | | | | | | | |
| 2009 | None | | | | | | | | |
| TOTALS | | | None | | | | | | |