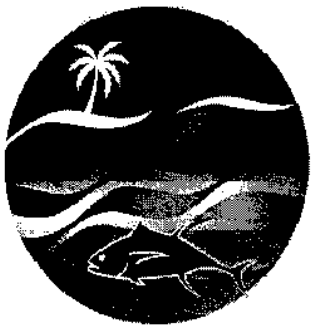

FFA

An Assessment of Opportunities for Increasing Utilization and Value Adding from Shark Bycatch in Tuna Longline Fisheries of FFA Member Countries

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PACIFIC ISLANDS FORUM FISHERIES AGENCY
P.O BOX 629 HONIARA SOLOMON ISLANDS
TELEPHONE (677) 21124
FAX (677) 23995
WEB http://www.ffa.int

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June 7, 2007

Mike A. McCoy
Gillett, Preston and Associates

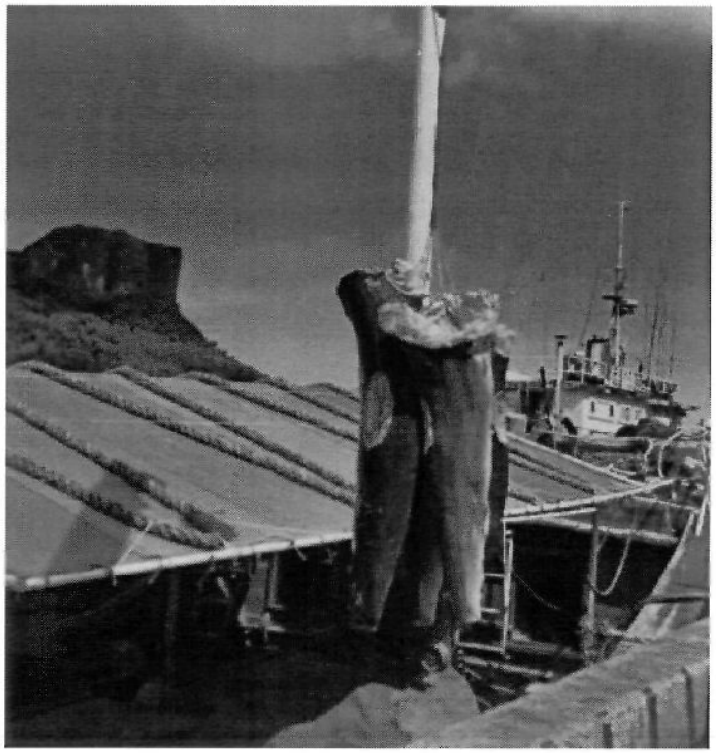

Photo: offloading shark carcasses from Chinese longliners in Pohnpei, Federated States of Micronesia, 1995.

ACRONYMS AND ABBREVIATIONS

FSM	Federated States of Micronesia
kg	Kilogram
PIC	Pacific Island Country
PNG	Papua New Guinea
RFMOs	Regional Fisheries Management Organizations
SPC	Secretariat of the Pacific Community
t	tonnes
TAL	Tropical albacore longline fishery
TDL	Tropical deep longline fishery
TSL	Tropical shallow longline fishery
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean

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SUMMARY OF FINDINGS

1. Shark bycatch landings and/or discards by longline vessels based in FFA Pacific Island member countries are not well documented. Four domestic-based fleets: Fiji, Papua New Guinea, Marshall Islands, and Samoa reported the largest tuna catches in 2005. Using the reported shark bycatch from these fleets and estimating shark discards using admittedly sparse observer data collected by SPC, the combined total shark bycatch by the four fleets is estimated to be on the order of 3,100–3,800 tonnes. Of those amounts, only 1,394 tonnes was reported bycatch and the remainder, 55–63 percent of the total, was discarded.
2. Blue shark is the most predominant species discarded, representing about 70 percent of discards in the four fleets as a whole. Due to their physical characteristics, including high urea content and poor storage qualities there is no current demand or market for blue shark landed in FFA member countries, other than for fins. The remaining 30 percent of non-blue shark discards represent the potentially marketable bycatch.
3. Landing and marketing this bycatch would require (i) vessels not to be constrained by space or holding method, (ii) the existence of cost-effective transportation links to appropriate markets, (iii) and the ability of those markets to absorb the catch at prices not unfavorable to the vessel operators.
4. The potentially marketable discarded bycatch, 522–731 tonnes, is estimated to have an ex-vessel value of from $261,000 to $366,000. The added revenue must, however, be weighed against the additional costs necessary to retain and land the bycatch. The value of this discarded shark bycatch is about 0.2–0.4 percent of the target tuna catch, estimated at around $95,000,000 for the fleets concerned. It is also only about 6–9 percent of the estimated value of shark fins thought to be landed from those fleets, which likely exceeds $4,000,000.
5. The constraints limiting utilization of the bulk of the discarded shark bycatch are not easily overcome. Paramount among these constraints is the high incidence of blue shark as bycatch in all domestic-based tuna-targeting longline fisheries in Pacific island FFA member countries. Although there may be minor markets available for such items as shark skin, the full utilization requirements referenced in current RFMO management measures exclude head, guts, and skin. A ban on finning cannot thus be overcome by simply landing the sharks and accessing existing markets.

1. INTRODUCTION

In 2003 the Pacific Ocean (including the Eastern Pacific Ocean) was the source for about 38 percent of the global shark catch (Lack and Sant 2006). Increasing international concerns over shark bycatch in the tuna longline fishery of the Western and Central Pacific Ocean (WCPO) have focused on banning the practice of finning[1]. Within the context of the Western and Central Pacific Fisheries Convention, this has taken the form of Conservation and Management Measure 2006-05 (Appendix 1) which states in part that:

> CCMs shall take measures necessary to require that their fishers fully utilize any retained catches of sharks. Full utilization is defined as retention by the fishing vessel of all parts of the shark excepting head, guts, and skins, to the point of first landing or transshipment.

Although this measure declares that its contents apply "at the initial stage" to vessels over 24 meters in length and that nothing in the measure shall prejudice the rights of coastal States to "apply alternative measures...within areas under their national jurisdiction", the intention to eventually curtail the practice of finning is clear.

In additional to a potential regional ban, several FFA member countries have already either prohibited the practice of finning through law or regulation, or are bound by membership in other Regional Fisheries Management Organizations (RFMOs) that already have prohibited the practice of finning to do so on their own flag vessels.

As part of its work, the Development of Tuna Fisheries in the Pacific—ACP countries (DEVFISH) project[2] is required to analyze changes affecting the economic viability of tuna operations. The cessation of finning activities is one such change that is likely to have an economic impact on the longline industries in FFA member Pacific Island countries (PICs). DEVFISH thus contracted this consultant, an Associate of Gillett, Preston and Associates, to conduct an assessment of the opportunities for increased utilization of shark bycatch and value adding as a desk study.

Many domestic longline fishing businesses in the region are already faced with the impacts of inadequate air freight services, higher fuel prices, and other rising costs that have adversely affected financial performance. The sale of shark fins has provided revenue for vessel operations and/or domestic crew in varying degree and its impending curtailment is a source of concern.

It has been proposed that one way to address this problem is to identify potential market opportunities for shark meat and other shark products, thereby enabling the continued production of higher value shark fins. It is reasoned that if such market opportunities are identified, full utilization of sharks could turn a ban on finning into a business opportunity for the region's longline fishing business.

The intention of the report is to see if current industry conditions are appropriate for the landing of sharks and subsequent marketing of products other than fins. As the title implies, this study is an assessment of opportunities. The subject is approached from the vessel owner/operator's perspective, rather than the shore-based entrepreneur who may not be directly connected to the existing longline fishing industry.

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[1] Finning is used here to mean the practice of removing shark fins when the carcass is discarded.

[2] The project is funded by the European Union and implemented by the FFA and Secretariat of the Pacific Community (SPC).

It is thus not the intention to create markets for shark landings by providing detailed business information on how to create commercially and economically viable shark products in the PICs. Such an undertaking would require far longer than the short period allocated for research and production of this report. For the purposes of this study only Pacific Island countries (PICs) were considered, with the emphasis on those countries whose domestic-based tuna longline fisheries produce or have the capacity to produce significant shark landings from bycatch.

The report first provides a brief review of commercial shark products other than fins that are currently produced and traded in world commerce. An overview of the international trade in shark meat follows to set an appropriate context within which to discuss shark landings in the PICs.

Rough estimates of the volumes of sharks currently discarded by PIC industrial longline fisheries provide an order of magnitude of product availability. A subsequent section discusses the estimated level and current use of shark landings. This is followed by a summary discussion of the assessment of opportunities and constraints to the further marketing of shark products. The report's conclusions include recommendations for possible investigations on this subject in the future.

Throughout this report, where the term chondrichthyans is used (usually in reference to trade statistics), it is meant to include sharks, skates, rays, and chimeras. All values given are in U.S. dollars unless expressed otherwise.

As a desk study, the report relies heavily on previously published and unpublished information. In compiling the report, the author used his 30-plus years' fisheries development and management experience in commercial tuna fisheries of the Pacific islands and Asia as well as information obtained from professional contacts and informants in various regions of the Pacific, including Marshall Islands, Federated States of Micronesia, Japan, Mexico, Papua New Guinea, and Fiji. Unless noted otherwise, the opinions expressed in the report are those of the author.

2. REVIEW OF COMMERCIAL SHARK PRODUCTS (OTHER THAN FINS)

The interest in greater utilization of sharks caught by longline for products other than fins is driven primarily by recent regulatory actions aimed at stopping finning practices. The "full utilization" requirements adopted by the various RFMOs refer to the body or trunk of the shark, and do not include the head, guts, and skin[3]. It is assumed, therefore, that the greatest interest in the PICs would be in the utilization of shark meat.

Nevertheless, it is useful in the Pacific island context to review some of the products known to be derived from sharks and where possible identify species most suitable for the production or manufacture of those products. The information available on many of these products is limited, as trade volumes tend not to be large and trade is not often monitored. For example, FAO recognizes 20 categories of shark products, but does not include shark skin as one of them.

It is important to keep in mind that different species and sizes of sharks do not necessarily have the same commercial value, nor can they always be used in a like manner. Certain species are more suited to particular products than other species, and size of shark is sometimes a determinant in its applicability.

2.1 Non-food Products from Sharks

Much of the information on non-food products in the following sections is taken from Vannuccini (1999) and Catarci (2004), as well as internet sources. The products described come from sharks harvested worldwide and are not limited to those found in the WCPO.

2.1.1 Shark liver oil

Since sharks have no swim bladder, it is believed that buoyancy in some species is maintained in part by relatively large livers saturated with oil. During the early to mid 20th century, shark liver oil was produced mainly by Japan, with an average of 3,800 tonnes (t) up to 1940. Its use was primarily as a lubricant and in manufactured products. One of the other main uses worldwide was in the production of vitamin A, prior to the availability of synthetic substitutes.

The major demand today is for squalene oil, used in cosmetics, health foods and as high-grade machine oil. Squalene is present in some, but not all, shark liver oils. It is most prevalent in *Squalidae* (dogfishes) that would be rarely, if at all, caught in any significant numbers by tropical tuna longliners. Exceptions where squalene is present are larger animals of several non-*Squalidae*, predominantly tiger sharks and thresher sharks. These sharks have a relatively high ration of liver weight to total body weight. Tiger sharks are reported to have livers weighing 17.5 percent of total body weight, and thresher sharks (species undefined) 10 percent.

Squalene has many uses: as a bactericide, and in the manufacture of pharmaceuticals and other products. Its availability is not limited to sharks, as it can also be found in cod liver oil, olive oil, wheat germ oil, rice bran oil, and other vegetable oils. It has been reported that 3 percent shark oil is one of the inactive ingredients in a popular non-

[3] The wording used is the same in conservation measures adopted by ICCAT, IOTC,IATTC, and WCPFC to prevent finning.

prescription medicinal treatment for the relief of hemorrhoidal tissue in the US, Preparation-H.

In recent years, shark liver oil has been touted as a cure for many diseases, and has been sold in capsule form. Shark liver oil has been produced in southern Australia from platypus sharks (*Deania spp.)*, a bycatch from trawlers targeting orange roughy in the past. These smaller sharks average from 10 to 20 kilogram (kg) total weight and contain livers of up to 25 percent of body weight. Oil recovery from this species is about 90 percent of liver weight. In 1999 laboratory-produced squalene exports from this source to Asia were reported to be about A$3 million[4].

The data on production and international trade in shark liver oil is questionable and spotty at best. For example, it has been reported that in 2001 the Maldives producing 1,700 t of shark liver oil[5] and was the only country since 1994 to report production, although Norway and South Korea have both continued to report liver oil trade as imports and/or exports (Clarke 2004).

2.1.2 Shark Cartilage

Cartilage is a type of tough, flexible connective tissue. The sources of cartilage from sharks include (1) as a byproduct from shark fin production and (2) as a result of the use of meat, since cartilage rather than bones serves as the internal skeleton.

Shark cartilage has been sold in Hong Kong as a byproduct from fin processing or as dried vertebral columns imported from North and South America. The material is reportedly cooked and eaten as food or boiled in soups with herbs to improve health. One report from Japan identifies *meikotsu*, boiled and dried cartilage made from pieces of jaw, fin, and head parts that has been exported to China (Nakano 1999).

Interest in shark cartilage in western cultures in recent years stems from its use as a health supplement and as a cure for some diseases. Treatment with cartilage has been touted as a cure for cancer and has created a large market for this product. The product is sold in powdered or tablet form after processing. According to the National Cancer Institute of the US, studies to date have not proven cartilage to be an effective treatment for cancer in people. The US Food and Drug Administration has not approved cartilage as a treatment for cancer, although it can be purchased as a "health supplement". Cartilage tablets or powder may be sold on their own or fortified with various so-called "health enhancers" (Hooi 1999).

It is known that shark cartilage contains chondroitin, a material is combined with other ingredients and used for the treatment of rheumatism (Nakano 1999). In the US, its use in this manner is also considered a health supplement and is not approved as a medical treatment.

Processors of shark cartilage for medicinal purposes emphasize the need for quality control, and that it is essential to remove meat and gristle by hand, without using strong or corrosive chemicals which may result in degradation. Cartilage is sun dried after cleaning and the cartilage chips are milled into a fine powder and sterilized. Although there appears to be significant emphasis on quality control to preserve shark cartilage in its natural form, there is very little information available on its preservation after sharks

[4] C. Lightfoot, personal communication.

[5] Clarke (2004) quotes the Maldives production volume from FAO FishStat Plus, but it is highly questionable given a lack of production figures for other shark products one would expect. On the other hand, low quality shark oil has for many years been used on locally-built wooden vessels in Arab countries as a hull preservative, and some of the reported production might still be directed to this use.

are landed onboard fishing vessels. It is not known, for example, if the cartilage is still useful if unfrozen, and if so for how long it could be kept in that state and still remain acceptable.

Shark cartilage can be made from a variety of sharks, including tropical sharks. The vertebral columns of cartilage cleaned of all meat are usually dried and bleached, to be sold in rod form of various diameters about one meter in length. One author mentions that the processing of shark cartilage is labor intensive and primary producers were usually limited to preparing the raw material, while others produced the actual tablets or powders used in health supplements (Rose 1996).

Cartilage from blue sharks is reported to contain high levels of chondroitin. In Japan, cartilage is obtained from the shark fin dealers who sell it to wholesale dealers. After the wholesale dealers have dried the product, it is sent to pharmaceutical factories (Nakano 1999).

2.1.3 Shark Skin

Although shark skin is eaten as food in some countries (including some areas of Solomon Islands[6] and in Taiwan[7]), the main use of shark skin is in the production of shark leather.

Sharks and rays have rough, hard small scales or "denticles" that can provide the skin surface with the properties of fine sanding paper or cloth that has been used for sanding wooden and ceramic objects. The product from dried but untanned skins is sometimes referred to as "shagreen" in western cultures. In the past shagreen had use as body armor, to cover the hilt of swords, and for other purposes. In some Pacific island cultures the dried skins were used as drum covers. Most shark skins in commerce now, however, are tanned[8].

Shark skins are tanned in much the same way as the skins of land animals and can be used in the same manner. Products include shoes, sandals, boots, wallets/purses, belts, watch bands, gun holsters, and so forth. In India shark skin is also made into grips for scooter/bicycle handle covers (Hooi 1999).

Shark skins must be kept dry after removal from the animal, and are typically salted when prepared on land. The fact that the skin is needed to protect shark meat onboard when intended for sale and is damaged by exposure to fresh water or ice limits the opportunities to collect them onboard fishing vessels. The skin from larger sharks, defined as trunks of no less than 1 to 1.5 meters, are preferred.

Skinning and properly storing shark skins onboard is dependent on the labor and time available for the tasks required. Since crew in most longline fisheries have little spare time, it is likely that preparation of shark skin for market is more feasible during production of dried and/or salted meat from large shark which occurs onshore where more time and labor is available. Small-scale fisheries aimed at preparation of dried and/or salted meat, such as in Indonesia and Mexico are examples of such fisheries.

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[6] Matthew (1996) describes the preparation of shark skin for food in Western Province of Solomon Islands.

[7] The caudal skin of the white-spotted Guitarfish, *Rhynchobatus djiddensis* is reportedly valued above all other shark skin in Taiwan. In countries where it is eaten, the skin is usually dried or smoked before it is finally cooked, and may have some meat attached as well. However, only a small amount of skin is eaten around the world (Hooi 1999).

[8] The modern tanning process involves the use of chemicals to remove the denticles and prepare the leather.

Since larger skins are preferred for use as leather, it is no surprise that most species able to be captured at larger sizes are preferred. The information in Table 1 shows the shark species whose hides are used as leather.

Table 1 Sharks Known to be Used for Leather

Tiger Shark (*Galeocerdo cuvier*)	Nurse Shark (*Ginglymostoma cirratum*)
Lemon Shark (*Negaprion brevirostris*)	Dusky Shark (*Carcharhinus obscurus*)
Sandbar Shark (*Carcharhinus plumbeus*)	Bull Shark (Carcharhinus leucas)
Porbeagle (*Lamna nasus*)	Shortfin Mako Shark (*Isurus oxyrinchus*)
Scalloped Hammerhead (*Sphyrna lewini*)	Shortnosed Saw Shark (Pristiophorus *nudipinnis*)
Blue Shark (*Prionace glauca*)	Taiwan Gulper Shark (*Centrophorus niaukang*)
Great Hammerhead Shark (*Sphyrna mokarran*)	Spotted Wobbegong (*Orectolobus maculatus*)
Ornate Wobbegong (*Orectolobus ornatus*)	Tasselled Wobbegong (*Eucrossorhinus dasypogon*)
Spinner Shark (*Carcharhinus brevipinna*)	Great White Shark (*Carcharodon carcharias*)
Broadnose Sevengill Shark (*Notorynchus cepedianus*)	Thresher Sharks (*Alopias* spp.)
Tawny Nurse Shark (*Nebrius ferrugineus*)	Basking Shark (Cetorhinus maximus)
Piked Dogfish (*Squalus acanthias*)	Kitefin Shark (*Dalatias licha*)
Sawback Angelshark (*Squatina aculeata*)	

Source: Hooi (1999)

Japan reportedly prefers blue shark skins for tanning (Nakano 1999), however it is not known if this is a preference or related to availability. In Japan, the traditional method for grating wasabi horseradish root for use as a condiment uses a sharkskin grater called an *oroshi*[9].

Little information is available on ex-vessel prices for shark skin. One source gives a price range in Australia from A$1.50 to A$3.50 per kg, and states that fishing vessel operators consider it worthwhile to obtain the skins only if the price is above A$2 (Brothers 2007).

A final point is to re-iterate that utilization of the skin of landed sharks does not qualify under the "full utilization" provisions the Western and Central Pacific Fisheries Commission (WCPFC) Conservation and Management Measure 2006-05.

2.1.4 Other Uses

The literature on sharks and shark products contains references to various uses that may be localized or not well known. In Hawai'i, for example, a small but undetermined number of shark gall bladders are taken for sale by ethnic Korean fishermen onboard some tuna longline vessels. The gall bladder is apparently processed ashore as Korean folk medicine. Taken with liquor, the gall bladder is said to relieve backache (McCoy and Ishihara 1999).

[9] From Pacific Coast Wasabi, viewed at www.wasabia.com.

Other parts of the shark have been also used for medicinal purposes. Hooi (1999) reports that the use of shark parts for health benefits has a long history, particularly in Chinese traditional medicine. There are also reports from various countries of ovaries, brain, skin, and stomach being used.

It has been recorded that shark livers are sometimes mixed with other food and used by shrimp farmers in aquaculture, however no further information was found[10].

2.2 Shark Meat

In addition to having a skeletal structure of cartilage instead of bone, another important difference between sharks and teleost (i.e. bony) fish is the presence of large amounts of urea and trimethylamine in their blood and tissues. This is because sharks concentrate urea waste in their blood and excrete it through their skin rather than using internal organs to accomplish excretion of the urea.

The urea present in the blood must thus be removed by immediate bleeding, dressing and icing or freezing of the shark after it is caught to prevent it from contaminating the meat. If urea in the shark is not removed, it is converted by bacteria into ammonia and remains in the meat tissue. Freezing slows down this process but does not eliminate the ammonia smell completely from poorly prepared shark carcasses.

Some species of sharks possess greater amounts of urea than others making their meat, even if handled well, smell strongly of ammonia. The blue shark, *Prionace glauca,* is one such species and as a result blue sharks have a low value relative to other species.

A problem connected with large sharks in particular is the concentration of methyl mercury in the tissue. Methyl mercury is a naturally occurring substance in the ocean, but levels are thought to be intensified by industrial pollution or other sources. It has been found that large amounts of mercury contained in food products can damage a human fetus during development. Some larger animals such as sharks, pilot whales, swordfish, and some large tunas tend to have concentrations above recommended safe levels for pregnant women and women of child-bearing age. This has resulted in health warnings as well as occasional outright banning of the sale of some large pelagic fish species.

At the top of the value scale for longline-caught sharks, mako (and some thresher species in North America and elsewhere) command the highest prices for meat. Shortfin mako can be used as high quality sashimi in Japan. Mako shark can be (and sometimes is) substituted for swordfish in markets and restaurants. Mako sharks that are handled well can be similar in color, taste, and texture to swordfish and both are sold in steak form. If mako is sold fresh, the skin is usually left on to maintain the shape of the fillet. The skin will feel rough, whereas swordfish skin is smooth. Raw swordfish is also usually lighter in color than shark and has definite eye-like whorls in the meat which are not present in shark steaks.

At or near the bottom of the scale for pelagic sharks commonly captured in tuna longline fisheries are the nearly ubiquitous blue sharks which, which few exceptions, are not retained because of the lack of demand. In addition to the high concentrations of urea in the flesh, poor storage characteristics and a tendency to become "mushy" have also been mentioned as reasons for its undesirability.

[10] This may have been the impetus for an ill-fated attempts to collect shark livers onboard longliners based in Noumea, New Caledonia some years ago (A. Desurmont, pers. comm.).

There are three basic forms of shark produced by fisheries in the WCPO: fresh, frozen and dried/salted. A large number of products can be manufactured from frozen sharks, as well as being marketed in steak form. Dried and salted shark meat is usually produced in lesser developed countries from artisanal fisheries and mainly contributes to protein consumption in those countries.

2.2.1 Fresh Shark Meat

Species of fresh shark of interest to this study are landed primarily by smaller inshore longline vessels taking trips of short duration (a few days only). An example of such a fleet occurs in Kesennuma, Japan, a port renown in Japan for its fresh shark landings caught by longline. In this port, sharks are landed headed and gutted, but with fins intact. Vessels usually target billfish with shallow sets, or tuna with deep sets, but some vessels target sharks during certain times of the year. The resultant shark catch, including blue sharks, is marketed locally. It is reported that blue shark in Japan is used in the production of *hanpen*, a surimi-like fish paste (Vannuccini 1999). Other species such as mako and thresher may be sold as fillets or steaks.

Storage of sharks on Kesennuma-based vessels is conducted in much the same way as with the target catch of billfish and/or tuna. Sharks are segregated from the target catch, usually placed on the bottom in vessels with limited capacity, or in separate holds on larger vessels. Of note in the Kesennuma situation is the relatively high prices for blue shark meat as compared with the prices for (frozen) sharks of other species. Clarke (2007) reported prices for blue shark in Kesennuma in April 2006 of US$1.70–$2.10 per kg.

Vessels based in other locations in the WCPO using only ice for refrigeration of the target catch may have sufficient space that they can retain and isolate shark trunks from the rest of the catch. Examples of these vessels are the Chinese longliners operating out of Micronesian ports in Majuro and Pohnpei[11]. In the case of these vessels, the shark catch is frozen upon landing in freezers onshore. Blue sharks are not retained as their value is deemed too low for freezing and later shipment.

2.2.2 Frozen Shark Meat

The most common form of shark produced by longline is that of a frozen trunk, i.e. the body minus head, belly, viscera, and fins[12]. The manner in which the shark portion of the catch is handled depends on the freezing capabilities of the vessel, its targeting strategy, the number of days at sea on a particular fishing trip, and other factors.

In industrial longline fishing directed at tunas and swordfish, the fins from sharks are removed and the sharks are dressed on deck in preparation for storage in a freezer hold. Distant-water Asian longline vessels usually have sufficient fish hold space to retain those of highest value, i.e. short fin mako, in a frozen state. The main markets for mako are the same as for tuna, and in distant water fisheries they are transshipped to market along with the target tuna catch by refrigerated carrier, or taken to the market ports by the vessel at the conclusion of its fishing voyage.

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[11] Chinese vessels also operate from Koror, Palau, however local regulations prohibit the retention of any sharks or shark parts onboard.

[12] It is believed that shortfin mako sharks caught by high seas longliners are dressed with belly flaps retained, in a manner similar to swordfish.

Taiwanese longline vessels, even those retaining the target catch in refrigerated seawater such as do many of those in the CT-3 (20-50 gross tons) and CT-4 (50-100) classes, have relatively large freezer storage space. For example, newer vessels in the CT-3 class that can hold an average of around 18-24 t of target tunas are designed to have additional freezer space capacity of about 12-15 t (McCoy and Ishihara 1999).

This large freezer space reflects the Taiwan interest in carrying a far greater amount of frozen bycatch onboard than, say, Japanese vessels of a similar size. The retention of bycatch has been driven by the market in Taiwan for bycatch species, including sharks, that was initially a fresh market satisfied by coastal vessels fishing in relative proximity to Taiwan. As coastal catches declined, this market is now also filled by frozen bycatch from vessels based overseas. Taiwanese longline vessels with freezer capacity typically retain all large sharks except blue sharks (which are finned). The fins are removed and both the trunks and fins are stowed in freezer holds until arrival at port or transferred during transhipment at sea (McCoy and Ishihara 1999).

In the PICs, Fiji is perhaps the largest producer and exporter of frozen shark. Vessels offloading in Suva typically provide a locally-based exporter with enough frozen shark to fill one and sometimes two 20-foot container per month. The price paid is F$1.00 (US$0.62) and the destination of exports is reportedly Korea[13].

Considerable but unknown quantities of frozen shark are also exported from Chinese-operated longline fish bases in Majuro and Pohnpei. Sharks are landed fresh by longliners using ice to retain the target tuna catch and then frozen ashore. They are exported along with other bycatch (e.g. marlins, wahoo) by container on an opportunistic basis.

As a commodity, frozen shark meat is most commonly used in manufactured items such as fish balls (mainly in Taiwan), fish cakes, fish sausage, surimi, fish ham, and fish paste.

2.2.3 Dried, Salted Shark Meat

In the Pacific Ocean region, dried and salted shark meat is most often produced in Indonesia and Mexico. Indonesia is the world's largest producer of shark, capturing a reported 120,670 t in 2003. A large but undetermined amount of the catch is produced by small-scale vessels that target sharks for their fins. Both shallow-set longlines and gillnets are used. Sharks are also captured as bycatch in industrial longline fisheries and landed as frozen trunks. Shark meat is usually processed into dry-salted or boiled-salted (*pindang*) commodities that is sold to lower income Indonesians.

In Latin America, sharks have been, and still are, a fishery resource of considerable importance throughout the region. Before the common use of ice and refrigeration in industrial fisheries, dried and salted shark was a basic fishery commodity, as the sharks were large and the flesh salted and dried well. Salted shark and ray is still a popular commodity, but with refrigeration the use of the fresh and frozen products has increased[14]. Salting is a value added process that, when properly done, results in a high-value product in Latin America that is substituted for salted, dried cod (known as *bacalao* in Spain).

There is an unsatisfied market for salted fish and shark in most Latin countries. The preferred species used by the salt-fish market is scalloped hammerhead, although all

[13] W. Moy, personal communication.
[14] The total production of shark on the Pacific side of Mexico by all gears in 2002 was about 13,500 t.

species may be salted. Most of the Mexican production of shark, in fresh, frozen or salted form, is retained in the national market[15].

3. OVERVIEW OF WORLD CATCHES AND INTERNATIONAL TRADE IN SHARK MEAT AND OTHER PRODUCTS

Worldwide, sharks are captured by several types of fishing gear and enter commerce under varying physical and economic conditions. The trade information contained in this section is not specific as to the fishery or capture methods. Application of the information presented should thus not necessarily be taken as directly relevant to sharks as bycatch of the industrial longline fisheries the WCPO without further economic analysis.

This is relevant because the economics of the various fisheries that produce sharks can be influenced by numerous factors, including whether sharks are targeted or bycatch, the location of operations (e.g. proximity to ports and markets), the gear employed, and various economic factors such as crew costs and method of storage. At the stage of investigations presented in this report, it is not practical to investigate the economics of such fisheries to determine whether or not identified markets are practical to apply to the economic conditions under which domestic-based industrial longline vessels operate in the PICs.

Further, no international trade figures have been found that detail trade other than that in shark meat and shark fins. Very limited information exists on trade in shark oil. This severely limits any useful review of international trade for non-fin or non-meat products.

Of all shark products, meat is the largest quantity commodity traded. Exports are mainly destined for European markets although there have been significant increases in demand by Asian markets in recent years[16].

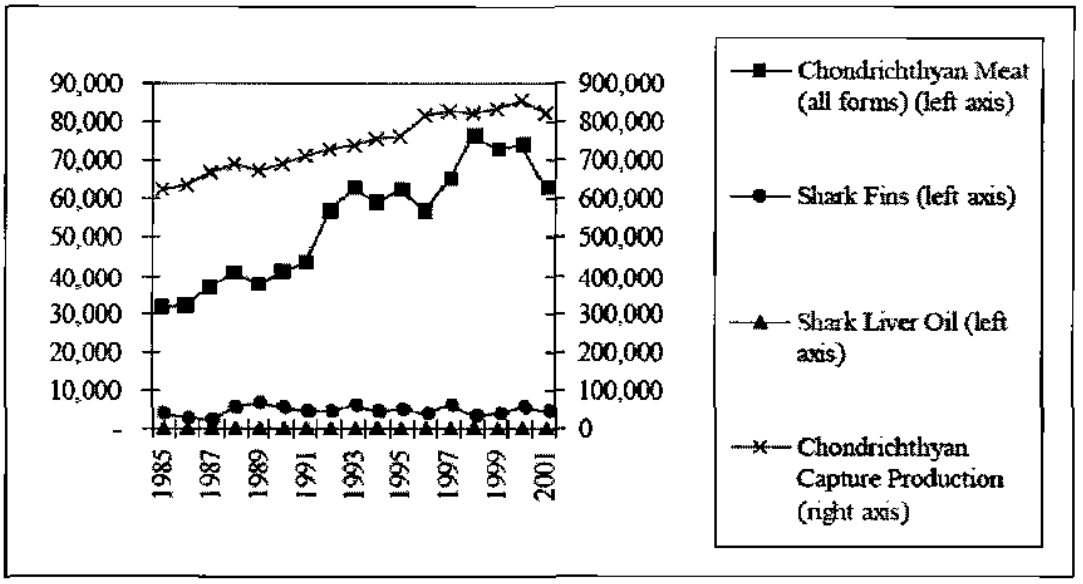
Citing FAO Clarke (2004) reports that during the period 1985–2001 the production of fresh, frozen and salted chondrichthyan meat and fillets more than doubled, from approximately 31,500 t to 63,000 t and grew by an average of 2 percent each year. Overall, the trade in meat is reported at about 10 percent of the estimated worldwide catches of chondrichthyans (sharks, skate, rays, and chimaera).

Clarke (2004) notes that the volume of meat production relative to catches likely represents a combination of under reporting, subsistence consumption or local market use in countries reporting relatively large catches such as Mexico, India, Pakistan, and Indonesia, and international market demand for a limited subset of species. The volumes of reported worldwide production quantities of the major products and catches in t are shown in Figure 2.

[15] F. Hester, personal communication.

[16] European nations are some of the most important shark fishing nations in the world. European Union countries caught nearly 115,000 t of chondricthyans in 2004, with Spain catching around 45 percent, France 18 percent, UK 14 percent and Portugal 10.5 percent.

Figure 1 Reported World Production of Chondrichthyan Products and Total Catches (tonnes), 1985-2001



Source: Clarke (2004) as reported from FAO trade data

3.1 Participants in International Trade Relevant to the PICs

The information on international trade includes both exports and imports of chondrichthyans, with FAO as the major source of most reports in the literature. Some authors having access to country-generated data have published detailed statistics, but these are usually not up to date.

According to FAO data used in Lack and Sant (2006) the top shark importing countries in 2003 (percentage) were Spain (15.1), Republic of Korea (14.5), China (11.6)[17], Mexico (10.1), Italy (8.8) and China (7.9). Others included Brazil, France, UK, and Singapore. The same reference listed the top shark exporting countries in 2003 as Taiwan (20.5), Spain (13.4), Costa Rica (6.7), Chile (6.3), UK (5.4) and Japan (4.9). Others included Canada, Panama, New Zealand, and USA.

The following summary of participants in international trade discusses briefly those countries that are believed to be of the greatest relevance to the Pacific island countries for export purposes. For brevity and ease of reading references have been omitted from the text, but most figures are from Vannuccini (1999), Clarke (2004), Lack and Sant (2006) or Gillman et al. (2007).

3.1.1 China

The market for shark meat has reportedly expanded ten-fold between 1998 and 2002, rising from 243 t to 4,603 t. In 2002 the market appeared to be served primarily by Singapore, Japan, and Spain. The source of product from Singapore is likely bycatch from tuna longliners from the Indian Ocean, whereas Japan and Spain probably supply sharks from their worldwide fisheries. Declared value was about US$1 per kg.

[17]This includes shark fin for Hong Kong which skews the figures considerably since Hong Kong handles about half of the world's imports of this commodity.

Some reports mention that in China shark meat is processed into canned meat, salted meat and shark meat balls, and that large sharks are preferred for the production of shark meat balls and canned shark meat. There is no updated information on uses of the increased volumes in the Chinese market. Given the large increases in the seafood processing sector in China, it is possible that at least a portion of the imports are re-exported as processed food products.

3.1.2 Japan

In 1999 Japan was noted as a significant trader in fresh and frozen shark meat. Major suppliers to the Japanese market were Spain, Canada, Ecuador and the USA. Exports of frozen sharks were sent to China, South Korea, Peru, and Spain, with frozen fillets exported to Singapore, Korea, Mauritius, Germany, and Italy. Mako, thresher and other species of *Carcharhinidae* (e.g. oceanic whitetip, silky) had a higher economic value on the Japanese market compared with other species.

3.1.3 Korea

Shark meat reportedly does not possess a high economic value in the Republic of Korea but prices there are higher than in other East Asian countries. In 2003, Korea imported about 15,500 t. The composition of imports changed since 1997 when the greatest bulk consisted of frozen skates to where now it is composed mainly of frozen sharks.

Taiwan was by far the main supplier of frozen sharks to Korea in 1997, followed by Singapore, Japan, Peru, New Zealand and Spain. In the previous years New Zealand has been the major exporter of shark meat to Republic of Korea.

Supplies from the domestic Korean tuna longline fleet are probably limited even though it fishes in the WCPO and Eastern Pacific. This is because usually only mako sharks are retained onboard due to space limitations, and much of the fleet's production has historically been transshipped at sea and sent to Japan.

3.1.4 Australia

It is reported by Brothers (2007) that around 8,000 t of sharks are produced annually from bycatch and directed fisheries in Australia, and that only around 17 t were exported recently (no time period given). Export destinations are given as Japan, Greece, Korea, Hong Kong, Malaysia and Singapore. It is also reported that the landed shark catch from the Australian pelagic longline fishery is exported to Japan. According to Taiwanese import data, however, Australia exported about 294 t of shark to Taiwan at an average price of around NT$11 (about US$.34) per kg in 2005.

Sources in China indicated that some shark has been recently exported to Australia from Zhejiang province, however no details are available. Other sources mention about 233 t of sharks imported into Australia from five countries: South Africa, New Zealand, Spain, New Caledonia, and Philippines (no time period given).

3.1.5 Taiwan

Capture production of sharks by Taiwan in 2003 was reported at 67,432 t, about 8 percent of the world total, the second largest catch after Indonesia's nearly 123,000 t or 14 percent of world total (Lack and Sant 2006). Taiwan fishery statistics for 2005 list the

production of 2,786 t of "fish paste" from sharks. Importation of raw material for either direct consumption or processing is highly regulated, and it is difficult for sharks (as well as shark fin) to be imported into Taiwan without some connection to Taiwanese fishing activity[18].

Destinations of exports of shark meat or shark meat products from Taiwan are not well understood. In the past (i.e. about 10 years ago), major foreign markets were the USA, Uruguay, Republic of Korea, Philippines, Singapore and UK. Frozen fillets were usually destined for export markets such as Japan and Europe.

Taiwan export statistics for 2005 list 8,926 t of "frozen shark" and 4,614 of ""other edible" as exports (TFA 2007). It may be that some of the volume consists of shark caught by Taiwanese vessels and sold elsewhere, but not actually imported into Taiwan. Some frozen shark meat as well as fresh shark meat has been exported to Mainland China from Taiwan. The declared value of frozen meat was US$1.00 per kg, whereas the fresh meat was $8.10 per kg. The high price of the fresh meat suggests it may well have been whale shark meat, since few other sharks (if any) have meat valued this high (Clarke 2004)[19].

3.1.6 Indonesia

The shark fishery in Indonesia is largely artisanal. Sharks and rays are generally caught as bycatch when using set gillnets, longlines and handlines to catch groupers and snappers. These activities occur mostly in shallow water coral reef and coastal environments. Several shark species are targeted for their fins. Examples include the white-spotted guitarfish *Rhynchobatus djiddensis* in the eastern provinces of Maluku and West Papua and *Carcharhinidae* in Nusa Tenggara and the Timor Sea[20].

Indonesia also has a significant longline fleet that fishes in both the Indian and Pacific Oceans. Most vessels target tunas, but there are also shark targeting vessels in operation. In 1997 exports of frozen shark were 2,370 t with an estimated value of US$740,000. Exports of shark meat are mainly directed to other Asian countries, with the great bulk exported to Taiwan Province of China and China and small quantities to Japan, Singapore and Europe (mainly UK). An undetermined amount of dried shark meat is reportedly exported to Hong Kong, Singapore, Malaysia, and Japan with brined shark meat exported to Singapore.

3.1.7 European Union

In 1997 Spain was the top producer of frozen whole sharks with 12,100 t, followed by Japan, the USA, Mexico and Indonesia. The catch has historically come primarily from the Atlantic swordfish fishery, which is a surface longline fishery and could be expected to produce significant numbers of sharks. It is reported that around one third of the catch is blue shark, and a further 20 percent is shortfin mako.

Spain is one of the world's leading exporters of shark. It also imports shark, and according to FAO in 1997 Spain imported nearly 7,200 t valued at US$11.4 million.

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[18] For example, a such a connection could be importation of products caught by a vessel that has retained its Taiwanese registration in addition to another flag in the country of operation, e.g. Taiwanese tuna longliners flagged in Indonesia that have retained their Taiwanese registration.

[19] Whale shark is a delicacy known as "tofu shark" in Taiwan and some parts of Mainland China. In May, 2007 the Taiwanese government declared an end to fishing for whale sharks and gave traders until 2008 to dispose of all currently held supplies.

[20] Most Indonesian vessels apprehended for fishing in northern Australian waters are targeting shark.

Shark meat is usually marketed skinned and gutted as steaks and fillets. Shortfin mako shark (*marrajo*) is the most favored species, followed by thresher shark, tope or school shark (*cazón*), smooth hammerhead, smooth hound, picked dogfish and bigeye thresher shark[21].

3.1.8 USA

The USA is a consumer of shark meat, with most being produced domestically from catches where fins are also obtained. On the West coast, the preferred market species is thresher shark, with the common thresher, *Alopias vulpinus*, being marketed in California and elsewhere. On the East and Gulf coasts, inshore species such as blacktip, *Carcharhinus limbatus*, scalloped hammerhead, *Sphyrna lewini*, and sandbar *Carcharhinus plumbeus*, are the most commonly caught and marketed. These are part of a "large coastal sharks" complex that is managed under a management plan with different quotas than for "large pelagic sharks".

Some shark meat is imported on the West coast, primarily from Baja California, Mexico. It is reported that this includes small amounts of blue shark, destined for the fried fish "taco stand" trade in heavily Hispanic southern California.

3.2 Transport and Distribution Networks

3.2.1 Export

The transportation of shark trunks from PIC domestic-based longliners landing this product in the region represents the largest segment of shark bycatch requiring transportation to markets. The markets for frozen shark trunks exist overseas; there has been no identification of transshipping to other PIC countries.

There are two methods currently utilized for shipment: (1) as back-haul freight on vessels that provide bait and other supplies to longline operations in some PICs and (2) in containerized shipments utilizing freezer containers, predominantly the standard 20 foot containers. In both cases, sharks are often co-mingled for shipment with other bycatch, including marlin, wahoo, and mahimahi.

The use of freezer containers in international trade has increased in some ports, while the use of dedicated carrier vessels serving domestic-based fleets has decreased. This is particularly true in the Micronesian region, where carrier vessels formerly served a number of ports, transporting bait from Taiwan and returning the shark and other bycatch there for processing.

There are several reasons for the increased use of containers for both importation of bait and export of bycatch during the past few years. Varied bait sources other than Taiwan are now being used, particularly since the Chinese longline fleet based in Pohnpei and Marshall Islands rely less heavily on Taiwanese squid for bait[22].

This has created opportunities to obtain bait from non-Taiwanese sources which, in many cases is less expensive and is shipped by freezer container. Another reason is the

[21] The preference for bigeye thresher in Spain is in contrast to the US west coast where it is reported to be the least desirable of the three thresher shark species (J. Arceneaux personal communication).

[22] Reliance on squid produced by distant-water Taiwanese squid vessels decreased with the introduction of mechanized monofilament longline "super spools" that enabled targeting of bigeye in deeper waters and the increased number of hooks set. Shallower sets have traditionally relied on squid as an effective bait.

increase in markets for bycatch for processing into manufactured fish products. Vietnam and China are two markets for bycatch that have opened in recent years, adding flexibility and options to companies exporting frozen longline bycatch.

In spite of the flexibility of containerized shipments, dedicated carriers are still used in some situations, particularly where there are no direct or frequent freight links with overseas markets or bait suppliers. Difficult logistics for containers in such locations can mean high per unit shipping costs by container as well as long intervals between shipments.

A further problem in these ports can be a lack of freezer container availability. An example of such a location where dedicated carrier vessels are still in use is Rabaul, which is the base for a small (<9 vessel) fleet of longliners targeting sharks in Papua New Guinea (PNG) waters. By comparison, large ports such as Suva or Port Moresby usually have freezer containers available and are served by many more shipping services providing direct or near-direct links to markets and bait sources.

3.2.2 Domestic Transport

The only significant domestic transport uncovered during the study was the occasional shipment of frozen shark fillets in Papua New Guinea to mining camps. In Fiji, previously frozen shark trunks are offloaded from longliners in Suva and delivered by truck to a firm that holds the product until sufficient volume has been reached to enable containerized shipment.

4. ESTIMATES OF SHARK DISCARDS BY INDUSTRIAL TUNA LONGLINE FISHERIES BASED IN FFA COUNTRIES

4.1 Country Reports to WCPFC

Based on annual country reports to the Scientific Committee of the Western and Central Pacific Fisheries Commission and the author's own estimates, it is believed that the domestic-based industrial longline fisheries in the PICs which produce the greatest amounts of shark bycatch currently operate in the Federated States of Micronesia (FSM), Marshall Islands, Fiji, and Papua New Guinea.

A small amount of shark bycatch was reported by Samoa (2.48 t). Cook Islands, FSM, Niue, Tonga and Vanuatu reported longline catch and/or landings; however the data did not identify the shark portion, if any. Vanuatu did not report shark catch separately, and indicated the catch of vessels from Vanuatu was mostly landed elsewhere.

Table 2 provides reported shark catch or landing data from FFA member countries for 2005[23]. It is difficult to determine the actual number of vessels active for each country, as the reports typically report only the number of licensed vessels.

[23] FSM is not included in Table 2 because the longline fishery based in Pohnpei only re-commenced operations during 2006.

Table 2 Reported Shark Catch or Landings Reported to Scientific Committee, WCPFC for 2005

	Active Vessels (2005)	Shark Catch or Landings (tonnes)	Notes
Fiji	72	696.0	Data do not include discards at sea, so assumed to be landings
Marshall Islands	30–35	504.0	Chinese and Belize flag vessels. Sharks represented 13.38% of total catch by weight
PNG	42	191.0	Sharks 4.86% of catch; mako predominant (167 t or 87 percent), 0 t blue shark means these are likely landings
Samoa	?	2.48	Fleet includes large number of <12 meter vessels. Shark 0.15% of total longline catch
TOTAL	**144-150**	**1,393.48**	

Sources: Country Annual Reports to the Second Meeting of the WCPFC Scientific Committee

The above summary is helpful in determining orders of magnitude of shark bycatch by these domestic-based fleets but is insufficient for estimating the total shark catch, including discards.

4.2 Estimates of Shark Discards Using Observer Data

Since country reports to WCPFC are inadequate to gauge the potential volumes of sharks produced in domestic-based longline fisheries, the onboard fishery observer data held at the Oceanic Fisheries Programme of the Secretariat of the Pacific Community was used to provide indicators of potential production.

The observer database was queried to extract information on the fate of sharks observed on longline vessels during the period 1995-2005. Only Pacific Island observer data was used to get a more accurate picture of domestic and domestic-based fleets.

The fate of sharks listed in the data collected by observers fall into 8 categories:

1. Retained
2. Escaped
3. Discarded trunk, fins retained
4. Discarded, undesirable species
5. Discarded, struck off
6. Discarded, shark damage
7. Discarded, difficult to land
8. Discarded, other reason

For the purposes of this study retained sharks are assumed to be sharks for which the fins and trunks were retained. The analysis concentrated on the total numbers of sharks caught where the trunks were discarded and fins retained, i.e. finned sharks. Species identification by observers is assumed to be accurate. The list above indicates there are other reasons for discarding other than finning. It is assumed that where the sharks were discarded and only fins retained, the trunk would have been of a size and in a condition suitable for retention.

It is important to note that the reasons for discarding after finning may be strongly influenced by vessel configuration and storage capabilities. In some fleets where it might be worthwhile to land shark carcasses, a lack of storage space (including freezer storage) may contribute to greater volumes of discards. Category 8 in the above list may or may not include this important parameter.

The data were separated into observations from three fisheries: tropical deep longline fishery (TDL), tropical shallow longline fishery (TSL), and tropical albacore longline fishery (TAL). The countries represented in the tropical fisheries are Palau, FSM, Marshall Islands, Kiribati, Papua New Guinea, and Solomon Islands. Tropical deep and shallow fisheries were separated by number of hooks between floats: those trips with less than 10 hooks between floats were characterized as shallow, while those with more than 10 hooks between floats fell into the tropical deep fishery category. The remaining countries (such as Fiji) represented a tropical albacore fishery.

The observer data for trips from which this shark data was obtained was then queried to obtain the total observed target (tuna) catch. These two data sets, finned/discarded sharks and total tuna catch for each of the three fisheries were then compared to obtain the number of sharks discarded per tonne of tuna caught. Since the observer data show the observed shark catch by species, this quantity can be further described to the species level.

The numbers of sharks discarded per tonne can be applied to catches of tuna reported for a particular country to obtain a rough estimate of the number of sharks that (at least theoretically) might be available for landing and/or processing.

Throughout all data sets for the three fisheries examined, blue sharks are the most common sharks caught, as well as the species most often finned/discarded. This is not surprising, as it is believed that the distribution of blue sharks in the water column is more widespread than many other shark species and therefore they would be present in all three fisheries.

The results show that in the TSL, about 11 sharks were discarded for every tonne of tuna caught (Table 3).

Table 3 Number of Sharks Retained and Finned/Discarded by Species, Tropical Shallow Longline Fishery

SPECIES	NUMBER CAUGHT	NUMBER RETAINED	NUMBER FINNED/ DISCARDED	NUMBER DISCARDED PER TONNE OF TUNA
BLUE SHARK	3473	382	2926	6.44
SILKY SHARK	2443	1355	981	2.16
OCEANIC WHITETIP SHARK	777	366	393	0.86
SHARKS (UNIDENTIFIED)	549	281	142	0.31
GREY REEF SHARK	193	138	43	0.09
BIGEYE THRESHER	190	56	106	0.23
SHORT FINNED MAKO	169	72	81	0.18
THRESHER SHARKS NEI	134	13	99	0.22
CROCODILE SHARK	111	23	12	0.03
PELAGIC THRESHER	89	42	43	0.09
LONG FINNED MAKO	50	25	18	0.04
SILVERTIP SHARK	32	24	5	0.01
WHITETIP REEF SHARK	18	14	4	0.01
HAMMERHEAD SHARKS	17	6	9	0.02
BLACKTIP REEF SHARK	13	11	2	0.00
MAKO SHARKS	13	0	11	0.02
BLACKTIP SHARK	8	8	0	0.00
THRESHER	8	1	7	0.02
GALAPAGOS SHARK	6	5	1	0.00
TIGER SHARK	5	0	5	0.01
GREAT WHITE SHARK	2	2	0	0.00
BIGEYE SAND SHARK	1	0	0	0.00
TOTAL	8301	2824	4888	10.76

Source: SPC Observer Data, Pacific Islands only

The greater number of sharks caught and discarded per tonne of tuna in the TSL as compared with the TDL and TAL is not surprising. Studies such as Moloney (2005) and Williams (1998) have identified the TSL as one where there a greater volume and diversity of bycatch, including sharks. The smaller number of hooks between floats is more representative of Taiwanese fishing techniques that include setting the line in a manner that maximizes the catching of sharks and other bycatch as well as the target tuna.

The second most prevalent species in the TSL, silky sharks, is illustrative of recent work by Kohin et al. (2007). In an experiment using pop off archival tags in the Eastern Pacific Ocean, it was shown that silky sharks spent 99 percent of their time in the upper 50 meters of the water column where water temperatures ranged from 24° to 30° C.

Similar work by Laurs et al. (2007) on three species of pelagic sharks points to restricted habitat use by the third most prevalent species in the TSL list, oceanic whitetip shark. This shark was found to have a "relative restricted 'home range' in the near surface tropical waters of about 24.5° to 26° C.

In the TDL shown in Table 4, about one third as many sharks are finned/discarded per tonne of tuna caught as in the tropical shallow fishery. Blue sharks also represent the

species with the largest number and percentage discarded. Bigeye thresher, *Alopias superciliosus*, replaces the oceanic whitetip as second most prevalent species in this fishery.

Table 4 Number of Sharks Retained and Finned/Discarded by Species, Tropical Deep Longline Fishery

SPECIES	NUMBER CAUGHT	NUMBER RETAINED	NUMBER FINNED/ DISCARDED	NUMBER DISCARDED PER TONNE OF TUNA
BLUE SHARK	5961	207	5341	1.76
SILKY SHARK	2719	859	1708	0.56
BIGEYE THRESHER	1212	40	1002	0.33
OCEANIC WHITETIP SHARK	985	275	672	0.22
PELAGIC THRESHER	748	36	620	0.20
SHORT FINNED MAKO	645	88	508	0.17
LONG FINNED MAKO	295	8	241	0.08
THRESHER SHARKS NEI	285	3	54	0.02
SHARKS (UNIDENTIFIED)	180	11	15	0.00
CROCODILE SHARK	164	10	26	0.01
BLACKTIP SHARK	151	42	104	0.03
SILVERTIP SHARK	99	8	24	0.01
GALAPAGOS SHARK	91	41	46	0.02
TIGER SHARK	91	50	28	0.01
THRESHER	72	0	59	0.02
BLACKTIP REEF SHARK	35	0	29	0.01
GREY REEF SHARK	34	4	21	0.01
MAKO SHARKS	34	0	23	0.01
GREAT WHITE SHARK	32	10	20	0.01
HAMMERHEAD SHARKS	26	6	18	0.01
SCALLOPED HAMMERHEAD	11	0	2	0.00
BRONZE WHALER SHARK	10	2	8	0.00
COOKIE CUTTER SHARK	3	0	0	0.00
DOG FISHES	3	0	0	0.00
WHITETIP REEF SHARK	1	0	0	0.00
TOTAL	13,887	1,700	10,569	3.49

Source: SPC Observer Data, Pacific Islands only

Table 5 describes the species retained and finned in the TAL, which has less observer coverage than the other two fisheries analyzed. Observer data show that the tropical albacore fishery fins and discards about 3.89 sharks by number per tonne of tuna caught in this fishery.

Table 5 Number of Sharks Retained and Finned/Discarded by Species, Tropical Albacore Longline Fishery

SPECIES	NUMBER CAUGHT	NUMBER RETAINED	NUMBER FINNED/ DISCARDED	NUMBER DISCARDED PER TONNE OF TUNA
BLUE SHARK	5613	437	4821	2.53
OCEANIC WHITETIP SHARK	1625	334	1233	0.65
SILKY SHARK	919	213	626	0.33
SHORT FINNED MAKO	652	396	221	0.12
BLACKTIP SHARK	280	167	98	0.05
SHARKS (UNIDENTIFIED)	221	16	54	0.03
LONG FINNED MAKO	103	57	26	0.01
BIGEYE THRESHER	101	19	34	0.02
GREY REEF SHARK	78	17	54	0.03
SILVERTIP SHARK	76	0	64	0.03
PELAGIC THRESHER	65	5	25	0.01
MAKO SHARKS	62	25	28	0.01
HAMMERHEAD SHARKS	58	36	19	0.01
TIGER SHARK	57	7	33	0.02
THRESHER SHARKS NEI	50	6	18	0.01
BLACKTIP REEF SHARK	49	0	39	0.02
CROCODILE SHARK	14	0	0	0.00
SMOOTH HAMMERHEAD	8	1	6	0.00
COOKIE CUTTER SHARK	7	0	0	0.00
GREAT HAMMERHEAD	7	0	7	0.00
SANDBAR SHARK	7	0	6	0.00
SCALLOPED HAMMERHEAD	6	0	6	0.00
BRONZE WHALER SHARK	4	1	3	0.00
THRESHER	4	3	1	0.00
SEAL SHARK / BLACK SHARK	3	1	0	0.00
GALAPAGOS SHARK	2	0	2	0.00
BIGNOSE SHARK	1	0	0	0.00
GREAT WHITE SHARK	1	0	1	0.00
TOTAL	10,073	1,741	7,425	3.89

Source: SPC Observer Data, Pacific Islands only

The total number of sharks discarded per tonne of tuna caught in the three fisheries described above can be applied to country target tuna catches (albacore + bigeye + yellowfin) to give a very rough estimate of shark tonnage discarded. The methodology uses the tuna catch tonnage reported to WCPFC in the annual country reports. Applying an estimated range of average shark trunk size an estimate can be made of shark trunk tonnage produced and discarded by those fleets.

Of the three elements used in the estimate, i.e. number of sharks discarded per tonne of tuna catch, total tuna catch, and estimated shark trunk weight, the shark trunk weight is the one element with the least available information. A range of 25 to 35 kg for shark trunk weight is used in the estimates, based on the author's estimates from occasional visual inspections, including transhipment of frozen sharks in PNG and offloading of

fresh sharks in FSM and the Marshall Islands. Depending upon species, shark meat in the form of a trunk represents from 50 to 60 percent of whole weight, according to one source[24].

For Fiji, primarily a tropical albacore fishery, target tuna catches were reported as 11,313 t in 2005 consisting of albacore 8,901 t, bigeye 423 t, and yellowfin 1,989 t. Applying the figure of 3.89 sharks per tonne results in 44,007 sharks. At an estimated 25-35 kg per trunk the total discarded catch in 2005 would have been about 1,100–1,540 t, of which 74 percent were blue sharks.

These very rough estimates do not take into account factors such as possible targeting of yellowfin using different gear setting characteristics, or intentional setting shark lines on buoys and floats, or other techniques that might be practiced to maximize shark catch for finning purposes.

The PNG situation is even more difficult to estimate because although the major catch in 2005 was albacore (2,088 t), yellowfin are also targeted (1,052 t). Bigeye (211 t) appears not to be a primary target species in the fishery. The composition of the fleet in PNG is also different, with about an equal number of Taiwanese and Japanese-style vessels and on the basis of setting techniques by these vessels it could be argued that half the fishery falls into the TDL and half in the TSL. Since the numbers of sharks discarded by TDL and TSL according to observer records are very similar, a midpoint of 3.69 sharks per tonne of target tuna caught is used. Using the same method of calculation as the Fiji example, PNG's domestic-based fleet might have been expected to have discarded from 309–433 t in 2005, of which a little over half (53 percent) could have been blue sharks.

Samoa's shark discards in 2005 can be estimated to have been in the range of 148–207 t, based on a total tuna catch of 1,525 t in their domestic albacore fishery. As with the Fiji albacore fishery, it is estimated that about 74 percent or 109–153 t could have been blue sharks.

The Marshall Islands' domestic-based fleet in 2005 was and continues to be exclusively Chinese. Using this method of calculation to estimate shark discards for a reported total tuna catch of 2,558 t, an estimated 223–312 t was discarded. This is in addition to the 504 t reported landed (Table 2). The overall catch (discards plus landings) of 727–816 appears high for tropical deep longline fleet.

The discrepancy in the Marshall Islands might be explained by several factors:

> (1) Although almost all vessels possess line shooters and monofilament longline spools, it is likely that these are used at least in part to simply set more hooks than with basket gear during certain moon phases where surface fishing is more attractive. These shallow sets, usually undertaken at night, would be expected to produce greater numbers of sharks.
>
> (2) There is also indication that Chinese crews on at least some vessels are utilizing shark lines on buoys and floats to increase shark catch.

Chinese vessels operating in the Marshall Islands generally take trips of 7–9 days' duration or less and have sufficient fish hold space to segregate and retain sharks. The base for these vessels in Majuro is operated by a Hong Kong-based company that has been exporting sharks and other bycatch since its inception in 2001 and provides a ready avenue of export for shark bycatch.

[24] Calculated from sharks caught in the Maldives shark fishery, Anderson and Ahmed (1993).

It is thus assumed that the 504 t reported in the annual country report to WCPFC for 2005 represents most marketable sharks caught by the domestic-based tuna longline vessels. In this scenario it is likely that discards would consist mostly (by weight) of blue sharks. An arbitrary figure of 80 percent of the total discards of 223–312 t is ascribed to this species.

The information discussed above is summarized in Table 6 where the tonnage of estimated shark discards, estimated tonnage blue shark discards, and the percentage of blue shark discards are presented.

Table 6 Estimated Shark Discards (Trunk Weight) and Blue Shark Discards in Major Domestic-based Longline Fleets, 2005

	Target Tuna Catch (t)	Estimated Shark Discards (t)	Blue Shark Discards as % of Total Discards	Estimated Blue Shark Discards (t)
Fiji	11,313	1,100—1,540	74	814—1,140
Marshall Islands	2,558	223—312	80	178—250
PNG	3,351	309—433	53	164—229
Samoa	1,525	109—153	74	81—113
TOTAL	18,747	1,741—2,438	70	1,059—1,482

Although FSM is not listed in Tables 2 and 6, the re-emergence during late 2006 of the Chinese fleet based in Pohnpei can be expected to contribute to further retained shark catches in the PICs. The fleet is controlled by the same firm that operates the fleet in the Marshall Islands, and existing freight and transport options are the same for each location. Fishing practices can be expected to be similar in both locations, and the marketing of bycatch as well as target tuna can also be expected to be undertaken in a like manner[25].

Palau has a significant locally-based longline fleet (Chinese and Taiwanese) that caught a combined 4,089 t of bigeye and yellowfin in 2005. They are not included here because domestic regulations in Palau prohibit the possession of sharks and/or shark parts on any longline vessel operating in Palau's Exclusive Economic Zone.

5. USES OF SHARK LANDINGS FROM DOMESTIC-BASED TUNA LONGLINE FLEETS

5.1 Current Domestic Use of Sharks Caught by Tuna Longline

Domestic use of sharks in the PICs is not well documented, and even less so for sharks from domestic longline sources. There are references in the literature to traditional uses for food and other purposes in Solomon Islands, and it is likely this occurs elsewhere.

[25] In May 2007 efforts were already underway to obtain fishery access to both Marshall Islands and FSM for the two fleets, enabling them to change location based on fishing conditions encountered.

Large urban areas such as Port Moresby, Lae, and Suva might be expected to have a ready market for shark, as it is a perceived low-cost commodity which might appeal to people at lower income levels. A cursory one-day survey of Suva fish shops and informal markets during May, 2007 found, however, that shark was not normally offered for sale. The sharks from longliners that did enter local trade were usually sold directly by vessel crews to restaurants to augment their wages. No estimates of volumes in this trade are available, but it is not thought to be large.

In Papua New Guinea's largest two urban areas, Lae and Port Moresby, there has been a demonstrated demand for shark that has not always been satisfied. Processing and distribution were reportedly bottlenecks, and there is some suggestion that it is easier to export shark trunks in frozen containers to institutional users such as mining camps where demand is strong.

One local firm in Lae that has been a highly successful manufacturer and marketer of other food products experimented with value-added products such as fillets and fish balls from the company's vessels. The company has now ceased production, citing regular supply problems and poor returns as the primary reasons[26].

Although it is reported that all tuna longliners land shark trunks and that the product is sold domestically and for export, in no case in PNG were there hard data available on sales, prices or market quantities. Estimates by knowledgeable people were that about 75 percent of shark landed by longliners was exported, with the balance sold on the local market. Papua New Guinea exports of shark meat go primarily as frozen trunks to Taiwan.

5.2 Shark Exports and Values

5.2.1 Shark meat

Frozen shark trunks are the major export commodity from domestic-based longline operations in the PICs. Worldwide, the prices paid for shark meat are low, typically from US$0.30 to around US$1.00 per kg. The distances of major PIC producers from larger markets in other parts of the world require shipment by refrigerated container.

In recent years, markets have developed worldwide in certain countries for shark meat from species other than mako shark in ports where some distant-water longline vessels often call for supplies and transshipping. These ports include Cape Town (South Africa), Callao (Peru), Las Palmas (Spain), Balboa (Panama), Cartagena (Venezuela) and Port Louis (Mauritius). These ports have both local markets and opportunities for export, so some vessels are able to retain sharks for sale. Even where such markets do exist, the price for shark meat is low, with large shark trunks greater than 10 kg fetching around US$0.60 per kg. and smaller sharks $0.20 per kg (Clarke 2007).

In the PICs, Fiji is perhaps the largest producer and exporter of frozen shark from tuna-targeting longline vessels. Longliners offloading in Suva typically provide a locally-based exporter with enough frozen shark to fill one and sometimes two 20-foot container per month. The price paid is F$1.00 (approximately US$0.62) and the destination for exports is reportedly Korea. The buyer will purchase only "brown" sharks, i.e. pelagic shark species, mainly *Carcharhinidae,* other than blue sharks[27].

[26] H. Walton, personal communication.
[27] Wayne Moy, personal communication.

Chinese-operated longline fisheries based in FSM and the Marshall Islands also export shark trunks along with other bycatch, but volumes and prices received are not known.

5.2.2 Shark Skin

Recently, some Chinese vessels operating from Majuro in the Marshall Islands have begun processing sharks onboard for their skins (as well as retaining fins). No prices were found for this product, however. The fate of the carcasses after skinning is unknown, but they are believed to be discarded after processing[28].

One possible reason for the Chinese interest may be that increased utilization of sharks for meat on a global level may have caused a decrease in skin availability with resulting increases in value for the latter product. Another reason for retaining skins may be to sell for favorable prices in a niche market. Figure 2 shows three bundles of dried shark skins photographed in 2006 onboard a Chinese longliner based in Majuro. The skins appear to be those from blue sharks, which are reportedly preferred in Japan for the production of leather.

Figure 2 Bundles of Dried Shark Skin Onboard a Chinese Longliner, 2006

6. ASSESSMENT OF OPPORTUNITIES AND CONSTRAINTS TO FURTHER MARKETING OF SHARK PRODUCTS

The interest in increasing the marketing of shark products most likely comes from interest in the PICs to retain as many fins as possible and remain in compliance with

[28] Manassah Avicks, personal communication.

intended or existing bans on finning by full utilization of sharks. Since "full utilization" is defined as not including head, guts, and skin, the focus for further utilization must be on the increase in the production of shark meat.

The WCPFC Conservation and Management Measure 2006-5 requires that the fins retained must be no more than 5 percent of sharks onboard at first landing. The 5 percent figure adopted by the WCPFC is based on a rough average of fin to carcass weight already used by other RFMOs.

The potential for further processing onboard beyond that for trunks is slim. Further processing could result in wastage and subsequent reduction in the allowable weight of fins onboard. The WCPFC Scientific Committee is to review the 5 percent limit in 2007, but it is highly unlikely that they would unilaterally allow significant changes given the worldwide acceptance of this value and continued environmental pressure to cease finning altogether,

Longliners targeting tunas who wish to also retain shark fins beyond the 5 percent limit where it applies are thus limited to landing shark trunks (i.e. carcasses) in either fresh or frozen form.

6.1 Estimated Values of Reported Shark Landings

It is useful to compare the estimated values of reported shark landings by the countries shown in Table 6 with values of longline tuna landings in those countries to get a sense of the relative landed value of the two products. In Table 7 a nominal (and somewhat generous) ex-vessel value of US$.50 per kg is assigned to catch/landings of frozen sharks, and it is assumed that volumes given in Table 6 are landed weights, i.e. shark trunks rather than live weight[29]. The values of target tuna species are from FFA[30] and represent the production of national fleets from all tuna landed. The reported target tuna landings of the Chinese fleet based Majuro are used in the case of the Marshall Islands. The results show that in no case does the estimated value of shark meat in these fleets exceed 1 percent of the value of the target tuna catch.

Table 7 Estimated Landed Shark Meat Value and Landed Tuna Value in Major Domestic-based Longline Fleets, 2005

	Shark Catch or Landings (tonnes)	Shark Meat Value (US$,000)	Target Tuna Value (US$,000)
Fiji	696.0	348.0	37,928
Marshall Islands	504.0	252.0	39,620
PNG	191.0	95.5	13,546
Samoa	2.48	1.24	4,882
TOTAL	1,393.48	696.74	95,976

[29] It is recognized that the values of shark meat in Table 7 do not take into account the indirect value of landing shark meat in order to increase the volume of fins able to be retained under the 5 percent regulatory scenario.

[30] C. Reid, personal communication.

It is also useful to compare the estimated value of shark fins that are assumed to also have been landed by each of the fleets mentioned. McCoy (2006) estimated that on the basis of rough estimates of fin value, vessels in the TAL might be obtaining around $225 for fins per tonne of tuna caught; while the TDL would be getting slightly less, around $200. For the four fleets in Table 7, these estimates are more appropriate to apply for the fleets in Fiji, PNG, and perhaps Marshall Islands[31] where the ex-vessel value of landed fins (percentage of tuna catch value) could be roughly:

- Fiji: $2,500,000 (6.7%)
- Papua New Guinea: $754,000 (5.6%)
- Marshall Islands: $512,000 (1.3%)

Samoa is a special case to which the above method of estimating fin value may not apply. In Samoa the reported target tuna catch is not apportioned between the 20 or so smaller vessels in the alia fleet (<12 meters in length) and the 9 larger vessels active in the fishery. The alias are mostly outboard powered catamarans that have very limited deck space and crews may not fin as many sharks as larger vessels owing to practical and safety concerns. As a result, and absent any further information on shark finning activities from Samoa's fleet, no attempt has been made to estimate fin value here.

6.2 Opportunities to Increase Shark Meat Production and Exports

As has been described above, shark meat delivered to port ex-vessel is most likely to be in the form of shark trunks. Vessels which sell frozen shark trunks to buyers in port likely receive the highest prices for this product form, as the buyer can place the product directly into storage with no further freezing cost. Those which either sell or offload fresh shark trunks for freezing ashore may not receive as high a price as the frozen product, due to the need to first handle and freeze the sharks.

The locations where frozen shark meat exports are most practically considered are those ports with direct or near-direct access to markets via overseas containerized shipping using standard 20 foot or 40 foot freezer containers. In the PICs, there are only a few such ports with locally based longline fleets: Suva, Pohnpei, Port Moresby, and Majuro.

In other ports such as Port Vila, Nuku'alofa, and Apia with potentially useful shipping connections, the practicality of export would be determined by:

- sufficient product volume from shark species acceptable to the market that would enable filling of a 20 foot equivalent (TEU) freezer container
- the production of such volume quickly enough to minimize demurrage charges on containers left in port, or
- adequate freezer storage onshore that would enable sufficient quantities to be collected in anticipation of container availability.

The potential for increased landing of sharks by fleets based in PIC ports is also highly dependent upon vessel refrigeration and fish hold configuration and capacity. Those

[31] The landed fin value for the Marshall Islands may be underestimated for the reasons given in Section 3.2 relating to estimates of shark catch plus discards.

most capable of retaining and delivering shark trunks are vessels with significant freezer hold space. At present, only Taiwanese-style longliners are constructed in this manner as they have consistently retained most non-shark bycatch as well as some shark bycatch for transhipment or delivery to Taiwan[32].

Longline vessels without significant freezer hold space onboard must either use bait freezers if available, or store the trunks in ice. It should be remembered that retention of shark trunks in either case results increased operational costs, either through increased fuel usage and maintenance for onboard freezers and/or increased ice consumption.

Further discussion on the suitability of existing vessels is limited due to a lack of detailed information on fish hold configuration and capacity for most domestic-based longline fleets in the region. New designs for longline vessels that might include sufficient freezer space for holding shark trunks would have to take into account the costs as well as economic advantages in retaining additional volumes of shark, including fins.

6.2.1 Transportation Costs

It is not certain that existing markets for shark trunks could absorb increased supplies without resulting in a drop in prices. Should increased shark trunk landings eventuate, the handling, storage and transportation costs to alternative markets should be considered. Several shipping agents in Suva were queried as to the cost of shipping a freezer container to potential markets outside the PIC region. Suva was chosen because of its central location, relatively large urban population and worldwide shipping connections that make it a center for trade in the region. Table 8 summarizes the information obtained and estimates transportation and handling costs per kg for frozen shark trunks in 20 foot freezer containers with an estimated capacity of 14 t[33].

Table 8 Containerized Shipping Costs from Suva to Foreign Ports for Loose Frozen Fish

Destination	Cost per Container (US$)	Cost per kg (US$)
Kaohsiung, Taiwan	4,900	0.35
Shanghai, China	4,800	0.34
Vigo, Spain	5,800	0.41
Melbourne, Australia	2,100	0.15

6.2.2 Problems Presented by Bycatch of Blue Sharks

With around 70 percent of discards consisting of blue sharks, the need to find both products from blue sharks and markets that can absorb those products are needed to enable any quantum increase in shark bycatch retention. The problems are two-fold: (1) a lack of extensive markets brought about by the unsuitability of blue sharks for most

[32] A detailed description of Taiwanese fleets and their bycatch retention practices can be found in McCoy and Ishihara (1999).

[33] The costs shown are indicative and represent inclusion of fuel surcharges and other charges in effect during May, 2007. Costs for 40 foot freezer containers are significantly less on a per unit basis, however are not included due to the amounts of product required and the fact that this size is not always available or able to be handled at Pacific Island ports.

products now obtained from shark meat, and (2) the poor storage characteristics of the shark as a fresh product that discourage retention.

Blue sharks are marketed in and by Spain and Japan. The Japanese case is a special one, with fresh sharks delivered by an offshore fleet fishing in temperate waters and delivering fresh shark to just one port where there is a niche market. Spain, on the other hand, is a less demanding market and might be an outlet depending upon EU trade requirements applicable to PICs.

Taiwan is one of the largest consumers of sharks in Asia. The plethora of products from sharks has benefited from research conducted at the National Taiwan Ocean University which has identified various products that are now commercially viable. It is not known the extent to which blue sharks have been targeted in research, but the continued discarding of blue sharks by Taiwanese longliners makes it unlikely that an economically viable product has been found.

6.3 Adding Value to Sharks Landed in the PICs

6.3.1 Manufactured Products

As previously mentioned, frozen sharks exported to overseas markets are mainly used in manufactured fish products such as fish balls, fish paste, and so forth. In Taiwan, it is believed that the greatest volume of such manufactured fish products are consumed domestically. It is not known if other countries such as Vietnam and China which have recently begun manufacturing these products are producing for the domestic or export markets.

The practicality of setting up such manufacturing in PIC ports would depend on several factors:

- Availability of required volumes of raw material on a regular basis
- Knowledge of and experience in the manufacturing process
- Identification of and ready access to overseas markets through existing transportation links

The experience of the manufacturer and vessel operator in Lae, Papua New Guinea should be carefully investigated and considered prior to any foray into manufactured shark food products.

6.3.2 Dried and/or Salted Shark Meat

It has been suggested that the markets for dried and/or salted shark meat in Mexico and other parts of Latin America have been unsatisfied for several years owing to drops in production. The low-tech processing of frozen shark trunks ashore into dried and salted shark fillets or pieces is something that might be investigated further, particularly in urban areas where labor is plentiful. Keeping in mind that much of Mexican production in the past has been done by artisanal fisheries in semi-arid locations such as Baja California, the minimum requirements in the PICs would be:

- Sufficient land area to enable construction of large drying racks or commercial facilities suitable for industrial hot-air dryers

- Relatively dry climate to enable sun drying or cost-effective energy sources to operate hot-air dryers
- Access to sufficient fresh water supplies for cleaning and preparation
- Proximity to international shipping

Potential competitors would include Indonesia, which has a large artisanal sector producing dried and salted shark products as well as industrial scale operations in large fishing ports. Figure 3 is a photo of one such product offered for sale recently on the internet by a supplier who operates a factory in Bali and claims the capability of supplying 40 t per month.

Figure 3 Salted and Dried Shark Meat From Indonesia Offered for Sale

One major drawback in considering overseas markets such as Latin America is the relatively high cost of transportation to those markets. The cost in May, 2007 for a 20 foot containerized shipment of dried fish products from Suva to Mazatlan, Mexico was quoted as approximately $5,800. Since dried fish products are relatively light but still take up considerable container space, the per kg cost for shipping is higher than for frozen products to Asian or European destinations. It is estimated that the unit cost of shipping a 20 foot container holding approximately 8 t of salted/dried shark meat would be on the order of US$0.73 per kg.

Salted fillets are not thought to be a high-value item in locations other than Latin America (e.g. Indonesia). It is possible that for dried/salted shark to be profitably produced in the PICs and exported, some sort of value-added processing and packaging would have to be done.

6.4 Market Opportunities for Other Products

If it is accepted that the primary impetus for increasing the retention of sharks is to retain fins due to bans on finning, there are severe limitations placed on opportunities to produce products other than shark meat.

One product that might warrant further investigations, however, is shark skin which does not require onshore processing prior to export. Recalling that shark skin must be obtained onboard in most situations before prolonged contact with ice or fresh water, it could be practical to consider if there is a means to protect the meat and maintain its shape during storage once the skin has been removed onboard.

For example, a protective bag or other container might be used on skinned shark trunks, making it possible for the meat to remain viable for storage and end use. It does not appear that this is currently being employed onboard the few vessels where shark skins are being taken. In addition to finding a storage wrap or container, adequate time and labor required to produce the skin would have to exist onboard and the economics of such a practice would have to be further explored.

Like shark fin produced by longlining tuna, the ex-vessel value of the raw material produced (in this case a dried skin) cannot be necessarily equated with end product values. The skins are likely to pass through several middlemen, and must undergo shipment to an overseas market and further processing and distribution before being used in specialized products. Thus products such as a wallet advertised for US$75 or a ladies' handbag for US$200 probably do not represent the magnitude of potential revenue to the fisherman from the landed raw material.

7. CONCLUSIONS AND RECOMMENDATIONS

Based on estimates contained in Section 3, the vast majority of currently discarded sharks are blue sharks. The remainder, approximately 30% or about 522–731 t consisting mainly of silky and whitetip sharks, might be retained and further utilized. This is assuming operators have the inclination, vessels have the space, and markets have the ability to absorb the production. It is almost certain that the latter requirement can be met, with price being an issue.

The current ex-vessel value for the estimated increase could be in the neighborhood of $261,000 to $366,000, which at approximately $1,740 to $2,440 per vessel for the number of vessels shown in Table 2 does not appear very substantial on a fishery-wide basis.

The remainder of most of the currently discarded sharks, i.e. blue sharks, will likely have to await further developments in food processing or expansion of markets to enable their retention and subsequent utilization.

The information and data on current shark utilization presented in this report could be refined by several means that might give a clearer picture of shark discards and the potential for marketing a greater proportion of shark bycatch.

A more rigorous look at observer data, such as consulting individual observer reports to see if it is possible to better determine reasons for discards could enhance the information shown in Section 3.

Better information on shark discards at sea and current retention of sharks could be obtained through greater observer coverage, on-site inspections and port sampling in offloading ports. This could lead to better data on the sizes and species of sharks potentially available for processing.

Time spent in interviewing shark buyers and exporters could give a better and up-to-date idea of market demands, rather than relying on published historical data. It could also shed light on the economies of scale required for economical marketing and transport.

Finally, any value-adding will require substantial investigation of both the technological and economic aspects on a product-by-product basis. In the WCPO, a start might be made in Taiwan or China to investigate possibilities. Elsewhere, the markets for dried, salted shark in Mexico and in Spain for shark trunks are two opportunities for investigation.

A final consideration is that the development of more economically viable or profitable products and the accessing or development of markets for these products could further encourage shark-targeting in longline fisheries. Increased efforts in fisheries management, including national plans of action for shark management, should accompany any such development.

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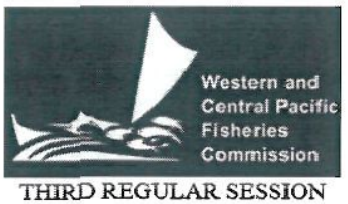
APPENDIX 1 Conservation and Management Measure 2006-05



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CONSERVATION AND MANAGEMENT MEASURE FOR SHARKS IN THE WESTERN AND CENTRAL PACIFIC OCEAN

Conservation and Management Measure 2006-05

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean;

In accordance with the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean;

Recognizing the ecological and cultural significance of sharks in the western and central Pacific Ocean (WCPO);

Recalling that the United Nations Food and Agriculture Organization (FAO) International Plan of Action for the Conservation and Management of Sharks calls on FAO members, within the framework of their respective competencies and consistent with international law, to cooperate through regional fisheries organizations with a view to ensuring the sustainability of shark stocks as well as to adopt a National Plan of Action for the conservation and management of sharks;

Recognizing the need to collect data on catch, effort, discards, and trade, as well as information on the biological parameters of many species, as part of shark conservation and management;

Recognizing further that certain species of pelagic sharks, such as basking shark and great white shark, have been listed on Appendix II of the Convention on International Trade and Endangered Species of Wild Fauna and Flora (CITES).

Resolves as follows:

1. Commission Members, Cooperating non-Members, and participating Territories (CCMs) shall implement the FAO International Plan of Action for the Conservation and Management of Sharks.

2. CCMs shall advise the Commission annually on their implementation of the IPOA Sharks, including, as appropriate, results of their assessment of the need for a National Plan of Action and/or the status of their National Plans of Action for the Conservation and Management of Sharks.

3. National Plans of Action or other relevant policies for sharks should include measures to minimize waste and discards from shark catches and encourage the live release of incidental catches of sharks.

4. Each CCM shall include key shark species, to be identified by the Scientific Committee, in their annual reporting to the Commission of annual catches and catch and fishing effort statistics by gear type, including available historical data, in accordance with the WCPF Convention and agreed reporting procedures;

5. The Commission shall consider appropriate assistance to developing CCMs for the implementation of the IPOA and collection of data on shark catches.

And adopts, in accordance with Articles 5 and 10 of the Convention, that:

6. CCMs shall take measures necessary to require that their fishers fully utilize any retained catches of sharks. Full utilization is defined as retention by the fishing vessel of all parts of the shark excepting head, guts, and skins, to the point of first landing or transshipment;

7. CCMs shall require their vessels to have on board fins that total no more than 5% of the weight of sharks onboard, up to the first point of landing. CCMs that currently do not require fins and carcasses to be offloaded together at the point of first landing shall take the necessary measures to ensure compliance with the 5% ratio through certification, monitoring by an observer, or other appropriate measures. CCMs may alternatively require that their vessels land sharks with fins attached to the carcass or that fins not be landed without the corresponding carcass.

8. The specification of the ratio of fin weight to shark weight described in paragraph 7 above shall be reviewed by the Scientific Committee in 2007 (and occasionally there after) and the Committee will recommend any appropriate revisions to the Commission for its consideration.

9. CCMs shall take measures necessary to require fishing vessels are prohibited from retaining on board, transship, landing, or trade in any fins harvested in contravention of this Conservation and Management Measure;

10. In fisheries for tunas and tuna-like species that are not directed at sharks, CCMs shall take measures to encourage the release of live sharks, that are caught incidentally and are not used for food or other purpose.

11. Nothing in this measure shall prejudice the sovereign rights of coastal States to apply alternative measures for the purpose of exploring, exploiting, conserving and managing sharks, including any national plan of action for the conservation and management of sharks, within areas under their national jurisdiction.

12. CCMs shall advise the Commission annually on the implementation of this conservation measure and any alternative measures adopted under paragraph 11 above.

13. On the basis of advice from the SC, the TCC and the Commission, CCMs shall review the implementation and effectiveness of this measure, and any alternative measures applied under paragraph 11 above, and shall consider the application of additional measures for the management of shark stocks in the Convention Area, as appropriate.

14. CCMs are encouraged to co-operate in the development of stock assessments for key shark species within the Convention Area.

15. This decision shall apply to sharks caught in association with fisheries managed under the WCPF Convention, and to sharks listed in Annex 1 of the 1982 Convention occurring in the Convention Area.

16. At the initial stage this Measure shall apply to vessels greater than 24m overall length.

17. This Measure shall enter into force on 1st January 2008 and in the interim shall be applied as a resolution.