THE MANAGEMENT OF SHARK CATCHES IN THE US-FLAG ISLANDS OF THE PACIFIC

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1 INTRODUCTION

This paper reviews the shark catches in fisheries under the jurisdiction it the Western Pacific Regional Fisheries Management Council (hereafter, the Council). The Council is one of eight such regional councils established by the Magnuson-Stevens Fishery Conservation and Management Act in order to manage fisheries in the federal waters of the US Exclusive Economic Zone (EEZ). These councils are appointed bodies with representation from federal and state agencies, and the fishing industry. They set policy and develop management regimes for fisheries within their respective regions by developing fishery management plans (FMPs). Management measures in FMPs are implemented through federal regulations and enforced by the National Marine Fisheries Service (NMFS) and the US Coast Guard. As conditions change in a fishery the original FMP may be modified by amendment.

The Council's jurisdiction covers EEZ waters around the State of Hawaii, the Commonwealth of the Northern Mariana Islands, the Territory of American Samoa, the Territory of Guam and six other island groups under either US military or direct federal control (see Figure 1). Since its inception in 1976 the Council has developed and implemented FMPs for precious coral, bottomfish, crustacean and pelagic fisheries. A fifth FMP is in preparation, for coral reef ecosystems in federal waters.

With one exception (discussed below), there has been no directed fishery for sharks within the Council's jurisdiction. However, sharks caught incidentally in pelagic fisheries have become a significant, and controversial, component of landings. Therefor, only fisheries falling under the purview of the eponymous Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region (Pelagic FMP) are discussed here.

In relation to sharks, the most important development in Council-managed fisheries has been a substantial increase in finning in the Hawaii-based longline fishery. Fins are a valued ingredient in Asian cuisine and command a high price. Fishermen cut off the fins, dry them, and sell them to local traders. These traders in turn sell the fins to brokers in Hong Kong and on the US mainland. In most cases the shark carcass is discarded at sea after the fins are removed. This practice has become controversial in Hawaii, as elsewhere, because of concerns about resource sustainability, waste, and the pain and suffering inflicted on sharks if fins are removed while the animal is still alive.

2 THE RESOURCE

2.1 Species composition of the fishery

Under the Magnuson-Stevens Act FMPs must specify the species of fish involved in managed fisheries, which are known as management unit species (MUS). Pelagic management unit species, and 1998 catches[1] for the region as a whole, are listed in Table 1. In the table MUS are ranked within subcategories by catches. It can be seen that tunas account for almost half of the total catch, with bigeye tuna (*Thunnus obesus*) the first-ranked species overall in terms of catches. Swordfish (*Xiphius gladius*) is second-ranked overall. Although sharks are not target species, they are a significant component of the catch at 17.7%.

Oceanic sharks are defined broadly as pelagic management unit species, at the family level (Alopiidae- thresher sharks, Carcharhinidae- requiem sharks, Lamnidae- mackerel sharks, and Sphyrnidae- hammerhead sharks, a primarily coastal group). But a few sharks species represent the preponderance of catches in pelagic fisheries. In fact, a single species, the blue shark (*Prionace glauca*), represents the vast majority of sharks caught in Council-managed fisheries. Table 2 lists shark species caught in the Hawaii-based longline fishery, based on observer reports. (Although observers do record numbers caught, a statistical model has not been developed to accurately expand these data to a fleet-wide annual catch estimate. Therefor, these numbers are not reported here.) Logbooks, maintained by these fishing vessels, represent a fleet-wide data source. Sharks are reported in four categories: blue, mako, thresher and other. Table 2 presents these data from 1999. The logbook data indicate that 89% of shark catches consist of the blue shark. (The percentage has been closer to 95% in years past.) While noting that observer data is not statistically expandable, in concert with logbook information it is safe to say that of other species only the oceanic whitetip (*Carcharhinus longimanus*), bigeye thresher (*Alopias superciliosus*), and shortfin mako (*Isurus oxyrinchus*) comprise more than one percent of the shark catch. In general, the blue, oceanic whitetip and silky shark dominate the pelagic shark community in the tropical and temperate Pacific [Bonfil, 1994 #21]. It can be seen that at least 15 other species have been observed, but are caught in very low numbers.

Available fishery statistics do not indicate shark species caught in other fisheries, which operate closer to shore and thus may encounter coastal species more frequently. However, one vessel operated in the Hawaiian Islands in 1998-99 specifically targeting coastal sharks with bottom longline gear. (The vessel has subsequently ceased operations.) Observer data, from a 1999 trip, indicate that the following sharks were caught: 684 sandbar (*Carcharhinus plumbeus*) (70% of the total number), 182 Galapagos (*Carcharhinus galapagensis*) (19%), 85 tiger (*Galeocerdo cuvier*) (8%), 20 grey reef (*Carcharhinus amblyrhynchos*) (2%) and 9 blacktip (*Charcharhinus limbatus*) (1%).

[1] Since Council-managed fisheries do not target sharks, and until recently few sharks or shark parts were retained, a distinction is made between to catching versus and landing fish throughout this document. Catching refers to those organisms that are 'brought to the gunwale' by the fishing gear but may be released or discarded. Landing fish is defined as "offloading fish from a fishing vessel, arriving in port to begin offloading fish, or causing fish to be offloaded from a fishing vessel" (federal regulations, 50 CFR 660.12). Therefor, the number of sharks caught is greater than the number that are landed.

2.1.1 Summary of blue shark biology

Because it is the most commonly caught shark in Council-managed fisheries, blue shark distribution and biology are briefly summarized here. 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 #24; Nakano, in review #25]. 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 #24].

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, in review #25]. 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 #1].

2.2 Distribution of the fishery

Although the Council manages fisheries throughout its region, Hawaii-based fisheries, and in particular the longline fleet, represent the bulk of landings. Hawaii landings are about 95% of the total and longliners by themselves represent 80% of landings in 1998 (see Table 3). Figure 2 shows the distribution of effort, in hooks set, for the Hawaii longline fleet. Although a significant proportion of fleet effort falls outside of the EEZ, the Council is mandated to manage stocks as a unit. Therefor, this activity by Hawaii-based US vessels falls under the Council management regime. US purse seiners represent another very large fishery in the region but they are not directly managed under Council FMPs. A small proportion (less than 1%) of their landings have been made in US EEZs around the remote island areas of Howland, Baker, Jarvis and Palmyra,. Tuna catches in these areas averaged 9,917 mt between 1990 and 1998.

2.3 Associated species either as bycatch or discards

As noted in the introduction, no currently active Council-managed fishery targets sharks. Although they fall under the broad definition of bycatch, the Magnuson-Stevens Act is defines bycatch as those fish that, although harvested, "are not sold or kept for personal use, and includes economic discards and regulatory discards." In Council-managed fisheries sharks are both discarded and retained, depending on the fishery, the spark species and landing locale. For this reason, sharks are considered an 'incidental catch.'

2.4 Discussion

The great majority of shark catches are blue sharks caught in the Hawaii-based longline fishery. In 1998 areas of high catch per unit effort for this species were north of the Hawaiian islands between 30° N and 40° N and 150° W and 165° W.

3 NATURE OF THE FISHERY

3.1 Fleet characteristics, evolution of the fleet and fishing effort

It is important to realize that Council-managed pelagic fisheries are but one component in a diverse array of fisheries that target tuna and billfish, and conducted by both distant water-vessels and smaller, offshore vessels making shorter trips from a shore-base. These vessels come from a various Pacific Rim and Pacific Island nations and all have a significant incidental catch of sharks. Since sharks are not target species, it is difficult to determine shark catches by pelagic fisheries throughout the region with precision. Nonetheless, Stevens [, 1996 #1] estimates that between 283,000 and 470,400 mt of sharks were landed by all high-seas Pacific fishing in 1994, of which 140,100 MT (30-50% of the total) were blue sharks. In comparison, all Council-managed fisheries caught less than 3,000 mt of sharks in 1998.

As already noted, the Hawaii-based longline fishery accounts for a majority of both total landings and shark catches in the Council region. For this reason discussion will focus on this fishery. The characteristics of other fisheries will also be described briefly at the end of this section. This includes foreign vessels transshipping shark products through US ports in the region.

The Hawaii-based pelagic longline fishery developed and expanded rapidly in the late 1980s and early '90s with the opening of local and export markets for fresh tuna and the discovery of swordfish stocks around Hawaii. Between 1987 and 1991 the number of active vessels increased more than four-fold (see Figure 3). This rapid expansion was due in part to the entry of vessels from the Atlantic and Gulf coasts of the US as those fisheries became overcapitalized. In addition, east coast fisheries were more tightly regulated in comparison to Hawaii fisheries; thus a move into the region was seen as promising because of the less constraining regulatory environment. An important part of this growth comes from vessels targeting on swordfish, although landings have declined since the first half of the 1990s. Hawaii longliners also target bigeye, yellowfin and albacore tuna and some vessels undertake so-called "mixed trips" where both swordfish and tuna are targeted [He, 1997 #27]. These new entrants are larger and have a greater fishing capacity than older Hawaii-based vessels.

Figure 4 presents overall fleet effort for the years 1991-1998, by area. This represents the period after fleet size stabilized due to a licensing moratorium and subsequent limited entry program (see Section 4.2). Total effort remained relatively stable up to 1994 but subsequently increased, up by 55% in 1999 in comparison to 1991. This increase is mainly due to east coast swordfish vessels entering the fishery [Ito, 1999 #10].

3.2 The harvesting process

Longline gear, consisting of a main line suspended in the water column by floats and hooked branch lines, is shot from the stern while the vessel is underway. Monofilament main lines are typically 30-50 nm long and consist of 800-1700 branch lines and hooks (depending on target species). After "soaking" or remaining in the water for up to 12 hrs the gear is retrieved, or hauled back. This involves reeling the main line in over the side at a work area either amidships or near the stern. The most significant characteristic of the Hawaii fleet is that they preserve their catch with ice because the market demand is for fresh rather than frozen fish [McCoy, 1999 #4]. Combined with the relatively small size (since vessel size is limited to 101 ft by regulations), this imposes significant constraints on these vessels in terms of processing, storing and preserving non-target species.

The NMFS in its reporting categorizes longline trips by target species: (1) swordfish, (2) tuna, or (3) mixed trips where both are targeted. Swordfish and mixed trips set their gear with fewer hooks between floats, which keeps the gear shallow. The gear is set in the evening and hauled the following morning. The main difference between swordfish and mixed-species fishing strategy involves the use of lightsticks, which are placed at more frequent intervals when targeting swordfish [Ito, 1999 #10, p 4]. In contrast, when targeting tuna more hooks are used between floats and the gear is set during the day.

Fishing strategy influences shark incidental catch [Bigelow, 1999 #28]. Swordfish sets are shallow while tuna are caught in deeper sets. In addition, some vessels use stainless steel wire leaders while others use monofilament. Depth of set affects species composition of shark incidental catch[2] and wire leaders result in higher catch rates (because sharks are less likely to bite through the leader and thus escape.) Overall, shark CPUE is about ten times higher in sets targeting swordfish than in tuna trips, although the catch rate fluctuates over time (see Figure 6). This higher catch rate is mainly due to the fact that swordfishing occurs at generally higher latitudes, where blue shark are more abundant, in contrast to tuna fishing. During fishing operations a mix of factors contributes to a decision as to whether a particular shark will be retained. Particularly active or "green" sharks may be cut loose or a skipper may decide that the crew is giving too much attention to boating and processing shark and this is interfering with proper handling of target species fish.

[2]Matsunaga and Nakano [Matsunaga, 1999 #5], analyzing historic catches of sharks aboard Japanese research and training longline vessels, found oceanic whitetip and silky sharks were more commonly caught in shallow sets. However, they found no difference between CPUE of shallow and deep sets for blue sharks and the CPUE of thresher sharks on deep sets was greater than on shallow sets.

3.3 Evolution of the catch

Shark catches increased substantially in the early and mid-1990s. This was due in large part to an increase in swordfish trips. Catches have since declined from that peak (see Figure 5). Nonetheless, the 1999 shark catch was 23% above the 1991 value, but this increase is still less than the 55% increase in total fleet fishing effort during the same period (in terms of number of hooks set). Figure 5 shows catches and disposition of sharks in the longline fishery. It shows that finning has increased dramatically. In 1991 less than 2% of all sharks were finned while in 1999 65% were. As will be discussed below (Section 3.4.), blue shark carcasses are discarded after being finned because their meat cannot be marketed. However, carcasses from other, marketable shark species are retained. Whole carcasses have remained a fairly stable component of shark landings, representing 1%-2% of the catch.

Although shark CPUE is considerably higher in swordfish targeted trips, a higher percentage of sharks are actually finned on trips where tuna are targeted, about 85% versus 48% for swordfish target trips and 40% for trips so-called mixed trips where sets are made on both tuna and swordfish. Thus the nature of fishing operations, changes in strategy dictated by the target species' resource status, and the status of market demand for both target species and shark products influence the number of sharks caught and the number retained. In the past few years there has been an overall decline in swordfish landings in favor of trips targeting tuna. As seen in Figure 5, shark catches have remained stable, or perhaps declined slightly, while the percent of the catch finned has steadily increased. This can be partly explained by the decline in swordfish trips (which have a higher shark CPUE) and the preference for finning on tuna trips.

3.4 Markets

Broader market factors--specifically, an increase in demand for shark fins in the early '90s--have contributed to the large increase in the number of fins retained. In Hawaii a small and apparently static market exists for meat from mako and thresher sharks. But, as already noted, blue sharks represent four-fifths of the fleet catch, and at present only the fins from these sharks are marketable. The ceratotrichia, commonly called fin needles, noodles or fiber, is a form of cartilage used in preparing an Asian delicacy, shark fin soup. Demand for shark fin is correlated with rising incomes in Asia, and particularly in the People's Republic of China. At the same time, many smaller, less sophisticated restaurants have opened to meet demand at a lower price point. (This is possible because of the variety of fin grades, and thus prices, available to retailers.) As a result, Hong Kong, the worldwide center for the fin trade, saw a steady rise in imports from the mid 1980s to 1995. The economic crisis in Asia, beginning in 1997, affected imports which fell from a high of 4,215 mt in 1997 to 3,723 mt in 1998 [McCoy, 1999 #4, , p. 43]. Exchange rate fluctuations affect relative price and thus the attractiveness of different sources of supply. In Hong Kong falling Asian currencies made supplies from within that region cheaper relative to the US, since the Hong Kong dollar is pegged to the comparatively strong US currency. McCoy and Ishihara (*ibid.*) argue that the price change may have resulted in reduced finning rates in the purse seine fishery. Despite these economic conditions the Hawaii longline fishery has continued to see a steady increase in finning rates through 1999.

McCoy and Ishihara (*ibid.*) point out that the US mainland is probably an important market for fins landed in Hawaii since there is a significant and growing population of Asian-

Americans there who could stimulate demand.[3] Further, in US coastal shark fisheries shark quotas have been reduced, limiting domestic supply. Trade figures, or 'exports' of fins from Hawaii to the mainland are not available, but these authors note that imports of shark fins into the US have fallen since the early 1990s despite a robust economy and a presumably growing market. This suggests that domestic supplies, including Hawaii, have taken a larger share of the market during this period. They (*ibid.*, p. 66) estimate that about 38 mt of dried shark fins are landed by the fleet; 95% are blue sharks and the remainder are mako (2%) and other sharks (3%). Table 4 presents 1999 logbook data on shark disposition. Blue sharks, at 90% of the total number finned, are slightly lower than their estimate, while other sharks are slightly higher. In addition, they do not consider thresher sharks; in 1999 1,857 thresher sharks, half the number caught, were finned. At the market peak, in 1995, fins sold ex-vessel in Hawaii for $61-$66/kg. They subsequently declined to $25-$30/kg by early 1999

Hawaii longliners only retain thresher and mako shark carcasses for sale. According to logbook data, 715 mako and 166 thresher sharks were kept by the fleet in 1999. The meat from blue sharks, which represent the vast majority of sharks caught, is generally not retained (although logbooks indicate that 81 carcasses, out of a total blue shark catch of 51,915, were kept in 1999, see Table 4). This is due to both physical and market constraints. McCoy and Ishihara [McCoy, 1999 #4, p. 56] identify four crucial barriers to the retention of blue shark carcasses: (1) short storage life of the flesh in ice, (2) capacity constraints of Hawaii-based longline vessels, (3) limited deck space on these vessels necessary for proper handling, and (4) low value for the landed product.

Sharks have high levels of urea (or more generally, non-protein nitrogen--NPN--compounds) in their flesh because of their primitive excretory and osmoregulatory system. When the shark dies bacteria rapidly convert this to ammonia, contributing to spoilage. Blue sharks are especially high in NPN compounds, compounding the difficulty of processing and preserving its flesh. In order to avoid this problem, sharks should be landed alive and rapidly bled in order to remove as much of the NPN compounds as possible. Work spaces have to be kept clean in order to avoid re-contamination, from blood-borne urea contaminating ice. Blue sharks need to be further processed aboard the vessel in order to remove still more urea. Even after careful processing blue shark meat can be held on ice for no more than five days before spoilage sets in. (This contrasts to frozen shark, which may be held for up to five months.) These characteristics contribute to the first and third constraints outlined above.

Hawaii vessels are also capacity constrained on several levels. First, even if sharks could be held using current ice-chilling methods, the total space available is limited and priority will always be given to much higher valued target species. Ice is also a limiting factor, except for vessels carrying ice makers. Thus by the same token, operators are unwilling to devote significant amounts of ice to chill and hold low value non-target species. In theory, and depending on their design and construction, existing vessels could be refitted with freezer holds specifically for shark carcasses. However, since market conditions demand a fresh product for target species, ice storage would have to be retained. Given size limits on the vessels, a second level of capacity constraint would be encountered to the degree that freezer holds supplants ice storage.

Clearly the fourth constraint, low market value for blue shark meat, is an overarching factor. Fundamentally, the costs involved in handling, processing, preserving and landing blue shark meat currently far outweigh the revenue that might be garnered from doing so. In fact, there is currently no established market for blue shark meat in Hawaii. But it is important to note that in

[3] One Hawaii buyer, who initially sold his fins in Hong Kong, now markets on the US west coast. He explained that this was easier and more profitable because face-to-face negotiations are often necessary and the cost involved in traveling to and staying in Hong Kong made selling there too expensive.

Japan and Taiwan markets do exist, supplied by coastal fisheries or frozen product. However, blue sharks are usually further processed in that they are used to produce kamoboko. Artisanal fisheries in Southeast Asia also occasionally retain blue sharks. In Mexico a significant market for blue sharks exists, supplied by coastal fishers in Baja California and frozen product from Japanese high-seas vessels. Spain also consumes a large amount of shark (of which an undetermined, but presumably high percentage, is blue shark) derived from Atlantic fisheries. A large proportion of these products also involve further processing, as either dried, smoked or pickled product [Kelly, 1999 #6]. In all of these markets prices in general are low. McCoy and Ishihara [McCoy, 1999 #4, p. 59] review prices and found the highest prices, about $3.74/kg ($1.70/lb), reported from the Tokyo Central Wholesale Market; but this price represents only the highest quality from throughout the country and is not ex-vessel. In Mexico ex-vessel prices range from $0.35 to $0.95/kg. Vannuccini [, 1999 #38, p. 91] reports 1999 prices of $1.00-$1.60/kg from Germany. These prices, even if other constraints could be overcome, compare unfavorably with target species prices, which range from $4.80/kg for swordfish to $7.08/kg for bigeye tuna.

Crew on Hawaii-based longline boats are usually instructed by buyers in shark processing methods (or they already possess this knowledge from experience in other domestic fisheries). Typically the dorsal, two pectoral, and lower caudal fins are removed and strung together as a set. The fins are sun-dried for three or four days and then stored in a warm, dry place such as the engine room. Sometimes other fins such as the small pelvic and anal fins, known as "chips", are also retained, but they command a much lower price. Blue shark fins are popular among traders because they are readily available at a comparatively low price, even though they are not considered of the highest quality [Vannuccini, 1999 #38]. Buyers prefer fins in 'sets' consisting of the fins noted above derived from the same shark. According to a Honolulu-based buyer, fin sets take into account the variation in quality between the constituent fins. Aside from the only occasionally retained 'chips,' for blue sharks the pectoral fins have the lowest value, the dorsal is intermediate and the lower caudal lobe most valuable. These differences are due to the ratio of cartilage and recoverable fin needles in each type of fin. Discounts may also be applied for fins that are not thoroughly dry.

3.5 Revenue from the fishery

Estimates of landings and value, made by McCoy and Ishihara [, 1999 #4] are presented in Table 5. This includes landings from transshipment by foreign vessels, discussed below in Section 3.8. They estimate fin revenues at about $1 million for the Hawaii longline fleet. Total longline fleet revenue in 1998 was $46.2 million [Ito, 1999 #10]. Figure 7 shows how components of the catch contributed to total fleet revenues. According to these figures, sharks account for a mere 3% of total fleet landings value. This is in line with the estimate made by McCoy and Ishihara, which comes out to about 2% if applied to 1998 values.

3.6 Economics of the fishery

As indicated above, in the longline fishery shark finning became more prevalent throughout the '90s, increasing from 1.5% of shark catches in 1992 to 65% in 1999. This growth follows the initial development of the longline fishery in the late '80s; fin buyers in Hawaii developed the market in response to high shark catch rates. This increase is noteworthy since the price paid for fins recently fell due to the economic crisis in Asia. (As the economies recover, spurring demand, it seems likely that prices will go up again.)

Generally, revenue from finning is shared out among crew members. As in other US fisheries, Hawaii longliners work on a share system where crew income is calculated as a percentage of landings revenue. The vessel owner takes the largest share, at least 50%, and the captain (if different from the owner) receives a greater share than any crew member. Crew are also expected to share in the variable costs of fishing including fuel, food, ice, bait and materials to repair the fishing gear. Income can thus be quite variable; if fishing is bad or the vessel has mechanical problems the crew can earn nothing or even end up owing money at the end of a trip. In contrast, income from finning is typically shared out exclusively among crew members; the vessel owner and/or captain do not receive any of this revenue. Owners try to control crew costs while securing a competent workforce. Therefor, they see finning revenue as an added incentive in attracting crew: it doesn't affect their income projections, which are based on target species landings, while giving crew additional income which may be steadier than the regular crew share, given that sharks are a large part of the catch [McCoy, 1999 #4].

McCoy and Ishihara (*ibid.*) estimate that crew members each earn $2,375-$2,850 a year from finning; representing about 10% of total earnings. The effect of the fall in fin prices on crew income is not known, but as noted the finning rate has increased. An attempt on the part of crews to keep this income source stable, or even increase it, may account for the increase as might an increase in the number of vessel crews engaged in the practice. McCoy and Ishihara speculate that an influx of recent immigrants serving as crew, who may be "more predisposed to finning despite the relatively small return" (*ibid.*, p. 81), may partly explain this increase.

Local fin buyers engage in the business on a part-time basis, typically as one of several enterprises. In Hawaii there are currently three active buyers. In addition to purchases from the longline fleet Hawaii also serves as a transshipment point. As noted below in Section 3.8, foreign longliners transship fins. In addition, a local businessman reportedly imported frozen fins from Spain, dried them in Hawaii, and shipped them on to Hong Kong. This was due in part to customs regulations, the US allows the importation of frozen fins while Hong Kong does not, and social connections, there is a large Chinese community in Honolulu. Fin buyers also operate in Guam and American Samoa, servicing mostly foreign vessels that land and transship product from those ports.

As already noted, Hong Kong is a world center for shark fin trading and it can be assumed that many of the traders in the region sell to middlemen there. However, "The distinction between trader, processor, and end user can be blurred in Hong Kong, Honolulu, or elsewhere as individuals can be active in all three sectors" [McCoy, 1999 #4, p. 47]. The US mainland is also an important market, especially the West Coast, because of the large Asian-American population and the ease of doing business there for Hawaii-based buyers.

McCoy and Ishihara have estimated the economic impact of shark landings and transshipments in the region, summarized in Table 6. In Hawaii spending by vessel crew represents about three-quarters of the total with trader gross margin the second-largest contribution. Overall, they estimate that shark catches contribute $2-$3 million to local economies in the region.

3.7 The fisheries workforce

The Hawaii longline fleet can be subdivided on ethnic lines. Broadly speaking, vessel owners and crew fall into three groups: whites, Koreans and Vietnamese. White-owned vessels represent the largest group by a small margin, comprising about two-fifths of the fleet. Koreans and Vietnamese make up the remainder in roughly equal measure. These ethnic differences play out in the sociology of the fleet and affect fishing strategy, business and social relationships, and crew composition. Unfortunately, there has not been very much social research on the fleet so little hard information exists about these characteristics. However, as an example of differences correlated with ethnicity, anecdotal reports indicate that Vietnamese-owned vessels tend to target swordfish, Korean-owned vessels prefer tuna, and white-owned boats engage in so-called mixed trips. Presumably other characteristics, such as internal fleet organization, sharing of knowledge, and sources of credit are correlated with ethnicity. Despite these ethnic differences, there has reportedly been an increase in Pacific Islander and Filipino crew in recent years. As already noted, these more recent immigrants may be more willing to put up with the hardships and relatively low pay of an entry-level position in the fishery.

3.8 Other fisheries briefly considered

As mentioned above, one vessel conducted a directed fishery for sharks in the Hawaiian Islands in 1999. The fishery was not profitable and the owner ceased operations by the end of the year. Information about fishing strategy and catches can be gleaned from an observer report based on a trip in late 1999 [Vatter, 2000 #13]. (A summary of the catch has been given above, in Section 2.1.) The fishing vessel was a steel-hulled Gulf shrimp boat with two longline reels (main and back up) for setting a monofilament groundline. During the observer-accompanied trip the vessel mainly fished around islands and on banks in the Northwestern Hawaiian Islands (NWHI),[4] although it also made a few sets at Penguin Bank in the main Hawaiian Islands. Shark abdomen meat was the primary bait, but on two occasions incidental catch was used in addition to shark as bait. After landing, smaller sharks (sandbar, Galapagos, blacktip, grey reef) were headed and gutted, rinsed clean, lowered into the hold and hung to freeze. The larger sharks (Galapagos and tiger) were finned and bled in the same manner, then filleted into 4.5 to 13.6 kg (10 to 30 lb) fillets. The fillets were rinsed and placed in baskets to remove excess water and frozen. Fins from all sharks were kept in the freezer hold to be dried later, ashore. Crew also saved the jaws, hides and gall bladders from tiger sharks. The latter are used as a remedy for back pain. The catch from the observer-accompanied trip was offloaded onto a freezer container at Honolulu for transshipment to Asia.

Of the other domestic fisheries in the region, only the longline fleet in American Samoa lands a significant number of sharks and is currently actively managed under the Council's Pelagic FMP. In this fishery small motorized catamarans deploy a short (3-5 nm) longline with a hand-powered reel. Trips last one or two days and these boats have a limited range, making this essentially a shore-based fishery. However, larger boats, in the 38-42 ft (11.5-13 m.) range have begun entering the fishery and still large boats are being planned. These vessels have a more extended range of up to 100 nm. Total landings in 1998 were 401 mt (see Table 3). American Samoa is a regional center for fish processing, hosting two tuna canneries. This provides a ready market for fleet landings. As in the Hawaii longline fishery, these vessels do not target sharks but

[4] The Northwestern Hawaiian Islands are a group of largely uninhabited islets, cays, atolls and banks. Although territorially part of the State of Hawaii, most of the land area is administered by the federal Fish and Wildlife Service as a protected area.

may land them. This local feet sells to fin buyers in American Samoa, but there are no data on the amounts.

Troll and handline fisheries in all areas comprise most of the remaining fisheries under Council jurisdiction. According to Haight and Dalzell [, 2000 #40], Hawaii troll fishers caught 1.8-6.4 mt of pelagic and coastal sharks annually 1994-98, or on average 4.1 mt annually. They also report that the handline fishery in Hawaii caught an average of about 2.6 mt sharks annually during the same period. However, figures derived from the Pelagic Fisheries Annual Report [WPRFMC / Western Pacific Regional Fishery Management Council, 1998 #23], suggest a larger figure--42.18 mt--for all Hawaii fisheries besides the longline fishery (see Table 3).[5] These figures do not include catches in the recreational sector and overall catches may be under-reported in these small boat fisheries. Further, since these values reflect catches and not necessarily landings, and bycatch has a high survival rate in line fisheries, actual fishing mortality is unknown.

Because of its canneries, American Samoa is also an important port for US purse seine vessels. US purse seine vessels fish throughout the tropical central and western Pacific between 130° E. and 150° W. longitude, gaining access to national EEZs based on licenses issued pursuant to a treaty between the US and Forum Fishery Agency member countries. As a result, this fishery is not directly managed by the Council. Seiners target skipjack and yellowfin tuna, which are frozen and delivered to canneries in the region. In 1998 about 35 vessels were active and a third of these are owned by US canneries. The rest are mostly owned by family enterprises. Catch of target species for all US purse seiners operating in the WCPO was 144,424 mt in 1997 [Lawson, 1998 #16]. Shark catch is not reported, but Lawson [Lawson, 1997 #8] estimates that the US fleet catches 429 mt annually.

These vessels commonly catch silky and oceanic whitetip sharks. These "brown" species command higher prices than blue sharks. In addition, careful processing by seiner crews adds value so that these fins command a higher price of $18-$23 per kg (see Table 5). As indicated in Table 5, seiners land between 9.1 and 10.6 mt of shark fins annually in American Samoa. Based on this figure total revenue in 1998 is estimated to be $162,000-$230,000. On a per crew basis this works out to $578-$821, or 4%-10% of total income.

Regional ports also serve as transshipment points for foreign vessels. Under US federal law foreign vessels may not land fish directly at US ports. However, American Samoa, Guam and the Northern Mariana Islands are exempted from this restriction. It is important to note that these fisheries are not under Council jurisdiction since they fish outside the US EEZ and are not US-flagged. Taiwanese longline vessels offload frozen catch in both Guam and American Samoa. In Guam, the target species, bigeye and yellowfin tuna, are transshipped to the sashimi market in Japan, while lower grade tuna are sold in local markets. In American Samoa smaller, older vessels deliver albacore tuna to local canneries while larger newer vessels, equipped with ultra low temperature (ULT) refrigeration systems, also target bigeye and yellowfin for the sashimi market, depending on market conditions. Taiwanese operators, more than those of other major Pacific fishing nations, see landings of shark products as an integral part of their operations. In the tropical western Pacific these vessels often retain carcasses from shortfin mako (*Isurus oxyrinchus*), oceanic whitetip (*Carcharhinus longimanus*) and silky (*C. flaciformis*) sharks, depending on the constraints of hold capacity and trip duration. (Higher valued target species will

[5] This figure is not reported in the Annual Report. It is derived by subtracting the longline shark catch from the total shark catch for all fisheries.

always be retained in preference to non-target species.) Blue sharks are normally finned and discarded because of the low value of blue shark meat.

Japanese longline vessels also transship through Guam. In 1999 50-60 vessels, mostly owned by small family-run businesses (owning two or there fishing vessels), were based in Guam. These vessels fish in the EEZs of the Republic of Palau and the Federated States of Micronesia, and on the high seas of the western Pacific. Japanese vessel operators put much less emphasis on the retention of shark products, partly because of vessel capacity constraints. Dried shark fins are sold to a local buyer who exports the product to Hong Kong. Generally, any income derived from the sale of shark fins is shared out among the crew to augment their income.

Foreign high-seas longliners operating in the north Pacific have been transshipping shark fins through Hawaii for most of the '90s. While vessels hail from Japan, Korea and Taiwan, most transshipments are made by Korean ULT longliners. These vessels stay out at sea for months at a time, freezing their catch of sashimi-grade bigeye tuna. Catch is periodically transferred at sea to refrigerated carrier vessels. They are also re-supplied with fuel and provisions at sea by tankers. These tankers put in at Honolulu to purchase fuel and supplies. This provides a convenient mechanism for the transshipment of shark fins. The tanker captains purchase shark fins from the high-seas longliners they service. US-flag vessels, including some Hawaii-based longliners, are contracted on a casual basis to transport fins from tankers to Honolulu since, as noted, landings cannot be made directly by foreign vessels in Hawaii. Typically, they meet the tanker as it heads into Honolulu and receive the cargo in international waters. In Honolulu the fins are transferred to shipping containers for onward shipment to Asia.

As can be seen from Table 5, transshipment volumes are overall much greater than landings by domestic fisheries. The estimate for Hawaii transshipments is by itself at least half the total volume passing through US ports in the region. The economic impact is more modest. As indicated in Table 6, transshipment costs represent the only economic impact of these operations and represent about one-tenth of the total.

4 MANAGEMENT OBJECTIVES

4.1 The fisheries within the context of national fisheries policies

Fisheries in the US EEZ fall under the auspices of the Magnuson-Stevens Conservation and Management Act of 1996, which represents the most recent amended and re-authorized version of legislation first enacted in 1976. In Section 301 it sets out ten national standards for fishery conservation and management. These standards mandate that conservation measures shall:

1. prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery;
2. be based upon the best scientific information available;
3. manage stocks as a unit throughout their range;
4. not discriminate between residents of different States or user groups in terms of allocations;
5. consider efficiency in the utilization of fishery resources;
6. allow for variations among fisheries, fishery resources, and catches;

7. minimize costs and avoid unnecessary duplication;
8. take into account the importance of fishery resources to fishing communities to provide sustained participation and minimize economic impacts;
9. minimize bycatch and bycatch mortality; and,
10. promote the safety of human life at sea.

When fishery management plans or amendments to these plans are prepared they must meet these standards, specifically describing how their provisions meet these standards.

During its 1999 session the US House of Representatives passed US Resolution 189 calling for a ban on the "wasteful and unsportsmanlike" practice of finning in waters under Council jurisdiction. Proponents of the measure also petitioned the US Secretary of Commerce to impose a ban. A bill was subsequently introduced to amend the Magnuson-Stevens Act to prohibit shark finning (defined as "remov[ing] any of the fins of a shark, including the tail, and discard[ing] the carcass of the shark at sea")

4.2 Objectives for the management of shark catches

Up until the last five years or so exploitation of sharks has been limited. Although a significant component of longline catch, especially in the swordfish fishery, mortality due to gear alone is low; observer reports indicate that 86% of sharks are brought to the gunwale alive. For these reasons the Council has only now begun to formulate significant management policies in relation to shark catches. An exception is Amendment 1 to the Pelagic FMP, implemented in 1991. This was drafted in response to guidelines from the Secretary of Commerce (head of the department within which federal fishery management responsibility lies) based on a then new national standard in the Magnuson Act requiring measurable definitions for recruitment overfishing for each species managed under FMPs. The spawning potential ratio is used as an overfishing index. It expresses the current spawning population of a stock in relation to that of the un-fished population. For pelagic teleost fish this was set at 0.20; that is, if a stock's spawning population size fell below 20% of that for the un-fished stock it would be considered overfished. For sharks the SPR was set at 0.35, recognizing that these species are on the whole less resilient to fishing pressure. More generally, the amended Pelagic FMP sets out objectives for all management unit species, including sharks. These are:

1. To manage fisheries for management unit species in the western Pacific region to achieve optimum yield (OY).
2. To promote, within the limits of managing at OY, domestic harvest of the management unit species in the western Pacific EEZ and domestic fishery values associated with these species, for example, by enhancing the opportunities for:
   - satisfying recreational fishing experiences;
   - continuation of traditional fishing practices for non-market personal consumption and cultural benefits; and;
   - domestic commercial fishermen, including charter boat operations, to engage in profitable fishing operations.
5. To diminish gear conflicts in the EEZ, particularly in areas of concentrated domestic fishing.

6. To improve the statistical base for conducting better stock assessments and fishery evaluations, thus supporting fishery management and resource conservation in the EEZ and throughout the range of the management unit species.
7. To promote the formation of a regional or international arrangement for assessing and conserving the management unit species and tunas throughout their range.
8. To preclude waste of management unit species associated with longline, purse seine, pole-and-line or other fishing operations.
9. To promote, within the limits of managing at OY, domestic marketing of the management unit species in American Samoa, Guam, and Hawaii.

The sharp increase in finning over the past five years has generated much public concern and controversy. For this reason at its quarterly meeting in October 1999 the Council recommended that the Pelagic FMP be amended to establish an annual quota for the number of sharks that could be harvested by vessels in the Hawaii longline fishery. In addition, managers determined that the inshore bottom longline fishery for sharks in Hawaiian waters, described above, could not be regulated under existing regulations. This is due to concerns that endangered monk seals (*Monachus schauinslandi*) might interact with the gear, and a general sentiment that this fishery was not sustainable. Therefor the Council recommended that this type of fishing be defined in regulations so that it could be banned. Amendment 9 to the Pelagic FMP has been prepared by Council staff to address these issues and is under review by the NMFS, which oversees and implements policies set by Councils.

4.3 The objective setting process

Objectives are set in broad terms through the instruments described above, the Magnuson-Stevens Act and the objectives specific to each FMP, as amended. The development and implementation of FMPs, and any substantial amendment is a lengthy process (see below, Section 6). Objectives for shark management must be consistent with both national standards and FMP objectives. In relation to the Pelagic FMP objectives, Amendment 9 seeks to manage shark catches to achieve optimum yield, to ensure that commercial fisheries remain profitable, to limit waste, and promote domestic marketing of sharks, and in particular the meat from blue shark for which no market currently exists in Hawaii.

5 MANAGEMENT POLICIES AND THE POLICY SETTING PROCESS

5.1 Identification and evaluation of policies

Council action outlined above is substantially a result of public controversy over shark finning, which has already been prohibited in US continental fisheries, partly because of concerns about the vulnerability of stocks but mainly because the practice is viewed as wasteful. As a result, the Hawaii longline fishery could be singled out as the only US domestic fishery in which finning was still being practiced. In Hawaii public attention was sparked in January 1999 when a domestic longline vessel, transshipping shark fins from foreign high seas longliners, was cited by Hawaii Division of Conservation and Resource Enforcement officials for transporting the fins without a license. A team from a local TV news organization was on hand as well as a representative from a conservation organization, both of whom photographed and publicized the event.

During its 2000 session the Hawaii State Legislature passed a bill stating that "No person shall knowingly harvest shark fins from the territorial waters of the State, or land shark fins in the State, unless the fins were taken from a shark landed whole in the State." (This follows an unsuccessful attempt to pass similar legislation during the 1999 session.) Although the law is intended to also regulate vessels fishing outside of state waters, if they are licensed in Hawaii or land fish there, it seems likely that the Magnuson-Stevens Act, and thus the Council's management actions, would take precedence.[6] The issue will most likely end up in court.

Despite this opposition to the practice of shark finning, the Council has responded cautiously for two reasons. First, the best available scientific evidence indicates that the shark stocks exploited by the Hawaii longline fishery are not over-exploited. Second, greater utilization is unfeasible because no market currently exists for the meat of the blue shark (*Prionace glauca*), which represents the vast majority of sharks caught in the fishery. As outlined above, there are also serious barriers to processing and preserving blue shark meat on longliners, because of the physical characteristics of the meat and the constraints of vessel configuration.

Amendment 9 identifies six issues from which policy recommendations stem. First, there is concern about the sufficiency of information on total fishing mortality to shark stocks. Foreign vessels, fishing on the high seas or the economic zones of other nations, account for most of the fishing mortality of Pacific shark stocks. Catches and shark mortality by these vessels are poorly documented. This makes accurate stock assessment impossible. Second, because of their reproductive biology, many shark species are considered intrinsically vulnerable to overfishing. There is thus concern that the current catch in Council-managed fisheries is unsustainable. Third, finning is viewed as wasteful because a small proportion of the fish is utilized--less than 5% of the animal's total body weight [WPRFMC / Western Pacific Regional Fishery Management Council, 1999 #26, p. 18]. Fourth, some members of the public attribute an intrinsic "existence value" to sharks. This is expressed in a variety of ways. People may see sharks as a "charismatic" member of the ecosystem. As one account puts it: "The loss of the graceful, mysterious creature disturbs the undersea ecosystem, removing an important predator that helps maintain the ocean's fragile balance of marine life..." [Kelly, 1999 #18]. Some consider finning inhumane, claiming that sharks are "thrown back into the water, more often than not, alive. It takes hours and sometimes days for the shark to die a slow and agonizing death" [Enders, 1999 #19].[7] Some native Hawaiians argue that killing sharks is, as one activist states, "very culturally offensive to the Native Hawaiian people.... [because of] a mystical association we have [with sharks]" [Tighe, 1999 #20]. Fifth, although the directed fishery for sharks mentioned above ceased, the practice should be banned in order to prevent it in the future, since it is deemed unsustainable and there is some potential for gear interactions with an endangered species, the Hawaiian monk seal. Finally, the definition for sharks designated as pelagic management unit species (MUS) is not specific; instead they are described as members of four families (Alopiidae, Carcharhinidae, Lamnidae, and Sphyrnidae). Thus coastal shark species, rarely or never caught in pelagic fisheries, are included under the Pelagic FMP. Required management measures can be less burdensome and more effective if these species are excluded from the Pelagic FMP.

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[6] Section 306 of the Magnuson-Stevens Act states, generally, that states may regulate fishing within their boundaries, that is, in internal waters and in the territorial sea out to three nautical miles. Outside of state boundaries states may regulate fisheries for which there is no federal FMP or set of regulations or as long as state regulations are consistent with the federal management plan. Although policies and regulations specific to sharks are limited, sharks are part of the Pelagic FMP. This state law does not appear consistent with the general objectives of the plan, but this will definitely be a subject of debate.

[7] It must be emphasized that, according to observer reports, in the Hawaii longline fishery 98% of sharks brought on board alive are killed before they are finned.

5.2 Policies adopted

Because Amendment 9 is under review, no policies have yet been implemented based on the six issue areas discussed above. In the amendment document itself no action is recommended in relation to four of the six policies. The amendment proposes an annual quota for shark harvests by the Hawaii longline fishery to address the second issue identified above. It also recommends that bottom longlining be defined in regulations and banned in existing longline exclusion zones (closure areas) that surround both the main and the Northwestern Hawaiian Islands to address the fifth issue.[8] (These are actions coincident with those first proposed by the Council.) Amendment 9 describes two separate annual quotas, one for blue sharks and one for all other shark species. Under the proposal, 50,000 blue sharks could be landed annually. (Since only the fins from this species are taken, an amount of fins equivalent to 50,000 sharks could be landed.) The 50,000 figure approximates average annual landings during the years 1996-98. For all other shark species a quota of one shark, landed as a whole carcass, is proposed. This distinction recognizes that these other shark species are generally less abundant than blue sharks and that a market exists for their meat. If these annual quotas are implemented, in the future they can be modified through an existing 'framework adjustment' process. This is an administratively simpler set of procedures for modifying existing measures or implementing new measures that are specific to the operation of the fishery.

Although implemented policies specific to sharks are limited, other regulations applied to the Hawaii longline fishery could have an impact on shark landings. Perhaps most important is the limited entry program, developed in response to the rapid growth in fleet size during the late '80s and early '90s, which limits overall fleet effort. This began in 1991 when emergency regulations, followed up by an amendment to the Pelagic FMP, established a moratorium on new entrants to the fishery. (Earlier amendments established a licensing system for longline vessels.) A later amendment, in 1994, fixed the number of licenses at 164 (although only about two-thirds of these permitted vessels are currently active) and established a length-based vessel capacity limit of 101 ft. Longline vessel exclusion zones around the Hawaiian Islands and around Guam and its offshore banks, probably reduce catches of primarily coastal shark species. In December 1999 a civil suit in federal court, brought against the Council and the NMFS by a consortium of environmental organizations, resulted in an injunction closing a large area north of Hawaii to domestic longline vessels. The environmental groups brought the suit because of concerns that the fishery was having an adverse impact on threatened and endangered marine turtles, which are occasionally hooked by longline gear. The court-ordered closed area stretches north of 28° N between 168° W and 150° W.[9] This encompasses the area of highest blue shark CPUE and will thus have a substantial impact on catches.

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[8] The Northwestern Hawaiian Islands longline vessel exclusion zone was established in 1991 to prevent gear interactions with the monk seal. The exclusion zone around the main Hawaiian islands was implemented in 1992 in response to conflicts between longliners and other fishers, particularly inshore trollers.

[9] While this injunction is in effect the NMFS must develop a permanent time/area scheme for the Hawaii-based longline fishery in order to minimize adverse impacts to turtles.

5.3 Discussion

The council system established under the Magnuson-Stevens Act allows substantial input. Outside interest groups, such as conservation organizations, have some influence, particularly if they can mobilize public opinion. Fishing interests have a more direct role in policy formulation since they typically hold formal positions both on councils and in their advisory bodies. Policy setting in relation to sharks has largely been driven by controversy and public sentiment against the practice of shark finning. Conservationists likely believe that the proposed annual quotas for sharks are insufficient. In addition, they do not believe that this measure addresses the waste and cruelty issues. In contrast, the Council argues the that best scientific evidence does not suggest that the particular stock being fished, north Pacific blue sharks, is being over-exploited and does not see finning as wasteful (at least in economic terms) since no market currently exists for blue shark meat. The proposed 50,000 annual quota for blue sharks is in some degree a compromise. It essentially caps the practice at a level 15% below the 1999 total. This reflects a belief that current catches are sustainable while employing a precautionary approach that stops an increasing trend. Perhaps ironically, the bottom longline shark fishery in the NWHI generated relatively little public concern (probably because it was not publicized), yet resource managers viewed this fishery as far less sustainable. There are several factors that could override the policies outlined in Amendment 9. First, as noted, pending federal legislation would ban the practice of finning altogether. It is still too early to assess the impact of the recently passed State of Hawaii legislation, but it too could limit fin landings in the state. Finally, the NMFS can disapprove the amendment provisions and the Secretary of Commerce can override Council policy altogether by formulating his own plan for managing a particular fishery (Section 304 of the Magnuson-Stevens Act). Given the general unpopularity of the practice of finning and the fact that some uncertainty exists with respect to the status of stocks, more restrictive regulations could supercede the Council's proposal.

6 THE MANAGEMENT PLANNING PROCESS

6.1 Provision of resource management advice

Councils act as forums for comment from the public and fishing industry on proposed management measures. According to the Magnuson-Stevens Act (Section 302), voting members of councils include the "principal State official with marine fishery management responsibility" for each relevant jurisdiction in the council region, the regional director of the NMFS for the area concerned, and several members appointed by the Secretary of Commerce based on recommendations from the Governors of the relevant jurisdictions. (The WPRFMC has eight such voting members.) In addition, each council has several non-voting members who are representatives other relevant federal agencies. The Act also mandates that councils create a scientific and statistical committee to assist them in the development, collection and evaluation of necessary data. Other such panels may be created at a council's discretion. The Council has established 'plan teams' who provide advice specific to each FMP and advisory panels with members drawn from the fishing industry. In addition to advisory panels for each FMP, the Council has established "Ecosystem and Habitat" and "Native and Indigenous Rights" panels. The SSC and plan teams, in contrast, are staffed by NMFS scientists, academic experts and resource managers from relevant state agencies. The Council also has a full-time staff who, in addition to general administrative tasks, bear the main responsibility for drafting FMPs and amendments.

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This structure provides several channels for formulating objectives and setting policy. An issue or problem can be addressed directly to the Council during one of its meetings or by contacting a member or staff person in between meetings. Alternatively, it can be introduced from one of the advisory bodies. In either case, broad policy is formulated by the Council while the details are worked out by advisory bodies and Council staff. All proposals, no matter where they originate, are reviewed by the relevant advisory bodies. Even if these advisory bodies propose modifications to a measure under consideration, the Council still has the option of adopting the original proposal. This process is in general fairly lengthy since it takes a minimum of at least two quarterly Council meetings for a formal policy proposal responding to an issue (e.g., an FMP amendment) to be finalized. In the case of the proposed policies for shark catches, the annual quota was first mooted by the Council itself during its October 1999 meeting and subsequently reviewed by the relevant panels. The prohibition on bottom longlining was raised during a meeting of the Bottomfish and Seamount Groundfish Plan Team (line fisheries in the NWHI are covered in that FMP); the Pelagics Plan Team subsequently assumed responsibility for developing recommendations before the issue was presented to the Council in October 1999. A draft of Amendment 9 was written prior to the Council's March 2000 meeting and policy proposals were modified slightly during that meeting.

It can be seen that policy development can proceed in a "top down" fashion--when proposals originate directly from the Council--or in a "bottom up" manner when issues are raised within an advisory body. (For comparison, see Branstetter's discussion [, 1999 #17] of the federal management process for US Atlantic coast shark fisheries.

6.2 Fishery statistics

The NMFS Honolulu Laboratory manages regional fisheries data under its Fishery Management & Performance Investigation (FMPI) section. Fisheries data are collected through logbooks maintained by fishing vessels, shoreside monitoring of landings, market sampling, and special surveys of fishery participants. These data and analyses by Laboratory staff support Council decision-making. FMPI has three components. The Fishery Monitoring & Economics Program (FMEP) collects and processes fishery-dependent information. It also conducts economics research on Federally-managed fisheries and issues reports on these fisheries. The Western Pacific Fisheries Information Network (WPacFIN) collects and processes fishery management agency data from member states and develops computer-based data quality control and summarization programs for these agencies. The Fishery Data Management Program (FDMP) manages data collected by the NMFS Honolulu Laboratory and maintains lists of current and past data sets [Pooley, 2000 #39].

The primary data source for Hawaii longline vessels are logbooks maintained under federal regulations. As mentioned above, vessel operators record sharks in four categories. (blue shark, mako shark, thresher shark and other shark species) and disposition is also recorded (fins only, kept whole, and not kept/released). Domestic transshipping vessels are also required to maintain logbooks documenting transported product. (Reporting categories for shark are blue, mako, and fins, which are not identified by species. Numbers are recorded for carcasses but only total weight of fins is recorded.) Fishery observer data provides a greater level of detail and accuracy as well as a source of independent verification. However, observer coverage is usually low and cannot currently be extrapolated to estimate total shark catches.

It is important to remember that Council-managed fisheries are not alone in fishing on pelagic stocks. Shark catches are not as accurately monitored as those of target species in all western Pacific high-seas fisheries. Further, sharks that are caught may already be dead but are

often discarded. These discards may not be reflected in catch statistics and make dockside verification of total catch impossible because discards are not landed. Thus shark catches are probably under-reported in foreign high-seas fisheries and in comparison data from the Hawaii longline fishery are fairly accurate.

6.3 Stock assessment

Because blue sharks comprise most of the shark catch in sub-tropical and temperate high seas fisheries, including the Hawaii-based longline fishery, its stock status is of great interest to managers. While Stevens [, 1996 #1] cautions that the impact of high seas fisheries on the blue shark population is not fully understood, he notes that while they "are among the most widespread, fecund and faster growing elasmobranchs the general life history characteristics of this group limit their ability to withstand heavy fishing pressure." Nakano and Seki [, in review #25] point out that total blue shark catch by ocean is not precisely known and no comprehensive stock assessment currently exists. However, they argue that analysis of available catch data does not suggest that the stock status is in a critical state.

This assertion is supported by historical fisheries data, which indicate that the north Pacific blue shark population has not substantially declined over the past several decades, despite heavy fishing pressure by international fleets. Matsunaga and Nakano [, 1999 #5] analyzed catch data from Japanese longline research and training vessels. Two data sets were available, one from 1967-70 and one from 1992-95. Catch data were stratified in four geographic areas.[10] Blue shark comprised 73%-85% of total catch in the two 10°-20° N strata and 31%-57% in the two 0°-10° N strata during the two periods. Almost all Hawaii longline effort falls within the two west longitude strata (0-10W and 10-20W, see footnote). Mastsunaga and Nakano found that blue shark CPUE increased slightly from the 1967-70 to the 1992-95 period in these two strata (1.79 versus 1.91 for the 0°-10° stratum and 5.22 versus 5.82 for the 10°-20° stratum), but the difference was not statistically significant. (There was a marked, and statistically significant, increase in blue shark CPUE in the two east longitude strata.) Oceanic whitetip CPUE declined significantly in both west longitude strata. Silky shark CPUE increased significantly in the 0°-10° W stratum and decreased slightly (but not statistically significantly at the 5% level) in the 10°-20° W stratum. Thresher shark CPUE increased significantly in both strata.

Nakano and Watanabe [, 1991 #33] attempted a stock assessment for blue sharks based on catch data from the high seas driftnet fishery (which ceased in 1992) with supplemental data from longliners. They estimated minimum stock size in the North Pacific at 52-67 million and argue that "even the minimum stock can sustain the present catch level although mortality rate at [the] early stage is not known for blue shark" (p. 4). However, other authors do not consider the information sufficient to make an adequate estimate of stock size [Wetherall, 1991 #34]

The NMFS Honolulu Laboratory has initiated several efforts aimed at increasing knowledge of blue shark stock characteristics [Laurs, 1999 #22]. Most significant is a joint effort with Japanese scientists to make a stock assessment for blue sharks. The Laboratory has also initiated a tag and release program for blue sharks.

[10]These are 0°-10° N and 10°-20° N between 140° E-180° longitude, and 0°-10° N and 10°-20° N between 140° W-180° longitude. The zones are designated by their latitude boundaries and longitudinal direction: 0-10E, 0-10W, 10-20E, 10-20W.

6.4 Evaluation of the management process

Two aspects of the Hawaii longline fishery have made management of shark catches difficult. First, the overall pelagic fishery developed quite rapidly, followed by a steep increase in shark exploitation (finning) throughout the 1990s. Management is generally reactive, but this is especially true for this fishery because of its rapid development. Second, the underlying data needed for formulating management measures is somewhat limited. As already pointed out, data from US managed fisheries are good, but many foreign vessels fish the same stocks and there are intrinsic problems with accurately monitoring shark mortality because of its status as an incidental catch. Coupled with the public controversy over finning, this has made it difficult to formulate optimal policy. Nonetheless, as argued above, the pending proposal in relation to finning represents a balance between a total ban (which is not justifiable in biological or economic terms) and a total absence of harvest limitations, which is also imprudent given the uncertainties about stock status.

7 FISHERY MANAGEMENT REGULATIONS

Currently, there are no federal regulations governing shark catches in Council-managed fisheries, except for those that cover fisheries generally. These are found in Chapter VI, Title 50, Part 660 of the Code of Federal Regulations (50 CFR 660). Subpart C covers western Pacific pelagic fisheries. These regulations are summarized below.

Permits: Longline vessels require a general permit in the US EEZ outside of Hawaii (50 CFR 660.21(a)) and a limited entry permit in the Hawaii EEZ (50 CFR 660.21(b)). (This includes Hawaii-based vessels that also fish outside of the EEZ.)

Monitoring: Regulations cover identifying markings for permitted vessels (50 CFR 660.16) and gear (50 CFR 660.24), recordkeeping (including logbooks) (50 CFR 660.14), and conditions for at-sea observer coverage (50 CFR 660.28). Longline vessels are also required to install a satellite-based vessel monitoring system (VMS) that federal enforcement agents use to keep track of vessel position (50 CFR 660.25).

Closed Areas: As already noted, exclusion zones have been established in Hawaii and Guam for permitted longline vessels (50 CFR 660.26) and north of Hawaii to protect sea turtles (50 CFR 660.22(z)-(bb)).

Gear Restrictions: Drift gillnets are prohibited (50 CFR 660.30).

Procedural Matters: As already noted, Amendment 7 to the Pelagic FMP implemented a process that allows 'framework adjustments to management measures' (50 CFR 660.31). This establishes a somewhat simplified process for implementing new regulations.

8 THE LAW AND ENFORCEMENT

8.1 Legal status

Fisheries in federal waters are governed by the Magnuson-Stevens Act, and the regulations that implement measures and policies laid out in fisheries management plans, as amended. Broadly speaking, almost all fisheries are considered open access; in the absence of specific regulatory prohibitions resources may be exploited by any citizen. The Council formulates policy through plans and amendments, which usually contain proposed regulations. But the Council is a federal "instrumentality" administratively separate from executive line agencies. Thus, it is the NMFS, and ultimately the Secretary of Commerce, who approve and implement regulations. There is ample scope for modification by the executive during implementation.

Although Hawaii longline fleet effort is limited (by vessel number and length), there are no regulations limiting the amount of any species harvested. The proposed quota for sharks would represent the first such limit for the longline fishery.

8.2 Enforcement problems

The main anticipated difficulty in relation to the annual quota has to do with dock side monitoring. First, since most shark landings consist only of fins, enforcement agents will have to determine how many sharks a given amount of fins represents. Although sold in sets, representing the fins from a single shark, dockside transactions may aggregate sets and use weight as a proxy for estimating the number of sets.[11] Sorting and counting fins would be a cumbersome and unpleasant process. On the other hand, since it is easy to distinguish particular fin types (e.g., pectoral fins from the blue shark) it would be possible to identify and count a particular type in order to determine the number of sharks caught. Alternatively, the methods used by buyers, using weight, could be adapted for use by enforcement agents. The limit of one carcass landed per vessel may also be difficult to monitor. However, dock side monitoring is mainly intended as a deterrent to infractions. Logbooks are a primary source of information and enforcement efforts are mainly intended to ensure that fishers are not falsifying the information that they enter.

The bill passed by the Hawaii State Legislature, banning shark fin landings, also raises problems, aside from the question of whether federal fishery management regulations take precedence. The law allows the continued importation of fins (as opposed to landings by Hawaii-based vessels). It may be difficult to distinguish between imported and landed fins.

8.3 Surveillance

State and federal agencies cooperate in enforcement. Each enforce their respective laws. On the federal side, the Coast Guard and the NMFS enforcement division have primary responsibility. The Coast Guard undertakes at-sea and aerial surveillance, including vessel boardings and inspections. The NMFS and state agencies are active in dock-side monitoring.

[11] The Honolulu-based buyer mentioned earlier uses this method since in his experience blue shark fin sets do not vary greatly from the average weight he has established.

8.4 The legal process

Branstetter [, 1999 #17], in his review of US Atlantic coast fisheries, provides a general overview of the federal legal process. His discussion is briefly summarized here. If an alleged violation is discovered at sea, the vessel is taken to port and the catch is seized. A Notice of Violation and Assessment (NOVA) is then issued by federal agency attorneys. The defendant, or respondent, can agree to pay the fine, or contest the NOVA in an administrative civil hearing. Any decision may be appealed to the Administrator of the National Oceanic and Atmospheric Administration (the umbrella agency over NMFS). If found guilty, the respondent's fishing permit may also be revoked in addition to being liable for any assessed fines or forfeitures.

9 MANAGEMENT SUCCESS

Since management regulations for sharks have not yet been implemented it is not possible to assess their success.

10 MANAGEMENT COSTS

There have not been any formal efforts to determine management costs in the Council region. A simple estimate can be developed by considering the budgets for the agencies involved in management. Looking at the Hawaii longline fishery, these agencies include the Council, the US Coast Guard, the NMFS--including the Honolulu Laboratory, the Pacific Islands Area Office and the Enforcement Division--and two Hawaii state agencies, the Department of Aquatic Resources and the Department of Conservation of Resource Enforcement. Table 7 presents these estimates. The total comes to --.

Table 1

Pelagic management unit species and 1998 catches. (Source: [Ito, 1999 #10] Tables 1 & 2.)

Management Unit Species	Landings (mt)	Percent of Total
Swordfish (*Xiphias gladius*)	3,267.4	20.1%
Indo-Pacific blue marlin (*Makaira mazara*)	630.1	3.9%
Striped marlin (*Tetrapturus audax*)	408.2	2.5%
Miscellaneous billfish	181.4	1.1%
Sailfish (*Istiophorus platypterus*)	3.4	0.0%
Shortbill spearfish (*T. angustirostris*)	0.4	0.0%
Black marlin (*M. indica*)	0.0	0.0%
Sub-total, billfish	4,490.9	27.7%
Oceanic sharks (Alopiidae, Carcharinidae, Lamnidae, Sphynidae)	2,864.6	17.7%
Bigeye tuna (*Thunnus obesus*)	3,359.2	20.7%
Albacore tuna (*T. alalunga*)	1,650.1	10.2%
Yellofin tuna (*T. albacares*)	1,644.3	10.1%
Skipjack tuna (*Katsuwonus pelamis*)	716.2	4.4%
Northern bluefin tuna (*T. thynnus*)	18.1	0.1%
Dogtooth tuna (*Gymnosarda unicolor*)	7.0	0.0%
Kawakawa (*Euthynnus affinis*)	1.7	0.0%
Other tuna relatives (*Auxis spp., Scomber spp., Allothunus spp.*)	1.2	0.0%
Sub-total, tunas	7,397.7	45.6%
Mahimahi (*Coryphaena spp.*)	500.2	3.1%
Moonfish (*Lampris spp.*)	409.0	2.5%
Wahoo (*Acanthocybium solandri*)	406.9	2.5%
Oilfish family (*Gempylidae*)	*	
Pomfret family (*Bramidae*)	*	
Sub-total, others	1,316.1	8.1%
Other**	149.9	0.9%
Total	16,219.3	100.0%

*No landings reported

**Includes barracuda, rainbow runner and miscellaneous pelagics

Table 2

Sharks caught in the Hawaii-based longline fishery based on 1998 observer data and 1999 catches as reported in logbooks.

Name	Number	Percent
Blue shark (*Prionace glauca*)	78,091	89.2%
Thresher sharks	3,716	4.2%
Bigeye thresher (*Alopias superciliosus*)		
Pelagic thresher (*Alopias pelagicus*)		
Common thresher (*Alopias vulpinus*)		
Unid. thresher (*Alopias spp*)		
Mako sharks	1,625	1.9%
Shortfin mako (*Isurus oxyrinchus*)		
Longfin mako (*Isurus paucus*)		
Unid. mako (*Isurus spp*)		
Other sharks	4,144	4.7%
Oceanic whitetip (*Carcharhinus longimanus*)		
Smooth hammerhead *(Sphyrna zygaena*)		
Scalloped hammerhead *Sphyrna lewini*)		
Unid hammerhead (*Sphyrna spp*)		
Tiger (*Galeocerdo cuvier*)		
Galapagos (*Carcharhinus galapagensis*)		
Dusky (*Carcharhinus obscurus*)		
White (*Carcharodon carcharias*)		
Crocodile shark (*Pseudocarcharias kamoharai*)		
Salmon shark (*Lamna ditropis*)		
Silky shark (*Carcharhinus falciformis*)		
Sandbar (*Carcharhinus plumbeus*)		
Cookie cutter (*Isitius plodius* or *brasiliensis*)		
Bignose (*Carcharhinus altimus*)		
Total	87,576	**100.0%**

Table 3

Landings and value of pelagic fisheries in the Council region in 1998. (Source: [WPRFMC / Western Pacific Regional Fishery Management Council, 1998 #23]. Landing value for Hawaii longline fishery is estimated round weight.)

	Total landings (mt)	**Value ($)**	**Shark landings (mt)**
American Samoa			
Longline	401.1		3.3
Troll	11.5		0.1
Am. Samoa total	412.5	$998,930	3.4
Guam			
All pelagic fisheries	370.6	$711,066	3.6
Hawaii			
Longline	12,972.7	$46,651,000	2,815.4
Aku baitboat	317.5	$932,000	
troll & handline	1,496.9	$7,226,000	42.2*
Other	589.7	**	
Hawaii total	15,376.8	$54,809,000	2857.6
CNMI			
All pelagic fisheries	89.2	398087	?
Total	**17,696.50**	**$56,917,083**	**2,850.6**

*Shark landings for all non-longline fisheries

** Value included under troll & handline

Table 4

Disposition of sharks in 1999. (Source:)

	No. finned	No. kept as carcass	Total no. caught	Percent of shark total catch	Percent of total caught that were finned, by category	Percent of total finned, by category
Blue	51,915	81	78,091	89.2%	66.5%	90.6%
Mako	624	715	1,625	1.9%	38.4%	1.1%
Thresher	1,857	166	3,716	4.2%	50.0%	3.2%
Other	2,890	20	4,144	4.7%	69.7%	5.1%
Total	57,286	982	87,576	100.0%	65.4%	100.00%

Table 5

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

Location and source fleet	Estimated volume (dry fin weight, mt)	Average price range ($/kg)	Estimate range of ex-vessel value ($ '000)
Hawaii-based longline	38	25-30	950-1,140
Hawaii transshipments	132	18-20	2,376-2,640
Guam: Taiwan longline transshipments	5-6	20-30	100-180
Guam: Japanese longline	18-28	10-13	180-364
Am. Samoa: foreign longline	35-47	13-15	455-705
Am. Samoa: purse seine	9-10	18-23	162-230
TOTAL	**237-261**		**$4,223-$5,259**

Table 6

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

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

Table 7
Estimate of management costs in the Council region.

Agency	Basis for Estimate	Amount ($)
WPRFMC	Proportion of Council staff time and resources devoted to pelagic fisheries, of which shark management has been a major component	200,000
US Coast Guard	Amount of 14th District budget devoted to monitoring and enforcement in longline fishery	1,600,000
NMFS Honolulu Laboratory	FMPI budget and budget item for shark assessment	434,000
NMFS Pacific Island Area Office	Staff time devoted to pelagic fisheries	100,000
NMFS Enforcement Division	Staff time devoted to pelagic fisheries	180,000
Hawaii State Department of Aquatic Resources	Staff time devoted to pelagic fisheries	487,733
Hawaii State Department of Conservation and Resource Enforcement	Not available	
TOTAL		

Figure 1: The WPRFMC region.

Figure 2: Distribution of fishing effort in the Hawaii-based longline fishery. (Source: [Ito, 1999 #10])