WESTERN
PACIFIC
REGIONAL
FISHERY
MANAGEMENT
COUNCIL

Fisheries for Sharks in the Western Pacific Region and Alternative Conservation and Management Measures

FOR PUBLIC REVIEW

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Western Pacific Regional Fishery Management Council
1164 Bishop St., Suite 1400
Honolulu, HI 96813

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Preface

The Western Pacific Fishery Management Council made the following recommendations with respect to management of shark catches in Western Pacific Region at its 101st meeting, held in Honolulu between the 19-21 October 1999.

Amend the Pelagics Fisheries Management Plan to:

1. Establish an annual fleet-wide quota of 50,000 sharks harvested by vessels with a Hawaii longline limited entry permit, retained (in whole or in part) and landed shoreward of the outer boundary of the EEZ around Hawaii. This limit is a precautionary measure to prevent further expansion of fishing mortality on shark stocks by the Hawaii longline fishery. When the quota is expected to be reached, the National Marine Fisheries Service (NMFS) would announce the date after which no additional sharks or shark fins could be retained.

2. Include a framework mechanism under which the NMFS would adjust the shark quota annually in consultation with the Council, based on changes in Catch per Unit of Effort (CPUE) (or other objective indicator of the health of the stocks) relative to CPUE rates.

3. Prohibit the use of demersal longline to fish for pelagic management unit species in the NWHI protected species zone, and within the MHI longline 3-75 nmi closed area. The definition of "demersal longline" would be the same as the existing definition for "longline" except the word "deployed" would be used in lieu of "suspended" and would encompass a line of any length.

An earlier version of this document was used as background information for the Council to develop their decisions concerning shark management. It is being made available for distribution and public comment in an augmented version, containing additional information on shark catches in the Western Pacific Region and options for management. Public comment will be solicited from copies mailed out to interested parties and through a series of public meetings which the Council will convene during December 1999 and January 2000.

2. Introduction

Over the past two years the United States has participated in an initiative of the United Nations Food and Agriculture Organization Committee on Fisheries (FAO-COFI) to foster international cooperation and coordination for conservation and management of shark stocks. The FAO-COFI initiative is referred to as the International Plan of Action for Conservation and Management of Sharks (IPOA-SHARKS). It calls for countries to develop by 2001 national plans of action with the following aims:

- Ensure that shark catches from directed and non-directed fisheries are sustainable;
- Assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term economic use;
- Identify and provide special attention, in particular to vulnerable or threatened shark stocks;
- Improve and develop frameworks for establishing and co-ordinating effective consultation involving all stakeholders in research, management and educational initiatives within and between States;
- Minimize unutilized incidental catches of sharks;
- Contribute to the protection of biodiversity and ecosystem structure and function;
- Minimize waste and discards from shark catches in accordance with article 7.2.2.(g) of the Code of Conduct for Responsible Fisheries (for example, requiring the retention of sharks from which fins are removed);
- Encourage full use of dead sharks;
- Facilitate improved species-specific catch and landings data and monitoring of shark catches;
- Facilitate the identification and reporting of species-specific biological and trade data.

Implementation of IPOA-SHARKS is designed to be in accord with the FAO Code of Conduct for Responsible Fisheries and the rules of international law.

The United States is also participating in the Multilateral High-Level Conference on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific, a fisheries management mechanism currently being negotiated by 28 Pacific Islands states and distant-water fishing nations. Oceanic sharks are expected to be covered by this regime.

The Western Pacific Regional Fishery Management Council's pelagic fisheries management plan (FMP) has the following objectives that are pertinent to the conservation and management of sharks and consistent with the goals of the Magnuson-Stevens Act, IPOA-SHARKS and the prescribed aims of a national shark plan.

- manage fisheries for management unit species (MUS) in the Western Pacific Region to achieve optimum yield (OY),
- improve the statistical base for conducting better stock assessments and fishery evaluations,
- promote the formation of a regional or international arrangement for assessing and conserving MUS throughout their range,
- preclude waste of MUS associated with longline, purse seine, pole-and-line or other fishing operations, and
- promote, within the limits of managing at OY, domestic marketing of the MUS in American Samoa, Guam, Hawaii and the Northern Mariana Islands.

To achieve these objectives the Council's pelagics FMP contains a number of conservation and management measures that regulate *in toto* the fishing for pelagic MUS, including sharks. These measures include a limited access system for the Hawaii longline fishery, longline vessel area closures in the 200-mile exclusive economic zone (EEZ) around Hawaii and Guam and a prohibition on the use of driftnets. The FMP, recognizing that sharks are less productive than boney fishes, defines the overfishing threshold for sharks as the point at which the spawning biomass is reduced to 35% of that of un-fished stocks, as opposed to 20% for boney pelagic fishes. Shark catches in the EEZ are monitored by National Marine Fisheries Service (NMFS), state, territorial and commonwealth fishery data collection systems.

In the course of discussing additional measures to address the requirements of a national plan under IPOA-SHARKS, the Council and its advisory bodies identified the following issues, which are presented in this document:

- imprecise identification of the shark management unit species,
- uncertainty about the impacts of fishing on stocks,
- low product recovery rates, and
- potential fishery interactions with protected species.

2. Background

2.1 Description of the principal species

The sharks included as MUS in the Council's pelagics FMP are broadly defined as the "oceanic sharks" in the families Alopiidae, Carcharhinidae, Lamnidae and Sphyrnidae. Several species of sharks within these families are harvested in fisheries occurring in the EEZ. The species most frequently captured are the blue shark *(Prionace glauca)*, oceanic whitetip shark (*Carcharinus longimanus*), thresher shark (*Alopias* spp*)*, mako shark (*Isurus* spp) and silky shark (*C. falciformis*). The blue shark is the principal species caught in temperate water pelagic fisheries, while silky and oceanic whitetip sharks are the dominant species taken in pelagic fisheries occurring in the tropical region (Nakano and Seki in review).

2.1.1 Blue shark

The blue shark is the most widely distributed of all the carcharinids and is found in temperate and tropical epipelagic waters throughout the world (Compagno 1984; Nakano and Seki in review). Although it is primarily an offshore species, it may venture inshore at night in areas with a narrow continental shelf and around islands. It is often found in large aggregations, frequently close to the surface. It prefers water temperatures 7°–16°C but can tolerate water temperatures over 22°C. It ranges far into the tropics but usually occurs at greater depths in the tropics than in temperate latitudes. In the Pacific, the blue shark is found in greatest abundance 20°–50°N. In these latitudes it shows strong seasonal fluctuations in abundance as it moves northward in the summers and southward in the winter. In the tropics 20°N–20°S it is uniformly abundant throughout the year (Compagno 1984).

Like many sharks, blue sharks segregate by sex and size. In the North Pacific, females and smaller sharks are found farther to the north than males and larger adults. After reaching sexual maturity, individuals move southward into the mating area (Nakano and Seki in review). Mating appears to occur in a band from 20°–30°N in the summer with pupping occurring in a band from 35°–45°N the following summer.

The blue shark is viviparous (live bearing) and after a gestation period of 9–12 months may bear as many as 135 young per litter, although the average litter size is 26 pups. The number of pups per litter is strongly correlated with the size of the pregnant female. Individuals grow to 4 m but may reach 6–7 m. Sexual maturity occurs at 5–6 years of age for females and 4–5 years of age for males.

With their relatively fast growth, high fecundity, extensive distribution and apparent high abundance, blue sharks are the most productive of the oceanic sharks in the Pacific (Stevens 1996) (Table 1).

Table 1. Distribution, ecological and biological characteristics of selected oceanic shark species.

	Blue	Oceanic whitetip	Silky	Shortfin mako	Thresher
Distribution	Cosmopolitan in tropical and temperate seas	Cosmopolitan in tropical and temperate seas; seasonal in warm temperate seas	Circum-tropical; seasonal in warm temperate seas	Cosmo-politan in tropical and temperate seas	Cosmopolitan in tropical and temperate seas
Temperature range (°C)	12-20	>20	>23	>16	?
Depth range (m)	0-400	0-150	0-500	0-400	0-400
Relative abundance	One of the most wide ranging and abundant sharks	Abundant in tropical waters	Abundant in tropical waters near to land masses	Generally less abundant	Generally less abundant
Length at birth (cm TL)	35-50	60-65	70-85	70	115-150
Length at maturity (cm TL)	M: 173-213 F: 187-213	M: 175-195 F: 180-200	200-210	M: 195 F: 265-280	M: 320-340 F: 260-400
Maximum length (cm TL)	380	300	330	400	600
Age at maturity (yrs)	M: 4-6 F: 5-7	?	6-7	M: 9 F: 15	M: 4-5 F : 3-7
Longevity (yrs)	20	?	20	45	45
Reproduction	Placental viviparity	Placental viviparity	Placental viviparity	Oophagy	Oophagy
Litter size (n)	avg: 35 max: 135	5-15	avg: 7 max: 15	4-18	2-4
Gestation (mos)	9-12	≈12	?	?	9
Pupping season	Spring or summer	Spring or summer	Throughout the year	Late spring	Birth in spring or summer

Source: Adopted from Stevens (1996).

2.1.2 Oceanic whitetip shark

The oceanic whitetip shark is distributed circumtropically but may venture into the warmest regions of temperate waters. This shark is primarily oceanic-epipelagic but occasionally moves into coastal waters. It is found in waters ranging 18°–28°C, but usually prefers water temperatures above 20°C. It is most abundant in the tropics 20°N–20°S. Oceanic whitetip sharks are viviparous with litter sizes of from 1–15 pups. Litter size is positively correlated with adult female size. Gestation is thought to be ~12 months (Compagno 1984).

2.1.3 Silky shark

The silky shark is found circumtropically from about 10°N–10°S in water temperatures of 23°–24°C. It appears to be more abundant offshore near land than in the open ocean. Reproduction is viviparous, with 2–14 young per litter. There is no pronounced reproductive seasonality. Females mature at 2.1–2.3 m and males reach maturity at 1.8–2.2 m. Maximum size is thought to be 3.3 m. The silky shark is primarily piscivorous (fish eating) and often associated with schools of tuna (Compagno 1984) (Table 1).

2.1.4 Thresher and mako sharks

Thresher and mako sharks are large and active swimmers. They feed on small to moderate sized prey. Both of these sharks are circumtropically distributed in pelagic to nearshore waters. Thresher and mako sharks may also venture into temperate waters, although mako sharks are seldom found in water temperatures less than 16°C. Thresher and mako sharks may reach a size of more than 4 m and are thought to attain sexual maturity at 2 m. Both thresher and mako sharks are ovoviviparous (producing eggs that develop within the maternal body and hatch within or immediately after extrusion from the parent) and bear 2–4 young per litter (Compagno 1984) (Table 1).

2.2 Stock status

In a study by Smith et al. (1998), intrinsic recovery rates and productivity were estimated for 26 species of sharks found in the Pacific. All of the principal species of oceanic sharks caught in the Council's area were categorized in the medium to high productivity category with a population doubling rate of 8–9 years. Because of their productivity rates, oceanic species are less prone to depletion than the slower growing coastal sharks. However, some of the oceanic species are vulnerable to the extensive exploitation of extant pelagic fisheries.

The fishery statistics available suggest that the blue shark stock in the North Pacific is not currently being overfished. The fishing pressure on this stock decreased by nearly half with the closure of the high seas driftnet fisheries in 1992. Studies of catch-per-unit-effort (CPUE) data reveal no evidence that the blue shark stock in the North Pacific is currently in a critical condition (Nakano and Seki in review) and that blue shark abundance may have remained unchanged from the late 1960s to the mid-1990s (Matsunaga & Nakano 1999). Similarly, an analysis of blue shark CPUE in the Hawaii longline fishery gives no indication of a decline in abundance (Bigelow *et al.* 1999). Walker (1998) suggests that the stabilizing CPUE trends for blue sharks in longline fisheries, in general, is an indication that blue shark stocks can be harvested on a sustainable basis. However, the NMFS Southwest Fisheries Science Center, Honolulu Laboratory, notes that there is an insufficient understanding of blue shark population dynamics and biology to support an analysis of fishery impacts on blue sharks (Laurs 1999). Similar concerns about the lack of knowledge of blue shark stock structure and population sizes have been expressed by Bonfil (1994) and Stevens (1996).

2.3 Fisheries in the Western Pacific Region

2.3.1 Longline

2.3.1.1 Hawaii longline fishery

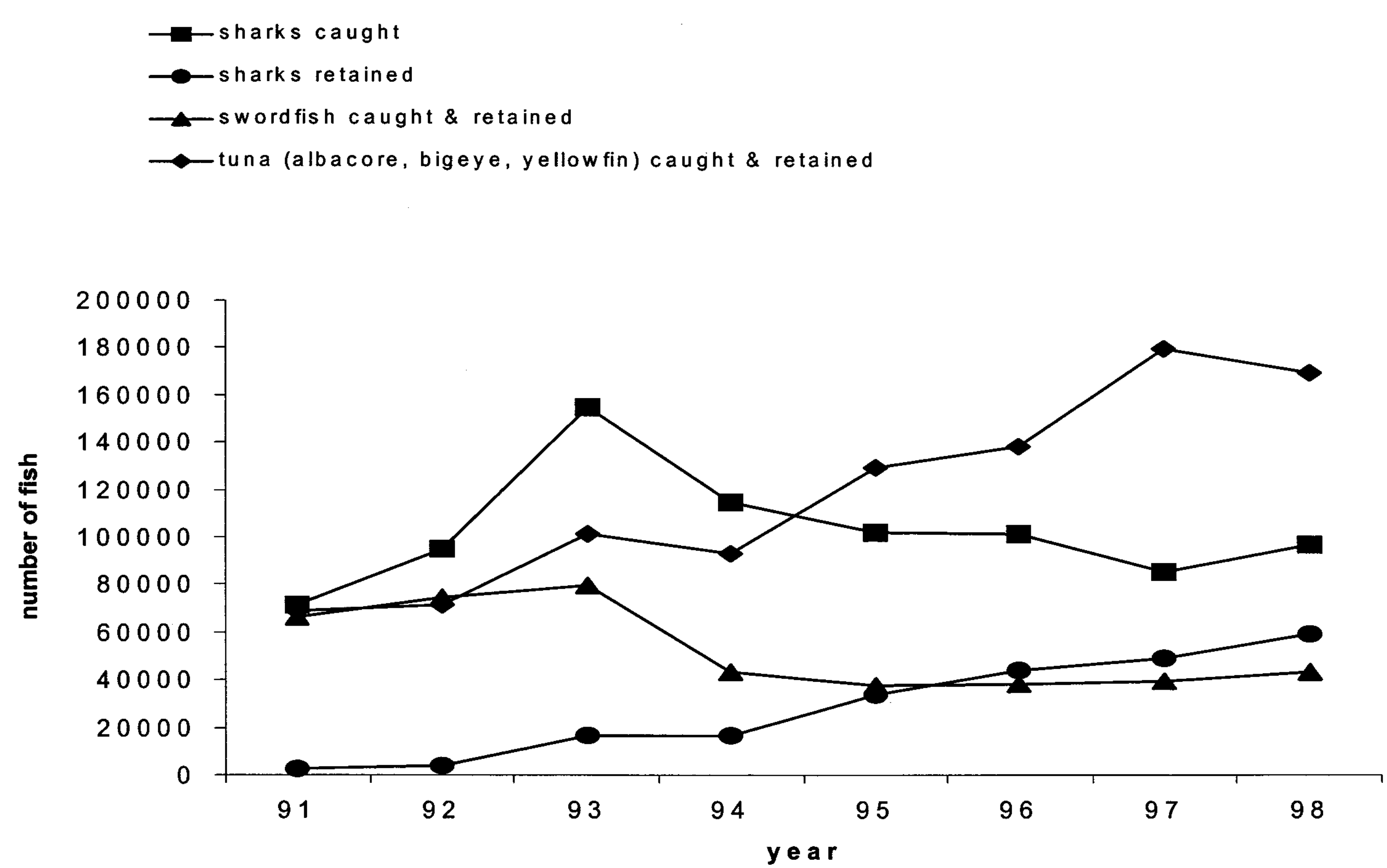
The Hawaii-based longline fleet is a limited access fishery with 164 NMFS permit holders. In 1998, 110 vessels were active in the fishery. The fleet is comprised of vessels ranging in size from 43 to 100 ft in length. The duration of longline fishing trips is typically 14–25 days for vessels targeting tuna and 30–45 days for those targeting swordfish.

Although sharks are not the target species in the Hawaii longline fishery, they account for about one-third of the total catch of all species reported by fishers in NMFS longline logbooks (Figure 1). NMFS statistics show that approximately 95% of the sharks caught are blue sharks (Laurs 1999). Oceanic whitetip, thresher, mako and various other sharks species account for the remaining 5%. The total shark catch in the Hawaii longline fishery peaked at 154,600 in 1993 and then decreased by about one-third until 1998 when the catch increased slightly (Figure 1). The general variability in shark catch is believed to be due mainly to a shift in target species, as longline vessels targeting tuna tend to catch fewer sharks than those targeting swordfish.

Much of the fishing effort of the Hawaii-based longline fleet occurs outside of the EEZ. Of the 99,910 sharks caught in 1998 (equivalent to about 2,864 metric tons (mt)), 59% were caught on the high seas (WPRFMC 1999). The State of Hawaii prohibits longline fishing within state waters. The Council's fishery management plan prohibits longline vessels from fishing within 50 to 75 nautical miles of the main Hawaiian Islands and within 50 nautical miles of the Northwestern Hawaiian Islands.

According to NMFS longline logbook data, until the early 1990s, about 97% of the sharks caught by Hawaii-based longline vessels were released (Laurs 1999). NMFS observer records indicate that about 85% of hooked sharks were alive when brought to the boat, and it is likely that a majority of the sharks that were released alive survived. As the market price of shark fins rose, the number of sharks released by longline vessels decreased, reaching about 40% by 1998 (Laurs 1999). The percentage of released sharks is higher for vessels targeting swordfish or a swordfish-tuna mixture than for those targeting tuna (Laurs 1999). According to NMFS observer reports, approximately 98% of the sharks retained for finning are either killed onboard prior to the removal of fins or are dead when brought to the side of the vessel.

Figure 1. Catch and retention of swordfish, tuna and sharks in the Hawaii longline fishery



2.3.1.2 American Samoa longline fishery

The other longline fishery within the Council's jurisdiction is in American Samoa. This is an open access fishery that is conducted mainly from 28-32 ft *alia* catamarans. The vessels deploy a short monofilament longline with 200-300 hooks from a hand-powered reel. The longlines harvest mainly albacore tuna, which forms about 70% of the catch and which are sold to the local tuna canneries. The use of longline gear requires the acquisition of a federal permit from the NMFS Pacific Islands Area Office, but there are no restrictions on the number of permits issued. This fleet consists of two vessels over 20 m in length and about 48 smaller vessels. To date, 50 permits have been issued, although only about 15 vessels are active on a regular basis.

The technology employed by the artisanal fleet is relatively unsophisticated. Ten percent or less of the boats carry a depth finder, fish finder or global positioning system (Severance et al. 1998). The small vessels equipped for longline fishing store their gear on deck on a hand-powered reel, which can hold as much as 10 nm of monofilament mainline. Typically, the longlines are 3 to 5 nm in length. An average of 214 hooks per vessel per fishing day are set. Most boats leave for the fishing grounds in the early morning and return in the afternoon or early evening. The boats fish up to 25 nm from shore, but effort is mainly concentrated on banks 5 to 10 nm off the southern coast of Tutuila.

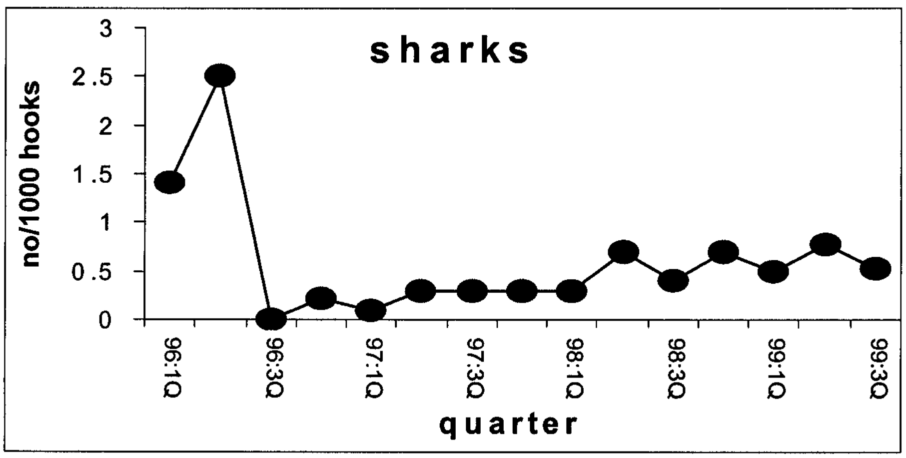


Figure 2. Average quarterly catch per unit of effort of sharks in the American Samoa longline fishery

In 1998, about 3.3 mt of sharks were caught incidentally by the small domestic longline fleet based in American Samoa (WPRFMC 1999). Unlike the Hawaiian fishery, sharks are not a major component of longline catches in American Samoa, and as a group, comprise about 1.4% of total catches by this small vessel fleet. Again, unlike Hawaii, the blue shark is not overwhelmingly dominant among the shark catch component, averaging about 35% of shark catches, followed by mako (27%) and thresher (9%) sharks. On average about 14% of sharks caught are retained for sale or given away. As with the Hawaii-based fishery, finning activity has increased in the American Samoa longline fishery, with on average 72% of sharks caught being finned.

Shark catch rates in the American Samoa fishery initially were high, ranging from 1.5 to 2.5 fish/hook, but declined to almost zero by the third quarter of 1997 (Fig. 2) Since that time catch rates for sharks have tended to increase slowly through 1997 and 1998. The reasons for the high shark catches early-on in the history of the fishery may have been an artefact of sampling only a small number of vessels active in the fishery, and possibly fishing closer to shore where they would most likely be catching a mix of pelagic and bottomfish shark species.

2.3.2 Purse seine

Lawson (1997) estimates that the US purse seine fleet operating in the Pacific catches an average of about 419 mt of sharks per year. The most prevalent species found in purse seine sets are the silky shark and oceanic whitetip shark (Williams 1997). Most of the fishing activity by the purse seine vessels occurs in the EEZ waters of Papua New Guinea, Federated States of Micronesia and other Pacific island nations in the central and western Pacific. However, during some years, particularly during an *El Niño*-Southern Oscillation event, a substantial portion of the US purse seine tuna harvest is made in the EEZ around Palmyra Atoll, Jarvis Island, Howland Island and Baker Island. In contrast to the relatively high survival rate of sharks caught by longline gear and released, capture by purse seines may cause 100% mortality (Bonfil 1994).

2.3.3 Other fishing gear

According to the Hawaii Division of Aquatic Resources (HDAR), commercial catch reports submitted by fishers indicate that between 1994 and 1998 the quantity of sharks caught by troll gear in the waters around Hawaii varied from 2.1 mt to 3.3 mt, with a yearly average of 2.8 mt. In the same time period the tuna handline fishery (which includes *ika shibi* and *palu ahi* techniques) caught an average of 1.3 mt of oceanic and coastal sharks per year and the bottomfish handline fishery caught a similar quantity. Reporting of species composition is poor and in all three fisheries "miscellaneous sharks" a dominant or sub-dominant feature of landings. In the troll fishery the commonest identifiable sharks include the mako, tiger, thresher and hammerhead sharks, which together form about one third of landings. Nearly three quarters of the bottom handline catch is not identified but thresher and tiger sharks collectively account for 25% of bottomfish shark catches. Almost half of the shark catch made by pelagic handlines are thresher sharks, which together with mako and tiger sharks form 60% shark landings.

These figures do not include sharks caught by recreational fishers (i.e., those who do not sell any of their catch) as there are no catch data collection mechanisms for recreational fisheries in Hawaii. These figures also do not include catches by "expense" fishers (i.e., those who sell a portion of their catch to cover expenses of fishing). Although these fishers are technically commercial under Hawaii state law, there is evidence that a substantial number of "recreational" fishers in Hawaii belong to the "expense" category. Furthermore, HDAR notes that catch records submitted by the commercial sector may underestimate the amount of sharks caught due to non-reporting by fishers.

It is likely that the total catch of sharks in the waters around Hawaii by vessels using gear other than longline increased in 1999 as a result of fishing activity by a newly arrived vessel that uses a gear commonly referred to as a "bottom longline." However, the NOAA Office of the General Counsel (NOAA-GC) determined that the gear does not meet the definition of longline gear in the pelagics FMP. According to the NOAA-GC, the description of a bottom longline is consistent with the NMFS definition of hook and line gear (*Federal Register* Vol. 64 No. 17 January 27, 1999). Preliminary data collected by NMFS observers deployed aboard the vessel indicate that the vessel's catch consists mainly of coastal sharks, such as sandbar shark (*C. plumbeus)*.

In Guam and the Northern Mariana Islands small boats using trolling gear also catch relatively low numbers of sharks. In 1998, small commercial and recreational vessels in Guam landed about 3.7 mt of both coastal and oceanic sharks (WPRFMC 1999). This shark catch comprised a mix of true pelagic sharks, such as the silky, Galapagos and oceanic white tip sharks, and more reef and lagoon associated species such as the black-tip, white-tip and tiger sharks. Overall the oceanic sharks formed about 60% of the total, with silky sharks (34%) being the largest single species in the shark catch. Troll catches of sharks in American Samoa are now very minor, amounting to only 200-400 lb annually, and reflecting fishermen's preference for longline versus troll fishing.

2.4 Foreign and continental US fisheries

Table 2. Estimated average annual catch of blue sharks in the North Pacific by fishery.

Fishery	Years of Data Collection	Average Number of Blue Sharks Caught Per Year
Active		
Japan and Korea longline	1988	1,940,000
Taiwan longline	1993-1997	430,000
US Hawaii longline	1991-1998	97,000
US California troll	1980-1998	23,600
US California gillnet	1990-1998	1,700
Subtotal		2,492,300
Inactive*		
Japan squid driftnet	1990-1991	945,000
Taiwan squid driftnet	1990-1991	136,000
Korean squid driftnet	1990-1991	656,000
Japan tuna driftnet	1990-1991	46,000
Taiwan tuna driftnet	1990-1991	191,000
Subtotal		1,974,000
Total		4,466,300

The driftnet fisheries were active in the high seas of the North Pacific until an international agreement led to their closure in 1992. Sources: Bonfil (1994); Stevens (1996); NMFS Southwest Fisheries Science Center Honolulu Laboratory; Rasmussen and Holts (1999).

Large numbers of oceanic sharks are also caught in foreign and other domestic Pacific fisheries. The high seas tuna longline fisheries of Japan, Korea and Taiwan; US gillnet and troll fisheries off the West Coast of California; and Mexico gillnet fishery off Baja California occur mainly in the North Pacific and predominately catch blue sharks (Stevens 1996). The estimated average annual numbers of blue sharks caught in the North Pacific by these various fisheries are presented in Table 2. Before the closure of the high seas driftnet fisheries in 1992 their contribution to the total incidental catch of oceanic sharks was exceeded only by the contribution of longline fisheries (Bonfil 1994).

The Pacific purse seine fisheries of Japan, Korea and Taiwan catch large numbers of mostly silky and oceanic whitetip sharks. Lawson (1997) estimates that the total annual quantity of sharks caught in these fisheries is about 1,000 mt.

2.5 Economic characteristics of the fisheries

2.5.1 Fins[1]

It is estimated that 34 mt of shark fins with an ex-vessel value of about $1 million were landed in 1998 by Hawaii-based vessels using longline gear (Table 3). The crew frequently receives most if not all of a vessel's revenue from shark fin sales, and for some members it is an important source of income. The average annual earnings from shark fin sales ranges from $2,375 to $2,850 per crew member or about 10% of the estimated annual income of these individuals. Shark fin dealers in Hawaii facilitate shark fin transactions by meeting vessels as they arrive in port and paying cash to purchase fins.

Anecdotal information suggests that at least some vessels fishing for bottomfish in the waters around the main and Northwestern Hawaiian Islands engage in shark finning on an opportunistic basis. It is possible that Hawaii-based vessels participating in the tuna handline fishery also occasionally sell shark fins.

US purse seine vessels annually land in American Samoa an estimated 8–9 mt of shark fins, worth $162,000 to $230,000 (Table 3). It is generally the lower paid crew on the purse seiners that augment their wages with income derived from finning. Landing of shark fins by US purse seine vessels are expected to decline due to a voluntary ban on shark finning recently adopted by the US purse seine fleet as an industry standard (D. Burney, pers. comm.). The total number of sharks finned by the domestic longline vessels based in American Samoa was 325.

Foreign fishing vessels with shark fins onboard are allowed to make port calls in Honolulu to purchase fuel and other supplies, but these vessels are prohibited under the

[1]The information presented in this section is from McCoy and Ishihara (1999) unless otherwise noted.

Nicholson Act from landing sharks fins or other fish products. However, shark fins from these vessels can be transshipped to a properly permitted domestic vessel meeting the foreign vessel or its mothership outside the US EEZ. By this means, an estimated 120 mt of fins are shipped through Hawaii annually to Asia markets without entering US commerce. The estimated ex-vessel value of these fins is between $2.4 million and $2.6 million.

Foreign fishing vessels are allowed to land shark fins directly in Guam and American Samoa because the territories are exempt from the Nicholson Act. It is estimated that foreign-flag vessels annually land in Guam 21–31 mt of shark fins, with an ex-vessel value of $280,000 to $544,000 (Table 3). In American Samoa foreign longline boats land 32–43 mt, worth between $455,000 and $705,000. The unprocessed fins offloaded in Guam and American Samoa are mainly exported to Asia markets. It is likely that the volume of shark fins landed in American Samoa and Guam is declining with the decrease in the number of port calls made in these territories by foreign longline vessels. As in the Hawaii longline fishery, it is the crew of the foreign fishing vessels who often acquire the revenue from the shark fin sales that occur in American Samoa and Guam

Table 3. Estimated quantity and value of unprocessed shark fins and shark meat landed in the Western Pacific Region by various types of vessels in 1998.

	Quantity of Shark Fins Landed (mt)	Value of Shark Fins Landed ($1,000)	Quantity of Shark Meat Landed (mt)	Value of Shark Meat Landed ($1,000)
Hawaii				
US longline vessels	34	950-1,140	109	146
US transshipment vessels	120	2,376-2,640	0	0
Misc. vessels	unknown	unknown	1.5	1.8
American Samoa				
US purse seine vessels	8-9	162-230	0	0
Foreign longline vessels	32-43	455-705	91-182	53-106
Misc. vessels	unknown	unknown	3.3	~0
Guam				
Foreign longline vessels	21-31	280-544	34-51	20-30
Misc. vessels	unknown	unknown	3.6	4.0
Northern Mariana Islands				
Misc. vessels	unknown	unknown	~0	~0

Sources: McCoy (1999); WPRFMC (1999); and Hawaii Division of Aquatic Resources

There are about three businesses involved in purchasing fins from fishing and transshipment vessels in each of the island areas of Hawaii, American Samoa and Guam. Most of these shark fin traders are also engaged in other businesses, but some receive a substantial portion of their income from purchasing and selling shark fins. The fins from sharks caught by Hawaii-based domestic fishing vessels may undergo some primary processing (e.g., trimming and additional drying) in the state that adds value to the product prior to shipment overseas. Shark fin dealers in Hawaii indicate that some of the fins landed by Hawaii-based longline vessels are shipped to the continental US for further processing, although no production figures are available. Some or all of the fins processed in the mainland US are sold in the domestic market. Rose (1998) states that there is a significant and apparently growing domestic consumption of shark fins, particularly in urban areas with large populations of ethnic Chinese, such as New York, San Francisco and Los Angeles.

The economic impacts of a restriction on the landing or transshipment of shark fins could be significant if it results in a decrease in the number of port calls made in Honolulu by foreign tanker vessels servicing the foreign fishing fleet. It is these vessels that transship the largest quantity of shark fins to Hawaii-based domestic vessels outside the EEZ. An industry estimate of the value of the goods and services purchased by these vessels is between $750,000 and $1,000,000 per port call. In addition, some of the foreign fishing vessels make port calls in Honolulu to directly procure goods and services from Hawaii businesses. One industry representative estimates that the total revenue obtained by Hawaii firms from servicing the foreign tankers and fishing vessels is between $50 million and $60 million. However, McCoy and Ishihara (1999) state that the greatest attraction of Hawaii as a port is to obtain fuel and supplies rather than to trade in shark fins. The most probable factors influencing the decisions to visit Hawaii are the fuel prices, the availability of other supplies for the fishing vessels and the geographic location of the foreign fishing fleet.

The economic impacts of a restriction on the landing or transshipment of shark fins could also be significant if it results in a decrease in the number of port calls made in American Samoa or Guam by domestic and foreign fishing vessels. Annual local fleet expenditures are estimated to be as high as $122 million in American Samoa and $92 million in Guam (Hamnett and Pintz, 1996). However, as in Hawaii, factors other than the opportunity to land shark fins make these island areas attractive port-of-calls for fishing vessels.

2.5.2 Meat and other products[2]

[2]The information presented in this section is from McCoy and Ishihara (1999) unless otherwise noted.

The carcasses of oceanic sharks that have a relatively high market value, such as those of the thresher and mako shark, are retained and landed by Hawaii-based longline vessels. If properly dressed, these sharks can be sold fresh in US markets at prices similar to swordfish. However, the percentage of the total number sharks caught in the Hawaii longline fishery that were landed whole was only about 3% at its peak in 1991, and in 1998 it was less than 1%. It is estimated that the total dressed weight of mako and thresher sharks landed by longline vessels in 1998 was about 109 mt, with a ex-vessel value of $146,000 (Ito and Machado 1999). In addition, the Hawaii Division of Aquatic Resources reports that about 1,500 kg of mako, thresher and other types sharks caught by troll or handline gear were sold in Hawaii in 1998 at a total value of about $1,800.

There is no commercial market for shark meat in American Samoa, Guam or the Northern Mariana Islands. However, fishers in these island areas may keep some species of sharks for their own consumption or distribute them as gifts to relatives and friends. The pelagics Advisory Panel members from these island areas recommended that funding be identified to develop markets for shark products.

The carcasses of blue sharks are seldom, if ever, retained in fisheries of the Western Pacific because the onboard handling requirements for blue sharks are particularly burdensome and the meat has a comparatively low market value. Few, if any, vessels operating in the region are equipped to handle and process blue sharks. Unless proper onboard handling techniques are followed, blue shark flesh is unmarketable because of the rapid breakdown of urea in the muscle tissue into ammonia and the subsequent tainting of the meat (Nakano and Seki in review). In addition, onboard storage of blue sharks may reduce the value of higher priced fish due to urea contamination.

The comparatively high ex-vessel value of fins, together with the relatively low cost of processing and storing shark fins at sea, make it improbable that a significant reduction in the finning of blue sharks will occur in the near future. The current economic incentive for fishers to retain only the fins of blue sharks could change if a market develops for other parts of the blue shark. The likelihood of such a market developing is uncertain, but at least one firm in Hawaii has expressed an interest in purchasing blue shark carcasses from local fishermen and conducting market tests for various products developed from the meat, cartilage, liver and other portions of the blue shark (Gomes 1999).

2.5.3 Non-market benefits

Shark resources may provide benefits that are less readily identified and translated into dollar values. For example, some people may derive benefits from the harvest of certain shark species in the form of recreational pleasure or food for personal consumption. It is difficult to measure the value of these benefits in monetary terms because the economic good or service in question is not traded in markets with observable prices.

Another possible non-market benefit is referred to by economists as non-use or existence value. For example, individuals may have no intention of ever "using" the shark resource itself but benefit from the knowledge that species of sharks are unharmed by human action. The harvest of sharks or other wildlife does not necessarily have to adversely affect the stock to result in lost benefits. Witness the opposition by some members of the public to the recent Makah grey whale hunt despite the fact that NMFS has deemed the grey whale stock to be in good condition and capable of withstanding a restricted harvest. For some opponents to the whale hunt the harvest of even a single whale is one too many because of the value of the special qualities they ascribe to a living whale.

Some individuals may have a personal commitment to an environmental ethic that sharks and other wildlife have value in and of themselves and have a right to exist beyond that to which they are entitled as a result of any benefit (or harm) they may yield to people. Other ethically-based motives are religious principles and beliefs. For example, some Hawaiian families hold the shark, in special esteem as *kinolau*, or physical manifestation of their *aumakua*, or personal family guardian.

On the other hand, it is well documented that Hawaiians engaged in shark fishing during pre-colonial times (Iverson et al. 1990; Taylor 1993). One commentator notes that "... ancient Hawaiian culture was complex in its consideration of sharks and recognized that different kinds were to be treated in special ways unique to each species and, in some cases, unique to individual sharks" (Taylor 1993:28). It is possible that contemporary Hawaiian beliefs and practices with respect to sharks are even more complex.

McCoy and Ishihara (1999) report that shark fishing also has a traditional cultural importance for the people of American Samoa. A cursory search by these researchers found little written information on the attitudes of the indigenous peoples of Guam and the Northern Mariana Islands towards sharks or shark fishing. To acquire a better understanding of the cultural-historic significance of sharks to the indigenous peoples of Hawaii and other US Pacific island areas NMFS has contracted a study that is scheduled to be completed by January 2000.

3. Issues

3.1 Imprecise definition of management unit species

The pelagics Plan Team has recommended that the Council clarify which shark species are managed under the FMP and include only those species that are generally recognized by fishery scientists as oceanic sharks. The Plan Team noted that species of sharks that are not included in the revised list of pelagic MUS can be added to the MUS of other FMPs, such as the bottomfish and seamount groundfish FMP or coral reef ecosystems FMP.

The intention of the Council's pelagics FMP was to include only sharks whose habitat is primarily pelagic: "The management unit species occupy a pelagic environment during all stages of their lives" (p.6-1). However, two of the included families, Sphyrnidae (hammerhead sharks) and Carcharhinidae (requiem sharks), contain species which are primarily coastal or bottom dwelling. Furthermore, the FMP specifically mentions several coastal carcharhinids as examples of MUS (i.e., tiger shark, blacktip shark, silvertip shark, and galapagoes shark). Recently, the

NOAA Office of the General Counsel has interpreted this to mean that all species in the family Carcharhinidae are currently included in the FMP as MUS.

3.2 Uncertainty about impacts of fishing on stocks

Stock assessments and overfishing definitions are required for all sharks managed under the FMP. However, many of the data crucial to addressing these requirements are lacking.

Because shark catches have been primarily incidental and treated as by-catch in high-seas fisheries, species specific estimates of shark catch in these fisheries are difficult to estimate. Additionally, because of the highly migratory nature of many species of oceanic sharks, compiling existing data is problematic in that fisheries statistics from several nations need to be included in the analyses (Bonfil 1994). To successfully estimate population and life history parameters for exploited sharks, more information on the geographical extent of shark populations, discrete stock structure and population segments and changes in maturity under fishing pressure need to be determined (Smith et al. 1998).

To address the information gaps that preclude a comprehensive assessment of blue shark stocks, the Japan National Research Institute of Far Seas Fisheries (JNRIFSF) and NMFS Southwest Fisheries Science Center, Honolulu Laboratory, established a program of cooperative research in 1997. Specific research projects include assessing the status of the blue shark stock in the North Pacific; development of a North Pacific blue shark population simulation model; determining depth of capture with longline gear; publishing a synopsis of blue shark biology; investigating blue shark movement and migration; and implementing a blue shark tagging program on longline vessels (Wetherall 1998). In addition to this research program, the NMFS Honolulu Laboratory has received funds from the Pelagic Fisheries Research Program to develop methods for identifying species and estimating sizes from retained fins and conduct archival tag research to collect information on shark habitat, growth, maturation, movement and post-release mortality and trophic relationships (Boggs n.d.).

The JNRIFSF-NMFS cooperative research program and other studies outlined above would provide data to fill the gaps in the knowledge base needed for stock simulation models and estimation of overfishing criteria. The cooperative research program is expected to be concluded by June 2000 (M. Laurs, pers. comm.). However, the completion of some shark research projects may be delayed by a shortage of funding and qualified personnel at the NMFS Honolulu Laboratory.

3.3 Low product recovery rates

An objective of the Council's pelagics FMP is to preclude waste of MUS associated with fishing operations. This objective is consistent with the IPOA-SHARKS prescribed aim to minimize waste and discards from shark catches in accordance with article 7.2.2.(g) of the Code of Conduct for Responsible Fisheries (for example, requiring the retention of sharks from which fins are removed). Furthermore, some members of environmental groups and the general public oppose the practice of finning because about 95% of the shark carcass is discarded. The NOAA

Office of the General Counsel responded to a request from the North Pacific Fishery Management Council for an opinion on the legal parameters of the issue of waste by noting that the balancing of economic considerations and societal objectives is the type of policy decision that the Magnuson Act mandates the Council to make (letter from M. Frailey and C. O'Connor, dated 12/1/89).

The proportion of an organism retained for sale or personal use varies greatly among fishery resources (Table 4). For example, the product recovery rate in the Atlantic sea scallop fishery ranges from 6-18%, while the product recovery rate in the Western Pacific tuna fishery is 50-52%. Estimates of alternative product recovery rates for all sharks can be estimated from the average proportion by weight of shark parts and products provided by Rose (1996): fillet - 42%; liver - 7%; cartilage - 4%; fins - 5%; and skin - 7%. For some pelagic and deepwater sharks the liver may comprise 20–30% of the body weight.

The type of processing, the size and condition of the fish, the vessel size and type, the area and season of the year and the experience of the processing crew all effect the recovery rate of particular species. In large industrial fisheries, such as the North Pacific groundfish fishery, many fishing and processing operations possess fish meal capacity and are capable of product recovery rates that approach 100%. Many factory trawlers are equipped with fish meal plants to render portions of the fish not suitable for human consumption into fish meal. These vessels are capable of producing a variety of seafood products including roe, fillets, surimi and fish meal. Further, these vessels typically possess large freezer holds that enable them to stay on the fishing grounds for extended periods of time. The North Pacific Council has established a product recovery rate of 15% as the acceptable minimum utilization standard for cod, pollock, yellowfin sole and rock sole.

In the Hawaii longline fishery, at-sea processing of swordfish consists of heading and gutting the fish and removal of the fins for storage purposes. Tuna are gilled and bled. Product recovery rates obtained for swordfish and tunas (without skins) are 38% and 52%, respectively.

Improving recovery rates for sharks on Hawaii longline vessels is hindered by a variety of factors including vessel capacity and physical constraints, lack of sufficient deck space and crew to facilitate proper processing of product, the short shelf life of product on ice, limited local markets for shark products and low product value compared to costs of handling and shipping. Blue shark meat has a high spoilage risk through bruising and needs to be handled and stored with special care to ensure suitability for human consumption. Such handling is both time and labor intensive and is further complicated by the physical space needed to perform this operation. Improved utilization of blue sharks could greatly increase ice-making requirement and would reduce the amount of capacity for the more valuable target species. Properly bled, cleaned and stored blue shark carcasses can be held on ice for up to 5 days. Given the extended trip duration of vessels targeting swordfish (30–45 days) and tuna (14–25 days) and the lack of freezer capacity, it will be possible to preserve sharks taken only in the final days of a trip. It is possible that existing longline vessels could be refitted with the necessary gear and freezer capacity to improve product recovery rates for blue sharks. In order to do so, physical constraints posed by existing deck space and hold capacity would have to be addressed. However, the costs to modify existing vessels to process and freeze sharks may outweigh the increased revenues that vessels would realize through improved utilization.

Table 4. Product Recovery Rates (PRR) by weight and ex-vessel value for selected fishery resources

Western Pacific Fishery Resources	PRR by weight (%)	PRR by value (%)	Other US Fishery Resources	PRR by weight (%)	PRR by value (%)
TUNA			POLLOCK		
Meat	45	91.5	Roe	4	--
Heads and bones[1]	45	8.5	Surimi	16-17	
BLUE SHARK[2]					--
Fins	5	72	Fillet meat	13-35	--
Meat	25	3	SKATES		
Cartilage	4	1	Wing meat	20-32	100
Liver	25	24	HERRING		
MAKO/THRESHER[3]			Roe	3-25	24-77
SHARK					
Fins	5	74	Fish meal	75-97	23-76
Meat	42	16	SEA URCHIN		
Cartilage	4	3	Roe	8-13	100
Liver	7	7	SEA SCALLOP		
OPAH			Adductor muscle meat	6-18	100
Meat	28	68	MONKFISH		
Head and bones	60	32	Tail meat	30	
SWORDFISH			Livers	0-15	
Meat	38	?			
HAPU'UPU'U					
Meat	30	86			
Heads & bones	60	14			

Sources: California Fish and Game; NMFS Alaska Fishery Science Center; NMFS Fisheries Statistics and Economics Division; and pers. comms. with industry representatives.

1. Sections of various Asian communities in Hawaii will buy fish heads and skeletons

2. & 3. Potential values for shark products other than fins and meat

It is estimated that the volume of blue sharks necessary to make a directed fishery economical would range from 4 to 5 tons per day (J. Cook, pers. comm.). The existing vessels in the Hawaii-based longline fleet are not capable of this type of processing. It is estimated that constructing a large vessel capable of processing the volume of product necessary to make such an operation economically viable would cost $1.4 million–$1.5 million.

Product recovery rate is affected by the potential income from products as well as production costs (Table 4). There are currently no local markets for shark products beyond fins and the meat of some species. One Hawaii firm has indicated interest in purchasing cartilage and liver at $0.20–0.40/lb and $1.50/lb, respectively. This firm is exploring possible markets for the hides. Because of concerns about methyl mercury levels, blue sharks are not retained by Australian, Taiwanese or Thai fishermen (Rose 1996). Blue sharks over 1.5 m have a 50% chance of having mercury levels higher then 0.5 ppm. The US Food and Drug Administration action level for methyl mercury is 1.0 ppm. Based on similar concerns about mercury levels, large coastal sharks are often not retained for their meat (Kelley 1999).

3.4 Potential for fishery interactions with protected species

The pelagics fishery Plan Team and Science and Statistical Committee have expressed concern that use of a gear commonly referred to as "bottom longline" in the protected species zone could result in fishery interactions with the endangered Hawaiian monk seal (*Monachus schauinslandi*). Currently, a single vessel is using this gear to target sharks in the EEZ around the Hawaiian Islands, including the Northwestern Hawaiian Islands.

The NOAA Office of the General Counsel determined that the gear does not meet the definition of longline gear in the pelagics FMP.[3] The FMP defines longline gear as "... a type of

[3]The NOAA Office of the General Counsel determined that "bottom longline" gear meets the definition of hook and line gear published in 50 CFR 600.10 and is included in the list of allowable gear types for fisheries under the authority of the Western Pacific Council.

fishing gear consisting of a main line that exceeds 1 nm in length, is suspended horizontally in the water column either anchored, floating or attached to a vessel, and from which branch or dropper lines with hooks are attached; except that, within the protected species zone, longline gear means a type of fishing gear consisting of a main line of any length that suspended horizontally in the water column either anchored, floating or attached to a vessel, and from which branch or dropper lines with hooks are attached." The gear being used by the vessel in the directed shark fishery rests on the bottom and is not suspended in the water column. Because the vessel is not operating with longline gear as it is defined in the FMP it is not prohibited from fishing within the protected species zone around the Northwestern Hawaiian Islands.

4. Management options

Possible management measures to resolve the problems described above and achieve the Council's management objectives are outlined below and are summarized in Appendix 1. Any particular measure listed could be applied to all or a selected group of US vessels landing or transshipping managed species of sharks. In addition, implementation of a particular measure could be incrementally "phased in" over a fixed period of time or delayed until a certain date in the future.

4.1 Imprecise definition of management unit species

The following options are not necessarily mutually exclusive.

4.1.1 Include all pelagic dwelling sharks as MUS

Define the MUS as all sharks dwelling in the pelagic habitat of the EEZ (Table 5). However, some of these species are infrequently (or never) caught and some are frequently caught but never sold or utilized. Other species that do not primarily occupy the pelagic habitat are sometimes (but not frequently) caught.

Table 5. List of pelagic sharks occurring in the EEZ.

Carcharhinidae - Requiem sharks
- Silky shark (*Carcharhinus falciformis*)
- Oceanic whitetip shark (*Carcharhinus longimanus*)
- Blue shark (*Prionace glauca*)

Alopiidae - Thresher sharks
- Pelagic thresher shark (*Alopias pelagicus*)
- Bigeye thresher shark (*Alopias superciliosus*)
- Common thresher shark (*Alopias vulpinus*)

Lamnidae - Mackeral sharks
- Shortfin mako shark (*Isurus oxyrinchus*)

Longfin mako shark (*Isurus paucus*)
Great white shark (*Cacharodon carcharias*)
Rhinchodontidae - Whale sharks
Whale shark - (*Rhinchodon typus*)
Pseudocarchariidae - Crocodile sharks
Crocodile shark (*psuedocarcharias kamoharai*)
Megachasmidae - Megamouth sharks
Megamouth shark (*Megachasma pelagios*)
Cetorhinidae - Basking sharks
Basking shark (*Cetorhinus maximus*)
Squalidae - Dogfish sharks
Cookiecutter shark (*Istius brasiliensis*)

4.1.2 Exclude infrequently caught species from MUS

The best source of information on the species composition of sharks caught by pelagics fisheries is the NMFS observer data. Looking just at the number of shark that are not blue shark shark, only oceanic whitetip shark, silky shark, the three thresher shark species, shortfin mako shark, and crocodile shark comprise more than 1% of the remaining shark catch. This option would not include as MUS the other, more infrequently caught species. The infrequently caught species would be identified on a list of "other sharks" for reporting, and monitoring purposes. The Atlantic shark FMP identifies a list of deepwater and other sharks for just such a purpose, and for which there is no attempt to estimate MSY or define control rules. These other species can still be subject to regulation as bycatch, for example in the Atlantic shark FMP finning of these other sharks is prohibited. The list of infrequently caught sharks could also include the coastal or deep benthic species infrequently caught by the pelagics fishery such as both hammerhead shark species, tiger shark, dusky shark, bignose shark, galapagoes shark, and sandbar shark. None of these species comprise more than 1% of the sharks other than blue sharks identified by NMFS observers on longline vessels.

4.1.3 Exclude discarded species from MUS

Crocodile shark has no use or commercial value at this time so it might not be defined as a MUS. It could also be included on a list of "other" sharks for reporting, monitoring, and bycatch regulation purposes. A number of pelagic shark species may have no remaining commercial value or use if finning is banned. In that eventuality this option might restrict the pelagic MUS to include only those that are retained in whole for sale of the flesh (e.g., the thresher and mako sharks).

4.1.4 Include longfin mako shark as a MUS

Option 4.1.2 excludes longfin mako shark as a MUS because it is caught infrequently. However, it is one of the few sharks whose flesh has commercial value in the Hawaii fishery and so it could become one of the more frequently retained sharks if finning were banned.

4.1.5 Include salmon shark as a MUS

Salmon shark (*Lamna ditropis*) is a mackeral shark (Lamnidae) that does not occur in the EEZ but is frequently captured by the Hawaii-based longline fishery in the North Pacific transition zone.

4.1.6 Include some non-pelagic dwelling sharks as MUS

In this option, the non-pelagic dwelling sharks observed to occur in the longline catch would be included as pelagic MUS, despite their infrequent occurrence and predominantly coastal habitat. Specifically, both hammerhead shark species, tiger shark, dusky shark, bignose shark, galapagoes shark and sandbar shark would be included. The coastal shark fishery now primarily catches these species as well as grey reef shark, reef whitetip shark and blacktip shark. If the coastal shark fishery is peculiarly defined to be a pelagic fishery and continues to operate, then there may be reason to include these coastal species as MUS.

4.2 Uncertainty about impacts of fishing on stocks

In the absence of a sufficient understanding of shark population dynamics and biology to accurately assess fishery impacts on shark stocks, the Council might recommend measures to reduce fishing mortality. For example, pending additional scientific analyses, the Council could recommend measures to restrict the retention of sharks; prohibit, limit or condition the use of specified types and quantities of fishing gear; reduce the catching of sharks; and/or increase the survival of sharks that are caught and released. These options are discussed in more detail below.

4.2.1 Restrict the retention of all or some species of sharks

The Council could prohibit the retention of any fins, carcasses or parts of a managed shark species. Alternatively, the Council might allow the retention of only those shark species, such as blue shark, believed to be able to withstand specified levels of fishing mortality. The establishment of species-specific commercial quotas and recreational bag limits would help ensure that the specified levels of fishing mortality are not exceeded. Counting dead discards against such quotas or bag limits would create an incentive to maximize the survival of those sharks released.

4.2.2 Prohibit, limit or condition the use of specified types and quantities of fishing gear

These measures reduce the risk of overfishing shark stocks by regulating the use of fishing gear. For example, the Council's Science and Statistical Committee and pelagics fishery Plan Team has recommended that the use of "bottom longline" gear be prohibited because the species of coastal-dwelling sharks targeted by this gear may be particularly vulnerable to overfishing.

4.2.3 Minimize shark catch

Incidental harvest of sharks can be minimized by requiring alterations in fishing gear and other changes in fishing operations. For example, the shark catch per set by longline gear utilizing wire leaders is much higher than the catch of sharks taken with monofilament because sharks are able to bite through monofilament leaders (Williams 1997). With regard to shark bycatch in the purse seine fishery, the catch of certain shark species is far higher in sets made on schools of tuna associated with floating objects (Williams 1997). Other potential measures to reduce the catch of sharks include further restrictions in longline fishing effort and additional longline fishing area closures.

4.2.4 Minimize mortality of released sharks

Establishing procedures for handling and releasing live sharks could increase the probability of their survival. For example, it might be required that sharks that are not landed as part of a commercial or recreational fishery be released uninjured by cutting the line near the hook without removing the shark from the water, or, for net-caught sharks, by returning the shark to the water quickly in a manner that minimizes injury.

4.2.5 Identify scientific data needs and revise recordkeeping and reporting requirements, as necessary

One option is to specify the nature and extent of data needed to assess the present and probable future condition of stocks of shark management unit species and recommend changes in record-keeping and reporting requirements that could facilitate the collection of that data.

4.3 Low product recovery rates

Restricting shark finning addresses the perceived wastage associated with this practice. In addition, it would also likely reduce the fishing mortality of sharks because the cost of retaining shark carcasses would encourage fishers to release a greater number of sharks. Alternative measures restricting finning include the following:

4.3.1 Require sharks that are landed[4]/transshipped[5] be landed whole (headed and gutted) with fins and tail attached

This alternative would prohibit the landing or transshipment of any shark fin or shark tail or portion thereof that has been removed from the carcass (defined as a shark with the internal organs and/or head removed) before the shark is brought ashore. Harvesters would be allowed to gut and bleed the carcass by making an incision at the base of the caudal peduncle as long as the caudal tail is not removed.

4.3.2 Prohibit finning and stipulate that, to land/transship fins, they must be landed in an appropriate proportion to quantity of carcass

This alternative would prohibit the landing or transshipment of any shark fins, carcasses or parts except if the corresponding carcass (defined as a shark with the internal organs and/or head removed) is also onboard for each tail and set of fins retained. Fins could not be stored aboard the vessel after associated carcasses are offloaded and would have to be counted and monitored at time of landing. Filleting of sharks at sea would be prohibited in order to enable accurate matching between carcasses and fins.

4.3.3 Restrict the finning of sharks through quotas, size limits, etc.

Instead of prohibiting finning a restriction could be placed on the species, type or number of sharks allowed to be finned. For example, the Council might restrict finning to

- blue sharks only, given their abundance and possible greater resilience to fishing impacts
- sharks of a minimum size
- male sharks only, as this would protect the reproductive potential of the stock by protecting females
- the current level of sharks being finned. An initial analysis of NMFS observer records indicates that the average number of sharks that were finned in 1998 in the Hawaii longline fishery was approximately 50 per trip.

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[4]Landing is defined in Sec. 660.12 of Title 50, Code of Federal Regulations, as offloading fish from a fishing vessel, arriving in port to begin offloading fish, or causing fish to be offloaded from a fishing vessel.

[5]Transshipping is defined in Sec. 660.12 of Title 50, Code of Federal Regulations, as offloading or otherwise transferring management unit species species or products thereof to a receiver vessel.

- sharks that are dead when hauled on board, as this may be less wasteful than discarding them. An initial analysis of NMFS observer records indicates that the average number of hooked sharks that are dead when brought on board is about 13 per trip. Incorporating this figure in a management measure, retaining or transshipping the fins or tails of more than 13 sharks would be prohibited except if the corresponding carcass (defined as a shark with the internal organs and/or head removed) is onboard for each tail and set of fins retained.

To minimize their impact, quotas might be phased into the fishery over a two- to three-year period, by initially capping finning at the present level and then by step-wise reductions to a target level.

4.3.4 Establish a mandatory product recovery rate

Allow shark to be retained only if a certain minimum percentage of the shark body was utilized. For example, the North Pacific Council established a product recovery rate of 15% for a variety of demersal species. The Western Pacific Council could likewise establish its minimum recovery rates for selected MUS.

4.3.5 Prohibit sale, trade or barter of shark fins

This measure would prohibit persons from engaging in the commerce of shark fins regardless of their origin. By also prohibiting the import of fins the "no-sale" measure removes the incentive for foreign vessels to increase their finning activity to fill the void in the US market for shark fins that may be created by prohibiting domestic vessels from finning.

4.4 Secretary of Commerce plan for shark management

In lieu of Council action on sharks, the Secretary of Commerce may prepare a plan or plan amendment if the Council fails to develop and submit to the Secretary a fishery management plan or a plan amendment for shark management. The Secretary can also intervene if in the event that he or she disapproves or partially disapproves any such plan or amendment, or disapproves a revised plan or amendment, and the Council fails to submit a revised or further revised plan or amendment.

4.5 Potential for fishery interactions with protected species

To reduce the risk of protected species interactions between vessels using "bottom longline" gear the Council could specifically prohibit fishing with this gear in the protected species zone around the Northwestern Hawaiian Islands. Alternatively, the definition of longline gear in the pelagics FMP could be revised so that the gear meets the definition of longline gear. Any vessel operating with gear that meets the definition of longline is prohibited from fishing within the protected species zone around the NWHI. For example, the word "suspended" could be removed from the definition of longline in the FMP. Alternatively, the NMFS definition of longline gear could be adopted, i.e., "Longline means a line that is deployed horizontally and to which gangions and hooks or pots are attached. Longlines can be stationary, anchored or buoyed lines that may be hauled manually, electrically or hydraulically" (*Federal Register* Vol. 64 No. 17 January 27, 1999).

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Appendix 1. Summary of the issues and potential solutions for shark management in the Western Pacific Region

	Issues		Management options	Comments
1.	Clarification of shark pelagic management unit species	a.	Make all pelagic sharks MUS	Better definition of pelagic MUS will clarify which Council FMP's are responsible for which species and, lead to more appropriate management measures for pelagic and coastal sharks
		b.	Exclude infrequently caught species in MUS	
		c.	Exclude discarded species from MUS	
		e.	Include longfin mako in MUS	
		f.	Include salmon shark in MUS	
		g.	Include some non-pelagic species in MUS	
2.	Uncertainty about fishing impacts on shark stocks	a.	Restrict retention of all or some species by quota, size limits etc	Reduction of some or all sharks in the longline fishery will contribute to overall decline in fishing mortality of Pacific pelagic sharks. Retention rates can be later adjusted to reflect stock status of pelagic shark species. Will require additional enforcement monitoring. Gear restrictions may constrain development of a directed shark fishery.
		b.	Prohibit or limit use of types and quantities of fishing gear	
		c.	Minimize shark bycatch	
		d.	Minimize post release mortality	

3. Identify scientific data needs, record-keeping and reporting requirements	a.	Review present data reporting systems to assess shortcomings in providing information required for stock assessment and stock monitoring.	Longline logbooks may be modified to include reporting of a greater range of shark species. Improvements in catch reporting by State of Hawaii would better define size of coastal shark catch. Implementation of regional management regime through MHLC may necessitate data reporting improvements
Issues		**Potential Solutions**	**Comments**

4.	Low product recovery rates	a.	Prohibit all finning at sea, require whole sharks to be landed before fin removal	Constraints on finning will reduce shark fishing mortality. Will require additional enforcement monitoring. Quota based on percentage of dead sharks in longline catch will allow some economic gain from sharks while maintaining relatively low harvest rate. Quotas could be phased in over 2-3 years to minimize adverse impacts and later adjusted based on stock assessment data. Establishment of an acceptable product recovery threshold may remove necessity of returning with whole shark carcass but still act to constrain finning. The shark-fin trade may be terminated by the Council in the WPR under Magnuson Act, but other legislation would be required to restrict shark-fin trade in the entire USA.
		b.	Permit finning at sea, but require fins landed in proportion to shark carcasses	
		c.	Restrict finning through quotas, size limits etc.	
		d.	Establish a product recovery threshold	
		e.	Prohibit possession, sale or trade of shark fins in Western Pacific Region (WPR) or entire USA	
5.	Potential for fishery interactions with protected species	a.	Prohibit "bottom longline gear" in the protected species zone around Northwestern Hawaiian Islands	Would remove potential for harmful or fatal interactions with monk seals and green turtles. May constrain development of a directed shark fishery.