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Perspectives

Social, Economic, and Regulatory Drivers of the Shark Fin Trade

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Abstract *The demand for shark fins is arguably the most important determinant of the fate of shark populations around the world. This paper examines the role that social and economic factors in China play in driving the trade both historically and under current trends of economic growth. The use of shark fin as a traditional and socially important luxury food item, along with rapidly expanding consumer purchasing power is expected to place increasing pressure on available resources. At the same time, the migration of the trade from its former center in Hong Kong to Mainland China has resulted in a severe curtailment of the ability to monitor and assess impacts on shark populations. Although recent international policy responses to this issue have resulted in the implementation of shark finning bans in some areas, these measures are likely to encourage full use of dead sharks;* i.e. *discourage carcass discards, as called for under the FAO International Plan of Action-Sharks, but not reduce shark mortality.*

Key words Asia, China, demand, finning, fisheries, management, seafood.

JEL Classification Code Q2.

Introduction

Shark fins have been a traditional element of Chinese haute cuisine for centuries (Rose 1996). However, during the Mao Zedong and early Deng Xiaoping eras, consumption was either discouraged by policies of cultural reform or priced beyond the reach of all but the wealthiest consumers (Cook 1990). As the historical hub of the

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entrepôt trade for China, as well as the heart of Cantonese culture, Hong Kong has long been the world's largest shark fin trading center, handling at least half of the global trade (Tanaka 1994; Vannuccini 1999; Clarke 2004a). The opening of the Mainland China economy under Deng in the late 1980s provided two types of opportunities for Hong Kong traders, who were already importing shark fins from all over the world to supply a limited local market. At first, less expensive labor on the Mainland made re-export for processing an attractive means of reducing costs and avoiding increasing complaints of odor nuisance at Hong Kong processing sites. Later, the Mainland also became an important destination for processed fins as markets developed within major urban areas. As a result, trade through Hong Kong expanded steadily during the 1990s at a rate of approximately 6% per annum (Clarke 2004a).

With the accession of China to the World Trade Organization in December 2001, and the ongoing implementation of further trade liberalization measures, shark fin trade dynamics between Hong Kong and the Mainland began to shift again. Hong Kong imports of shark fins remained stable through this period, but recorded Mainland imports dropped, contradicting Hong Kong traders' reports of escalating competition from Mainland dealers and highlighting concerns regarding Mainland trade data (Clarke 2004b). The reasons for this peculiar trend will be discussed further in this paper, but it remains reasonable to assume that trade through Hong Kong is still reflective of trends in the global trade even if its share of the global total has dropped. If this assumption is correct, the market reached its highest levels ever in 2003 with 6,960 tonnes imported to Hong Kong (*sensu* Clarke 2004b, updated with data from Anon. 2006). Calculations based on recent recorded trade figures suggest that the minimum global value of the trade ranges between approximately US$400 and 550 million per year (Appendix 1).

Concerns regarding the ability of shark resources to keep pace with market demand have increased in parallel with trade growth (Camhi *et al.* 1998; Baum *et al.* 2003; Baum and Myers 2004; Ward and Myers 2005). As apex predators, sharks' life history strategies have not evolved under the pressures of high natural mortality that characterize many other fishes. Consequently, many shark scientists believe these species are particularly vulnerable to overexploitation (Bonfil 1994; Castro, Woodley, and Brudek 1999; Fowler *et al.* 2005). In response to trade-related threats, the great white (*Carcharodon carcharias*) was listed on Appendix III of the Convention on International Trade in Endangered Species (CITES) in 2001; the basking shark (*Cetorhinus maximus*) and whale shark (*Rhincodon typus*) were listed on Appendix II in 2002; and the great white was up-listed from Appendix III to Appendix II in 2004 (Clarke 2004b). These contentious Appendix II listings are believed to have been achieved, in part, because of the perceived failure of the Food and Agriculture Organization's (FAO) International Plan of Action for Sharks to motivate voluntary National Plans of Actions by many major shark fishing nations (FAO 1998). The practice of shark finning (removal of fins and discarding of the carcass at sea) is particularly controversial and is prohibited by national bans in the USA, the European Union, South Africa, Brazil, and Costa Rica (Fowler *et al.* 2005). It is also regulated through administrative measures in Australia and Canada and contrary to recommendations or resolutions agreed upon by several regional fisheries management organizations (RFMOs) (Clarke *et al.* 2006b). Nevertheless, the number of sharks killed remains unregulated in most national waters and on the high seas. Few stock assessments for sharks have been conducted, and these have been heavily constrained by a lack of species-specific catch data (Kleiber, Takeuchi, and Nakano 2001; West, Stevens, and Basson 2004; ICCAT 2005). Estimates based on shark fin trade data suggest that between 26 and 73 million sharks are traded annually worldwide. This figure, when converted to shark biomass, is three to four times

higher than the catch recorded in FAO capture production statistics, the only global database of shark catches (Clarke *et al*. 2006b).

Previous studies of the shark fin trade have characterized various aspects of the market. Parry-Jones (1996) and Clarke (2004a) described product flows and prices, Fong and Anderson (1998, 2000) characterized distribution channels and shark fin grading, and Clarke *et al*. (2006a) determined species composition, all in Hong Kong. Other studies of the shark fin trade based outside of Hong Kong have assessed its economic relationship to fisheries (McCoy and Ishihara 1999; Fong and Anderson 2002) and global scope, diversification, and value (Rose 1996; TRAFFIC 1996).

In this study, we explore trends in the shark fin trade by examining social, economic, and regulatory factors which, we argue, will most likely shape its future and the future status of shark populations. First, we describe the history of shark fin as a luxury food and discuss how traditional beliefs are still held by older consumers, while younger consumers' preferences may be changing. We then investigate linkages between three potential economic indicators (disposable income, price of shark fin, and price of substitutes) and the vibrancy of the shark fin trade. While currently available data do not support application of econometric modeling techniques, our comparison of trends suggests interesting topics for further research. Finally, we discuss the effectiveness of recent finning bans and their influence on the shark fin trade. This discussion aims to inform ongoing assessment of trade impacts on shark species by international bodies such as CITES and RFMOs (*e.g*. CITES 2006a).

Historical and Current Cultural Aspects of the Shark Fin Trade

Shark fins were first established as an ingredient in formal Chinese banquets prepared for the emperors of the Ming Dynasty (1368–1644 AD) (Rose 1996). Many of the dishes which earned a permanent place in Chinese cuisine through imperial tradition initially gained their reputation from being difficult or expensive to source. In this case, the risk involved in catching a shark served as a kind of tribute to the emperor (Anon. 1995a). Consumption of shark fin remains a status symbol by means of the same factors of exclusiveness and exoticism that fuel demand for other rare wild animals in Chinese society (Mills 1997; Bell, Roberton, and Hunter 2004).

In addition to these factors, the connection between shark fins and beliefs about health and vitality play a role in market demand. Products from animals known to be strong or fierce, such as sharks, were believed to impart strength to those who ate them and thus were considered suitable for the imperial family (Anon. 1995a). Records of shark products, such as skin and bile, in traditional Chinese medicine date from the Tang Dynasty (618–907 AD) (TRAFFIC 1996), but the use of shark fin specifically for medicinal purposes is less clear. While the fins of four shark species are listed as having medicinal properties, such as strengthening of the blood, in one reference (Anon. 1983), other references, which are considered to be authorized versions of the current Chinese Materia Medica, do not include any shark products (Anon. 1995b, 1996). Notwithstanding, there is a widely held folk belief that shark fins are beneficial as a tonic, particularly in winter, similar to the use of chicken soup in western cultures as a broad spectrum cure-all. While some shark fin traders suggest that shark fins can serve as an aphrodisiac, this appears to be more closely linked to the perceived strength-giving properties rather than any specific effects on organs or systems.

These traditional beliefs play a role in determining which types of shark fin products are most desirable. Since there is no branding of shark fin goods, consumers judge both the prestige and tonic properties of the product by the length, thickness, and texture of the ceratotrichia, or fin needles, believing that the better

quality ceratotrichia are derived from the larger, more powerful sharks. Ironically, traders maintain that the largest sharks, such as those listed on CITES, are not preferred for food due to the low-quality texture of their ceratotrichia, although they admit to a market for these fins as curios (Clarke 2004b), and both basking shark and whale shark fins have been observed at auctions in Hong Kong. In addition, there are reports of very large fins being served at highly conspicuous social functions in Mainland China where the price of the fin may be posted outside the banquet hall as a status symbol, despite the fact that many of the guests may not be able to distinguish between low- and high-quality products. Traders cite fusiform rays including *Anoxypristis cuspidate* and genera *Rhynchobatus* spp., *Pristis* sp., *Rhina* spp., and possibly *Rhinobatos* spp.; hammerheads (*Sphyrna* spp.); and shortfin mako (*Isurus oxyrinchus*) lower caudal fins as the sources of the best quality fin needles for consumption.

Another factor in determining the desirability and price of various shark fin products is the consumer's ability to verify the amount of true shark fin product that will be provided per serving. Artificial shark fin, reportedly formed from mung bean extract is allowed to be mixed with real, loose shark fin needles in Japan as long as at least 10% of any product labeled as shark fin is real shark fin (Vannuccini 1999). In societies such as Japan and to some extent in Southeast Asia, where the tonic properties are considered unimportant and the price of the product is generally low, such mixing commonly occurs. However, the use of artificial shark fin in traditional Chinese societies is usually objectionable and thus covert. To ensure value for money, knowledgeable Chinese consumers choose products in which the fin needles are still in their original configuration; *i.e.*, a chevron, and avoid canned or loose fin needle items.

Until the mid 1990s, shark fin cuisine in China was found almost exclusively in the southern provinces of Guangdong and Fujian, and in the major cities of Hong Kong, Beijing, and Shanghai. Today, shark fin is available in most, if not all, major cities in China, and with population growth between 2000 and 2005 of 9.5 million per year, a large number of consumers are sampling it for the first time (FAO 2006b). Older people are more likely to adhere to traditional beliefs about shark fin's tonic properties, and their propensity to purchase shark fin may be fuelled by a documented increase in sales of medicinal products (Li 1998). The older generation is also more likely to insist on the traditional practice of serving shark fins at weddings and other celebratory events (Jones 2005) and to be unaware that *yú chì* (translated literally from Chinese as "fish wing") actually derives from sharks (WildAid 2007).

Balanced against this trend toward higher consumption, younger consumers, who are motivated more by taste and status than by purported health benefits, may be more attuned to recent health and conservation warnings about shark consumption. Published tests by the Hong Kong Government in 2004 indicated that 10% of all dried seafood samples, the majority of which were shark fins, contained impurities hazardous to human health. These impurities included hydrogen peroxide and the carcinogen formaldehyde which are believed to be used as bleaching or finishing agents (Anon. 2004; Clarke 2004b). Other warnings that sharks contain high levels of mercury (US Government 2004), and that mercury from seafood may be lowering fertility rates in Hong Kong men (Dickman, Leung, and Leung 1998), received wide coverage by local media. There are also indications that younger consumers may respond more readily to shark conservation campaigns (Lee 1998). For example, a recent campaign by schoolchildren against plans at Disney's new theme park in Hong Kong to offer shark fin soup resulted in withdrawal of shark fin from Disney's menus (Bradsher 2005; Parry 2005).

Potential Indicators of Demand for Shark Fin

Tradition, culture, and demographics in Chinese society shape the general dimensions of the shark fin trade, but traders unanimously cite economic vibrancy as the most important influence on the short-term profitability of their business (Clarke 2004a). Lack of complete and accurate data constrains our ability to formally test many of the potential influences on shark fin trade dynamics. However, as a starting point, we examine trends in raw shark fin imports as a potential indicator of demand and investigate how this may be influenced by three standard economic variables; *i.e.*, disposable income, price of shark fins, and price of substitutes.

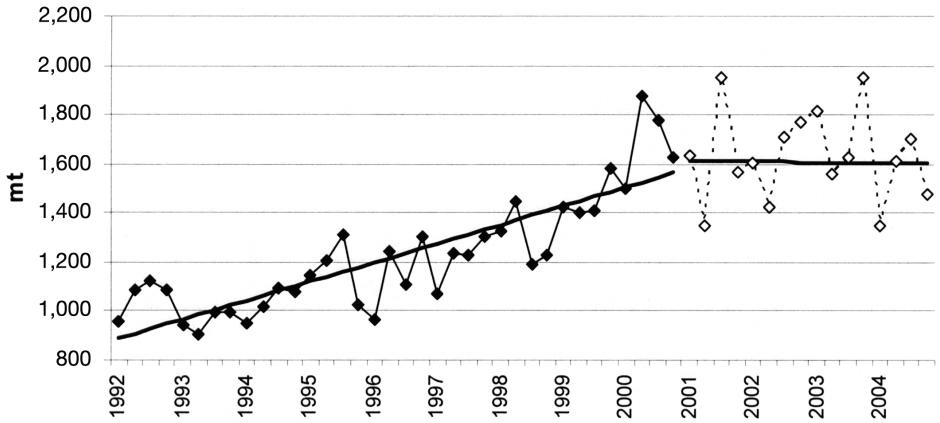
Imports as an Indicator of Market Demand and Other Factors

Since there are no data compiled on shark fin sales volumes in Hong Kong or Mainland China, import data from national customs authorities are the only available indicators of market demand. Figure 1a, showing adjusted Hong Kong data (Appendix 2), illustrates the overall trend of generally increasing imports through 2000 documented by Clarke (2004a), but more recent data show a nearly level, slightly declining linear trend. Although Hong Kong was certainly the primary entrepôt for Mainland China, not only for shark fins but also for a wide variety of other goods until 2000, this assumption has become more tenuous in recent years, as Hong Kong's intermediary role has waned with the entry of Mainland China to the World Trade Organization in November 2001 (Ferris 2002). Given this, we would expect to see a corresponding increase in Mainland China's imports of shark fin since 2000.

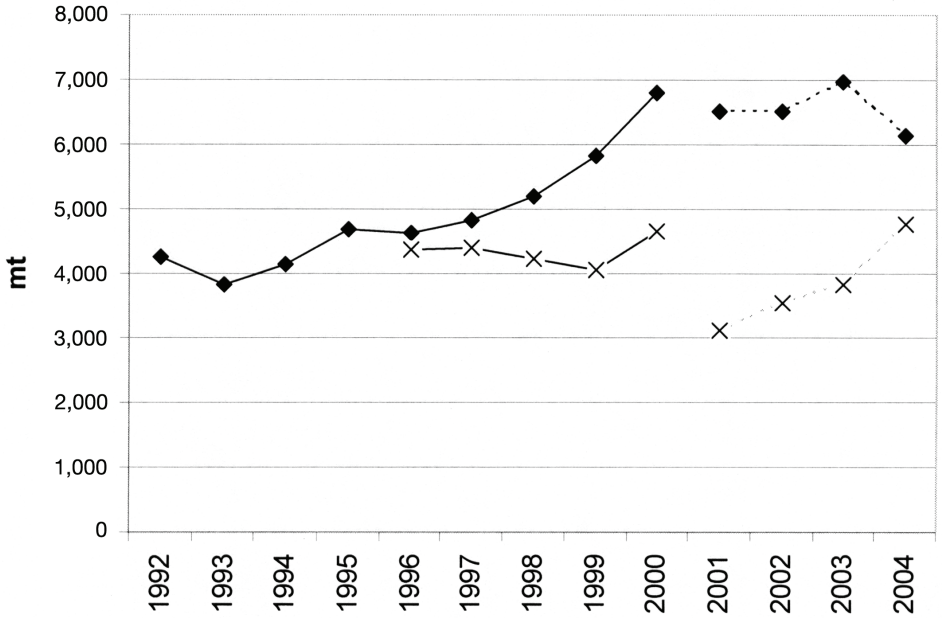
In contrast to expectations, Mainland China's statistics show a generally stable level of imports through 2000, with depressed levels immediately thereafter (figure 1b). Rather than indicating a decline in the volume of the shark fin trade, the trend more likely reflects an under-representation of trade volumes by Mainland China since 2000 due to a customs coding system amendment, compounded by the exclusion of some portion of raw shark fin imports from official statistics prior to 2005. The amendment of China's commodity coding system in mid-2000 served to remove all frozen shark fins from the commodity category shown in figure 1b (0305-5920) and classify them with frozen shark meat (0303-7500) (Clarke 2004b). Hong Kong statistics indicate that frozen shark fin constituted 40–50% of the recorded trade through Hong Kong from 2000–05 (Anon. 2006), and it is likely that frozen fins were also a large component of Mainland imports. Therefore until China implements a commodity code specific to frozen shark fins, it will be impossible to accurately quantify trade flows through the world's largest market.

Compounding the under-reporting bias in the Mainland China statistics, a scheme by which some raw materials, including shark fins, imported for processing and subsequent export (also known as "inward processing trade") were not subject to duties and were not counted in trade statistics (Jin 2005) was in effect until November 2004 (CITES 2006b). This situation is illustrated by the observed large discrepancy in Hong Kong and Mainland China shark fin trade statistics on the northbound route (*i.e.*, export from Hong Kong and import to Mainland China) and close agreement on the southbound route (*i.e.*, export from Mainland China and import to Hong Kong) (Clarke 2004a). All shark fins legally imported since 2004, whether for inward processing or domestic consumption, should now be recorded in official customs statistics.

The greater reliability of the Hong Kong data, in addition to its availability in monthly form, allows us to examine other factors which may influence imports. In



Hong Kong



Figures 1 a & b. Quarterly and Annual Imports of Shark Fin, 1992–2004

Note: Due to potential new biases in the data, points from 2001 onward are shown in outline. Figure 1(a) shows Hong Kong data only (compiled to quarterly values from monthly data, adjusted [see Appendix 2], unprocessed commodity codes only); Figure 1(b) shows Hong Kong (♦) and Mainland China (x) imports in annual form.

addition to the flattening of import quantities since 2000, figure 1a also reveals increased temporal variability. Since there is no seasonal pattern apparent, seasonality in supply due to shark fishing activities or weather patterns interfering with fin drying in producer countries, are not expected to be major factors. The large number of countries exporting fins to Hong Kong also argues against seasonal supply factors (Clarke and Mosqueira 2002). Seasonal demand could drive import patterns, and if so, imports would be expected to rise in the late fall to allow for processing prior to the Chinese New Year holiday in late January-mid February. However, such regular patterns are not discernable in the monthly data (figure 2).

Customs enforcement is one sporadic factor known to contribute to variability in shark fin imports in Hong Kong. The extremely low quantity of imports recorded in June 2001 (figure 2) is known from interviews with traders to be the result of increased enforcement activity by Mainland customs officials. Some traders who had previously avoided paying duties were prosecuted, exports ground to a halt, warehouses in Hong Kong were filled to capacity, and imports plummeted during this period. This example illustrates that due to lack of storage space, the Hong Kong trade is vulnerable to disruptions in the flow of product to the Mainland, and thus is unlikely to stockpile raw product voluntarily.

Disposable Income as a Driver of Trade Growth

Shark fin is considered a luxury seafood item, thus we would expect a positive relationship between disposable income and demand for shark fin, as measured by imports to Hong Kong. Data on per capita disposable income for Hong Kong and Mainland China were compiled from official statistics and adjusted for inflation based on available figures (figure 3). Published monthly data on average Mainland disposable income in yuan for 35 cities nationwide were adjusted for inflation and

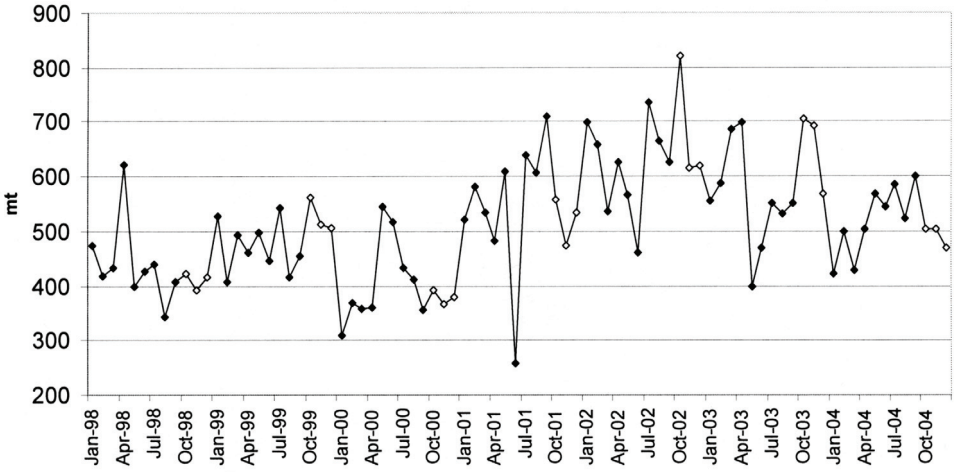


Figure 2. Monthly Hong Kong Imports of Unprocessed Shark Fin (adjusted), 1998–2004

Note: Open circles indicate fourth quarter data points when imports would be expected to peak.

summed to quarterly values (Anon. 2005). A small number of missing values, typically for December of each year, were interpolated. Reported values were deflated to 1990 yuan values using Consumer Price Index (CPI) data through 1999 provided by a confidential source (available from the corresponding author on request). The CPI series was extended by indexing published total CPI data referenced to the same month in the preceding year to the previous series (Anon. 2005).

As there was no direct measure of income available for Hong Kong, data on quarterly private consumption expenditure per capita, which represent household spending on consumed goods and services, were used as a proxy. Data on the actual dollar amount of private consumption were compiled in quarterly intervals for 1992–2001 in constant 1990 prices. Data for 2002–04 were calculated from published indices. Per capita values were obtained by dividing by population figures (Anon. 2006).

The sharp drop in consumer spending in Hong Kong between the fourth quarter of 1997 and the first quarter of 1998 was attributed to the Asian financial crisis, which had a substantial impact on Hong Kong's economy, but was not a major influence in China (Wang 1999). Hong Kong's economy failed to recover fully before the onset of the global economic downturn in 2001, and it was only in early 2003 that consumer spending began to climb again. In contrast, China's consumer spending grew steadily throughout the period. The lack of a prolonged downward trend in the import data (figure 1) corresponding to the Asian financial crisis suggests that if there is a link between consumer spending and the quantity of shark fins traded, conditions in Hong Kong alone do not determine the overall trend.

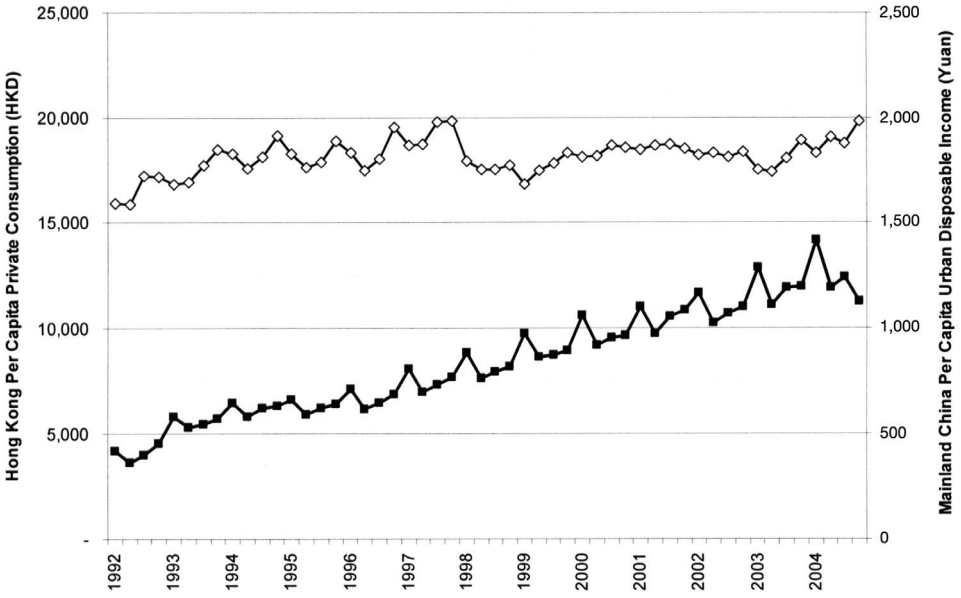


Figure 3. Quarterly Disposable Income for Hong Kong (◇) and Mainland China (■) (base year = 1990)

Price of Shark Fins

Based on what is known about the shark fin trade from previous studies (Fong and Anderson 2000; Clarke 2004a), demand for shark fin is expected to be price sensitive. Relevant price data for shark fins are not available for either Hong Kong or Mainland China. Therefore, a time series of price quotes for sets; *i.e.*, first dorsal, both pectorals, and lower caudal fins of "ocean white," "blue shark," and "mako shark" fin sets originating in the South Pacific, including delivery to Singapore, was compiled as the best proxy for price of unprocessed shark fin in Hong Kong and the Mainland (figure 4). Quotes for these products were published on a monthly basis from January 1997 through July 2003 and sporadically thereafter until April 2004 (INFOFISH 2004). Prices were quoted in US dollars and since the US dollar has been pegged to the Hong Kong dollar throughout the period, no currency conversion was necessary. US dollar values were adjusted for inflation using US Government CPIs with a March 2005 base. Since Hong Kong and Singapore shark fin traders often compete and trade amongst themselves (Clarke 2006), and the transportation cost component is expected to be minimal and easily adjusted for other ports, these price quotes are expected to fairly represent prices for raw product on the international market.

Examination of this time series reveals two periods of price fluctuation: a downturn in early 1998 with recovery by early 2000 corresponding to the time of the Asian financial crisis; and a slump beginning early 2001 and continuing through 2004 with only a slight recovery, corresponding to the global economic recession. Assuming there was no substantial change in supply, and in concert with an observed dip in Hong Kong imports in the latter half of 1998, these price data suggest

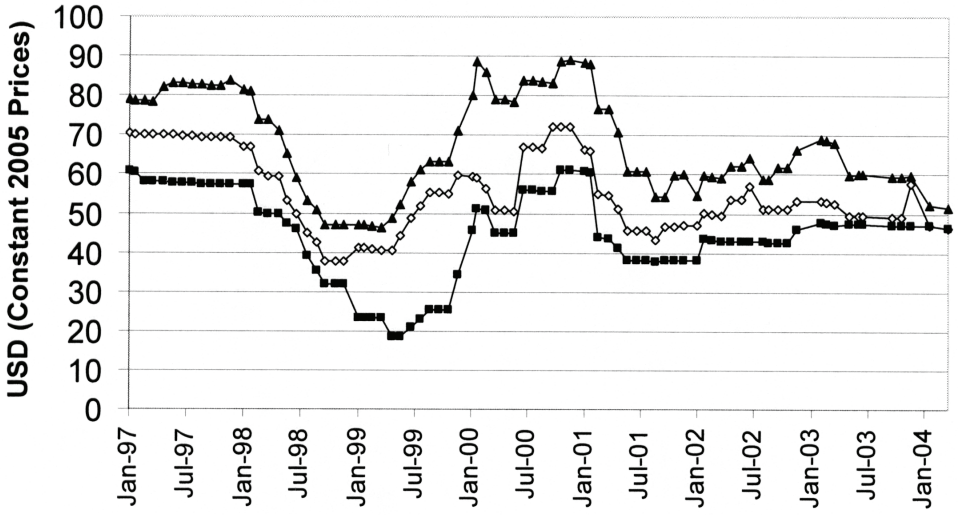


Figure 4. Shark Fin (Ocean White ▲; Blue ◇, Mako ■) Prices, January 1997-April 2004

Source: Anon. (2002). Note: Prices are based on public offerings for shark fin sets sourced from the South Pacific and include freight delivery to Singapore.

a linkage between regional economic conditions and demand for shark fin during that period. The relatively flat price trend since mid-2001 corresponds to a period of slightly negative growth in imports of shark fins into Hong Kong in 2001–04, although, as described above, there are other potential explanations for the Hong Kong import levels since 2001.

Price of Substitutes

According to economic theory, prices of substitute or complement products may influence market demand for a particular good (Dubin 1998). Since shark fin is served at wedding banquets, important business functions, and other special occasions, other foodstuffs served on these occasions may be possible substitutes or complements. The only available, standardized time series data for products which are common components of Cantonese banquet cuisine were prices of garoupa (or grouper) (Froese and Pauly 2005; figure 5). This large reef fish is usually shipped live and served in steamed form at business dinners and weddings in Hong Kong and the Mainland (Lee and Sadovy 1998). Monthly retail prices of garoupa per kg were adjusted for inflation using Hong Kong Government CPI data (base period: October 2004 – September 2005). Prices were converted to US dollars using the Hong Kong dollar-US dollar peg.

Price trends for garoupa show a declining trend beginning at the time of the Asian financial crisis (early 1998), with prices falling to consistently below US$10 and remaining at or near this lower level until a further drop in late 2003. The price of garoupa relative to shark fin declines during some periods while increasing during others (figure 6). These fluctuations do not appear to be synchronous with trends

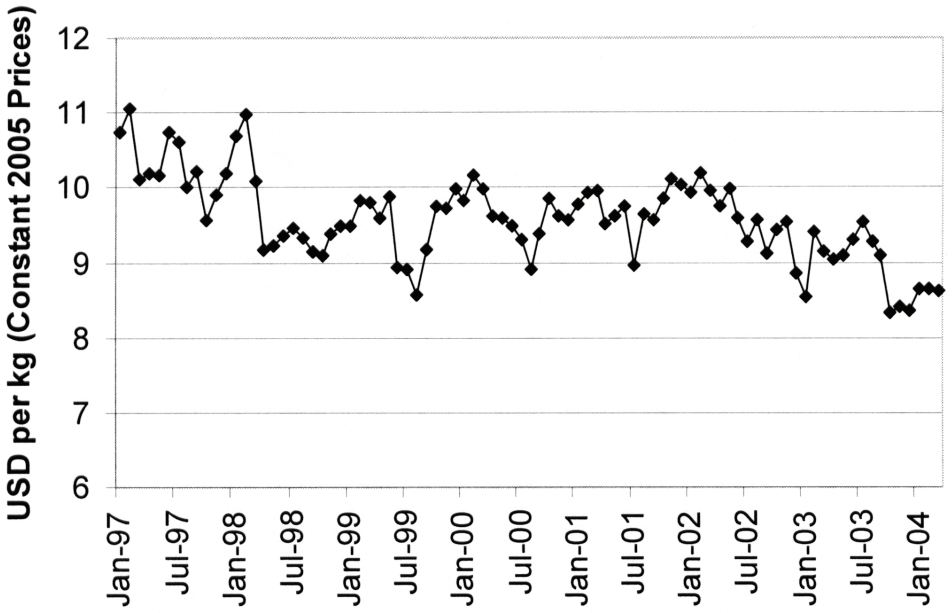


Figure 5. Retail Price of Garoupa, January 1997–March 2004

in the import of shark fins to Hong Kong. Therefore, it is difficult to assess what impact, if any, the price of garoupa may have on the consumption of shark fins.

Summary

During the period 1997–2004, as illustrated by disposable income data, the Hong Kong economy felt the effects of both the Asian financial crisis (beginning in late 1997) and the global economic downturn (beginning in early 2001). On the basis of disposable income data, the Mainland Chinese economy appears to have been unaffected by either event. Regional prices of shark fins track these changes quite closely, showing sharp drops in 1998 and 2001. Trends in price of garoupa in Hong Kong relative to shark fin are not clearly related to changes in imports of shark fin to Hong Kong. These imports reveal a variable but increasing trend until 2001, with no growth or loss between 2001–04.

These trends are indicative but not conclusive, particularly in view of the fact that other drivers of demand are potentially operating on the shark fin market. One critical factor for Mainland China is population growth, and in both areas changes in consumer sentiment either toward or against shark fin, as discussed above, may be at work.

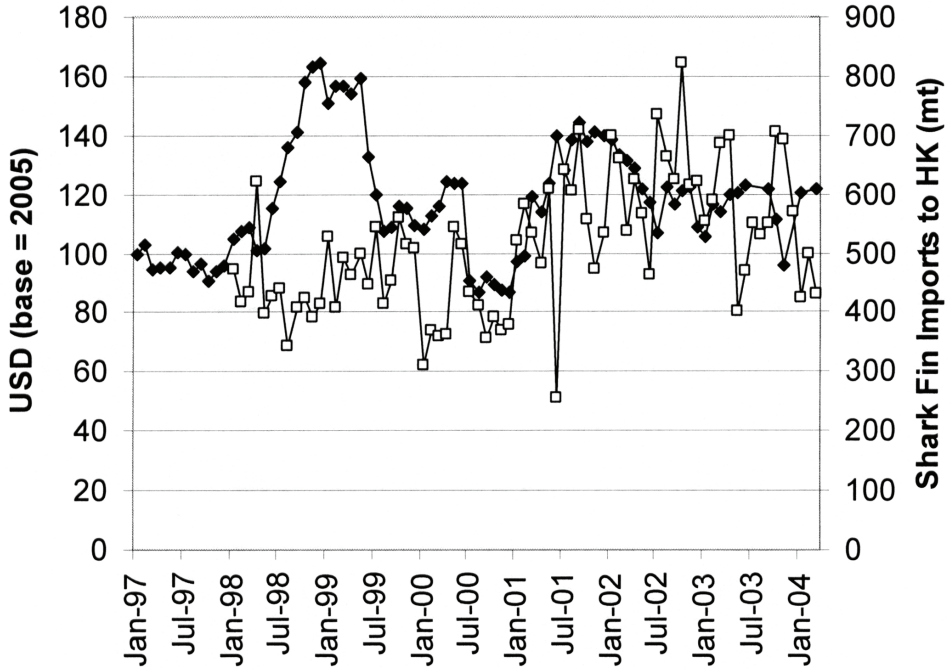


Figure 6. Price of Garoupa Relative to Blue Shark Fin (◆) and Shark Fin Imports to Hong Kong (□), January 1997-March 2004

Note: The monthly shark fin import data series begins in 1998 due to a change in the commodity coding system between 1997 and 1998.

Recent Regulatory and Policy Actions affecting the Shark Fin Trade

Having explored the demand side of the shark fin trade, we now turn our attention to recent regulatory and policy actions designed to discourage the practice of shark finning. The issue of finning has arisen most commonly in fisheries targeting high-value species such as tuna or billfishes. Vessels in these fisheries often make lengthy trips with limited hold capacity and therefore do not wish to keep shark carcasses, but appreciate the high value of fins. In addition to these fisheries, some vessels may be targeting sharks specifically for their fins, while a number of coastal longline fleets, including those based in Japan and Taiwan, land large numbers of whole sharks thereby utilizing both fins and meat. The current extent of finning is unknown, but in 2004 the countries reporting the highest number of shark catches were Indonesia, India, Spain, Taiwan, and Mexico (FAO 2006a).

The following discussion first describes the effect of national finning bans on shark fin exports from regulated countries and on the shark fin trade as a whole, and then on shark mortality. The regulatory mechanism underlying these regulations is discussed in terms of its effectiveness and resistance to fraud.

The Effect of Prohibitions on Finning

The most publicized of the national anti-finning actions are the Shark Finning Prohibition Act enacted by the USA in 2000, implemented in March 2002 (NMFS 2005), and the Removal of Shark Fins regulation implemented by the European Union in September 2003 (EU 2003). Both measures prohibit the landing of shark fins unless accompanied by a corresponding weight of shark carcasses, but while the US regulation states that fins on board may weigh no more than 5% of the weight of sharks on board (which may be headed and gutted), the EU regulation applies the 5% factor to the total (live) weight of the shark catch.

Many advocates of these policies believe that a reduction in the number of sharks that are finned will result in a reduction in shark mortality. This is because finning is believed to occur most often when vessel hold space is limited and fishermen wish to retain only the compact, but valuable, shark fins. However, it is important to note that even where finning regulations apply, they do not prevent fishermen from killing or grievously injuring hooked sharks during haul-back or hook removal, and discarding them whole, nor do they in any way prevent utilization of fins if the carcass can be stored and landed.

We first consider whether the implementation of these finning regulations has affected the share of imports by regulated countries into Hong Kong. Figure 7 shows Hong Kong imports from the USA and EU along with total imports into Hong Kong. Shark fin imports to Hong Kong from EU countries dropped by 30% (from 785 to 550 tonnes) between 2003 and 2004, the first year after implementation of the finning regulations, and remained below 600 tonnes in 2005. In contrast, the quantities of shark fins imported by Hong Kong from the USA increased slightly after implementation of the US regulation in 2002. This phenomenon may be explained by enactment of a State of Hawaii shark finning prohibition in the summer of 2000 (Morse 2000), which coincided with a steep decline (54%, from 374 to 171 tonnes) in imports by Hong Kong from the USA in 2001. The State of Hawaii law not only banned finning by Hawaii's own longline fleet, but it also required all shark fins to be landed with their carcasses, thus effectively foreclosing the continued use of Hawaii as a fin trading center for other international fisheries which had been finning in the Central Pacific (Anon. 1999).

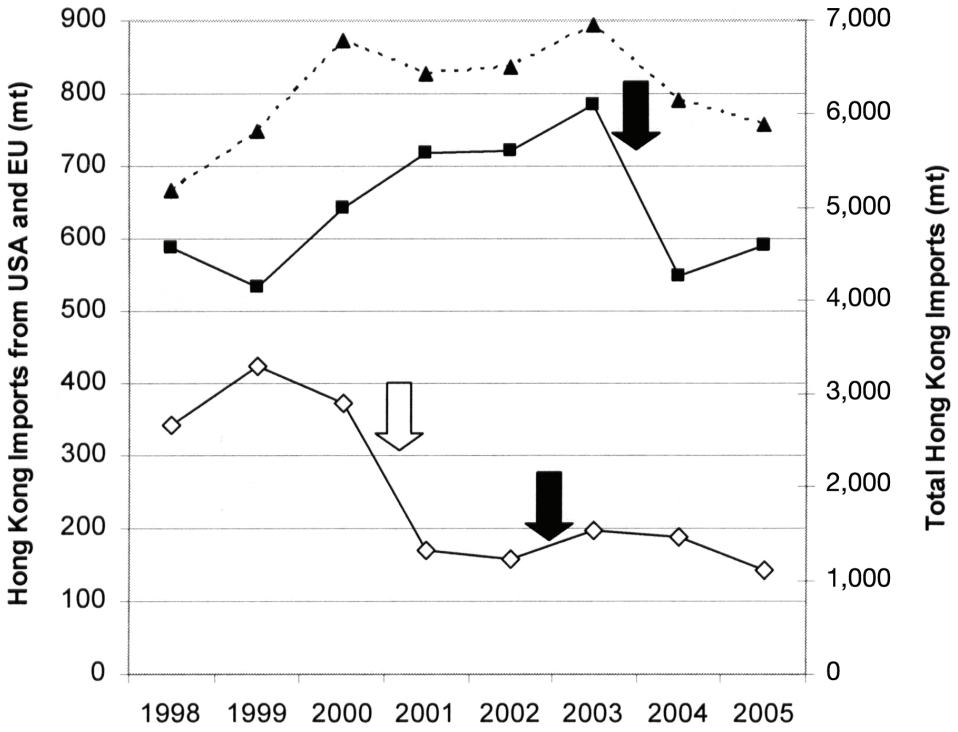


Figure 7. Annual Shark Fin Imports to Hong Kong from the USA (◇) and the EU (■) and Total Hong Kong Imports (▲)

Note: Black arrows indicate the date of implementation of national/union finning regulations. The clear arrow indicates the start of finning regulations in the State of Hawaii.

Although sharp drops in imports to Hong Kong from countries implementing shark fin regulations appear to have occurred, the effect of finning regulations on the shark fin trade as a whole is less clear. Data availability limits our analysis to 2005, precluding full analysis of finning resolutions by the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Inter-American Tropical Tuna Commission (IATTC), the Indian Ocean Tuna Commission (IOTC), the Northwest Atlantic Fisheries Organization (NAFO), and the Western and Central Pacific Fisheries Commission (WCPFC) taken in 2004–06. While trends in total Hong Kong import quantities during key periods of regulatory implementation in the USA (*i.e.*, between 2000 and 2001) and the E.U. (*i.e.*, between 2003 and 2004) are negative, there are many other factors which could account for this. Primary among these is the ongoing shift in trade from Hong Kong to Mainland China, where it cannot be accurately tracked. Economic factors, such as those described in the previous section, are also expected to influence import levels. It is also important to consider that regulations may act to drive the trade underground so that reported import quantities become decoupled from actual trade volumes.

The Effect on Shark Mortality Levels

We next attempt to assess trends in shark mortality. Anecdotal information from interviews suggests that in recent years there is a growing market for shark meat (Gilman *et al*. 2007). Over the period 1985–2004, reported production of fresh, frozen, and salted chondrichthyan (shark, skate, ray, and chimaera) meat and fillets more than doubled, from approximately 40,000 tonnes to 100,000 tonnes (FAO 2006a; figure 8). Over time, the ratio of reported chondrichthyan meat production to reported capture production (catches) grew from 6% in 1985 to more than 12% in 2004. Despite this growth in reported meat production, and assuming both sets of figures are accurately reported, these figures still represent much less than full utilization of reported capture production. For example, although it is not possible to know whether catches are reported to the FAO by each country in whole weight or dressed weight (generally 50% of whole weight), assuming that meat yield is 35% of whole weight (or 70% of dressed weight), the figures above (*i.e*., 6–12%) suggest that a large proportion of biomass is either used domestically (for subsistence or local market use), or discarded.

The growing market for shark meat may be entirely or partially spurred by finning regulations or due to independent factors. In either case, even if finning regulations *per se* are acting to reduce shark mortality, trends in utilization of shark meat are operating in the opposite direction. In terms of net mortality to sharks, further analysis will be required to assess the number of sharks associated with: (*i*) fisheries in which there has been a reduction in shark mortality, such as those which previously finned sharks and now release all or a proportion of them live due to finning regulations and the lack of a market for meat; (*ii*) fisheries in which there has been an increase in shark mortality, such as those which previously did not

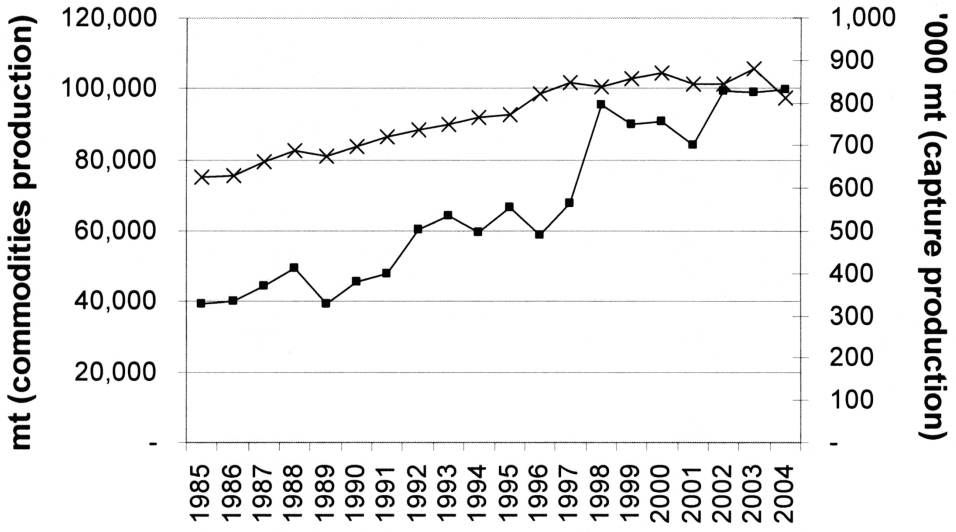


Figure 8. Shark Commodities Production and Capture Production

Source: FAO (2006a). Note: Commodities production data (left axis) are for chondrichthyan meat, fresh, frozen, and salted (■); Chondrichthyan catches (×) include sharks, skates, rays, and chimaeras.

handle sharks but have begun to primarily or secondarily target sharks for fins and meat due to expanding markets and/or declining catches of other target species; (*iii*) fisheries in which there has been no net change in shark mortality. There are potentially several types of fisheries in this category including: (*a*) fisheries which even prior to finning regulations fully utilized all sharks; (*b*) fisheries which continue to fin sharks because finning regulations do not apply or are not enforced; (*c*) fisheries which previously finned sharks but now comply with finning regulations by fully utilizing both fins and meat.

While there is at least one example in the first category (the Hawaiian longline fishery; Gilman *et al*. 2007), there are many examples under one or more of the headings in the third category (Japanese, Spanish, Peruvian, and Chilean longline fisheries; Gilman *et al*. 2007), and perhaps, with the increasing market for shark meat, a growing number of examples in the second category. Quantitative data on the extent of current finning activities is difficult to obtain, but it should, in theory, be possible to reduce the number of fisheries in Category 3b if more fisheries management organizations enact and enforce finning regulations. However, as this framework illustrates, finning regulations will only result in a decrease in shark mortality if the markets for shark meat remain limited, localized, and low value. Existing shark product data (FAO 2006a), anecdotal information from longline fisheries (Gilman *et al*. 2007), and declining stocks of current target species (FAO 2004) suggest this will not be the case. Therefore, fisheries management authorities must be urged to think beyond finning regulations toward measures which directly address the issue of shark mortality.

The Effectiveness of Fin-to-Weight Ratios

Finally, we seek to examine whether finning regulations based on a 5% ratio between fins and live or dressed weight are an effective means to prevent discarding of low-value carcasses. It is believed that the 5% ratio was defined based on data compiled by the US National Marine Fisheries Service which shows that the weight of wet fins is approximately 5% of dressed (headed and gutted) weight or 2% of live, whole weight (IUCN 2003). However, some important assumptions are inherent in these ratios. First, among the 10 species which were included in the NMFS database, the fin to dressed weight ratios varied from 2.3 to 5.1, and the fin to whole weight ratios from 1.3 to 2.5. Therefore, fin weight ratios are known to vary by species. Second, the NMFS data are based on the use of the first dorsal, both pectorals, and the lower caudal fin. If other fins are cut, such as the second dorsal, anal, pelvic, or upper caudal fins, the ratios may vary significantly. Third, dressed weight will vary by fishery since the point at which the head is cut can have a strong influence on the resulting ratio.

Perhaps the most important of these potential sources of variation is the use of the upper caudal fin. In a comprehensive study of the shark fin trade in Hong Kong, upper caudal fins were not considered one of the primary traded fins because they were of no use in producing the typical shark fin products (*i.e*., fin rays; Clarke *et al*. 2006b). Still, auction lots of upper caudal fins or mixtures of upper caudal fins with other fins were observed to comprise 8% of the observed auction weight (S. Clarke, unpubl. data). The issue of upper caudal fin utilization was recently revisited through a limited survey of shark fin traders in Hong Kong, Japan, and Singapore, all of whom attested to the value of the upper caudal fins (S. Clarke, unpubl. data). One Hong Kong trader imports his upper caudal fins separately, as their value is low and the cost of air freight cannot be justified. His factory processes caudal fins to remove the small pieces of attached meat resulting in a product called "fish lips"

(*yú chún*), which can be served as an appetizer or mixed with low-value shark fin ray products as a bulking agent. A number of traders and fishermen in Japan also confirmed the value of the upper caudal for minced meat products. One Singaporean trader claimed that the upper caudal fin is a valuable source of chondroitin for the cosmetics industry.[1]

This anecdotal evidence suggests that upper caudal fins would be taken in many, if not most, fisheries. While the use of one extra fin may appear trivial, the upper caudal fin contains cartilage and may be heavier than all the other fins combined. Some sources suggest that when the upper caudal fin is included, the correct fin to dressed weight ratio may be as high as 16% (Ariz *et al*. 2006). While setting the ratio too low could unnecessarily hamper fishing operations attempting to comply with the regulations, setting the ratio too high could camouflage finning activities (*i.e*., some carcasses could be discarded while still maintaining an allowable ratio).

Conclusion

Under unregulated conditions, such as those applicable to most shark populations around the globe, the sourcing of shark fins is expected to continue as long as fishing activities remain economically viable. Given the high prices of this luxury good, and the apparently unrelenting nature of demand in China as both personal wealth and population increase, there is a clear danger that fisheries will continue to deplete shark populations well beyond limit reference points, which mark a danger threshold for biological recovery (Caddy and Mahon 1995). Also, as there is no particular premium attached to individual species other than the quality of the fin rays produced from them, dwindling supplies of species which have already been depleted (*e.g*. the dusky shark, *Carcharhinus obscurus*, in the Atlantic and Gulf of Mexico (Cortés *et al*. 2006)), are likely to be masked by substitution of other more prolific species, such as the blue shark (Clarke *et al*. 2006b). The current inability to either accurately track trade levels, due to data paucity in the China market, or to conduct rigorous shark stock assessments, due to glaring deficiencies in species-specific data (Nakano and Clarke 2006) and other gaps (*e.g*. ICCAT 2005), undermines our competence to call for strong, effective management and conservation action.

It is thus necessary to simultaneously work to rectify data deficiencies while supporting precautionary measures as a hedge against scientific uncertainties. The most serious, and yet perhaps most easily remedied, data deficiency is that associated with frozen fin imports to China. A decision by the Government of China to reverse the coding guidance of 2000 and ideally to separate dried and frozen and processed and unprocessed shark fin imports and exports as Hong Kong does, would greatly benefit all research into the shark fin trade. In order to close unavoidable loopholes in the regulation of shark fins via fin-to-carcass weight ratios, finning

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[1] This trader also raised an interesting issue regarding the former "inward processing trade" duty system used in China until 1 November 2004. Under this system certain goods imported for the sole purpose of processing were exempt from customs duties as long as the imported and [processed] exported weight conformed to the expected ratio of raw product to processed product yield (*i.e*., for shark fin, approximately 30–50% (Parry-Jones 1996) or 35% (Clarke 2003)). This system was subject to considerable abuse since the major market for processed fins was within Mainland China; thus, there were many traders who wished to both import duty-free raw materials and sell the finished product on the domestic market. Since the upper caudal fins are the heaviest shark fin per unit weight (*i.e*., because of their cartilage content), traders would import raw upper caudal fins and re-export minimally processed upper caudal fins in order to increase the export weight, thereby allowing some processed fins to be sold on the domestic market. It is not clear to what use, if any, the exported processed upper caudal fins were put.

regulations should be amended to require that sharks be landed with fins attached, as was specified in the State of Hawaii legislation in 2000. Not only would such a measure reduce the opportunities for undetectable finning, it would facilitate data collection on shark catch by species due to easier carcass identification. Finally, since it is not the fin trade *per se* but the overall level of shark mortality which should be of primary concern, efforts to better capture the true extent of total shark catches should be strengthened wherever possible. Such efforts should begin with tuna and billfish RFMOs making shark catch reporting, by species, mandatory and linking compliance with this requirement to catch or effort allocations for major commercial species (Willock and Lack 2006). Better fishery data should be used at the earliest possible opportunity to initiate or update shark stock assessments and impose catch or effort limits if warranted.

While most of these recommended actions would operate on the supply side of the economic equation, demand side actions, such as consumer awareness and precautionary demand reduction campaigns, also appear appropriate. The target audience for such campaigns would obviously be consumers and potential consumers in Mainland China, as no other group can so strongly affect the fate of shark populations. In this regard, recent statements by Chinese government fisheries officials calling for "sustainable development of sharks and people's dining culture" represent an unprecedented step toward engagement of the most critical driver of the shark fin trade (Associated Press 2006).

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Appendix 1

The estimate of the global value of the shark fin trade was calculated using the following assumptions and estimates:

- Hong Kong imports in 2000, after adjustment for water content, totaled 6,788 tonnes (Anon. 2006);
- Every 1 kg of unprocessed shark fin produces 350g of processed shark fin material (Parry-Jones 1996);
- Based on unprocessed (raw) traded weights, Hong Kong imports represent 44% to 59% (multipliers of 2.273 or 1.695, respectively) of the annual global trade in shark fins from 1996–2000 (Clarke *et al*. 2006b); after 2000 it is difficult to estimate global trade quantities (see main text);
- An average retail price for processed shark fins is $US100 per kg (Clarke 2002, 2006).

Therefore,

$$6{,}788{,}000 \text{ kg raw} \times \frac{0.35 \text{ kg proc}}{1 \text{ kg raw}}$$

$$\times\ 1.695 \text{ (if Hong Kong share is 44\%)} \times \frac{100 \text{ USD}}{1 \text{ kg}} = 403 \times 10^6 \text{ USD}$$

$$6{,}788{,}000 \text{ kg raw} \times \frac{0.35 \text{ kg proc}}{1 \text{ kg raw}}$$

$$\times\ 2.273 \text{ (if Hong Kong share is 59 \%)} \times \frac{100 \text{ USD}}{1 \text{ kg}} = 540 \times 10^6 \text{ USD}$$

Appendix 2

This appendix presents quarterly data on Hong Kong imports of shark fin from 1992–2004 in unadjusted and adjusted form (Anon. 2006). Prior to 1998, there were only two shark fin commodity categories: 0305-5920 (shark fins, dried whether or not salted but not smoked) and 0305-6920 (shark fins, salted or in brine but not dried or smoked). All "salted or in brine" fins were assumed to be frozen, and were normalized for water content by dividing by 4 (Clarke 2002). As these categories did not allow unprocessed and processed fins to be distinguished, there was the potential for a single fin to be counted once when imported from the source country in unprocessed form, and again when imported from the Mainland in processed form. To correct for this, imports from the Mainland (Anon. 1995c, 1998) were subtracted from total imports from 1992–97 (*sensu* Parry-Jones 1996). In 1998, separate codes for dried and salted, processed, and unprocessed shark fin were implemented, and this adjustment was no longer necessary.

Table A2
Hong Kong Imports of Shark Fin, 1992–2004

Year/ Quarter	Total Hong Kong Imports		Hong Kong Imports from Mainland China		Adjusted Total
	Dried	Salted	Dried	Salted	
1992Q1	1,121,889	213,592	216,240	16,639	954,887
1992Q2	1,271,996	224,413	233,590	40,773	1,084,316
1992Q3	1,291,083	164,534	208,350	12,038	1,120,857
1992Q4	1,342,025	232,085	312,043	19,313	1,083,175
1993Q1	1,140,121	198,427	242,694	21,485	941,663
1993Q2	1,103,231	122,053	221,779	19,385	907,119
1993Q3	1,219,043	151,209	259,718	14,713	993,449
1993Q4	1,293,072	65,242	309,886	8,795	997,298
1994Q1	1,180,973	110,872	258,052	13,645	947,228
1994Q2	1,279,426	43,371	269,153	7,786	1,019,169
1994Q3	1,365,014	107,696	297,946	13,479	1,090,622
1994Q4	1,410,056	207,042	383,230	6,652	1,076,924
1995Q1	1,423,888	247,306	337,657	5,073	1,146,789
1995Q2	1,584,378	132,430	409,811	5,845	1,206,213
1995Q3	1,646,525	528,734	461,271	26,219	1,310,883
1995Q4	1,467,105	279,036	503,880	34,796	1,024,285
1996Q1	1,375,830	239,778	465,780	9,870	967,527
1996Q2	1,572,371	520,137	457,499	4,449	1,243,794
1996Q3	1,450,804	496,598	465,473	11,804	1,106,530
1996Q4	1,597,334	689,098	460,749	19,838	1,303,900
1997Q1	1,467,856	382,352	492,505	13,539	1,067,554
1997Q2	1,567,624	624,267	484,567	4,620	1,237,969
1997Q3	1,662,423	622,336	575,033	48,424	1,230,868
1997Q4	1,760,886	582,421	591,553	40,545	1,304,802
1998Q1	1,220,585	417,460	na	na	1,324,950
1998Q2	1,296,476	599,047	na	na	1,446,238
1998Q3	1,051,589	561,384	na	na	1,191,935
1998Q4	1,052,789	719,580	na	na	1,232,684
1999Q1	1,315,057	447,754	na	na	1,426,996
1999Q2	1,281,074	495,742	na	na	1,405,010
1999Q3	1,257,243	620,596	na	na	1,412,392
1999Q4	1,364,618	858,673	na	na	1,579,286
2000Q1	1,269,383	927,502	na	na	1,501,259
2000Q2	1,649,514	913,973	na	na	1,878,007
2000Q3	1,489,287	1,161,133	na	na	1,779,570
2000Q4	1,382,824	985,076	na	na	1,629,093
2001Q1	1,387,461	990,963	na	na	1,635,202
2001Q2	1,173,872	705,360	na	na	1,350,212
2001Q3	1,605,354	1,396,980	na	na	1,954,599
2001Q4	1,330,542	933,910	na	na	1,564,020
2002Q1	1,322,222	1,142,797	na	na	1,607,921
2002Q2	1,196,008	918,085	na	na	1,425,529
2002Q3	1,403,542	1,241,889	na	na	1,714,014
2002Q4	1,491,812	1,129,913	na	na	1,774,290
2003Q1	1,493,209	1,340,369	na	na	1,818,727
2003Q2	1,286,133	1,130,076	na	na	1,560,508
2003Q3	1,310,456	1,295,986	na	na	1,625,550
2003Q4	1,559,303	1,626,228	na	na	1,954,914
2004Q1	1,132,416	878,865	na	na	1,348,959
2004Q2	1,292,467	1,293,674	na	na	1,611,530
2004Q3	1,446,237	1,054,826	na	na	1,706,062
2004Q4	1,227,589	1,005,606	na	na	1,475,417