Managing Sustainable Shark Fishing in the Mariana Archipelago

August 2013

Western Pacific Regional Fishery Management Council

1164 Bishop St., Ste. 1400

Honolulu, Hawai'i, 96813

A report of the Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400, Honolulu, HI 96813

Prepared by Max Markrich

Published in the United States by the Western Pacific Regional Fishery Management Council

ISBN 978-1-944827-54-0

Introduction

This white paper explores the potential for sustainable shark fishing within the US EEZ surrounding the Mariana Archipelago and adjacent high seas. Marianas fishery participants have made it known to the Council that high levels of shark populations in the Marianas Archipelago are believed to occur, resulting in depredation of target catches when pelagic trolling and bottomfishing.

In addition, in mid-2000s, the USCG and NOAA successfully apprehended illegal foreign fishing vessels targeting sharks in the Mariana Archipelago, which also suggests commercially viable catch rates. Attempts to establish a pelagic longline fishery within the Marianas Archipelago may consider harvesting sharks as well as the more valuable tunas and billfish species.

The purpose and need for this paper is to:

- Provide the rationale for a systematic survey of shark resources in the US EEZ around the Mariana Islands
- Describe relevant information on shark fisheries and markets,
- Identify potential management options for Council consideration with regards the harvests of sharks in the Marianas Archipelago.

Background Information

Sharks continue to be the focus of much concern from conservation groups, due to the vulnerability of some shark populations to fishing and increasing demand for shark products, (TRAFFIC 2006; Worm et al 2013) especially with the rise in wealth in China (Bain & Company 2011). A particular focal point for the conservation community has been the traditional Chinese dish, shark fin soup, where the cartilaginous filament from shark fins, is served in a soup of chicken or beef stock. It is believed that this is the major market for shark.

As shark fins have become more valuable, captured sharks caught incidentally may be finned and the carcass discarded at sea. This practice is known as shark finning and occurs in many fisheries worldwide. This was a common practice in the Hawaii longline fishery prior to the year 2000, when landing shark fins without corresponding carcasses was prohibited federally through the Shark Fin Prohibition Act (SFA)[1]. The SFA permitted finning at sea but required shark fins to account for no more than 5% of the total weight of sharks on board a vessel. In 2010, the Shark Conservation Act (SCA) amended the Magnuson-Stevens Act (MSA)[2], requiring all sharks to be landed with fins attached[3]. It is important to note that the intent of Congress was not to prohibit harvesting, possession or sale of shark fins, but to address the practice of shark finning by requiring fins to be attached to carcasses. Congress chose to prohibit the discarding of shark carcasses at sea

[1]Federal Register, Vol. 67, No. 28, February 11, 2002, 6194-6202.
[2] Magnuson-Steven Act Fishery Conservation and Management Act, U.S. Department of Commerce, 170 pp.
[3] Federal Register, Vol. 78, No. 85, May 2, 2013, 25685-25690

and thus strike a balance between addressing the wasteful practice of shark finning and the preserving opportunities to land and sell sharks harvested consistent with the MSA.

The rise of middle class in China will continue to generate a demand for sharks and shark products. As such, it is reasonable to pose the question, can sharks be harvested sustainably, and how might this be achieved?

Mariana Archipelago

The Mariana Archipelago comprises two US territories, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI). Figure 1 shows a map of the Marianas Archipelago and the surrounding EEZ.

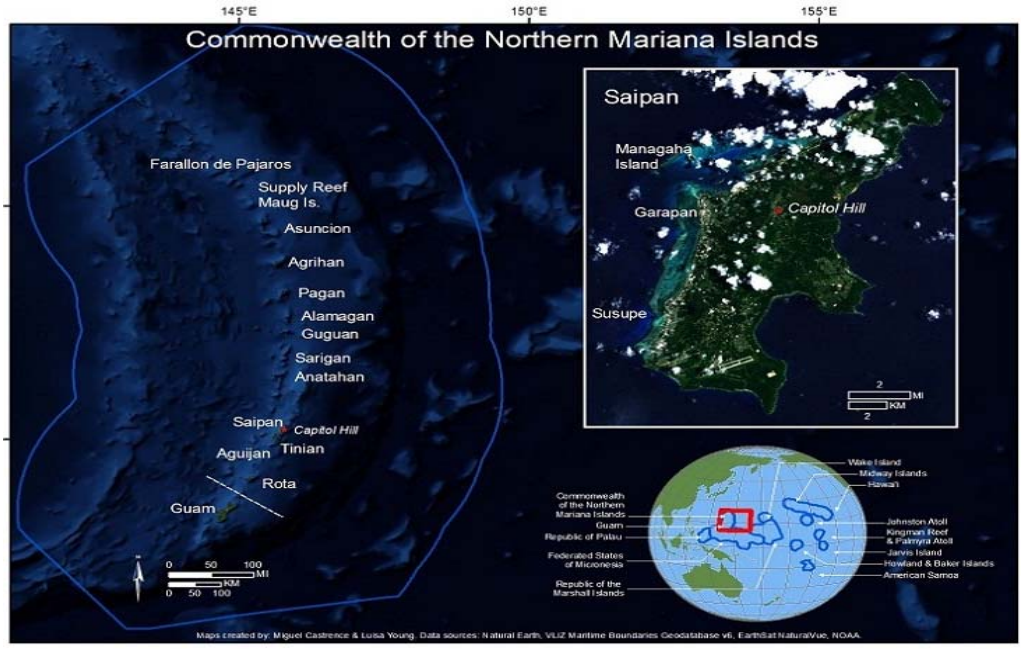


Figure 1. Map of the Marianas Archipelago

The US EEZ around the Mariana Archipelago has a spatial extent of about 181,000 sq nm. Both territories have fisheries that are dominated by small boats catching mainly pelagic fish in near shore waters, i.e. within 20 nm of land, though fishermen do on occasion fish on offshore banks up to 50 nm from land. There is no industrial scale fishing in either Guam or CNMI. Recent ventures to establish longline fishing in the CNMI over the past decade were unsuccessful, and no longline fishing is currently occurring within the EEZ of the Mariana Archipelago, although a few vessels still based in the Marinas hold Western Pacific General longline permits.

National Standard 1 in the MSA states that conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield (OY) from each fishery for the United States fishing industry. The term "optimum", with respect to the yield from a fishery, means the amount of fish which:

- will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;
- is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and
- in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery.

Fisheries in the Mariana Archipelago including those targeting reef fish and bottomfsih are fishing well below established Annual Catch Limits and potential Optimal Yield, ,due to extensive areas of the entire archipelago that are uninhabited or lightly inhabited. Even on Guam, large areas of the coast are closed to fishermen by the military[4] but is not yet or allocated primarily to other sector of the economy, e.g. Tumon Bay for tourism. However, pelagic fisheries represent the greatest potential for fisheries development with respect to achieving OY for the Marianas. Current harvest of all pelagic species amount to 500 mt annually. The potential for skipjack harvest alone from within the Mariana EEZ is estimated to be about 18,000 mt (Bigelow 1998).

Although domestic pelagic longline fishing has not been able to gain a secure foothold in the Marianas, future attempts to establish a pelagic longline fishery within the archipelago could consider harvesting sharks as well as the more valuable tunas and billfish species. As is shown later in this paper, shark meat commands relatively low prices but shark fins are much more valuable. Thus any fishery development for a pelagic longline fishery may make a greater contribution of achieving OY with the inclusion of shark catches directed to the shark fin market while also finding utilization of shark meat and other products.

Lastly, fishermen in Guam have noted for the past two decades about the level of shark depredation of pelagic, bottomfish and reef fish catches (PIFG 2012). The establishment of a fishery that harvests sharks may provide some measure of relief for fishermen losing catch to sharks, and may provide some balancing effects on the ecosystem by reduce levels of top predators.

Table 1. Shark species observed in the Mariana Archipelago

Common name	**Scientific name**
Coastal and Reef Sharks	
Blacktip reef shark	*Carcharhinus melanopterus*
Galapagos shark	*Carcharhinus galapgensis*
Gray reef shark	*Carcharhinus amblyrhynchos*
Tawny nurse shark	*Nebrus ferrugineus*
White-tip reef shark	*Triaenodon obesus*

[4] Fishing by military personnel occurs on military bases and is currently being documented in a project being conducted jointly by the Guam Division of Aquatic and Wildlife Resources and the US Navy

Common name	Scientific name
Pelagic Sharks	
Blacktip shark	*Carcharhinus limbatus*
Blue shark	*Prionace glauca*
Bluntnose sixgill shark	*Hexanchus griseus*
Cookiecutter shark	*Isistius brasiliensis*
Great hammerhead shark	*Sphyrna mokarran*
Oceanic whitetip shark	*Carcharhinus longimanus*)
Pelagic thresher shark	*Alopias pelagicus*
Scalloped hammerhead shark	*Sphyna lewini*
Shortfin mako shark	*Isurus oxyrinchus*)
Silky shark	*Carcharhinus falciformis*
Silvertip shark	*Carcharhinus albimarginatus*
Tiger shark	*Galeocerdo cuvier*
Whale	*Rhinocodon typus*

Marianas Shark Resources

In the Marianas Archipelago, there is an estimated total reef shark population biomass of about 400 mt (Williams *et al* 2010) based on underwater visual surveys. Table 1 lists all of the observed shark species in the Marianas Archipelago.

The uninhabited northern islands have higher relative densities of sharks, and three of the islands are off limits to commercial fishing as part of the Mariana Trench National Monument (see below). There are many seamounts in the Mariana Archipelago, with seamount chains to the east and west in parallel with the island chain. Many of these seamounts are shallow enough to support coral reef habitat and fauna including reef sharks. Moreover, seamounts are aggregators of pelagic fish which would also include pelagic sharks.

Ward-Paige *et al*. (2010) found that in the Carribean, sharks in general, occur more frequently in areas with lower human population density, suggesting sharks populations are sensitive to anthropogenic pressures. In the Western and Central Pacific, Nadon *et al* (2012) found that shark populations have also been found to be larger around smaller reefs because there tends to be increased fishing by humans at larger reefs and on isolated islands where the shallow reef habitat attracts transient sharks.

Fisheries in the Marianas do catch and land sharks but there currently are no directed fisheries for sharks in the archipelago, and sharks tend to be discarded as bycatch[5]. The Guam troll fishery in the period 1996-2004, annually caught 2.5 mt on average comprised primarily of silky, Galapagos and oceanic whitetips (Dalzell *et al* 2008), while in 2011, 238 lbs (0.1mt) of pelagic

[5] The term "bycatch" in the Magnuson-Stevens Act means fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards.

shark were landed in Guam (WPRFMC 2013). CNMI shark bycatch is negligible and there are no documented accounts of sharks being landed.

Fisheries of the Marianas Archipelago

Table 2 summarizes the recent catch composition of commercial landings in Guam and CNMI (NMFS PIFSC). The following descriptions are freely adapted from the WPRFMC (2012) for bottomfish and reef fish and from WPRFMC (2013) for pelagic fisheries.

Table 2. Composition of commercial catches in Guam and CNMI based on mean of 2008-2012 landings

Archipelago	Pelagic Fishes (lb)	% Pelagic	Bottomfish (lb)	% Bottomfish	Reef Fishes (lb)	% Reef	Other Fishes (lb)	% Others	Total (lb)
Guam	151,868	53	13,382	5	109,058	39	8,819	3	283,127
CNMI	173,130	60	29,776	10	60,334	21	27,242	9	290,482

In Guam, shore based fishing is primarily a subsistence or sport fishery, while boat based fishing also includes commercial fishing and expense fishing (sales of fish to cover trip costs). Shore based fishing accounts for most of the fish and invertebrate harvest from coral reefs around Guam. The shore based coral reef fishery is comprised mostly of the hook and line, gill net, snorkel spear, and surround net methods. Guam coral reef fisheries are general non-selective, target a wide variety of species where most of the catch is retained. These fishery characteristics have minimal by-catch. The bottomfish fishery is comprised of a shallow water complex (< 500 feet) and a deep water complex (>500 feet). Bycatch has been reported only by charter boats and is composed primarily of juvenile groupers, triggerfish and goatfish and not sharks. Vessels from Guam make trips to the southern banks which are between 20-50 miles from Guam.

In CNMI the coral reef fishery is important to families as a source of food, income, social and culture purposes and for recreation. Finfish and invertebrates are the primary targets caught commonly by cast netting, spear fishing, hook and line, gleaning, trolling and bottom fishing. The bottom fish fishery in CNMI consists primarily of small scale local boats engaged in local commercial and subsistence fishing, although a few (generally <5) larger vessels (30-60 ft) usually participate in the fishery. The deep water fishery is primarily commercial, targeting snappers and groupers, and the shallow water fishery is mostly commercial targeting redgill emperor, but also includes subsistence fishermen. As with Guam, reef and bottom fisheries catch few if any sharks. In

the mid-2000's, a deep-water shrimp fishery existed in CNMI. Fishery participants reported using shark as bait within the shrimp traps.

Troll fishing is the primary method of pelagic fishing in CNMI, followed by handline fishing for bottomfish and reef fish. Troll fisheries in the Marianas archipelago mostly target skipjack tuna (*Katsuwonus pelamis*), mahmahi (*Coryphaena hippurus*), yellowfin tuna (*Thunnus albacares*), and wahoo (*Acanthocybium solandri*). In contrast to Guam's vessels, which are generally under 33 feet, CNMI pelagic fishing fleets consist mostly of vessels under 24 feet. CNMI troll vessels typically do not venture more than 20 miles from Saipan (Hospital et al. 2013). Troll fisheries in the Marianas generally do not catch sharks, nor target sharks. Pelagic fisheries in the Marianas produce the largest volume of commercial landings.

Commercial fishing offshore of the CNMI and Guam has centered on pelagic fish, caught by longline and trolling. Four U.S. longliners fished offshore of Saipan in the 2007-2011 period and one U.S. longliner fished briefly offshore of Guam in 2007. The four longliners may each potentially caught up to 15,000 pounds per trip, comprising mostly of yellowfin and albacore tuna but actual estimates are confidential. Presently, no longliners operate in the Marianas after the longline fishery failed due high operating costs and poor business planning And lack of infrastructure to support a longline fishery (P. Bartram *pers. comm.*).

Traditional Uses of Sharks

Sharks have been and continue to be important in the culture of Pacific islands. Across the Pacific sharks were both revered and hunted.

Sharks in the Marianas were traditionally fished as a food sources and their skins and teeth were used for various purposes. Mainly sharks were caught by hooks, and harpoons but fishing for sharks appears not to have been as prevalent as in other parts of the Pacific (Nunez, 2003). In Guam, boiled breadfruit dipped in blood was used to attract and catch sharks. The hot breadfruit would implode inside the shark's stomach subsequently killing it.

Sharks in CNMI and Guam were part of the traditional religious practices. Sharks, as in other part of the Pacific, were considered part of the family and were called upon to protect capsized voyagers and fishermen. Chants were recited to call upon sharks for protection. Although there was a strong affiliation with sharks by the people of the Marianas, many navigators, voyagers, and fishermen wore tattoos of dolphins to ward off shark attacks.

Evidence connecting sharks and people in the Marianas Archipelago has recently been unearthed. A burial of a woman at Tumon Bay, Guam, contained 12 drilled tiger shark teeth. The burial, which dates to the Pre-Latte Phase (prior to AD 1000), also contained numerous cone shell beads. Two other burials from the same site each contained one drilled shark tooth (not tiger shark). These two burials date to the Latte Phase (approximately AD 1000-1521) (Amesbury *pers. comm.*) Four drilled shark teeth, as well as 14 smaller, non-perforated teeth, were recovered from the excavation of Pagat, Guam (Craib, 1986). Other archaeological sites in Guam, Saipan, Tinian

and Rota have yielded fish remains identified to the family Carcharhinidae or the subclass Elasmobranchii (Amesbury and Hunter-Anderson 2003; Amesbury and Hunter-Anderson 2008).

Nunez (2003) summarizes the importance of sharks in Hawaiian and Samoan culture and tradition. In Hawaii, like much of the Pacific, the primary use of sharks was as a source of food but the shark skin and teeth were also used for cultural artifacts. Throughout the Pacific, in places as diverse as Hawaii, the Solomon Islands, Papua New Guinea and Tonga, people traditionally believed and still believe that sharks are an embodiment of their ancestors and fishermen would "call" sharks in order to catch them.

Hawaii's fishing traditions have been extensively documented, and include stories describing forms of shark manifestations as Gods, traditional implements and methodology of catching sharks, and shark guardians of specific areas and families (Maly, 2003). Sharks played and still play for some individuals and communities an important part in Hawaiian religious practices. The '*aumakua*, family god, was the spirit of an ancestor or relative in a physical form. '*Aumakua* were and still are intimate members of Hawaiian families through spiritual and physical relationships. Sharks are still recognized as one of the most common '*aumakua*.

Noosing sharks is a traditional shark catching method practiced in Hawaii, Samoa, Palau, Papua New Guinea, and Tonga. Pacific islanders discovered that certain types of vibrations will attract sharks (Johannes, 1981). On shark calling excursions, a shark rattle made from coconut half shells is used to attract sharks to the canoe and the shark is led by a baited spear into a noose woven from coconut husks and then pulled into the hull where it is bludgeoned to death (Johannes, 1981).

Hawaiian chiefs fished for sharks using the hook and noose methods while fishermen often used the shark nets. Shark hooks were fashioned from koa wood grown with a natural curve by bending twigs to the right shape and lashed in position so that it would curve on itself and were left to grow in order to be strong enough to withstand a shark's bite (Charlie Ka ai ai *pers. comm.*). This method of making shark hooks was commonly practiced throughout the Pacific islands such as also documented in the Gilbert islands (Grimble, 1952).

Hawaiians used the skins of great white shark (*Carcharodon carcharia)*, tiger shark, and mako sharks, as drum heads for ceremonial temple drums and hula drums. The teeth of great white and grey reef sharks were used for tools and weapons but the teeth of tiger sharks were the most commonly used for weapons. Shark teeth were fitted to weapons such as spears, daggers swords and even knuckledusters. Shark weapons were multi-functional and were used as tools for carving, cutting and in sizing or etching on gourds. Shark teeth tools were used to cut *wuake*, paper mulberry bark, to make *kapa,* traditional Hawaiian cloth.

Sharks and shark fishing played an important traditional and political role in Samoa's highly structured social system. Only chiefs had the right to receive and distribute captured sharks.

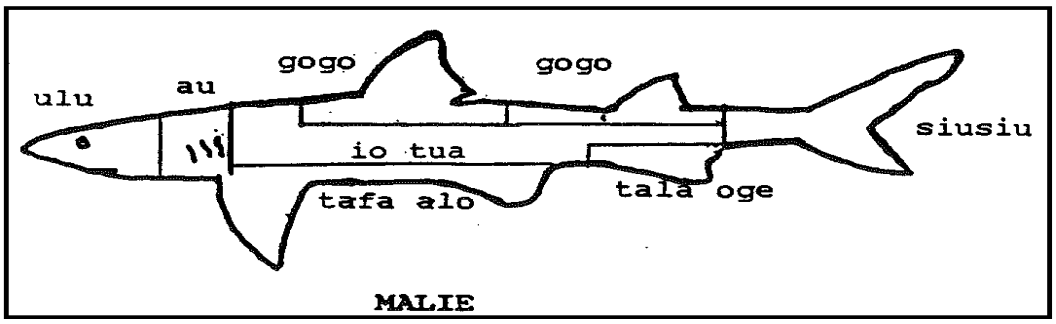


Figure 2 Shark sections distributed in Samoa according to rank (Severence *et al* 1989)

Sections of caught sharks were distributed based on social ranking. The *io tua* and *gogo* were reserved for the highest ranking chiefs. The *tafa alo* and *tala oge* were presented to other ranking chiefs, and the *siusiu* went to talking chiefs presiding over the ceremony. The *ulu* went to an untitled man who distinguished himself during the *lepaga* (shark catch expedition) or the '*ava* (preparation ceremony). Figure 2 illustrates the sections of shark distributed in Samoa.

There is little information on traditional Chamorro shark fishing in Guam and CNMI after the colonization and the near total genocide by the Spanish (1521-1898). Further cultural erosion occurred during the subsequent administration by the United States (1898-1941, 1944-1950) and Japan (1941-1944). The gradual elimination of dances, chants, songs of the past, and especially the loss of other cultural practices such as the arts, crafts and fishing practices passed on generationally, has left Chamorros with an eroded identity (Taimanglo, 2010).

Vulnerability of Sharks

Sharks in general are more vulnerable to fishing than most other bony fish. Compared with other marine fishes, sharks have relatively low productivities, but they vary widely between shark species, and which have differing abilities to withstand, or to recover from exploitation. A summary of the sharks observed in the Marianas and their potential vulnerabilities is given in Table 2.

Smith *et al* 1998 studied the intrinsic rebound potential of 26 shark species and found that in general, there is a tendency for smaller-sized species to mature earlier, to be shorter lived, and to have higher intrinsic rates of increase than larger species (e.g. dogfish). The lowest recovery capabilities also tended to be coastal species, but were generally medium to large sized sharks, slow growing and late to mature such as the sandbar shark (*Carcharhinus plumbeus*). The sharks within the mid-range of productivity were mostly large pelagic species, relatively fast growing and early maturing, including the black tip, grey reef, silky, tiger and blue shark.

Although the Smith *et al* 1998 study found that pelagic sharks are productive relative to large and medium coastal sharks, it was not focused specifically on the impact of pelagic longline fisheries. Cortes *et al* 2010 studied 11 elasmobranch species' vulnerability in order to categorize the relative risk of overexploitation by pelagic longline fleets in the Atlantic Ocean for each species. The silky, shortfin mako and bigeye thresher are at the highest risk of overexploitation, the whitetip and longfin mako are also highly vulnerable, the blue shark shows intermediate vulnerability, the

smooth and scalloped hammerheads have a lower risk and the common thresher has the lowest risk. Cortes *et al* 2010 found that pelagic sharks as a group are vulnerable to the effect of pelagic longline fisheries because of their limited productivity.

Table 3 Observed Sharks of the Marianas, Adult Size, Habitat, Productivity and Vulnerability (Sharks of the Marianas Archipelago, 2006. Cortes *et al* 2010. Compagno *et al* 2008)

Sharks of the Marianas					
Type	**Common/Scientific Names**	**Adult Size (M/F)**	**Habitat**	**Productivity**	**Vulnerability**
Oceanic					
	Blacktip Shark (*Carcharhinus limbatus*)	1.4-1.8m/1.2-1.9m	Littoral, semipelagic	medium	
	Blue Shark (*Prionace glauca*)	1.8-2.8m/2.2m	Oceanic, semipelagic	high-medium	medium
	Bluntnose Sixgill Shark (*Hexanchus griseus*)	3.1-3.3m/3.5-4.2m	Benthic, semipelagic		
	Cookiecutter Shark (*Isistius brasiliensis*)	0.31-0.37m/0.38-0.44m	Oceanic		
	Great Hammerhead Shark (*Sphyrna mokarran*)	2.3m/2.1m	Littoral, semipelagic		
	Oceanic Whitetip Shark (*Carcharhinus longimanus*)		Oceanic, semipelagic	medium	high
	Pelagic Thresher Shark (*Alopias pelagicus*)	2.5-3m	Oceanic, occasionally littoral		
	Scalloped Hammerhead Shark (*Sphyrna lewini*)	1.4-1.65m-2.12m	Littoral, semipelagic	low	low
	Shortfin Mako Shark (*Isurus oxyrinchus*)	2-2.2m/2.8-2.9m	Oceanic, semipelagic, littoral	medium	high
	Silky Shark (*Carcharhinus falciformis*)	1.9-2.2m/2.1-2.3m	Oceanic, semipelagic	low-medium	high
	Silvertip Shark (*Carcharhinus albimarginatus*)	1.6-1.8m/1.6-2m	Littoral, semipelagic		
	Tiger Shark (*Galeocerdo cuvier*)	2.9m/3.3-3.5m	Littoral, semipelagic	low-medium	
	Whale Shark (*Rhinocodon typus*)	8-9m/8m	Oceanic, semipelagic, littoral		
Reef					
	Blacktip Reef Shark (*Carcharhinus melanopterus*)	0.91-1m/0.96-1.12m	Littoral, coral reef		
	Galapagos Shark (*Carcharhinus galapgensis*)	1.7-2.4m/2.4m	Littoral, semipelagic	medium	
	Gray Reef Shark (*Carcharhinus amblyrhynchos*)	1.1-1.5m/1.2-1.4m	Littoral, coral reef	medium	

	Tawny Nurse Shark (*Nebrus ferrugineus*)	2.5m	Littoral, coral reef	high	
	Whitetip Reef Shark (*Triaenodon obesus*)	1-1.1m/1.1m	Littoral, coral reef	medium	

Shark demand

Unlike many other targeted species, sharks are capable of providing multiple sources of revenue from a single catch. Shark fins and meat are a well known product, but teeth and jaws, hides, liver oil, and cartilage are also valuable sources of income for fishermen.

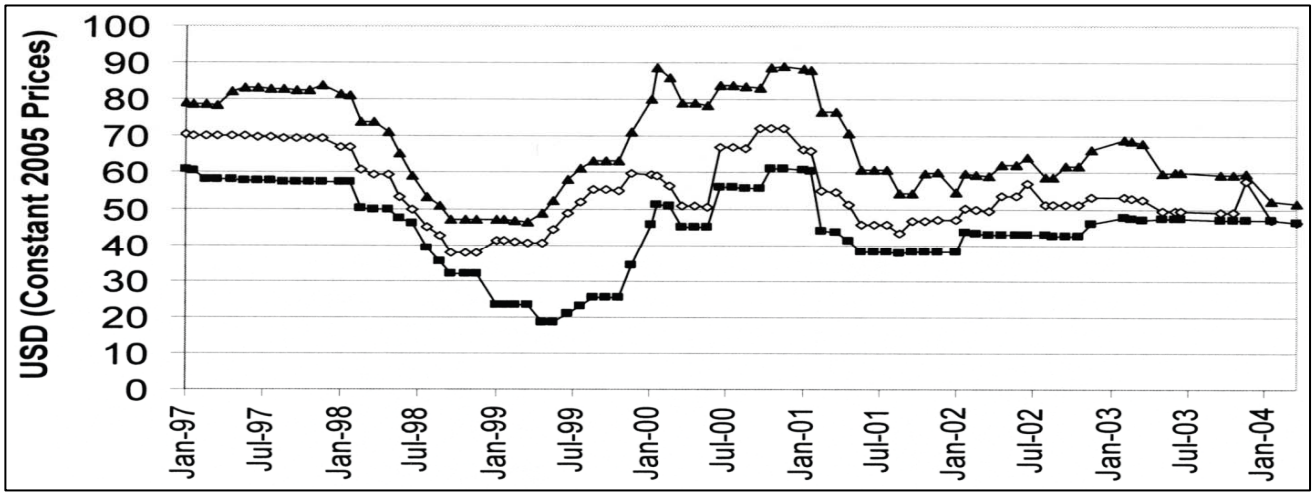


Figure 3: Shark Fin (Ocean White ▲; Blue ◊, Mako ■) Prices, January 1997-April 2004

Shark meat forms part of the fresh fish trade and is also consumed dried, salted or smoked in many communities. Shark liver was once valued as a source of vitamin A, but is now harvested to extract squalene. Squalene is low in cholesterol and rich in polysaturated fatty acids that can act as an anticoagulant in treating cardiac arrest. In addition it can be used as a high grade machine oil, a skin rejuvenator in cosmetics, and pharmaceutical products. Shark cartilage is harvested and used as a dietary supplement. Dried shark skin provides 'shagreen', traditionally used for polishing wood and binding books. The skin can also be turned into leather which has higher tensile strength than leather made from cattle hides and can be made into products such as hand bags, wallets, belts, watch bands, shoes and boots (Walker. *et al* 1998).

The largest trading center for shark fins is Hong Kong and Figure 3 shows that the Hong Kong price of a single shark fin ranges from US$20 to US$90. (Clarke *et al*. 2007). By contrast shark meat has a substantially lower value and requires fishing vessel storage space that might be used to store more valuable boney fish. In 2011, shark meat, predominantly makos and thresher, sold for US$0.65 per pound in Hawaii.

The rapid growth in Chinese disposable income in the new millennium has resulted in the increased demand for shark fins as a luxury seafood product and a medicine. The implications of China's economic growth and consumer spending patterns for the utilization of high-end fisheries resources such as shark fins will depend on several factors. These include consumers' spending priorities, the ability of supplies to keep pace with demand, and potential changes in consumers' awareness of conservation issues (Clarke *et al* 2003). The market show signs of price elasticity illustrated by declines in import records immediately following strict shark fin trade bans in the US (Walsh *et al* 2009). Additionally, there are signals that the shark fin trade is declining, most likely caused by the Chinese government's changing attitude toward luxury products and its ongoing anti-smuggling campaigns (S. Clarke *pers. comm.*).

According to Clarke *et al* 2003, between 1,108 mt and 1,247 mt of shark fins were auctioned annually in Hong Kong between October 1999 and March 2001. The largest fraction of identified fins, 17-20% was blue shark, while all other identified shark species individually comprised 5% or less of the total traded weight. The most commonly traded shark fins, that have been verified include shortfin and longfin mako, common, pelagic, and bigeye thresher, tiger, blue, and silky sharks. The smooth, scalloped and great hammerheads comprise the major proportion of hammerhead shark fins but are less common in the Hong Kong market.

Guam already exports goods from its garment and jewelry industry averaged 13.3% to Hong Kong, in 2012. The Marianas Archipelago provides a potentially good location to support the Chinese demand for shark products. The Marianas Archipelago location is favorably located geographically to export to other major Asian countries such as Japan, Republic of Korea, Philippines, Singapore and Taiwan within a 3-6 hours flight time.

Shark Fishery Options

Potential coastal and reef shark fishery

Vessels targeting bottomfish in Guam and CNMI catch a mix of shallow water reef fish and the deeper snapper and grouper complex on the deep reef slope. In CNMI, in 2010, 26 vessels ranging in size from small skiffs to boats 70 feet in length reported commercial catches of bottomfish. It is likely, however, that in addition to commercial fishing many more small skiffs conduct bottomfishing for subsistence. The shallow BMUS component, dominated by *Lethrinus rubrioperculatus*, is fished both commercially and for subsistence with most fishing trips made by small vessels primarily using handlines or electric reels, and lasting a single day. The deep BMUS component is fished commercially and the fishing effort includes a substantial number of large vessels conducting multi-day trips.

In Guam, bottomfish are caught by a combination of recreational, subsistence, and small-scale commercial fishing operations. In 2010, 99 vessels were reported to participate in bottomfishing activities. Most of the fleet consists of vessels less than 25 feet in length that target the shallow species components around Guam for recreational or subsistence purposes. Some recreational vessels (<25 ft) also target the deep component at the offshore banks and other areas

offshore of Guam where deep bottomfish habitat occurs. Larger vessels (> 25 ft) fishing commercially target the deep species components at offshore banks (e.g., Galvez and Santa Rosa Banks to the south and Rota Bank to the north).

A large scale fishery for reef and coastal sharks is unlikely to be sustainable in the long term, given the current low catches, and the current longline exclusion zones in the Mariana Archipelago. Reef sharks in particular are unlikely to support a large scale fishery due to their population vulnerability. In addition, reef sharks tend to be smaller than their oceanic counterparts, reducing their value for fins and meat in comparison to oceanic sharks.

There may be potential for revenue to be gained for bottom fishermen who incidentally catch sharks. Fishermen in the Marianas have continued to complain about shark depredation of their catch. In the Marianas there are many occasions where the sharks are not hooked, but the depredation rate is so severe that bottom fishers will relocate to another fishing site (PIFG 2012). Moving can be time consuming because the majority of fishermen in smaller vessels often rely on geographical features for guidance to a fishing area. Bottom fishermen typically make multipurpose trips, trolling on their way to reefs. Retained reef and pelagic sharks and selling fins could supplement the loss in revenue from depredation.

Potential pelagic shark fishery

Any substantial full-time directed shark fishery targeting pelagic sharks would likely have to employ pelagic longlines. Longline fishing in the US EEZ around Mariana Archipelago has been sporadic and currently longline fishing operation has ceased. Nevertheless, the Council implemented longline exclusion zones around Guam and the CNMI to avoid and potential fishery interactions with CNMI and Guam troll fisheries. The exclusion zone around Gaum extends 50 nm to the east and west of the islands and almost 100 nm to the south. The boundaries of the exclusion zone include the southern banks, which are extremely important to small vessel fishermen on Guam. In the north, the longline exclusion zone extends 30 nm to the east and west of the archipelago. In the far north of the CNMI, the islands unit of the Mariana Trench Marine National Monument prohibits all commercial fishing within 50 nm of the islands of Uracas, Maug, and Asuncion. Figure 4 illustrates the CNMI and Guam longline prohibited areas.

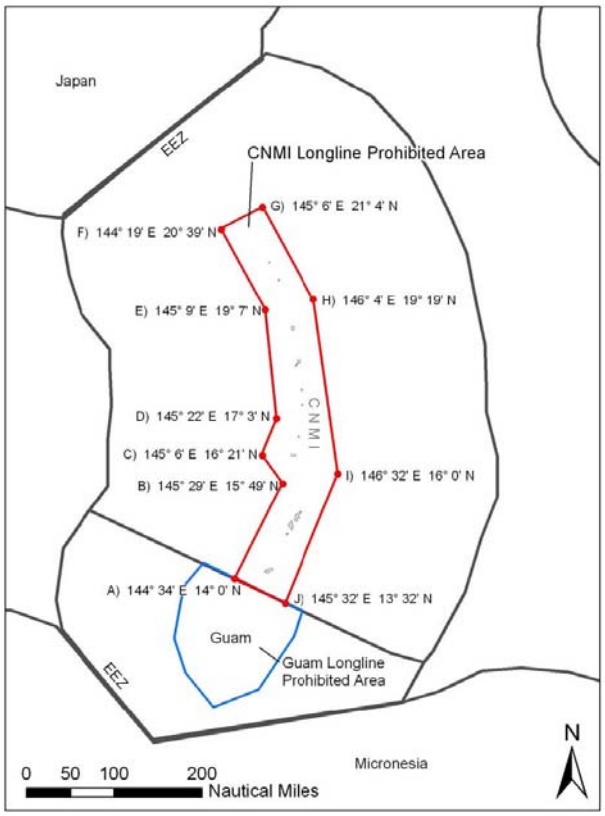
Longline fishing by 3-4 vessels operating out of Saipan began in 2007 and ceased operations in 2012. Little is known about the volume of fish caught by this fishery, as the data remains confidential. However, based on interviews with the company manager (Paul Bartram, *pers. comm.*), individual vessels, if operating optimally may each have been capable of catching 167,200 lbs annually. This is based on an assumed landing of 1,900 lbs per set all species combined, 8 sets per trip and 11 trips per year.

The Saipan-based longline company, USA Islands Seafoods, authorized a limited release of information on catch composition, based on logbook data from 2007-2010 (WPRFMC 2011). The top ten species retained by the company's fishing vessels were as follows: Yellowfin Tuna 30%,

Albacore Tuna 22%, Mahimahi 17%, Bigeye Tuna 8%, Oilfish 6%, Skipjack Tuna 4%, Pomfret, 4%, Wahoo 2%, Blue Marlin 1%, Spearfish 1%, Others (Sharks) 5%.

Ex-vessel prices for these longline caught fish are unknown, however, using an average 2010-2011 price for sharks in Hawaii of $0.58/lb would give a value for the shark catch of $4,849. This is at best a crude estimate, to demonstrate the low potential value of shark flesh, using the highest potential prices from Hawaii markets, without the revenue from fins. In contrast, using the same basic methodology, pomfret, another minor catch component of the caught in the Marianas longline fishery, accounted for 4% of the catch and had estimated potential revenue of $20,395 using a 2010-2011 Hawaii price of $3.05.

Most of the longline shark catch is likely to be dominated by blue sharks but there is no market for their meat in the Marianas (Anon 2013). Shark catch composition by the Japanese small offshore longline fishery in the Western Central and North Pacific, comprised of 81% blue sharks (Anon 2013; Figure 5). The Japanese small offshore longline vessels are likely to be comparable to longliners operating from CNMI in terms of vessels size and operations, although the Japanese vessels operate in both the subtropics and equatorial latitudes. Processing blue shark flesh to make an edible product is highly labor intensive with very little value added. At most the meat is worth no more than 5 cents pe



There are no els; however, it is likely that as with other fisherie a comparison of a potential shark longline fisher fuel costs amount to about 90% of trip costs (Pa sels in the Marianas are likely to be similar t nted for 27% of total expenditures and 60) showed that over a decade (2001-2009), averag a fishery rose by 66% and greatly eroded profit

Figure 4: The Marianas Archipelago CNMI and Guam Longline Prohibited Area

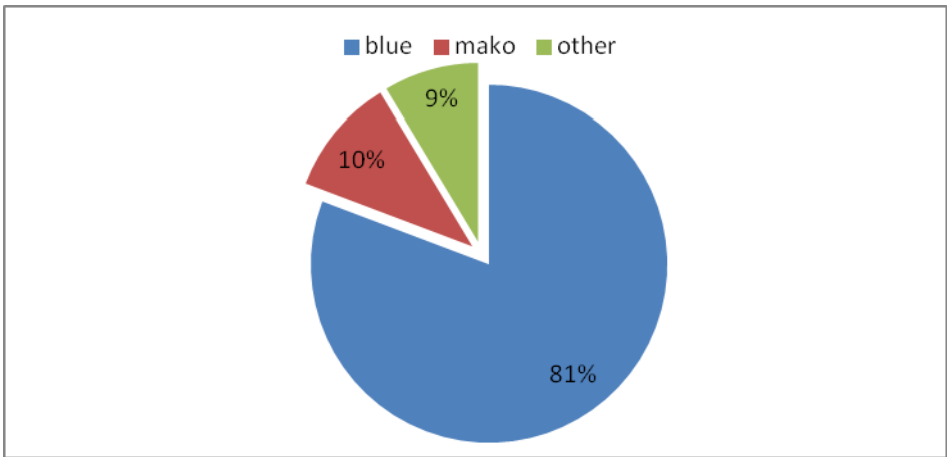


Figure 5: Japanese Small Offshore Longline Average Shark Catch Composition in the Western Central and North Pacific (Anon 2013)

A part time directed shark fishery is a strategic option for fisheries in the Marianas. The longline fisheries in Peru target sharks as an alternative source of revenue when the tuna are not abundant. Typically sharks are retained as an incidental catch when the fleet targets mahimahi. Sharks are retained for their fins and meat and the products are distributed to domestic and international markets (Mangel *et al* 2007). A part time directed shark fishery in the Marianas may give fishermen the flexibility to catch other marketable species during different times of the year.

An incidental shark catch fishery is also a strategic option. Sharks throughout the WCPO are caught in commercial fisheries as incidental bycatch. Prior to shark finning bans implemented by the Shark Conservation Act, incidentally caught sharks were commonly retained in the Hawaii longline fishery for their valuable fins and the revenues comprised up to 20% of crew income until the Shark Finning Prohibition Act came into effect (McCoy & Ishihara 1999). Currently, sharks caught in the Marianas are usually released upon capture because of their negligible value without the sale of fins.

Management

Managing pelagic shark catches by a longline fishery in the Mariana Islands should not incur a major administrative burden to the Council, NMFS, and CNMI and Guam, due to the

Pelagics FEP management. The commercial longline fisheries from the Marianas archipelago are required to obtain a Western Pacific general longline permit from the National Marine Fisheries Service. Further, medium (40-50ft) and large boats (>50 ft) are required to carry observers if requested, carry a vessel monitoring system (VMS) beacon, and to comply with handling measures for safe release of sea turtles. As noted earlier, the Council also has in place longline exclusion zones around the Mariana Archipelago, to minimize the potential for interactions between longline vessels and the small vessel troll fisheries of Guam and CNMI

There are no domestic rules concerned with catches of sharks other than the requirement to land sharks with fins attached. However, the US is a member of two Pacific tuna regional fishery management organizations (t-RFMOs), namely the Western and Central Pacific Fishery Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC). Both t-RFMOs have management measures governing shark catches, but the WCPFC measures are the most relevant to longline vessels operating out of the Mariana Archipelago.

Under WCPFC Conservation and Management Measure (CMM) 2011-04, Commission Members and Cooperating Non-Members shall require all vessels flying their flag and vessels under charter arrangements to release any oceanic whitetip shark that is caught as soon as possible after the shark is brought alongside the vessel, and to do so in a manner that results in as little harm to the shark as possible. Other sharks which may be subject to CMMs in 2013 include blue sharks and silky sharks, stock assessments for which were reviewed at the WCPFC's ninth Science Committee meeting in August 2013. However, considerable uncertainty surrounds stock assessments for pelagic sharks, this is illustrated by two recent assessments for blue sharks. One model using a Bayesian production model (ISC 2013) found that blue sharks are not overfished. The other, an age structured model (Rice *et al* 2013) found that North Pacific blue sharks may be in an over fished state but recovering under current levels of catch.

Bycatch, in longline and purse seine fisheries is the greatest fishery impact on shark stocks in the Pacific (Clarke *et al* 2011). As noted earlier, bycatch of sharks is minimal to nonexistent in the Marianas small vessel fisheries but some members of the WCPFC may push for a ban on the use of wire leaders as a fishery mitigation measure for longline vessels. There is uncertainty about the impact of gear and hook changes, baits used and the role of shark lines for reducing or increasing shark bycatch rates. The impact of hook type and leader type can be difficult to distinguish from one another based on observer data in which catchability is influenced by additional factors. Circle hooks reduce gut hooking, and increase jaw hooking, when compared to J-hooks but gut hooking may give sharks greater access to biting off nylon leaderline. Subsequently, mortality may be high due to internal injury, bite off is less likely with a wire leader (Bromhead *et al* 2013).

Currently in CNMI[6] and Guam, the possession, sale, trade and distribution of shark fins is prohibited. This legislation was enacted following the passage of a similar ban in Hawaii, Guam and American Samoa. A proposed rule by NMFS to implement the provisions of the Shark

[6] The CNMI legislation allows for subsistence harvest of sharks and shark fins

Conservation Act (SCA) of 2010[7] would require sharks caught by US vessels to be landed with fins naturally attached. State prohibitions on possession, landing, transfer or sale of sharks or shark fins lawfully harvested seaward of state boundaries constrain the ability of federal fishery participants to make use of those sharks for commercial and other purposes. The language of the proposed rule for the SCA would preempt state statues, such as in American Samoa, CNMI and Guam, allowing the sale, trade and possession of shark fins caught in federally managed fisheries.

Conclusions

This paper has explored the potential for a stringently managed shark fishery in the Marianas Archipelago. There are three options for domestic fisheries:

- Incidental shark fishery – no targeting, sharks taken as incidental catch of longline tuna by longlines
- Part time shark fishery – seasonal targeting of sharks, during low periods of tuna and tuna like species abundance
- Full time shark fishery - longline fishery targeting sharks, with tuna and tuna line species caught incidentally

In addition to purely domestic fisheries, the MSA also permits the governments of American Samoa, Guam, or the Northern Mariana Islands to enter into Pacific Insular Area fishery agreements (PIAFAs) to authorize foreign fishing within the exclusive economic zone adjacent to a Pacific Insular Area. Negotiation of a PIAFA is conducted through the auspices of the Department of State, but revenues from such an agreement are remitted to the insular area, which is required to complete a Marine Conservation Plan to account how PIAFA funds would be spent.

Regardless of the whether shark catches would be taken purely domestically or through a PIAFA arrangement, allowing fishermen to retain sharks would contribute to achieving OY while potentially providing some relief for fishermen who complain of depredation by sharks. There is very little potential for a coastal and reef shark fishery but coastal and bottom fishermen should be able to land and trade shark fins to offset depredation. Sharks are currently discarded because there is little revenue to be made from the flesh without the sale of fins.

The shark resource is limited by its generally low productivity but there is supplemental revenue that can be made through the sale of flesh and other shark products. There is a very small local market for shark meat. Reef sharks could be caught and retained as incidental catch by bottom fishermen to compensate for depredated catches but there is more potential revenue to be made from pelagic sharks.

[7] Federal Register Vol. 78, No. 85 25685-25690

Pelagic sharks are also generally more resilient to fishing pressure. An oceanic pelagic shark fishery could provide additional revenue for fishermen by retaining incidental catch or by targeting marketable shark species.

The abundance of pelagic shark resource is unknown in the US EEZ around the Marianas Archipelago. As such a first step would be to conduct a carefully designed fishing survey to target sharks in order to establish which sharks are present within the US EEZ, and to provide information which could be used to establish future management measures for sharks. Moreover, there is also a need to quantify the current level of catch depredation by sharks in the Marianas, to establish a baseline for future comparison, especially if longline fishing, either targeting sharks or maximizing incidental catches becomes a reality

In addition a sound business plan that clearly identifies markets for shark products such as fins, flesh, teeth, etc. is essential. The absence of a business plan, current poor infrastructure and knowledge of markets could cause the failure of a newly established shark longline fishery, just as it did previously to the pelagic longline fishery in CNMI targeting more valuable tunas and tuna like species.

However, in CNMI and Guam it is prohibited to possess, sell, distribute or trade shark fins. This regulation likely precludes the establishment of a shark fishery. Without the revenue from fins a directed or incidental shark fishery is economically unfeasible. The costs required for a pelagic shark fishery, particularly fuel, are high and for a fishery to be profitable a large amount of sharks and shark fins would have to be harvested and sold abroad. Sharks can be sold for their flesh but the value, particularly blue sharks, is extremely low domestically and internationally.

Shark fins are essential to an economically viable shark fishery in the Marianas and a ban limiting the possession for fins would prevent any shark fishery from contributing to OY. Resolving this issue would need to be a high priority if the Council chooses to move forward on management of shark fisheries in the Marianas.

References

American Samoa and Marianas FEP Plan Team. 2012. Archipelagic Fishery Ecosystem Annual Report. Western Pacific Regional Fishery Mangement Council.

Amesbury, J.R. and R.L. Hunter-Anderson. 2003. Review of Archaeological and Historical Data Concerning Reef Fishing in the U.S. Flag Islands of Micronesia: Guam and the Northern Mariana Islands. Prepared for Western Pacific Regional Fishery Management Council, Honolulu by Micronesian Archaeological Research Services, Guam. Available on the website of the Fishery Management Council at www.wpcouncil.org

Amesbury, J.R. and R.L. Hunter-Anderson. 2008. An Analysis of Archaeological and Historical Data on Fisheries for Pelagic Species in Guam and the Northern Mariana Islands. Prepared for Pelagic Fisheries Research Program, University of Hawai'i at Mānoa by Micronesian Archaeological Research Services, Guam. Available on the website of the Pelagic Fisheries Research Program atwww.soest.hawaii.edu/pfrp

Arita, S., M. Pan. 2013. Cost-Earnings Sutdy of American Samoa Longline Fishery Based on Vessel Operations in 2009. Western and Central Pacific Fisheries Commission, Ninth Scientific Committee, Pohnpei, Federated States of Micronesia, WCPFC-SC9-2013/MI-WP-06

Bain & Company. 2011. China Private Wealth Report. China's private banking industry: Competition is getting fierce. Bain & Company , Beijing, 71 pp.

Bromhead, D., J. Rice, and S. Harley. 2013. Analyses of the potential influence of four great factors (leader type, hook type, "shark" line and bait type) on shark catch rates in WCPO tuna longline fisheries. Western and Central Pacific Fisheries Commission, Ninth Scientific Committee, Pohnpei, Federated States of Micronesia, WCPFC-SC9-2013/EB-WP-02 rev 1, 71 pp.

Clarke, S. 2003. Quantification of the Trade in Shark Fins. Renewable Resources Assessment Group, Department of Environmental Science and Technology, Faculty of Life Sciences, Imperial College London.

Clarke, S., E. J. Milner-Gulland, T. B. Cemare. 2007. Social, Economic, and Regulatory Drivers of the Shark Fin Trade. Marine Resources Economics. Vol. 22, pg. 305-327.

Clarke, S. 2011. A Status Snapshot of Key Shark Species in the Western and Central Pacific and Potential Management Options. Western and Central Pacific Fisheries Commission, Seventh Scientific Committee, Pohnpei, Federated States of Micronesia, WCPFC-SC7-2011/EB-WP-04, 37 pp.

Compagno, L.J.V. 2008. Pelagic Elasmobranch Diversity. Pages 14-21 *in* M.D. Camhi, E.K. Pikitich, and E.A. Babcock. Editors. Sharks of the Open Ocean: Biology, fisheries and conservation. Blackwell Scientific Publishing, Oxford, UK.

Cortés, E., F. Arocha, L. Beerkircher, F. Carvalho, A. Domingo, M. Heupel, H. Holtzhausen, M. N. Santos, M. Ribera, and C. Simpfendorfer. 2010. Ecological risk assessment of pelagic sharks caught in Atlantic pelagic longline fisheries. Aquatic Living Resource 23, 25-34.

Craib, J.L. 1986. Casas de los Antiguos: Social Differentiation in Protohistoric Chamorro Socitey, Mariana Islands. Unpublished Ph.D. dissertation, University of Sydney, Australia.

Dalzell, P., R. M. Laurs, and W. R. Haight. 2008. Case Study: Catch and Management of Pelagic Sharks in Hawaii and the US Western Pacific Region. Pages 268-273 *in* M.D. Camhi, E.K. Pikitich, and E.A. Babcock. Editors. Sharks of the Open Ocean: Biology, fisheries and conservation. Blackwell Scientific Publishing, Oxford, UK.

NMFS, PIRO, Fossen, L. V., V. Brown, M. Jordan, A. Torres, . 2006. Sharks of the Marianas Archipelago.. Secretariate

Grimble, A. 1952. A Pattern of Islands. John Murray Ltd. London.

Gilman, E., S. Clarke, N. Brothers, J. Alfaro-Shigueto, J. Mandelman, J. Mangel, S. Petersen, S. Piovano, N. Thomson, P. Dalzell, M. Donoso, M. Goren, T. Werner. 2008. Shark Interactions in Pelagic Longline Fisheries. Marine Policy 32 (2008) 1-18. Available online at www.sciencedirect.com.

ISC. 2013. Stock assessment and future projections of blue shark in the North Pacific Ocean. Western and Central Pacific Fisheries Commission, Ninth Scientific Committee, Pohnpei, Federated States of Micronesia, WCPFC-SC9-2013/ SA-WP-11, 84 pp.

Japan. 2013. Annual Report to the Commission Part 1: Information on Fisheries, Research, and Statistics. Western and Central Pacific Fisheries Commission, Ninth Regular Session, Pohnpei, Federated States of Micronesia, WCPFC-SC9-AR/CCM-09.

Johannes, R.E. 1981. Words of the Lagoon Fishing and Marines Lore in the Palau District of Micronesia. University of California Press Berkely and Los Angeles, California.

Maly, K., O. Maly. 2003. Volume 1: Ka Hana Lawai'a A Me Na Ko'a O Na Kai 'Ewalu A History of Fishing Practices and Marine Fisheries of the Hawaii Islands Compiled from: Native Hawaiian Traditions, Historical Accounts, Government Communications, Kama'aina Testimony and Ethnography. Kumu Pono Associates LLC. 554 Keonaona St. Hilo, Hawaii 96720

Mangel, J., J. Alfaro-Shigueto. 2007. Peru artisanal mahimahi and shark longline fishery: Industry practices and attitudes towards shark depredation and bycatch. Shark depredation and unwanted bycatch in pelagic longline fisheries: industry practices and attitudes and shark avoidance strategies. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii, 101-110.

McCoy, M. and H. Ishihara. 1999. The socioeconomic importance of sharks in the U.S. Flag Areas of the Western and Central Pacific. Us Dept. of Commerce, Admin. Rep. AR-SWR-99-01. 119 pp.

Nadon, M.O., J. K. Baum, I. D. Williams, J. M. Mcpherson, B. J. Zglicynski, B. L. Richerads, R. E. Schroeder, and R. E. Brainard. 2012. Re-creating missing population baselines for Pacific reef sharks. Conservation Biology, Vol. 26, No. 3, 493-503. Society for Conservation Biology.

Nunes, K. 2003. Investigation of the Cultural Importance of Sharks to the Indiginous People of the U.S. Flag Areas in the Central and Western Pacific. The Hawaii Audobon Society, Pacific Fisheries Coalition, Honolulu, Hawaii.

Pacific Islands Fisheries Group. 2012. Proposal: Shark Depredation Occurance in Mariana Small Boat Fishery.

Rice, J. , S. Harley, M. Maunder and A. A. Da-Silva. 2013. Stock assessment of blue sharks in the north Pacific Ocean using Stock Synthesis. Western and Central Pacific Fisheries Commission, Ninth Scientific Committee, Pohnpei, Federated States of Micronesia, WCPFC-SC9-2013/SA-WP-02, 44 pp.

Rice, J., S. Harley. 2012. Stock Assessment of Oceanic Whitetip Sharks in the Western and Central Pacific Ocean. Western and Central Pacific Fisheries Commission, Eighth Scientific Committee, Busan, Republic of Korea, WCPFC-SC8-2012/SA-WP-06 Rev 1.

Richards, B. L., I.D. Williams, O.J. Vetter, G.J. Williams. 2012. Environmental Factors Affecting Large-Bodied Coral Reef Fish Assemblages in the Mariana Archipelago. Vol. 7. Issue 2. Available on the website of Plos One at www.plosone.com.

Severnce, C. J., R. Franco. 1989. Justification and Design of Limited Fishery Alternatives for the Offshore Fisheries of American Samoa, and an Examination of Preferential Fishing Rights for Native People of American Samoa Within a Limited Entry Context. Anthropology, University of Hawaii at Hilo, Hilo Hawaii.

Smith, S. E., D.W. Au, and C. Show. 1998. Intrinsic rebound potential of 26 species of Pacific sharks. Marine and Freshwater Research 49:663-678.

Stevenson, C., L. S. Katz, F. Micheli, B. Block, K. W. Heiman, C. Perle, K. Weng, R. Dunbar, J. Witting. 2006. High apex predator biomass on remote Pacific islands. Coral reefs.

Taimanglo, P. L. G., 2010. The Chamorro People of Guam. Find this Article online at http://www.apa.ord/pi/oema/resources/communique/2010/08/chamorro-people.aspx

TRAFFIC Asia. 2006. shark product trade in Hong Kong and mainland China and implementation of the CITES shark listings. TRAFFIC Asia, Hong Kong, 60 pp.

Walker, T. I. 1998. Can shark resources be harvested sustainably? A question revisted with a review of shark fisheries. Marine and Freshwater Research 49: 553:-572

Walsh, W. A., K. A. Bigelow, K. L. Sender. 2009. Decreases in Shark Catches and Mortality in the Hawaii- Based Longline Fisher as Document by Fishery Observers. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 1:270-282

Ward-Paige, Christian A., C. Maro, H. K. Lotze, C. Pattengill-Semmens, L. McClanachan, E. Arias-Castro, R. A. Myers. 2010. Large-Scale Absence of Sharks on Reefs in the Greater-Caribbean: A Footprint of Human Pressures. Vol 5. Issue 8. Available on the website Plos One at www.plosone.com

WPRFMC. 2012. Archipelagic Ecosystem Report. Sabater, M. (Ed.) Western Pacific Regional Fishery Management Council. Honolulu, Hawaii 96813

WPRFMC. 2013. Pelagic Fisheries of the Western Pacific Region 2011 Annual Report. Pelagics Plan Team and Council Staff. Western Pacific Regional Fishery Management Council. Honolulu, Hawaii 96813

Williams, Ivor. 2010. US Pacific Reef Fish Biomass Estimates Based on Visual Survey Data. Pacific Islands Fisheries Science Center.

Worm, B., B. Davis, L. Kettemer, C.A.Ward-Paige, D. Chapman, M.R. Heithaus, S.T.Kessel, S.H.Gruber. 2013. Global catches, exploitation rates and rebuilding options for sharks. Mar. Pol. 40, 199-204.


BLUE
SMALL


BLUE
MEDIUM


BLUE
LARGE


BLUE
XTRALARGE


BLUE
JUMBO