Sharks in the seas around us:

How the *Sea Around Us* Project is working
to shape our collective understanding
of global shark fisheries

2000

The Pew Charitable Trusts

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Foreword

As a result of efforts by a vast number of people, the tide may be turning for sharks, of which millions are finned every year and used to make a supposed delicacy in which the shark-fin component could easily be replaced by thin cardboard strips. Indeed, shark fin soup is the main driver of the global slaughter of sharks. But so much killing for so little benefit is morally costly, and we are beginning to see a change with many countries now turning around, and restricting or forbidding finning in their EEZ's.

The battle is not over, however, and good arguments are always rooted in the best science; the *Sea Around Us* Project is thus proud to contribute the scientific results it gathered on sharks. The results presented in this report are drawn from numerous activities conducted by the *Sea Around Us* - notably the catch reconstructions that we now emphasize, and supporting modelling and biodiversity studies.

However, the insights originating from these various studies would not have 'gelled together' were it not for the first author of this report, Ms. Leah Biery, presently one of my MSc students, who agreed to abandon her thesis work for the time it took to assemble the material contributed by her co-authors and to write the bulk of the connecting text (that her Master thesis is about shark finning also helped).

Thus, I conclude by thanking her on behalf of the *Sea Around Us* Project, and also on behalf of the sharks, which I hope don't mind me speaking for them, especially as they still need all the help they can get.

Daniel Pauly

Vancouver,
December, 9, 2011

Executive Summary

The Chinese demand for shark fins to be served in shark fin soup has grown rapidly since the 1980s. This growth has generated an increase in the number of fisheries targeting sharks, and consequently the number of sharks caught worldwide each year. As a result of increased fishing pressure, many species are currently threatened or at risk of becoming threatened with extinction in the near future.

Prior to the recent increase in demand for shark fins, sharks were of low monetary value and were considered relatively unimportant from a global economic standpoint. Hence, shark fisheries were seen as warranting sparse research, reporting, regulation and monitoring in many countries, especially at the species level. Although species status, catch, and trade data for sharks have improved in recent years, many records remain incomplete and difficult to access, and data are lacking for large spatial areas and time periods. Furthermore, the accuracy of existing data has been challenged.

Sea Around Us Project researchers are working to compile the best available data and information related to sharks, identify gaps, and fill in the blanks using a variety of estimation and modelling techniques. We present our results in formats that are accessible and convenient for scientists to use. Our findings are being applied by scientists and ecosystem modellers at the *Sea Around Us* Project and elsewhere to conduct studies that will help us better understand the status of sharks, shape global management policies, and hopefully work toward a sustainable future for shark species globally. An overview of current projects is provided in the Introduction.

Caribbean reef shark *Carcharhinus perezii*, Florida Keys. Photo Credit: Olivier Frei.[1]

[1] All species names have been verified against FishBase (www.fishbase.org)

Introduction

Sharks have functioned as top predators in marine ecosystems for over 400 million years (Anon., 2007; Camhi *et al.*, 2009). Today, over 500 species of sharks exist globally, some of which act as ecologically important apex predators, but many of these species are becoming threatened with extinction due to shark finning and overfishing in recent years (Froese and Pauly, 2007; Camhi *et al.*, 2009; Last and Stevens, 2009).

Historically, shark products were of low monetary value, thus sharks were generally seen by fishers as a nuisance rather than a lucrative commodity and were not heavily fished (Anon., 2007). During the early 1900s, shark products such as liver oil, hides, fins, meat, teeth and jaws were harvested and sold, but the demand was small enough that shark populations were not substantially impacted on a global level until the Chinese demand for shark fins escalated in the 1980s (Beaumariage, 1968; Kreuzer and Ahmed, 1978; Anon., 2007).

In China, shark fin soup has traditionally been consumed as a status symbol at formal banquets and celebrations for hundreds of years. The soup is usually comprised of tasteless but texturally distinct shark fin needles in a chicken or pork broth (Rose, 1996). Although it has been on Chinese menus for centuries, it was historically only attainable by the very wealthy, so shark populations were not substantially damaged as a result of its consumption in early years (McCoy, 2006). The soup's popularity fell briefly when the Chinese government discouraged consumption following World War II, but was revived again in the 1980s after state market controls were loosened (Rose, 1996; Anon., 2007). Economic growth in China since then has allowed for more disposable income among the middle classes, and spurred a consequent growth in the demand for shark fin soup (Rose, 1996; Figure 1). Today, the dish is widely served at Chinese weddings and banquets, and hundreds of millions of bowls are consumed each year in China and Chinese communities worldwide (Anon., 2007).

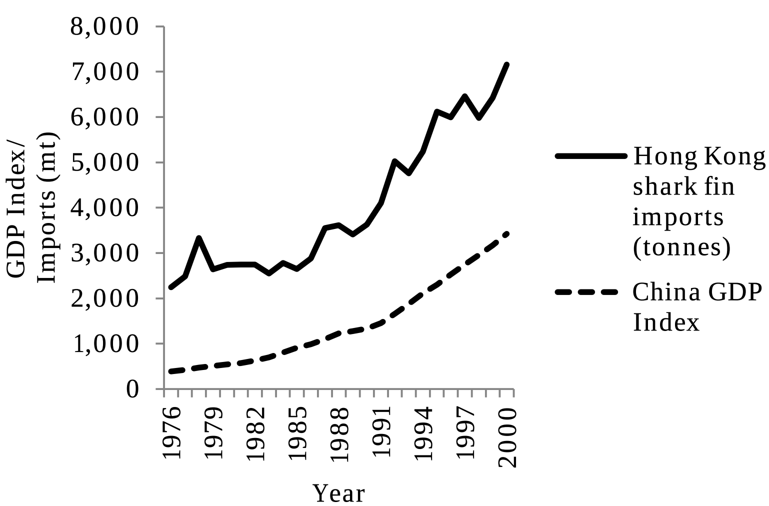


Figure 1. China's GDP Index and shark fin imports to Hong Kong from 1975-2000. Data from National Bureau of Statistics, China Statistical Yearbooks; FAO FishStatJ.

Because shark fins are now considered a highly desirable delicacy in China, they are of higher value than other shark products (Hareide *et al.*, 2007). Dried shark fins can sell for 700 US dollars per kilogram, while shark meat is worth only about 15 US dollars per kilogram (Anon., 2010a). In order to meet the demand for high-value fins without being burdened by bulky, low-value shark meat, shark finning - the act of removing fins at sea and discarding the carcass overboard - is practiced both legally and illegally in fisheries worldwide (Cortés and Neer, 2006). Shark finning makes it possible for fishing vessels to store fins more efficiently than if they were to retain entire carcasses, thus maximizing profit (Hareide *et al.*, 2007). Shark finning is a wasteful practice which fails to utilize sharks to their full potential as a natural resource, makes catch monitoring difficult, and contributes to the overharvesting and resulting decline of many of these species (IUCN, 2003). It should be noted that the removal of fins during processing on land is not considered shark finning (Fowler and Séret, 2010).

Sharks tend to grow slowly, reach maturity at a large size and late age, and have low fecundity, all of which are traits which make them especially sensitive to and slow to recover from overfishing (Hoenig and Gruber, 1990). Some sharks have a gestation period longer than an elephant, taking up to 25 years to mature and giving birth to only one offspring at a time (Anon., 2007). Sharks have also been observed to segregate by sex and size, which can lead to many mature females being caught by fishers at once, subsequently causing devastating effects on breeding populations and further complicating population recovery (Anon., 2007). As a result of legal and illegal shark fishing and finning to meet the demand for shark fin soup, many shark populations have experienced rapid declines in recent years (Rose, 1996; Mejuto and Cortés, 2004). The IUCN Red List currently lists 141 shark species as critically endangered, endangered, vulnerable, or near threatened (IUCN, 2011).

Although a growing number of shark species have been classified as threatened by IUCN, in many cases a lack of data makes it difficult to identify their exact status. As a result of sharks' historical classification as a low-value 'trash fish', early reports of catches and landings are often scarce or non-existent, especially at a species-specific level (Barker and Schluessel, 2005). Additionally, the research and management of shark fisheries has not yet caught up with the booming demand for shark products. Until recently, very little effort was placed on the management of shark resources (Barker and Schluessel, 2005). Attention to this issue has grown in recent years, but catch data collection is still less than optimal, some regulations may not be scientifically sound, and most regulations exist in developed countries, despite the fact that the majority of sharks are caught in developing countries' waters (Barker and Schluessel, 2005; Cortés and Neer, 2006). It is also known that a large quantity of sharks are caught as bycatch and finned by commercial fisheries operating in the High Seas, but the amount of sharks killed in this manner is largely unstudied (Bonfil, 1994).

Spreading Shark Truth

Shark Truth is a grassroots organization in Vancouver, founded by Chinese-Canadian Claudia Li, that aims to protect sharks by educating the local community about sustainability issues associated with shark finning and the consumption of shark fin soup. Two *Sea Around Us* Project members are on the board of *Shark Truth* and many others show their interest and support for science and policy related to elasmobranchs by volunteering regularly.

SHARK TRUTH

Furthermore, the act of shark finning makes catch monitoring and regulation enforcement difficult because shark bodies are not present to be counted or weighed upon landing, and these figures are challenging to estimate based solely on the quantity of fins landed. The resulting lack of accurate catch data makes effective shark fishery management troublesome, because fishing pressure is not well understood and is therefore commonly underestimated (Jacquet *et al.*, 2008). Such under-estimation or under-reporting of actual catches is not limited to sharks, as the landings data submitted by countries to FAO generally under-report actual catches, as we have documented through catch reconstructions (e.g., Zeller *et al.*, 2007, 2011).

In order to better understand the global status of sharks, The *Sea Around Us* and its related projects collect, compile, and analyse a variety of available shark related data. The following is an overview of several shark-related *Sea Around Us* studies that are in progress or have recently been completed. Each will be addressed in further detail in the body of this report:

- FishBase contains searchable data for over 500 species of sharks, which can be used to identify large-scale trends related to biology, habitat, vulnerability status and more. Additionally, scientists outside the *Sea Around Us* Project from around the world can easily access and use this information to supplement their own research;
- A comprehensive literature review of species-specific shark fin to body weight ratios and wet to dry fin weight conversion factors has been completed in order to understand these ratios at a higher taxonomic resolution (Biery and Pauly, in review);
- Existing shark-related legislation has been reviewed on a global scale and classified into categories as a way to better understand the scope and coverage of laws and regulations, and to gauge the increase of such legislation in recent years (Biery and Pauly, in review);
- An enhanced database of global shark catches has been created by supplementing FAO shark catch data with *Sea Around Us* Project catch reconstruction and catch allocation data, as well as information from the literature and direct communication with experts around the world. This dataset paints a more complete picture of the geographical distribution and scale of global shark catches than was previously available;
- A broad analysis of the decline of top marine predators, including sharks, has been completed, with data spatially allocated from 1950-present (Tremblay-Boyer *et al.*, 2011);
- A meta-analysis of Ecopath with Ecosim ecosystem models that include sharks has been completed in order to better describe the role of sharks in various types of marine ecosystems based on visible trends, and to examine their status as a predatory species on a global scale;
- Recent studies of the effects of climate change on marine fishes have been used to form hypotheses about the potential effects of climate change on sharks over the next century.

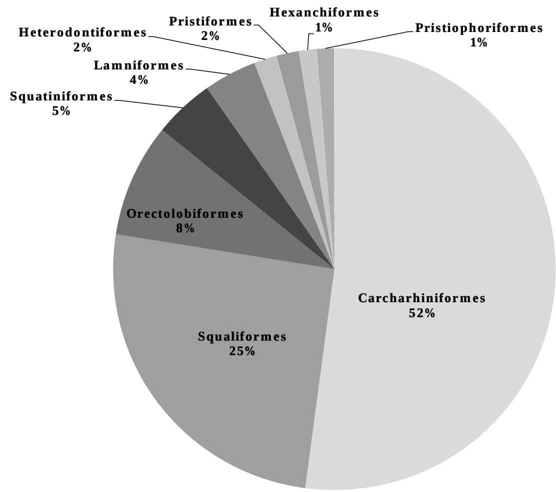
Shark biodiversity is threatened

Fishbase (www.fishbase.org) is a global information system that provides information about tens of thousands of fish species to researchers and other interested parties worldwide. As of October 2011, the database includes 543 valid species of sharks belonging to 106 genera, 35 families and 9 orders (Figure 2A). For each species, we can extract data related to a variety of characteristics including habitat preference, biological traits, and vulnerability status, among others.

Whitetip reef shark *Triaenodon obesus*, Cano Island, Costa Rica. Photo Credit: Brian Sears.

A simple FishBase query tells us that 88% of shark species listed are strictly marine, about 10% are found in brackish and marine waters, and about 3% are found in all aquatic environments. One species, the Borneo river shark, *Glyphis fowlerae*, is found only in freshwater, as its name implies (Compagno *et al.*, 2010). Sharks inhabit all levels of the water column with 10% being truly pelagic (living and feeding in the open sea), 41% demersal (living at or near the bottom and feeding on benthic organisms), 36% found at depths more than 200 m and 13% reef-associated. Half of all shark species in the world inhabit depths that include the 0-200 m layer of the water column; however, only 100 species are restricted to it (Figure 2B). Priede *et al.* (2006) reported that sharks are confined to only 30% of the world's oceans and are rare or absent in the abyssal depths (>3,000 m). Only 5 deep-sea species are recorded in FishBase, with the largetooth cookiecutter shark, *Isistius plutodus* (Kiraly *et al.*, 2003) reaching to depths of 6,500 m. Moreover, sharks are patchily distributed around sea mounts, ocean ridges and ocean margins, which make them highly accessible to artisanal and commercial fisheries, and therefore vulnerable to overfishing (Priede *et al.*, 2006).

More than half of the shark species listed in FishBase have maximum recorded lengths of 12-2000 cm (weighted average L_{max}=161 cm) with the largest being the basking shark, *Cetorhinus maximus* (Gunnerus, 1765) at 980 cm TL and the *whale shark*, Rhincodon typus Smith, 1828 at 2000 cm TL (Figure 2C). Average longevity of sharks is 27.5 years (t_{max} range of n=64 species with age data is 6-75 years; s.e.=2.19). Data on length at first maturity available for 53 shark species provides a mean of 34 cm (range of 34-922 cm, s.e.=21.8). On the average, sharks mature when they reach 68% of their asymptotic lengths (L_m/L_∞, a variable of the von Bertalanffy growth function; range=37-91%, n=48, s.e.=0.0198). Furthermore, females mature at larger sizes, i.e., later, than males, with average L_m/L_∞ values of 0.705 (range=0.37-0.90, n=21, s.e.=0.0306) and 0.679 (range=0.47-0.91, n=20, s.e.=0.025), respectively. This information suggests that sharks tend to grow slowly and reach maturity at a large size and late age, which makes them especially sensitive to and slow to recover from overfishing (Hoenig and Gruber, 1990).



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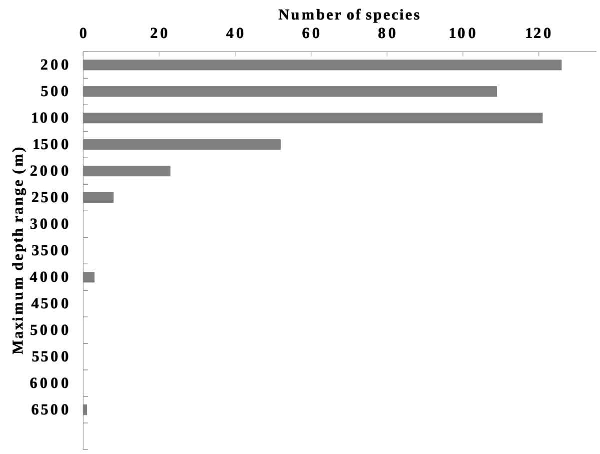

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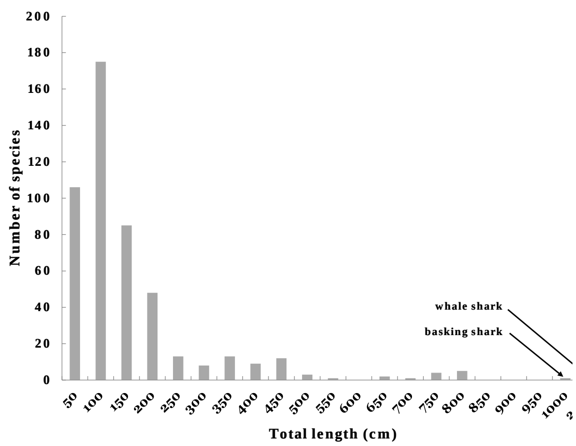

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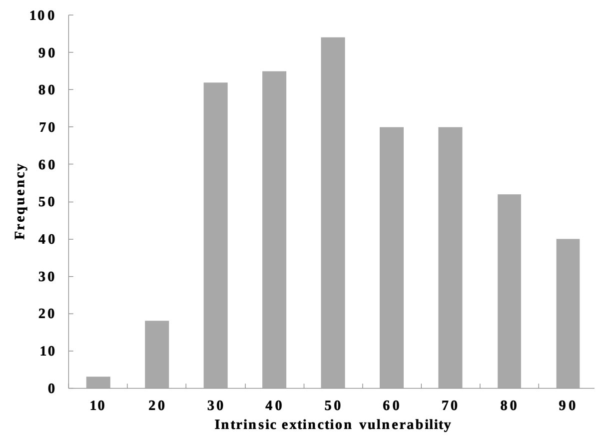

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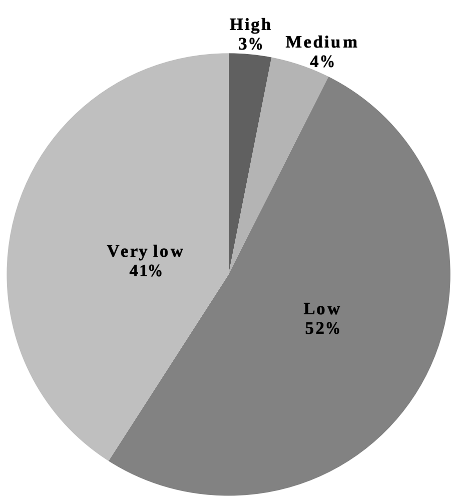


E

Figure 2. A: Distribution of the world's shark species (n=543 in total) by order (n=11). **B**: Distribution of shark species by maximum depth range (n=443 with $Depth_{max}$ data). **C**: Maximum length frequency distribution of sharks species for 487 shark species; weighted average L_{max}=161 cm); largest sharks are the basking shark, *Cetorhinus maximus* at 980 cm TL and the whale shark, *Rhincodon typus* at 2000 cm TL. **D**: Frequency distribution of intrinsic extinction vulnerability of 514 shark species; weighted average vulnerability=54.1. **E**: Resilience of 484 shark species estimated using the method of Musick (1999). Data from FishBase October 2011 version.

Shark species have a weighted average vulnerability of 54.1% (range=10-90%) estimated in FishBase using the method in Cheung *et al*. (2005) for 514 shark species (Figure 2D). Appendix 1 lists average vulnerability values (in decreasing order) for the world's sharks and rays (Elasmobranchii) and bony fishes (Actinopterygii) grouped in 58 orders. Here, we see that a majority of shark orders (7 of 11) have high vulnerability values (>50%) as opposed to the 6 of 47 bony fish orders. Furthermore, 93% of 484 species with resilience data (estimated in FishBase using the method in Musick, 1999) are in the low or very low resilience categories (Figure 2E).

All of these variables confirm that sharks grow to large sizes, are long-lived, mature late in their life cycle, belong to highly vulnerable and low resilient categories, and are usually found in shallow waters. The combined effects of these factors also puts them at risk from anthropogenic and environmental changes and the reason why most shark species are red-listed by IUCN (2010). Table 1 shows that 30% of these are threatened (3.9% critically endangered, 3.2% endangered, 14.5% near threatened, 8.2% vulnerable). The rest are of least concern (24.8%) and data deficient (45.4%). However, 92% of species in these last two categories are evaluated in FishBase to have low or very low resilience, which further stresses the need for more detailed studies on the biology and fisheries of these species.

Table 1. Number of shark species per order which are red-listed by the IUCN (IUCN, 2010), i.e., 85% of all shark species in the world. CR=critically endangered; EN=endangered; NT=near threatened; VU=vulnerable; LC=of least concern; DD=data deficient.

Order	CR	EN	NT	VU	LC	DD	Totals
Carcharhiniformes	7	10	37	21	64	117	256
Heterodontiformes	–	–	–	–	4	5	9
Hexanchiformes	–	–	3	–	–	2	5
Lamniformes	–	–	1	–	2	2	5
Orectolobiformes	–	–	11	7	8	10	36
Pristiformes	7	–	–	–	–	–	7
Pristiophoriformes	–	–	1	–	3	2	6
Squaliformes	1	–	13	6	32	65	117
Squatiniformes	3	5	1	4	2	7	22
Totals	**18**	**15**	**67**	**38**	**115**	**210**	**463**

Shark-related legislation

adapted from Biery and Pauly (in review)

Sharks were considered a low-value catch for many years before the rise in popularity of shark fin soup, thus in many cases, the management of shark fisheries has not yet caught up with the growing demand for shark products. Until recently, very little effort was placed on the management of shark resources (Barker and Schluessel, 2005). Globally, steps are being taken to improve the effectiveness of shark management strategies and introduce them where they do not yet exist, but challenges still remain. An International Plan of Action for the Conservation and Management of Sharks was adopted by the FAO Committee on Fisheries in 1999, but so far none of its elements have been implemented successfully (Lack and Sant, 2011). Some countries have realized the need for more rigorous management of shark fisheries, and have adopted a country-specific National Plan of Action for the Conservation and Management of Sharks or established other regulations which limit or ban shark finning (Cortés and Neer, 2006). Some countries have also implemented shark-related legislation separate from or in addition to their National Plan of Action, and this has become increasingly common in recent years as the decline of shark fisheries becomes more apparent (Figure 3).

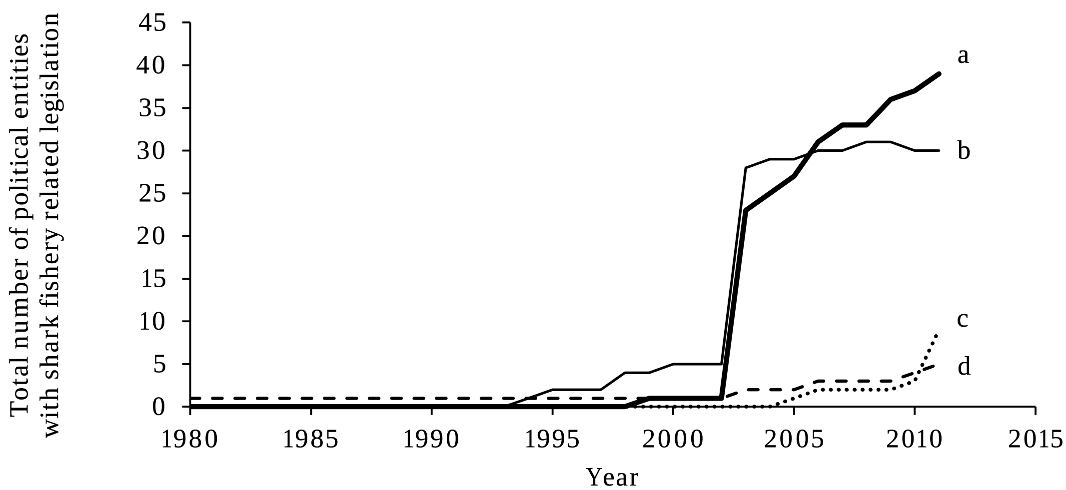


Figure 3. Number of political entities having implemented shark-related legislation since 1980. Legislation is classified into the following four categories: (a) that which mandates that sharks be landed with fins attached, (b) that which implements fin to body weight ratio-based regulations, (c) that which specifies trade regulations, and (d) that which creates a shark sanctuary (an area where shark fishing is entirely prohibited). The 22 maritime EU members are included for years in which EU-wide legislation is instated, and individual US states are included where state-specific legislation exists. Adapted from Biery and Pauly (in review).

The *Sea Around Us* Project has collected and compiled current regulations globally by political entity in order to provide an overview of existing legislation and the instatement of new legislation over time. Legislation and regulations related to shark fisheries were collected from legal documents and secondary literature sources for countries, states, and Regional Fishery Management Organizations (RFMOs). These political entities have been classified into one or more of the following categories based on the characteristics of their existing legislation and regulations: shark sanctuary (an area where shark fishing has been entirely prohibited), area where sharks must be landed with fins attached, area where fin to body weight ratio-based regulations have been implemented, area where shark product trade regulations exist, or other. Individual regulations are listed and described by political entity in Appendix 2.

Regulations were found in 38 countries and the European Union (EU), which includes 22 maritime countries. Additionally, legislation was pending in the US state of Oregon at the time of publication. Five countries were classified as shark sanctuaries, 17 countries, the US state of Alaska, and the European Union were classified as areas where sharks must be landed with fins attached, 8 countries and the European Union have implemented ratio-based shark regulations, and 7 countries and 4 US states have passed legislation to regulate the trade of shark products (note that individual countries may be classified into multiple categories). Nine RFMOs have designated shark-related regulations, with 8 RFMOs enforcing ratio-based regulations and the entire area covered by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) classified as a shark sanctuary.

Laws and regulations are rapidly changing and are not always effectively enforced by countries, states, and RFMOs. Enforcement can be challenging due to confusion, time constraints, and lack of resources. Additionally, the accuracy of the 5% fin to body weight ratio that is commonly used in ratio-based legislation for all species has also been questioned (Cortés and Neer, 2006; see below). Although progress has been made in recent years to protect sharks through international partnerships and the creation and implementation of shark-related legislation, on a global scale, the majority of countries remain unregulated. Further action is necessary in order to protect sharks sufficiently in the future. Because many shark species are highly migratory and move between countries and RFMO areas, it is important for additional countries and organizations to adopt legislation in order to prohibit finning and overharvesting over a larger geographical range.

Shark fin to body weight ratios

adapted from Biery and Pauly (in review)

As the necessity for shark-related legislation becomes more urgent, many countries struggle to instate laws that effectively prevent the practice of finning and protect sharks while also satisfying fishers. Regulations that require fishers to land sharks with fins attached are helpful from an ecological perspective, but due to the low value of shark meat and the rigidity of shark fins, fishers often think that it is impractical to store bodies on-board vessels with fins attached (Hareide *et al.*, 2007).

As a compromise, some countries permit fishers to remove fins from bodies at sea for separate storage if the bodies are kept and the weight of fins on board a vessel corresponds, via a pre-established fin to body weight ratio, to the weight of carcasses present. The European Union requires most vessels to land sharks with fins attached, but Special Fishing Permits can be issued which allow certain vessels to separate fins from carcasses at sea as long as ratio requirements are met, a common practice among Spanish and Portuguese longline vessels (Fowler and Séret, 2010). This type of regulation made the establishment of standard fin to body weight ratios necessary to confirm that landed fins correspond to the shark carcasses present on board (Cortés and

Neer, 2006). The US Fishery Management Plan for Sharks of the Atlantic Ocean proposed a 5% wet fin to dressed carcass weight ratio, which was based on an independent examination of 12 individual sandbar sharks *Carcharhinus plumbeus* (NMFS, 1993). This ratio was later validated by a study of 27,000 sharks by the US Commercial Shark Fishery Observer Program, which found a mean ratio of 4.9% for 28 shark species. The 5% ratio was officially adopted by the European Union in 2003, but the regulation specifies a wet fin to round (total) weight ratio instead of a wet fin to dressed carcass ratio, where fins and head have already been removed, so the validity of the ratio is undermined and it may allow fishers to fin extra sharks (Hareide *et al*,. 2007; Ariz *et al*., 2008). Similar ratio-based regulations have been implemented in additional countries, and by some RFMOs.

The 5% wet fin to round weight ratio is not a realistic mean for all shark species and fishing fleets, as numerous data sources show considerable variation in ratios between species. Accurate ratios for each species are essential in order to monitor total catches (Ariz *et al*., 2008, Cortés and Neer, 2006). If regulated ratios are set at levels higher than observed ratios, a loophole is created which allows fishers to harvest more fins than correspond to the number of carcasses on board while still meeting weight ratio requirements. Ratio-based regulations also provide an opportunity for high-grading, the practice of mixing carcasses and fins from different animals to maximize profit (Hareide *et al*., 2007).

In order to examine the validity of the 5% ratio more closely and to provide a database of fin to body weight ratios at a higher taxonomic resolution than was previously available, species-specific mean wet fin to total body weight ratios were compiled from numerous sources. We reviewed literature including scientific papers and reports, NGO reports, private government studies, and unpublished sources, and mean fin to body weight ratios were calculated by species, genera and family based on the primary fin set, which is the most commonly harvested set of fins (Figure 4). Appendix 3a-c lists the mean ratios for these groups.

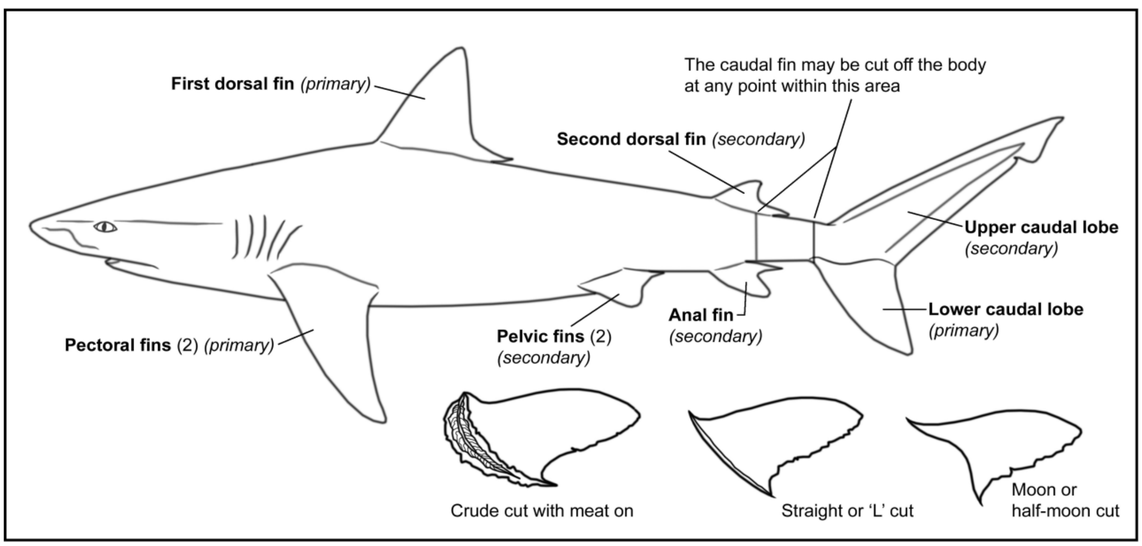


Figure 4. Diagram of whole shark with primary and secondary fin sets labelled. Three common fin cuts are illustrated. (Figure modified from Anderson and Hudha [1993]; S. Fowler *in* Hareide *et al*. [2007]; Cortés and Neer [2006]).

It should also be noted that during processing, and sometimes prior to landing, fins may be dried in preparation for trade (Anderson and Hudha, 1993). Fins are typically rinsed in saltwater, then spread out on mats or tables to dry for four to seven days, depending on various factors including fin cut, fin size, and weather (Anderson and Hudha, 1993). The weight of wet frozen fins has been described anecdotally to decrease by 70-80% when dried (Clarke, 2003). Such a conversion factor can be applied to estimate the wet weight of dried fins, making it possible to enforce wet fin to round weight ratio regulations even when fins are landed dry. In order to calculate a more accurate wet to dry fin weight conversion factor based on multiple observations, observed, legislated and anecdotal wet fin to dry fin weight conversion factors were compiled from 10 sources (Table 2). The mean wet weight to dry fin weight conversion factor was 0.43 ± 0.01 for all sources.

Table 2. Mean wet to dry fin weight conversion factors by study. Adapted from Biery and Pauly (in review).

Study	n	Conversion factor	±SE	Methods/ Remarks
Anderson & Hudha (1993)	1	0.46	0.000	Conversion factor provided in text, based on 18 sharks of mixed species.
Anon. (2004)	3	0.41	0.006	Calculated from legislated wet fin to round weight and dry fin to round weight conversion factors for *Prionace glauca*, *Isurus oxyrinchus* and *Lamna nasus*.
Rose *et al.* (2001)	14	0.45	0.013	Calculated from observed wet fin to round weight ratios and dry fin to round weight ratios for 12 shark species.
NMFS (1993)	3	0.40	0.069	Calculated from observed wet fin to round weight ratios and dry fin to round weight ratios for *Prionace glauca*, *Isurus oxyrinchus* and *Sphyrna zygaena*.
Clarke (2003)	1	0.25	0.000	"Anecdotal information from Hong Kong shark fin traders suggests that the weight of frozen fins will decrease by 70-80% when dried, thus a factor of 1 kg 'salted or in brine' (i.e., frozen) = 0.25 kg dried fins has been used to normalize the 'salted or in brine' data..." (p.164)
Horvat, pers. comm. (2011)	1	0.46	0.000	Calculated from legislated frozen or fresh fin to trunk weight and dry fin to trunk weight ratios.
Fong (1999)	28	0.59	0.004	Calculated from the wet weight and dry weight of individual dorsal, pectoral and caudal fins from *Carcharhinus limbatus*.
Clarke, pers. comm. (2011)	1	0.40	0.000	“An Australian fin trader once insisted to me that the figure should be more like 0.4 but he didn’t have any data to back it up so I went with what the Hong Kong traders told me (0.25).”
Mean conversion factor	**52**	**0.43**	**0.011**	

By species, mean shark wet fin to round weight ratios were found to range from 1.06% for Nervous shark *Carcharhinus cautus* to 10.9% for Smalltooth sawfish *Pristis pectinata*. When ordered by genera, mean ratios ranged from 1.34% for the genus *Carcharias* to 5.65% for the genus *Prionace*, and by family ranged from 1.34% for members of the family Odontaspididae to 5.40% for members of the family Ginglymostomatidae. Of those reviewed, 42 out of 50 species, 19 out of 24 genera, and 11 out of 13 families had mean wet fin to round weight ratios lower than the 5% ratio regulated by many countries.

Variation in ratios between species is likely due to anatomical differences, which indicates that species-specific fin to body weight ratios should be enforced in ratio-based regulations. However, due to the complications presented by the development and enforcement of species-specific regulations, finning bans which require that sharks be landed with fins attached are even better. When sharks are landed with fins attached, it is easier for trained observers at landing sites to record the number, weight and species of sharks landed, making data collection and monitoring more straightforward and accurate.

Catches of sharks worldwide

As mentioned previously, before the surge in Chinese demand for shark fins began in the 1980s, sharks were of low monetary value and were considered relatively unimportant from a global economic standpoint (Anon., 2007). Hence, shark fisheries were historically characterized by poor regulation and monitoring, resulting in limited data on catches, landings, and the trade of shark products, especially at the species level (Barker and Schluessel, 2005). It is also difficult to monitor sharks caught in non-target fisheries as bycatch, because there is uncertainty surrounding how much finning and discarding happens in the high seas, and these catches are often recorded as ‘mixed fish’ or ‘unidentified sharks’ (Castro *et al.*, 1999; Barker and Schluessel, 2005). Although catch and trade data for sharks have improved in recent years, many records remain incomplete and data are lacking for large spatial areas and time periods. Furthermore, the accuracy of existing data has been challenged, and actual shark catches estimated to be larger than data from the UN Food and Agriculture Organization (FAO) would suggest (Clarke *et al.*, 2006). This uncertainty, combined with the sparse nature of available data, makes estimating global shark catches a challenge.

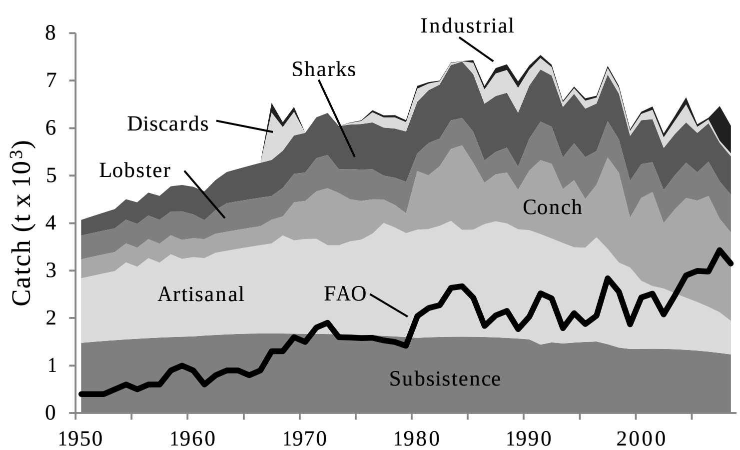


Figure 5. Total reconstructed catch by fisheries sector for Belize compared to FAO catch, 1950-2008. Artisanal sector represents reported and unreported finfish; Industrial includes shrimp and pelagic fish catches (from Zeller *et al.*, 2011).

The *Sea Around Us* Project has developed new approaches for reconstructing total catches in individual countries’ waters and allocating catches to the appropriate waters (Zeller *et al.*, 2007). This strategy has also indirectly improved the quality of shark catch estimates in quantity, taxonomic resolution, and geographical specificity.

Catch reconstructions from the *Sea Around Us* Project complement officially reported landings data with additional sources of information in order to provide a more comprehensive estimate of marine fisheries removals by country since the 1950s. In addition to commercial fisheries data, these reconstructions include catches from frequently unreported sectors such as artisanal, subsistence and recreational fisheries, discarded bycatch and other unreported and unregulated components. Catch reconstructions also disaggregate shark catches to species-level whenever possible. This can provide important information about species most at risk of decline due to overfishing. A recent catch reconstruction for Belize used available shark catch data to interpolate shark catches for missing years (Figure 5), and provided a list of commonly caught species in Belize waters based on literature and information from the Ministry of Aquaculture and Fisheries (Table 3) (Zeller *et al.*, 2011).

Table 3. Species composition of shark catches in Belize derived from Graham (2007) and J. Villanuva (pers., comm., Belize Fisheries Department).

Common name	**Species name**	**Fraction**
Caribbean sharpnose	*Rhizoprionodon porosus*	0.17
Blacktip shark	*Carcharhinus limbatus*	0.06
Great hammerhead	*Sphyrna mokarran*	0.35
Scalloped hammerhead	*Sphyrna lewini*	0.12
Nurse shark	*Ginglymostoma cirratum*	0.15
Bonnethead	*Sphyrna tiburo*	0.01
Lemon shark	*Negaprion brevirostris*	0.03
Bull shark	*Carcharhinus leucas*	0.11

The fisheries of Ecuador also feed the demand for fins, and fishers there catch more than 40 different shark species. Until the 2005 update of fisheries data, the United Nations Food and Agriculture Organisation (FAO) did not report elasmobranchs for Ecuador, indicating that the Ecuadorian government did not report on these species. One *Sea Around Us* Project study (Jacquet *et al.*, 2008) reconstructed Ecuador's mainland shark landings from the bottom up from 1979 to 2004 using a variety of techniques, including examining reported Hong Kong shark fin imports from Ecuador. Over this period, shark landings for the Ecuadorian mainland were an estimated 7,000 tonnes per year, or nearly half a million sharks. Reconstructed shark landings were about 3.6 times greater than those retroactively reported by FAO from 1991 to 2004. The discrepancies in data show that a serious shark landings monitoring system and effective chain of custody standards are needed in Ecuador, and probably in many other countries around the world (Jacquet *et al.*, 2008). Catch reconstructions such as these have been or are in the process of being done for all fishing countries of the world, and will provide substantial improvements to currently available global shark catch data.

To allocate these catches spatially, The *Sea Around Us* Project uses a rule-based approach which includes information about fishing access agreements between countries (Watson *et al.*, 2004). Species distribution and habitat information from FishBase is also incorporated into the procedure as a means of disaggregating 'lumped' categories of fish species, such as "Sharks and rays." This information can be extracted and displayed as species-specific catch time series for various marine areas, including Exclusive Economic Zones (EEZs) (Watson *et al.*, 2004). In many cases, catch allocations identify catches by outside countries within EEZs that reported zero catches to FAO, indicating that a lack of reported landings from a given country to FAO does not necessarily mean that their marine resources are untapped.

In order to better understand the scale and global distribution of shark catches during the 2000s, we have also used data from our catch reconstructions and catch allocations, in combination with information from the literature and direct communication with experts around the world, to supplement FAO shark landing statistics. Our enhanced dataset divides shark catches by EEZ waters and provides a more accurate and complete picture of the geographical distribution and scale of mean yearly global shark catches than was previously available for the 2000s (Appendix 4). Also, the preliminary version of a multiple regression used to predict missing mean shark landings values for countries where no data were available is shown in Table 4.

Table 4. Multivariate model outputs. Adjusted R-squared: 0.3217.

Parameter	Unit	Estimate	SE
Intercept	-	-8.00423	2.26427
1980s mean catch	tonnes	-0.34216	0.22062
1990s mean catch	tonnes	-0.18066	0.21290
$(\log_{10}(\text{EEZ area}))^2$	km^2	0.05132	0.01234
$\log_{10}(\text{EEZ area})$	km^2	-0.47480	0.27228
$\log_{10}(\text{primary production})$	$mgC \cdot m^{-2} \cdot day^{-1}$	1.64210	0.15612
$(\text{Human development index})^2$	-	-3.96508	2.93975
Human development index	-	4.78375	3.76005

Our *Sea Around Us* Project estimate of mean total yearly shark catches in the EEZs of countries for 2000-2009 was 567,787 metric tonnes, i.e., very close to the result of an independent study from Clarke *et al.* (2006) based on fin trade data, which provided the mid-range estimate that approximately 600,000 metric tons of sharks are caught yearly.[1] In contrast, FAO data (adjusted to eliminate other elasmobranchs based on ratios in Bonfil, 1994) indicate a mean yearly catch of 439,197 metric tons of sharks. Of the estimate of Clarke *et al.* (2006) of 600,000 mt, about 65%, i.e. 390,000 t are thought to be utilized for their fins. Both *Sea Around Us* Project[1] and Clarke *et al.* (2006) results indicate that global shark catches are higher than FAO data suggest, confirming that there is a need for improved monitoring and reporting on a global scale. Species-specific catch data are also lacking for most countries.

In upcoming months, our enhanced shark landings values will be distributed among commonly caught species, genera, and families within each EEZ to describe shark catches at a higher taxonomic resolution. We will also use our data on species-specific shark fin to body weight ratios to estimate the predicted output of shark fins from global catches, and see if this also corresponds to the estimate of Clarke *et al.* (2006).

[1] Note, the *Sea Around Us* Project's reconstructed shark catches relate to EEZ waters only, therefore currently do not include High Seas catches or international Illegal catches of sharks.

Sharks in Ecosystem models

Sharks play an important trophic role in marine ecosystems. It is generally acknowledged that most sharks are top predators, but little is known about their exact role in the foodweb. Of the hundreds of extant shark species that inhabit a wide range of habitats worldwide, only a few have been studied in detail.

Over the last 50 years, our understanding of predator-prey relationships within marine food webs and ability to quantify these relationships has improved. Today, sharks are facing threats such as overfishing and shark finning (Anon., 2007), which is worrisome because it is now clearly established that the removal of top predators now occuring on a grand scale can cause massive changes within ecosystems and on organisms at lower trophic levels (Morissette *et al.*, 2006; Tremblay-Boyer *et al.*, 2011). In the case of sharks, it is very difficult to determine what the effect of extinction or local extirpation of species on the marine ecosystem might be. This is due to the complex nature of their environment leading to practical problems of year-round sampling and an inability to conduct manipulative experimentation with most species of sharks. It is reasonable to hypothesise that there will be a measurable effect on the community structure following removal of a shark species.

The development, validation, and application of ecosystem models are a useful method to study predation (Trites, 2002). Ecopath with Ecosim (*EwE*) models are mass-balance models that are normally used to integrate biomass and rate estimates, and to identify major energy pathways and gaps in the knowledge of an ecosystem (Christensen *et al.*, 2008). They are relatively straightforward to parameterize and calculate, thus making it possible to standardise and to test the mutual compatibility of a set of estimates related to single species (Jarre *et al.*, 1991). Moreover, these approaches also provide a comprehensive overview of the interactions in a given scenario, when the data requirements of a more elaborate approach cannot be met (Jarre-Teichmann, 1998). Finally, the *EwE* models force marine ecologists to consider all ecosystem compartments relevant to fish production, rather than limiting their focus to important commercial species (Jarre-Teichmann, 1998).

To understand the trophic role of sharks on a global scale, an ecosystem-level meta-analysis approach was undertaken using a set of over 150 *EwE* models of marine systems around the world. In this contribution, we highlight an established modelling approach currently in use by fisheries scientists to describe the functioning of the ecosystems upon which fisheries are based. The specific aims of this contribution are to i) review the coverage of sharks in published trophic models of ecosystems and important parameterization features of *EwE* so that future modelling efforts may correctly incorporate shark species; ii) to present an overview of the ecological role of sharks in a context of different ecosystem structure; and iii) simulate the long-term impacts of the declining trend of many shark populations on the food webs they live in, and the collateral effects on other species.

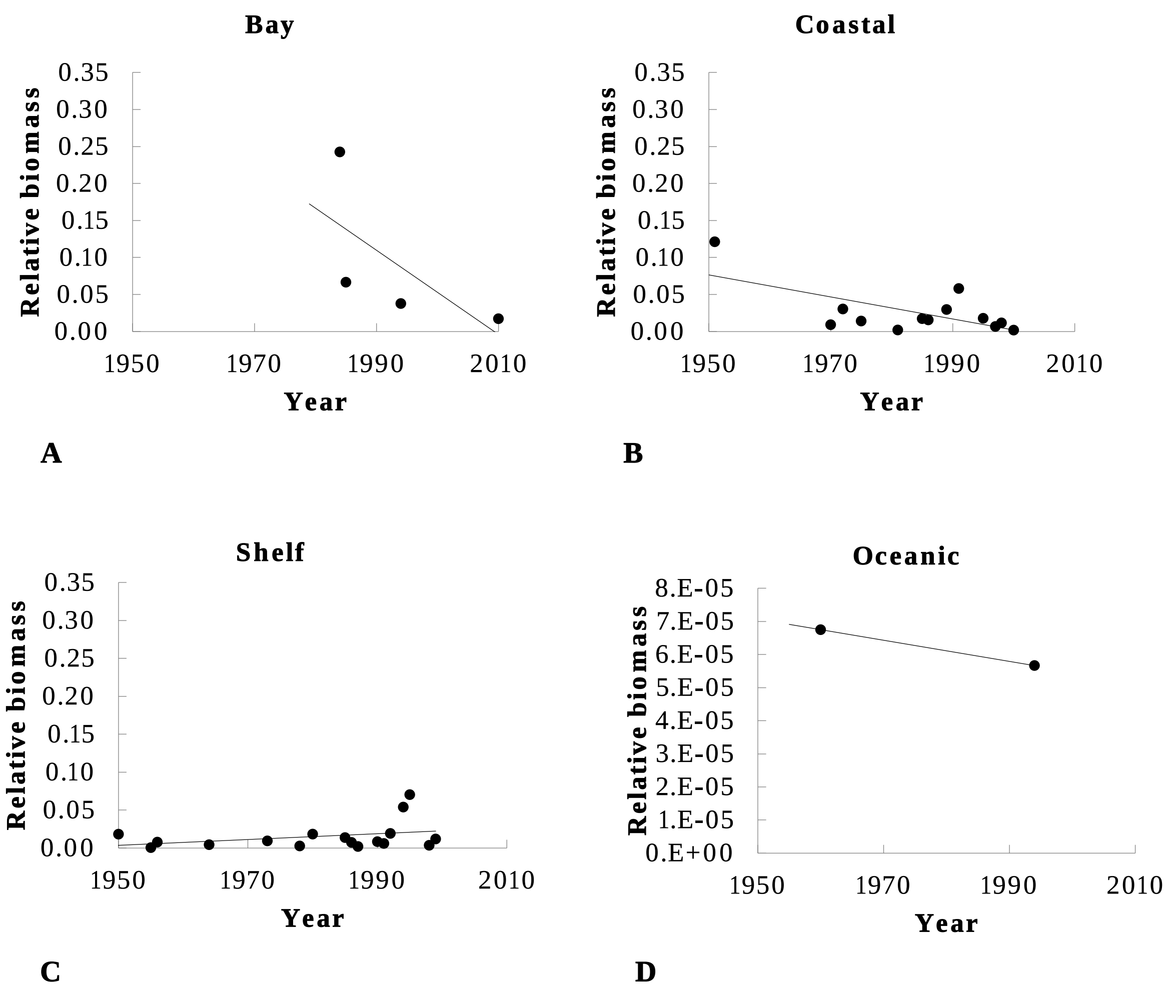
We found that sharks were well represented in the ecosystem models that we analysed. They were included in an area representing 11.6 million km^2 of the world's oceans (or about 3%), and covering coastal, oceanic, shelf, reef, and bay ecosystems. Of the 150 models analyzed, 75 included sharks in their list of taxa covered, and 65 specifically included sharks as a distinct functional group in their food webs (Appendix

5). Although most models incorporated sharks, many tended to collapse all shark species into a single functional group, which poorly represents the diversity of taxa and the trophic interactions involving sharks in marine ecosystems.

An analysis was also conducted which shows how sharks' representation in ecosystem models has changed since the early 1980s, and to assess whether the biomass of sharks changed relative to other large fish in marine ecosystems, in line with increasing fishing effort on these species. We found that most of the shark populations in the world are declining faster then the biomass of other high trophic level fishes (which themselves are rapidly declining throughout the world; see Tremblay-Boyer *et al.*, 2011). This indicates that the impact of shark fishing around the world should be the focus of international concern despite the fact that we do not know much about their ecology (Figure 6A-E).

Ecological modelling provides a useful tool to understand the trophic role of sharks in large fisheries-based ecosystems of the world when data are sparse. Global meta-analysis allow us to overcome these gaps in data and describe the trophic role of sharks in different types of marine ecosystems, despite the fact that we are missing important biological and habitat information for many species.

Leopard shark, *Triakis semifasciata*, Catalina Island, California. Photo credit: Olivier Frei.



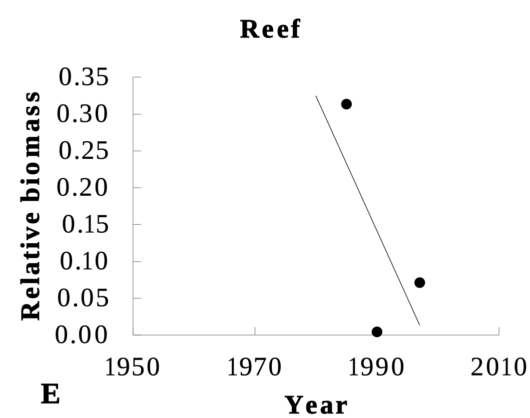


Figure 6. Shark biomass relative to the biomass of trophic level 3+ groups in 107 marine ecosystems of the world over time: **A**) bay, **B**) coastal, **C**) shelf, **D**) oceanic, and **E**) reef systems. Note that the change (mostly decline) indicated by these graphs is additional to the change of the biomass at trophic level 3+, which is known to have severely declined throughout most of the world's oceans (Tremblay-Boyer *et al.*, 2011).

Sharks and climate change

Global warming is caused by an amplification of the greenhouse effect due to the release of carbon dioxide and other anthropogenic greenhouse gases into the atmosphere, which increases atmospheric temperatures worldwide, and in turn increases the temperature of the ocean. The IPCC assessment report (IPCC, 2007) presents compelling evidence that the global ocean has become warmer in recent years, with an estimated increase in average temperature of 0.2°C within the top 300 m depth of the ocean between the mid-1950s and the mid-1990s. The global ocean also contains less sea-ice, with summer Arctic sea ice decreasing at about 7.4% per decade. It has been predicted that the Arctic Ocean may become ice-free in summer by 2030, relative to the 1960s. The pH of surface ocean waters has dropped by an average of about 0.1 units from preindustrial levels, particularly in high latitude regions, which indicates that global oceans have become more acidic in the 20th century by about 30%. These trends are all expected to continue over the next century under the climate change scenarios considered by the IPCC. Although available evidence indicates that climate change is expected to result in expansion of oxygen minimum zones (OMZs) (Stramma *et al.*, 2010), changes in primary productivity (Boyce *et al.*, 2010; Steinacher *et al.*, 2010), changes in ocean circulation patterns (Toggweiler and Russell, 2008), sea level rises (10 – 90 cm increase by 2100) and increase in extreme weather events, estimates and projections of the magnitude and regional patterns of changes are still uncertain.

These changes in ocean biogeochemistry are expected to affect the biology and ecology of sharks. Although direct empirical evidence for biological responses of sharks to climate and ocean changes are lacking, there are numerous studies on responses of marine (bony) fishes (Osteichthyes) and invertebrates to these changes. The main biological responses include shift in distribution, changes in phenology, and changes in body size and other related life history characteristics such as length at maturity (see reviews by Cheung *et al.*, 2009; Sumaila *et al.*, 2011). These biological responses are determined by fundamental theories of biology and ecology, including (1) oxygen- and capacity- limited thermal tolerance; (2) metabolic scaling and life-history theories; (3) ecological niche theory; and (4) predator-prey interactions. Since sharks, like other marine fishes, are ectotherms that obtain oxygen from gills, they are constrained by the same sets of biological and environmental factors under the above fundamental biological theories. Thus, sharks are expected to respond to climate change similarly to other marine fishes and invertebrates.

Integrating these fundamental theories of biology and ecology through a modelling framework, Cheung *et al.* (2009, 2010, 2011) predicted how 1,066 exploited marine fishes and invertebrates (including 98 species of sharks) would respond to climate and ocean changes. Overall, the species are expected to expand their distribution poleward (~25 km $decade^{-1}$) and to deeper waters (~3.8 m $decade^{-1}$) by 2050 relative to 2000 under the scenario that atmospheric CO_2 concentration is doubled by 2100. As a result, distribution of sharks may expand to higher latitude regions. In contrast, in the tropics, shark abundance may decrease and some species may become locally extinct (Figure 7) (Cheung *et al.*, 2009). Moreover, the distribution of oxygen minimum zones affects the vertical and horizontal distribution of pelagic predators such as tuna and billfishes (Prince *et al*., 2010; Stramma *et al*., 2011), which will be affected as distribution and extent of OMZs are expected to change under climate change (Stramma *et al*., 2010). Some pelagic sharks should be affected similarly to other pelagic predatory fishes. Moreover, changes in primary productivity are expected to affect the abundance and productivity of shark populations. Based on the projections by Cheung *et al*. (2010, 2011), the catch potential of sharks in the tropics is expected to decrease, while it may increase in higher latitude regions. However, the increase in the latter case would depend on the sensitivity of ecosystems in higher latitude regions to ocean acidification (Cheung *et al*., 2011).

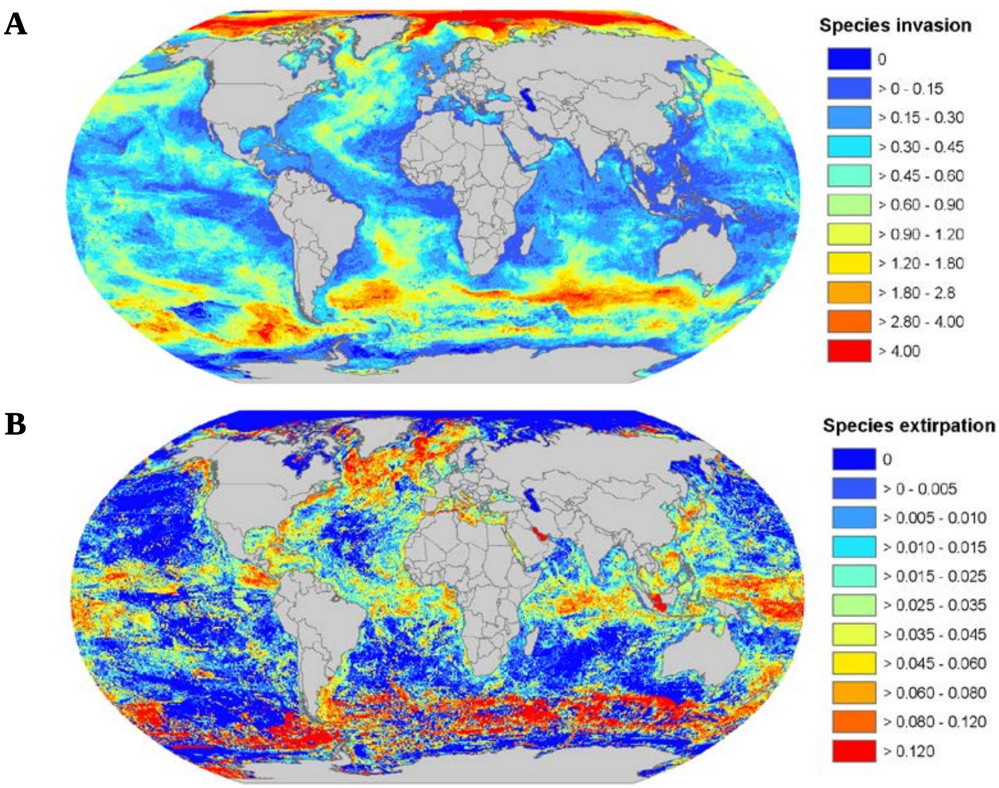


Figure 7. Projected impacts on diversity of marine fishes and invertebrates by 2050 relative to 2000: (A,) rate of species invasion, calculated from the number of newly occurring species relative to the original species richness; and (B) rate of species local extinction or loss, calculated from the number of locally extinct species relative to the original species richness under the SRES A1B scenario. The analysis included 1066 species of fishes and invertebrates. (Redrawn from Cheung *et al*. 2009).

Conclusions

Results of recent *Sea Around Us* Project research confirm the widespread view that many shark species are at risk of extinction in the near future, and that shark biomass has decreased since the 1950s in most marine ecosystems. Protective legislation is becoming increasingly common worldwide, but due to loopholes, enforcement challenges, and lack of broad geographical coverage, it is probably inadequate to facilitate the recovery of most species. Additionally, the *Sea Around Us* Project is working to demonstrate scientifically and rigorously the obvious fact that shark catches are much higher than statistics reported to FAO suggest. As global temperatures continue to rise as a result of global warming, sharks will undergo shifts in distribution, as well as changes in phenology and related life-history characteristics that are not yet well understood.

It is likely that sharks will remain threatened as long as the demand for shark fin soup in China continues to grow and global warming modifies their habitats. Because sharks are highly vulnerable to and slow to recover from overfishing, there is an urgent need to protect them through the establishment of effective and well-enforced legislation over a wide range of marine ecosystems. Laws and regulations that prohibit or limit shark fishing and the trade of shark products will be useful in ensuring the future sustainability of shark populations. In cases where anti-finning laws are enacted, they should require fishers to land sharks with fins attached, rather than separate from the carcass. Also, species that are at high risk of extinction should be awarded special protection, and catch quotas should exist for all shark fisheries in order to end the unlimited harvesting of sharks that occurs in some areas. Because many shark species are highly migratory and move between EEZs, there is a need for cooperation between countries in creating and enforcing new legislation to protect them. In addition to shark-related legislation, both local and international Marine Protected Areas (MPAs) that are designated as shark sanctuaries can provide a safe zone where sharks can reproduce without the threat of being fished or finned.

Although it is known that many shark species are important top predators at great risk of being overfished, their specific roles in different marine ecosystems are not well understood, so the resulting effects of decreasing shark populations on these ecosystems are largely unknown. The *Sea Around Us* Project continued meta-analyses of existing ecosystem models that include sharks will help us to better understand their role and the effects that their decline could potentially have on other marine organisms This information can provide important clues for improving ecosystem management in the future.

The impacts of global warming and ocean acidification on sharks are also uncertain, but based on studies of other marine fishes, the effects could be substantial, with tropical species migrating poleward and into deeper waters. The appearance of previously absent shark species will affect these higher-latitude ecosystems, as well as the lower-latitude ones they left behind, and will provide an interesting topic for further scientific investigation.

Sea Around Us Project researchers are continuously working to identify and study the highest-quality sources of information related to sharks. It is our goal to identify gaps in existing data, and to fill in the blanks using creative and sometimes unconventional approaches. For this reason, we are able to see trends that might otherwise be overlooked and draw conclusions accordingly. We will use the results presented in this report and others to continue conducting research that will allow us to better understand the status of sharks, shape global management policies, and protect the future of sharks and ocean biodiversity as a whole.

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Appendices

Appendix 1: Mean maximum length (L_{max}) and intrinsic extinction vulnerability values (estimated using Cheung *et al*., 2005) based on data in FishBase (October 2011 version) and arranged in from highest to lowest mean vulnerability values. Note that a majority of shark orders (7 of 9) have high vulnerability values (>50%) as opposed to the 6 of 47 bony fish orders

Class	Order	Name	No. species	Mean vulnerability
Elasmobranchii	Pristiformes	sawfishes	9	79
	Lamniformes	mackerel sharks	26	77
	Hexanchiformes	frill and cow sharks	7	68
	Squatiniformes	angel sharks	24	59
	Heterodontiformes	bullhead and horn sharks	9	58
	Pristiophoriformes	saw sharks	7	55
	Rajiformes	skates and rays	562	55
	Squaliformes	bramble, sleeper and dogfish sharks	146	53
	Carcharhiniformes	ground sharks	283	46
	Orectolobiformes	carpet sharks	45	45
	Torpediniformes	electric rays	67	38
			Total 1185	Mean 51
Actinopterygii	Acipenseriformes	sturgeons and paddlefishes	55	79
	Lepisosteiformes	gars	7	71
	Lampriformes	velifers, tube-eyes and ribbonfishes	24	70
	Ateleopodiformes	jellynose fishes	13	63
	Elopiformes	tarpons and tenpounders	9	57
	Salmoniformes	salmons	231	50
	Polymixiiformes	beardfishes	10	48
	Esociformes	pikes and mudminnows	13	42
	Gadiformes	cods	673	42
	Mugiliformes	mullets	82	41
	Notacanthiformes	halosaurs and deep-sea spiny eels	27	41
	Amiiformes	bowfins	1	40
	Batrachoidiformes	toadfishes	80	39
	Polypteriformes	bichirs	18	38
	Zeiformes	dories	33	38
	Albuliformes	bonefishes	12	37
	Anguilliformes	eels and morays	903	37
	Osmeriformes	smelts	327	32
	Beryciformes	sawbellies	163	31
	Scorpaeniformes	scorpionfishes and flatheads	1596	31
	Pleuronectiformes	flatfishes	809	30
	Saccopharyngiformes	swallowers and gulpers	28	30
	Gobiesociformes	clingfishes	159	28
	Tetraodontiformes	puffers and filefishes	430	27
	Cypriniformes	carps	4074	26
	Myctophiformes	lanternfishes	255	26

Class	Order	Name	No. species	Mean vulnerability
	Osteoglossiformes	bony tongues	239	26
	Percopsiformes	trout-perches, pirate perches and cavef	9	26
	Aulopiformes	grinners	258	25
	Stomiiformes	lightfishes and dragonfishes	413	25
	Ophidiiformes	cusk eels	511	24
	Perciformes	perch-likes	10752	24
	Lophiiformes	anglerfishes	346	23
	Synbranchiformes	spiny eels	120	22
	Atheriniformes	silversides	333	21
	Clupeiformes	herrings	412	20
	Gymnotiformes	knifefishes	186	19
	Siluriformes	catfish	3502	19
	Beloniformes	needle fishes	272	18
	Syngnathiformes	pipefishes and seahorses	320	18
	Cetomimiformes	whalefishes	33	16
	Cyprinodontiformes	rivulines, killifishes and live bearers	1225	15
	Gonorynchiformes	milkfish	37	15
	Characiformes	characins	2001	14
	Gasterosteiformes	sticklebacks and seamoths	34	13
	Stephanoberyciformes	pricklefishes, bigscales and gibberfishes	64	12
	Elassomatiformes	Pygmy sunfishes	7	10
			Total 31106	**Mean 31**

Appendix 2: Shark-related legislation and regulations listed in alphabetical order by country and in yearly order by RFMO. Countries are classified into the following categories based on the nature of each regulation: shark sanctuary (an area where shark fishing is entirely prohibited) (SS), area where sharks must be landed with fins attached (FA), area where fin to body weight ratio-based regulations have been implemented (RB), area where shark product trade regulations exist (TR), or Other (O). Countries with a National Plan of Action (NPOA) for sharks are indicated with a "Y" for yes. A "-" in the NPOA column indicates an unspecified NPOA status. Table adapted from Biery and Pauly (in review).

Location	Year	Law	Area	Description	NPOA (Y/N)	Type	Source
Argentina	2009	Law No. 24.922	Argentina waters	Finning activities, described as the removal of shark fins and disposal of remaining body, are prohibited. Sharks larger than 160 cm in length must be returned to the ocean.	Y	FA	(Consejo Federal Pesquero, 2009)
Australia	-	-	Commonwealth/ federal waters; ranges from 3 - 200 miles offshore	Finning is not allowed in any tuna or billfish longline fishery, or in any Commonwealth fishery taking sharks. Fins must be landed attached, and additional regulations apply in some territories. Finning has been banned in six State and Northern Territory waters to three miles, including: Queensland in 2002, New South Wales in 1999, Victoria in 1972, Tasmania in 2001, Western Australia in 2000, and Northern Territory. See details below.	Y	FA, RB	(Camhi *et al.*, 2009)
Australia (Northern Territory)	2003	Northern Territory Licence Owners Licence Conditions	Northern Territory waters	A person may not discard a shark with its fins removed unless (1) there has been an interaction with a marine organism (such as lice) which reduces the value of the product to the point that it cannot be utilized for sale or (2) the product cannot be used for sale due to mechanical or on-board processing error. Discards must be logged. Fresh or frozen fin weight is to be no more than 6.5% of trunk weight... shark fin ratios to be reviewed annually.	Y	RB	(Horvat, pers. comm., 2011; Beatty, pers. comm., 2011)
Australia (Western)	1995	Fish Resources Management Regulations 1995, Regulation 16	Western Australia's temperate demersal gillnet and demersal longline fisheries off WA's West and South coasts	A master of a fishing boat must not have on the boat any shark or ray other than a whole shark or ray unless every part of the shark or ray (other than disposable parts – i.e. head, tail, parts removed during gutting) are on the boat together; and the only parts that have been removed from the shark or ray are one or more of the	Y	RB	(Horvat, pers. comm. 2011)

Location	Year	Law	Area	Description	NPOA (Y/N)	Type	Source
				fins.			
Australia (Western)	-	Western Australia Fishery Licence Conditions 16 and 17	Western Australia's temperate demersal gillnet and demersal longline fisheries off WA's West and South coasts	(16) Sharks taken in the zone must not be finned, but may have their fins removed with both the fins and trunk retained on board... (17) When fishing in the northern zone, all shark product on board or brought onto land from the fishing boat must conform to the following weight ratios: total landed weight of fins does not exceed 11% of the total weight of shark fillets, cartilage, liver, head and upper tail or if not filleted, total landed weight of fins must not exceed 5.5% of the total weight of shark products.	Y	RB	(Horvat, pers. comm. 2011)
Bahamas	2011	-	Bahamas waters	Shark fishing is prohibited, and a ban is in place on the sale, import and export of shark products.	-	SS	(Anon., 2011b)
Bahamas	1990	Statute 244.22	Bahamas EEZ	Statute 244.22 prohibits longline fishing in the EEZ, thought to be responsible for healthy local shark populations.	-	O	(Commonwealth of the Bahamas, 1993)
Brazil	1998	Portaria N°121/98	Waters under national jurisdiction	Prohibits the discard of shark carcasses which have had fins removed. Fins being transported or landed must be proportional to the weight of withheld shark carcasses on board. The total fin weight may not exceed 5% of the total weight of shark carcasses, and all fins must be weighed upon landing (none may be retained on board from previous travels).	-	RB	(Anon., 1998)
Canada	1994	Canada's National Plan of Action for the Conservation and Management of Sharks Section 2.1.1	Atlantic and Pacific waters	Shark finning is banned. This applies to Canadian fisheries waters and Canadian licensed vessels fishing outside of the EEZ. Moreover, the trade and sale of fins must be in appropriate proportion to the quantity of carcasses landed (five per cent of dressed carcass weight).	Y	RB	(DFO, 2007)
Toronto	2011	-	Toronto	A ban on the consumption and sale of shark fins.	-	TR	(Heilbron, 2011)
Cape Verde	2005	-	Cape Verde waters	Finning is prohibited throughout EEZ.	Y	FA	(Camhi *et al.*, 2009)

Location	Year	Law	Area	Description	NPOA (Y/N)	Type	Source
Cayman Isl. (UK)	2007	-	-	Fins must be attached upon landing, permits are required for transporting fins after landing, and transshipping of fins while at sea is forbidden.	-	FA	(Camhi *et al.*, 2009)
Chile	2011	-	Chile waters	All sharks must be landed with fins naturally attached.	-	FA	(Cranor, 2011)
Costa Rica	2006	Article 40, Costa Rican Fishery Law	Costa Rica waters, applies to all CR vessels and vessels unloading in CR ports	Article 40 of the Costa Rican Fishery Law requires all shark fins to be landed attached "in natural form," and not "tied on."	-	FA	(Anon., 2006)
Ecuador	2004	-	Ecuador and Galapagos waters	Shark finning is prohibited. Targeted fishing for sharks is banned, and bycatch should be fully utilized. A ban on the trade of shark fins was overturned in 2007.	Y	FA	(Camhi *et al.*, 2009; Jacquet *et al.*, 2008)
Egypt	2006	-	Egyptian waters in the Red Sea , to 12 miles offshore	Fishing for sharks is prohibited in Egypt's territorial waters in the Red Sea (to 12 miles offshore).	-	SS	(Camhi *et al.*, 2009)
El Salvador	2006	-	El Salvador waters, all ES vessels	Fins should be at least 1/4 attached to the carcass.	-	FA	(Camhi *et al.*, 2009)
European Union (EU) (27 members states)	2003	-	EU waters and vessels	Fins should be landed attached to the carcass. Special fishing permits can be obtained which allow fins to be landed or transshipped separately from carcasses, but "in no case shall the theoretical weight of the fins exceed 5% of the live weight of the shark catch."	-	FA, RB	(European Union, 2003; Camhi *et al.*, 2009)
Spain	2002	-	Spanish waters and vessels	Same as EU, but enacted earlier.	-	FA, RB	(Camhi *et al.*, 2009)
Fiji	2011	-	Fiji waters	Pending: A ban on the trade of shark fin and other shark products, which will not prohibit locals from consuming shark meat.	-	TR	(Anon., 2011c)
French Polynesia	2006	-	French Polynesia waters	Finning is forbidden. Trade in shark parts and products is prohibited (except for shortfin mako).	-	FA, TR	(Camhi *et al.*, 2009)
Galapagos Isl. (Ecuador)	2004	-	Galapagos waters	Same as Ecuador.	-	FA	(Camhi *et al.*, 2009; Jacquet *et al.*, 2008)
Gambia	2004	-	Gambia territorial waters	A finning ban exists in territorial waters. Sharks landed in Gambian waters must be landed on Gambian soil.	Y	FA	(Diop & Dossa, 2011)
Guam	2011	Bill No. 44-31	Guam waters	It is against the law for any person to possess, sell, take, purchase, barter, transport, export or	-	TR	(Guam Legislature, 2011)

Location	Year	Law	Area	Description	NPOA (Y/N)	Type	Source
				import, offer for sale, or distribute shark fins, alive or dead.			
Guinea	2009	-	Guinea territorial waters	A finning ban exists in all territorial waters. A fishing ban exists for seven critically threatened species of sharks and rays. The fees associated with obtaining a shark fishing license were increased substantially in 2005.	Y	FA,O	(Diop & Dossa, 2011)
Guinea-Bissau	-	-	-	A ban on shark fishing is in place for marine protected areas.	Y	O	(Diop & Dossa, 2011)
Honduras	2010	-	Honduras waters	A moratorium has been enacted on all shark fishing.	-	SS	(Anon., 2010b)
Israel	1980	-	Israel waters	Sharks are protected in Israeli waters, all shark fishing and finning is illegal.	-	SS	(Camhi *et al.*, 2009)
Japan	2008	-	Japanese vessels except far seas and those landing outside Japan's waters	All Japanese vessels (excluding far seas and those outside of Japanese waters) are required to land all parts of the shark. Heading, gutting, and skinning are allowed.	Y	O	(Camhi *et al.*, 2009)
Malaysia	-	-	-	-	Y	-	(FAO, 2011)
Maldives	2009	Law 5/87, Clause 10	12 miles from atoll rim of all atolls in the Maldives	A ban exists on any fishery targeted at the killing, capturing or extraction of any shark species inside and within 12 miles from the outer atoll rim of all Maldivian Atolls.	-	O	(Anon., 2009b)
Marshall Islands	2011	-	-	A moratorium has been put in place on the trade in and export of shark fins until effective regulatory measures can be implemented.	-	TR	(Johnson, 2011)
Mauritania	-	-	-	A minimum landing size of 60 cm is specified for houndsharks, shark finning is prohibited in the Banc d'Arguin National Park, and a ban exists on tuna seiners and longline surface boats fishing for basking shark *Cetorhinus maximus* (Gunnerus 1765), great white shark *Carcharodon carcharias* (Linnaeus 1758), sand tiger shark *Carcharias taurus* Rafinesque 1810,and tope shark *Galeorhinus galeus* (Linnaeus 1758).	Y	O	(Diop & Dossa, 2011)
Mexico	2007	-	Mexican waters and vessels	A finning ban applies to sharks caught intentionally or as bycatch. Carcasses of landed sharks must be present on board.	Y	FA	(Camhi *et al.*, 2009; Gronewald, 2011)

Location	Year	Law	Area	Description	NPOA (Y/N)	Type	Source
				Plans have been announced to declare a moratorium on shark fishing beginning in 2012.			
Namibia	-	-	Territorial waters	Namibian law prohibits the discarding of biological materials in territorial waters, which does not specify, but includes shark fins.	-	O	(Camhi *et al.*, 2009)
New Zealand	2004	-	NZ vessels	Legislated conversion factors are applied to landed fins and carcasses to ensure that fin weight corresponds to carcass weight.	-	RB	(Anon., 2004)
Nicaragua	2005	-	Nicaragua waters	Finning is prohibited, weight of fins shall not exceed 5% of total carcass weight on board. If fins are exported, exporters must show proof that meat was also sold.	-	RB, TR	(Camhi *et al.*, 2009)
Commonwealth of the Northern Marianas	2011	HR 17-94 (Public Law No. 17-27)	Commonwealth of the Northern Marianas	HR 17-94 prohibits any person from possessing, selling, offering for sale, trading or distributing shark fins in the Commonwealth of the Northern Marianas Islands.	-	TR	(Commonwealth of the Northern Mariana Islands, 2010)
Oman	Before 1999	-	-	Waste of shark parts is forbidden at sea and on land. Fins must remain attached to carcasses, and permits must be obtained in order to handle all sharks and shark parts.	-	FA	(Camhi *et al.*, 2009)
Palau	2003	-	Palau waters	Palau is a shark sanctuary - all commercial fishing is banned in its waters. All incidentally caught sharks (dead or alive) must be released.	-	SS	(Black, 2009; Camhi *et al.*, 2009)
Panama	2006	-	Panama waters	Sharks must be landed with fins attached by at least 1/4 of the fin to body union. Vessels with outboard motors less than 60 hp may land fins separately, but fins must not weigh more than 5% of landed meat. Fin trade requires certificate of origin.	-	FA, RB	(Camhi *et al.*, 2009)
Senegal	-	-	-	-	Y	-	(Diop & Dossa, 2011)
Seychelles	2006	-	Seychelles vessels 24m or less, all foreign vessels	Finning is banned; weight of fins must not exceed 5% of landed dressed carcass weight.	Y	RB	(Camhi *et al.*, 2009)
Sierra Leone	-	-	-	Shark fishing licenses are required, a ban on finning is in place, and an export tax is applied to shark products.	Y	FA, TR	(Diop & Dossa, 2011)

Location	Year	Law	Area	Description	NPOA (Y/N)	Type	Source
South Africa	1998	-	South African waters and vessels	Finning is banned; fins can be separated from carcasses if the fin to dressed carcass weight ratio does not exceed 8% for domestic vessels and 5% for foreign vessels.	-	RB	(Camhi *et al.*, 2009)
Taiwan	2011	-	-	Sharks must be landed with fins attached.	Y	FA	(Anon., 2011a)
United Kingdom	2009	-	-	Sharks must be landed with fins attached.	Y	FA	(McKie, 2009)
United States	2000	HR 5461	US waters and vessels	H.R. 5461 prohibits removal of shark fins without the corresponding carcass.	Y	RB	(United States Congress, 2000)
United States	2010	HR 81	US waters and vessels	H.R. 81 prohibits finning at sea and the posession, transfer, and landing of fins not naturally attached to the shark carcass.	Y	FA	(United States Congress, 2010)
Alaska	2010	5 AAC 28.084 (c)	Alaska waters	Any person that retains any species of shark as bycatch and sells or retains any species of shark, must sell or utilize the whole shark. Harvested sharks must have fins, head, and tail attached when sold. Utilize is defined as the use of the flesh of the shark for human consumption, for reduction to meal for production of food for animals or fish, for bait, or for scientific, display, or educational purposes.	-	FA	(Anon., 2010c)
California	2011	AB 376	State of California	It is unlawful to posess, sell, offer for sale, trade, or distribute a shark fin.	-	TR	(California Assembly, 2011)
Florida	2011	-	Florida	The killing of tiger sharks *Galeocerdo cuvier* (Peron & Lesueur 1822), great hammerheads *Sphyrna mokarran* (Rüppel 1837), scalloped hammerheads *Sphyrna lewini* (Griffith & Smith 1834), and smooth hammerheads *Sphyrna zygaena* (Linnaeus 1758) is prohibited.		O	(Fleshler, 2011)
Hawaii	2010	SB 2169	State of Hawaii	It shall be unlawful for any person to possess, sell, offer for sale, trade, or distribute shark fins.	-	TR	(Hawaii Legislature, 2010)
Oregon	2011	HB 2838	State of Oregon	A person may not possess, sell, offer for sale, trade or distribute shark fins in the state of Oregon.	-	TR	(Oregon Legislative Assembly, 2011)
Washington	2011	SB 5688	State of Washington	It is unlawful to sell, offer for sale, purchase, offer to purchase, or otherwise exchange a shark fin or shark fin derivative product. The preparation or processing of shark fins	-	TR	(Washington Senate, 2011)

Location	Year	Law	Area	Description	NPOA (Y/N)	Type	Source
				and shark fin derivative products is also prohibited.			
Uruguay	-	-	-	-	Y	-	(FAO, 2011)
RFMO	**Year**	**Law**		**Description**		**Type**	**Source**
International Commission for the Conservation of Atlantic Tunas (ICCAT)	2004	Rec. 04-10	Atlantic, Mediterranean, Gulf of Mexico waters	Full utilisation is required (only head, skin and guts may be discarded); landed fins are not to exceed 5% of landed shark weight; encourages, but does not require, live release of incidentally caught shark.	-	RB	(ICCAT, 2004; Camhi *et al.*, 2009)
Inter-American Tropical Tuna Commission (IATTC)	2005	Resolution C-05-03	Eastern Pacific waters	Same as ICCAT.	-	RB	(IATTC, 2005; Camhi *et al.*, 2009)
Indian Ocean Tuna Commission (IOTC)	2005	Resolution 05/05	Indian Ocean waters	Same as ICCAT.	-	RB	(IOTC, 2010; Camhi *et al.*, 2009)
North Atlantic Fisheries Organisation (NAFO)	2005	Article 17	NW Atlantic waters	Same as ICCAT.	-	RB	(NAFO, 2011; Camhi *et al.*, 2009)
General Fisheries Commission of the Mediterranean (GFCM)	2006	GFCM/2006/8 (B)	Mediterranean waters	Same as ICCAT.	-	RB	(GFCM, 2006; Camhi *et al.*, 2009)
Western and Central Pacific Fisheries Commission (WCPFC)	2006 (mandatory in 2008)	Conservation and Management Measure 2006-05	Western and Central Pacific waters	Similar to ICCAT, but full utilization is required to the point of first landing or transshipment. Fins can be landed and transshipped separately.	-	RB	(WCPFC, 2006; Camhi *et al.*, 2009)
Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)	2006	Conservation Measure 32-18 (2006)	Antarctic waters	Directed fishing on shark species is prohibited in the convention area for purposes other than scientific research. Any by-catch of shark, especially juveniles and gravid females, taken accidentally in other fisheries should be released alive if possible.	-	SS	(CCAMLR, 2006)
Southeast Atlantic Fisheries Commission (SEAFO)	2006	-	SE Atlantic waters	Same as ICCAT.	-	RB	(Camhi *et al.*, 2009)
North East Atlantic Fisheries Commission (NEAFC)	2007	-	NE Atlantic waters	Same as ICCAT.	-	RB	(Camhi *et al.*, 2009)

Appendix 3a: Mean fin to round weight ratios by species, for species with available data, ranked from lowest to highest. n = sample size and SE = standard error. Adapted from Biery and Pauly (in review).

Species	Common name	n	Mean FW:RW ratio	± SE	Source(s)[a]
Carcharhinus cautus	Nervous shark	1	1.06	0.00	16
Carcharhinus signatus	Night shark	2	1.30	0.16	3
Carcharhinus taurus	Sand tiger shark	1	1.34	0.00	3
Carcharhinus dussumieri	Whitecheek shark	18	1.35	0.06	16
Carcharhinus perezii	Caribbean reef shark	2	1.37	0.16	3
Galeocerdo cuvier	Tiger shark	48	1.41	0.06	3,4,7
Carcharhinus sorrah	Spottail shark	31	1.42	0.04	1,16
Carcharhinus amblyrhynchoides	Graceful shark	13	1.47	0.06	16
Scymnodon ringens	Knifetooth dogfish	9	1.50	0.06	16
Carcharhinus tilstoni	Australian blacktip shark	50	1.53	0.03	16
Carcharhinus melanopterus	Blacktip reef shark	36	1.59	0.04	1,16
Carcharhinus amboinensis	Pigeye shark	6	1.68	0.10	16
Mustelus canis	Smooth dogfish	6	1.69	0.31	4
Squalus suckleyi	Spiny dogfish	9	1.69	0.01	17
Carcharhinus acronotus	Blacknose shark	27	1.71	0.09	3,4
Carcharhinus fitzroyensis	Creek whaler shark	14	1.71	0.07	16
Carcharhinus obscurus	Dusky shark	6	1.80	0.13	3,4
Rhizoprionodon terraenovae	Atlantic sharpnose shark	45	1.81	0.04	3,4
Rhizoprionodon acutus	Milk shark	1	1.92	0.00	16
Sphyrna mokarran	Great hammerhead	11	1.96	0.25	3,4,16
Carcharhinus altimus	Bignose shark	11	1.98	0.15	3,4
Centroscymnus coelolepis	Portuguese dogfish	10	2.00	0.13	10
Alopias vulpinus	Thresher shark	10	2.06	0.05	3,4
Sphyrna lewini	Scalloped hammerhead	81	2.13	0.05	2,3,4
Carcharhinus limbatus	Blacktip shark	70	2.18	0.08	3,4,7
Lamna nasus[b]	Porbeagle shark	620	2.20	0.02	3,5
Carcharhinus brevipinna	Spinner shark	58	2.27	0.12	3,4
Negaprion brevirostris	Lemon shark	1	2.30	0.00	3
Sphyrna tiburo	Bonnethead shark	76	2.46	0.06	3,4
Eusphyra blochii	Winghead shark	10	2.47	0.16	7,16
Dalatias licha	Kitefin shark	1	2.50	0.00	7
Carcharhinus plumbeus	Sandbar shark	103	2.52	0.04	3,4
Isurus oxyrinchus[b]	Shortfin mako shark	265	3.14	0.04	2,4,8,15
Centroscyllium fabricii	Black dogfish	10	3.40	0.16	10
Loxodon macrorhinus	Sliteye shark	175	3.69	0.04	9
Carcharhinus albimarginatus	Silvertip shark	4	3.48	0.27	1,3
Centrophorus squamosus	Leafscale gulper shark	10	3.80	0.09	10
Carcharhinus amblyrhynchos	Grey reef shark	3	4.00	0.31	1
Centroselachus crepidater	Longnose velvet dogfish	10	4.00	0.13	10
Carcharhinus falciformis	Silky shark	324	4.46	0.03	1,2,3,4,6,7,11,13
Galeorhinus galeus	Soupfin shark	1	4.50	0.00	7
Mustelus antarcticus	White-spotted gummy shark	1	4.50	0.00	7
Legislated ratio (EU and Canada)	**-**	**-**	**5.00**	**-**	**-**
Carcharhinus brachyurus	Bronze whaler	1	5.10	0.00	7
Deania calcea	Birdbeak dogfish	10	5.40	0.25	10
Nebrius ferrugineus	Tawny nurse shark	3	5.40	0.31	1
Prionace glauca [b]	Blue shark	3959	5.65	0.02	2,3,4,6,7,11,12,13,15
Negaprion acutidens	Sicklefin lemon shark	1	5.70	0.00	1
Sphyrna zygaena	Smooth hammerhead	127	5.74	0.04	3,13
Carcharhinus longimanus	Oceanic whitetip shark	225	7.34	0.06	1,2,6,7,11,13
Pristis pectinata	Smalltooth sawfish	1	10.90	0.00	14

[a] 1) Anderson & Hudha (1993) 2) Ariz *et al.* (2008) 3) NMFS (1993) 4) Baremore *et al.* unpublished data in Cortés & Neer (2006) 5) Campana *et al.* unpublished data in Cortés & Neer (2006) 6) Dai *et al.* (2006) 7) Gordievskaya (1973) 8) Hore, A., pers. comm. 9) Humber, F., pers. comm. 10) Kjerstad *et al.* (2003) 11) Mejuto & Garcia-Cortés (2004) 12) Neves dos Santos & Garcia (2005) 13) Neves dos Santos & Garcia (2008) 14) Pauly (2006) 15) Petersen *et al.* (2007) 16) Rose *et al.* (2001) 17) Own observation (see text)

[b]In New Zealand, the legislated wet fin to round weight ratio is 2.22 for *Lamna nasus*, 1.70 for *Isurus oxyrinchus*, and 1.50 for *Prionace glauca*.

Appendix 3b: Mean wet fin to round weight ratios by genus, ranked from lowest to highest. The total number of species within each genus is given and the number of species included in each genus is indicated by *n*. Adapted from Biery and Pauly (in review).

Genus	n	Total species	Mean FW:RW ratio	± SE	Source(s)[a]
Carcharias	1	2	1.34	0.00	3
Galeocerdo	1	1	1.41	0.00	3,4,7
Scymnodon	1	2	1.50	0.00	16
Squalus	1	26	1.69	0.00	17
Rhizoprionodon	2	7	1.87	0.06	3,4,16
Centroscymnus	1	5	2.00	0.00	10
Alopias	1	3	2.06	0.00	3,4
Lamna	1	2	2.20	0.00	3,5
Carcharhinus	21	31	2.44	0.35	1,2,3,4,7,11,13,16
Eusphyra	1	1	2.47	0.00	7,16
Dalatias	1	1	2.50	0.00	7
Sphyrna	4	8	3.07	0.90	2,3,4,13,16
Mustelus	2	27	3.10	1.41	4,6,7
Isurus	1	2	3.14	0.00	2,3,4,8,15
Centroscyllium	1	7	3.40	0.00	10
Loxodon	1	1	3.69	0.00	9
Centrophorus	1	14	3.80	0.00	10
Centroselachus	1	1	4.00	0.00	10
Negaprion	2	2	4.00	1.70	1,3
Galeorhinus	1	1	4.50	0.00	7
Legislated ratio (EU and Canada)	**-**	**-**	**5.00**	-	-
Deania	1	4	5.40	0.00	10
Nebrius	1	1	5.40	0.00	1
Prionace	1	1	5.65	0.00	2,3,4,6,7,11,12,13,15
Pristis	1	6	10.90	0.00	14

[a] 1) Anderson & Hudha (1993) 2) Ariz *et al.* (2008) 3) NMFS (1993) 4) Baremore *et al.* unpublished data in Cortés & Neer (2006) 5) Campana *et al.* unpublished data in Cortés & Neer (2006) 6) Dai *et al.* (2006) 7) Gordievskaya (1973) 8) Hore, A., pers. comm. 9) Humber, F., pers. comm.. 10) Kjerstad *et al.* (2003) 11) Mejuto & Garcia-Cortés (2004) 12) Neves dos Santos & Garcia (2005) 13) Neves dos Santos & Garcia (2008) 14) Pauly (2006) 15) Petersen *et al.* (2007) 16) Rose *et al.* (2001) 17) Own observation (see text)

Appendix 3c: Mean wet fin to round weight ratios by family, ranked from lowest to highest. The total number of genera within each family is given and the number of species included in each family is indicated by *n*. Adapted from Biery and Pauly (in review).

Family	**n**	**Total genera**	**Mean FW:RW ratio**	**± SE**	**Source(s)[a]**
Odontaspididae	1	4	1.34	0.00	3
Squalidae	1	29	1.59	0.00	17
Alopiidae	1	3	2.06	0.00	3,4
Somniosidae	3	19	2.50	0.76	10
Dalatiidae	1	10	2.50	0.00	7,10
Carcharhinidae	28	53	2.64	0.31	1,2,3,4,6,7,11,12,13,15,9
Lamnidae	2	5	2.67	0.47	2,3,4,5,8,15
Sphyrnidae	5	9	2.95	0.70	2,3,4,7,13,16
Etmopteridae	1	45	3.40	0.00	10
Triakidae	3	45	3.56	0.94	4,7
Centrophoridae	2	18	4.60	0.80	10
Legislated ratio (EU and Canada)	-	**-**	**5.00**	-	-
Ginglymostomatidae	1	3	5.40	0.00	1
Pristidae	1	7	10.90	0.00	14

[a] 1) Anderson & Hudha (1993) 2) Ariz *et al.* (2008) 3) NMFS (1993) 4) Baremore *et al.* unpublished data in Cortés & Neer (2006) 5) Campana *et al.* unpublished data in Cortés & Neer (2006) 6) Dai *et al.* (2006) 7) Gordievskaya (1973) 8) Hore, A., pers. comm. 9) Humber, F., pers. comm. 10) Kjerstad *et al.* (2003) 11) Mejuto & Garcia-Cortés (2004) 12) Neves dos Santos & Garcia (2005) 13) Neves dos Santos & Garcia (2008) 14) Pauly (2006) 15) Petersen *et al.* (2007) 16) Rose *et al.* (2001) 17) Own observation (see text)

Appendix 4: Best estimated mean catch in EEZs (2000-2009) and FAO mean annual reported landings of sharks listed by continent and country. FAO Fishstat capture production values have been adjusted to exclude rays based on the ratios provided by Bonfil (1994). For FAO areas that encompass more than one EEZ, catches were distributed proportionally based on EEZ area.

Continent	EEZ	Estimated mean catch (t)	Source(s)	FAO mean landings (t)
Africa	Algeria	172.80	(FAO, 2011)	172.80
	Angola	744.71	(FAO, 2011; Watson, 2011)	1019.41
	Ascension Islands	233.31	(Watson, 2011)	-
	Benin	58.02	(FAO, 2011; Watson, 2011)	101.43
	Bouvet Island	0.20	Estimated	-
	Brit. Indian Ocean Territory	1.86	(Watson, 2011)	-
	Cameroon	377.59	(FAO, 2011)	377.59
	Canary Islands	2433.08	(Watson, 2011)	-
	Cape Verde	357.29	(Watson, 2011; Diop, 2011)	-
	Comoros	28.67	(FAO, 2011; Watson, 2011)	105.37
	Congo, ex-Zaire	1028.76	(FAO, 2011)	1028.76
	Congo, Republic of	1074.50	(FAO, 2011)	1074.50
	Côte d'Ivoire	358.44	(FAO, 2011; Watson, 2011)	107.73
	Crozet Island	87.25	(Watson, 2011)	-
	Djibouti	2.78	Estimated	-
	Egypt	1316.32	(FAO, 2011)	1316.32
	Equatorial Guinea	43.41	(FAO, 2011; Watson, 2011)	71.69
	Eritrea	136.00	(Tesfamichael & Mohamud, 2011; *Sea Around Us*, 2011)	118.90
	Gabon	67.36	(FAO, 2011; Watson, 2011)	257.45
	Gambia	1505.54	(FAO, 2011; Diop, 2011)	940.51
	Ghana	1490.22	(FAO, 2011)	1490.22
	Guinea	982.18	(FAO, 2011; Watson, 2011; Diop, 2011)	695.91
	Guinea-Bissau	185.09	(FAO, 2011; Watson, 2011; Diop, 2011)	5.42
	Kenya	106.21	(FAO, 2011)	106.21
	Kerguelen Island	0.36	Estimated	-
	Liberia	556.03	(FAO, 2011; Watson, 2011)	419.49
	Libyan Arab Jamahiriya	8937.00	(FAO, 2011)	8937.00
	Madagascar	6968.00	(LeManach, 2011; *Sea Around Us* Project, 2011)	1.43
	Madeira Islands	266.31	(Watson, 2011)	-
	Mauritania	2491.05	(FAO, 2011; Watson, 2011; Diop, 2011)	443.27
	Mauritius	158.29	(*Sea Around Us* Project, 2011)	100.49
	Mayotte	4.09	(FAO, 2011)	4.09
	Morocco	862.14	(FAO, 2011; Watson, 2011)	1784.41
	Mozambique	681.67	(FAO, 2011; Watson, 2011)	293.51
	Mozambique Channel Islands	0.50	Estimated	-
	Namibia	2325.17	(FAO, 2011; Watson, 2011)	2949.40
	Nigeria	4924.64	(FAO, 2011)	4924.64
	Prince Edward Island	0.19	(Watson, 2011)	-
	Réunion	41.17	(FAO, 2011)	41.17
	Saint Helena	9.63	(*Sea Around Us* Project, 2011)	1.10
	St. Paul & Amsterdam Island	0.39	Estimated	-
	Sao Tome and Principe	45.69	(FAO, 2011; Watson, 2011)	91.68
	Senegal	6300.40	(FAO, 2011; Watson, 2011; Diop, 2011)	6059.06
	Seychelles	62.31	(FAO, 2011; Watson, 2011)	133.16
	Sierra Leone	1015.22	(FAO, 2011; Diop, 2011)	736.25
	Somalia	6700.48	Estimated	-
	South Africa	842.65	(FAO, 2011; Watson, 2011)	1014.34
	Sudan	221.14	(FAO, 2011; Watson, 2011)	44.92
	Tanzania	1068.74	(FAO, 2011)	1068.74
	Togo	98.88	(FAO, 2011)	98.88
	Tristan da Cunha Islands	3.50	(*Sea Around Us* Project, 2011)	-
	Tromelin Island	70.27	(Watson, 2011)	-
	Tunisia	1231.56	(FAO, 2011; Watson, 2011)	1213.30
	Western Sahara	63.19	(Watson, 2011)	-
Total	**Africa total**	**58742.25**	**-**	**39350.54**
Asia	Andaman and Nicobar Isl.	1727.36	(*Sea Around Us* Project, 2011)	-
	Bahrain	420.07	(FAO, 2011; Watson, 2011)	43.00
	Bangladesh	3174.31	(FAO, 2011; BBS, 2004; Anon., 2009; Jit, 2008)	2588.25
	Brunei Darussalam	0.88	Estimated	-
	Cambodia	977.00	(Try *et al.*, 2004)	-
	China	934.59	(FAO, 2011)	934.59
	Christmas Island (Australia)	41.60	(Watson, 2011)	-

Continent	EEZ	Estimated mean catch (t)	Source(s)	FAO mean landings (t)
	Cocos (Keeling) Islands	26.47	(Watson, 2011)	-
	Gaza Strip	4.15	(Watson, 2011)	-
	Hong Kong	49.40	(Clarke, 2004)	-
	India	58881.68	(*Sea Around Us* Project, 2011)	44723.95
	Indonesia (Eastern)	12405.08	(FAO, 2011; Watson, 2011)	24999.79
	Indonesia (Western)	9673.19	(FAO, 2011; Watson, 2011)	17016.67
	Iran	10187.36	(FAO, 2011; Watson, 2011)	11218.50
	Iraq	3.55	(Watson, 2011)	-
	Israel	27.73	(FAO, 2011; Watson, 2011)	76.03
	Japan (main islands)	5061.84	(FAO, 2011)	5061.84
	Japan (outer islands)	7224.19	(FAO, 2011)	7224.19
	Jordan	0.66	(Watson, 2011)	-
	Korea (North)	1706.39	Estimated	-
	Korea (South)	246.44	(*Sea Around Us* Project, 2011)	998.77
	Kuwait	179.35	(Watson, 2011)	-
	Lebanon	13.75	(FAO, 2011; Watson, 2011)	34.62
	Macau	15.28	Estimated	-
	Malaysia (Peninsula East)	1752.28	(FAO, 2011)	1752.28
	Malaysia (Peninsula West)	907.37	(FAO, 2011)	907.37
	Malaysia (Sabah)	518.49	(FAO, 2011)	518.49
	Malaysia (Sarawak)	1622.70	(FAO, 2011)	1622.70
	Maldives	3150.70	(FAO, 2011)	3150.70
	Myanmar	40461.99	(*Sea Around Us* Project, 2011)	-
	Oman	2933.11	(FAO, 2011)	2933.11
	Pakistan	17626.60	(FAO, 2011)	17626.60
	Philippines	1561.66	(FAO, 2011)	1561.66
	Qatar	0.23	(FAO, 2011; Watson, 2011)	0.15
	Saudi Arabia (Persian Gulf)	856.99	(FAO, 2011; Watson, 2011)	113.67
	Saudi Arabia (Red Sea)	643.44	(FAO, 2011; Watson, 2011)	619.67
	Singapore	17.43	(FAO, 2011)	17.43
	Sri Lanka	19723.05	(*Sea Around Us* Project, 2011)	12530.14
	Syrian Arab Republic	86.99	(FAO, 2011)	86.99
	Taiwan	26784.04	(FAO, 2011)	26784.04
	Thailand	5067.02	(FAO, 2011)	5067.02
	Timor Leste	180.89	(Watson, 2011)	-
	Turkey (Black Sea)	679.90	(FAO, 2011; Watson, 2011)	582.95
	Turkey (Mediterranean Sea)	425.63	(FAO, 2011; Watson, 2011)	283.25
	United Arab Emirates	2636.10	(FAO, 2011)	2636.10
	Vietnam	0.77	Estimated	-
	Yemen	2314.30	(FAO, 2011; Watson, 2011)	5507.80
Total	**Asia total**	**242933.99**	**-**	**199222.32**
Europe	Albania	85.65	(FAO, 2011)	85.65
	Azores Islands	1231.84	(Watson, 2011)	-
	Belgium	132.32	(FAO, 2011; Watson, 2011)	490.90
	Bosnia and Herzegovina	8.86	(Watson, 2011)	-
	Bulgaria	24.44	(FAO, 2011; Watson, 2011)	50.30
	Channel Islands	314.21	(FAO, 2011; Watson, 2011)	-
	Croatia	217.11	(FAO, 2011; Watson, 2011)	57.60
	Cyprus	18.92	(FAO, 2011; Watson, 2011)	9.88
	Denmark	0.78	(*Sea Around Us* Project, 2011)	184.35
	Estonia	7.21	(FAO, 2011; Watson, 2011)	26.64
	Faeroe Islands	522.59	(FAO, 2011; Watson, 2011)	377.18
	Finland	0.94	(Watson, 2011)	-
	France	7598.55	(FAO, 2011; Watson, 2011)	11878.59
	Georgia	13.57	(FAO, 2011)	13.57
	Germany	94.68	(FAO, 2011; Watson, 2011)	369.30
	Gibraltar	3.49	Estimated	-
	Greece	702.75	(FAO, 2011; Watson, 2011)	529.10
	Iceland	222.37	(FAO, 2011; Watson, 2011)	169.05
	Ireland	5734.88	(FAO, 2011; Watson, 2011)	1633.80
	Italy	398.48	(FAO, 2011; Watson, 2011)	691.16
	Jan Mayen Island	2.46	(Watson, 2011)	-
	Latvia	0.72	(FAO, 2011; Watson, 2011)	0.00
	Lithuania	4.72	(FAO, 2011; Watson, 2011)	18.35
	Malta	29.09	(FAO, 2011; Watson, 2011)	26.74
	Monaco	0.08	(Watson, 2011)	-

Continent	EEZ	Estimated mean catch (t)	Source(s)	FAO mean landings (t)
	Montenegro	21.42	(FAO, 2011; Watson, 2011)	15.00
	Netherlands	89.96	(FAO, 2011; Watson, 2011)	64.30
	Norway	1448.45	(FAO, 2011; Watson, 2011)	1169.90
	Poland	0.99	(FAO, 2011; Watson, 2011)	1.67
	Portugal	5619.61	(FAO, 2011; Watson, 2011)	12811.46
	Romania	1.44	(FAO, 2011; Watson, 2011)	4.00
	Russia (Kaliningrad)	0.61	(FAO, 2011; Watson, 2011)	0.21
	Russia (St. Petersburg)	0.61	(FAO, 2011; Watson, 2011)	0.23
	Russia (Barents Sea)	5.12	(FAO, 2011; Watson, 2011)	24.53
	Russia (Black Sea)	3.63	(FAO, 2011; Watson, 2011)	1.20
	Russia (Pacific)	43.43	(FAO, 2011; Watson, 2011)	63.47
	Russia (Siberia)	0.00	(FAO, 2011; Watson, 2011)	60.76
	Slovenia	2.89	(FAO, 2011; Watson, 2011)	2.55
	Spain	15564.64	(FAO, 2011; Watson, 2011)	42661.02
	Svalbard	0.04	(Watson, 2011)	-
	Sweden	203.55	(FAO, 2011; Watson, 2011)	175.11
	Ukraine	66.17	(FAO, 2011; Watson, 2011)	159.14
	United Kingdom	10243.91	(FAO, 2011; Watson, 2011)	7713.51
Total	**Europe total**	**50687.17**	-	**81540.22**
N. America	Alaska (USA)	704.53	(Watson, 2011; Tide, 2011)	2975.09
	Anguilla	0.14	Estimated	-
	Antigua and Barbuda	21.09	(FAO, 2011)	21.09
	Bahamas	0.38	(FAO, 2011)	0.38
	Barbados	8.57	(FAO, 2011)	8.57
	Belize	283.13	(*Sea Around Us* Project, 2011)	397.07
	Bermuda (UK)	4.10	(FAO, 2011)	4.10
	British Virgin Islands (UK)	0.24	(FAO, 2011)	0.24
	Canada	11190.53	(FAO, 2011; Watson, 2011; DFO, 2007)	7590.98
	Cayman Islands	0.20	Estimated	-
	Clipperton Island	0.02	(Watson, 2011)	-
	Costa Rica	2289.02	(FAO, 2011; Watson, 2011; Carvajal, 2011)	4830.10
	Cuba	203.99	(FAO, 2011; Watson, 2011)	768.62
	Dominica	0.22	Estimated	-
	Dominican Republic	182.67	(FAO, 2011)	182.67
	El Salvador	400.85	(FAO, 2011)	400.85
	Greenland	388.98	(FAO, 2011; Watson, 2011)	2.05
	Grenada	11.72	(FAO, 2011)	11.72
	Guadeloupe	21.35	(*Sea Around Us* Project, 2011)	-
	Guatemala	106.00	(FAO, 2011)	106.00
	Haiti	0.20	Estimated	-
	Honduras	5.62	(FAO, 2011)	5.62
	Jamaica	1171.28	Estimated	-
	Martinique	37.72	(*Sea Around Us* Project, 2011)	22.91
	Mexico	9005.71	(FAO, 2011; Watson, 2011)	18758.00
	Montserrat	0.30	Estimated	-
	Navassa Island	0.17	Estimated	-
	Netherlands Antilles (L)	0.09	Estimated	-
	Netherlands Antilles (W)	0.86	Estimated	-
	Nicaragua	73.28	(FAO, 2011; Watson, 2011)	214.10
	Panama	3229.44	(FAO, 2011)	3229.44
	Puerto Rico	63.50	(FAO, 2011; Watson, 2011)	11.66
	Saint Kitts and Nevis	79.72	Estimated	-
	Saint Lucia	8.18	(FAO, 2011)	8.18
	Saint Pierre and Miquelon	1.52	(FAO, 2011; Watson, 2011)	4.55
	St. Vincent & Grenadines	2.45	(FAO, 2011)	2.45
	Trinidad and Tobago	32320.70	(*Sea Around Us* Project, 2011)	756.94
	Turks and Caicos Islands	0.13	Estimated	-
	USA (East)	2289.97	(FAO, 2011; Watson, 2011)	722.67
	USA (Gulf of Mexico)	1048.66	(FAO, 2011; Watson, 2011)	558.58
	USA (West)	1196.32	(FAO, 2011; Watson, 2011)	651.48
	US Virgin Islands	33.34	(Watson, 2011)	-
Total	**North America total**	**66386.89**	-	**42246.10**

Oceania	American Samoa	51.78	(FAO, 2011; Watson, 2011)	0.00
	Australia	8499.06	(FAO, 2011; Watson, 2011; Bensley *et al.*, 2009)	7089.51
	Baker and Howland Islands	0.00	(Watson, 2011)	-
	Cook Islands	3.31	(FAO, 2011; Watson, 2011)	12.67
	Easter Islands	83.15	(Watson, 2011)	-
	Fed. States of Micronesia	41.67	(*Sea Around Us* Project, 2011)	-
	Fiji	0.32	Estimated	-
	French Polynesia	458.67	(*Sea Around Us* Project, 2011)	276.14
	Guam	0.03	(FAO, 2011; Watson, 2011)	0.08
	Hawaii Main Islands	100.97	(Watson, 2011)	706.56
	Hawaii Northwest Islands	182.53	(Watson, 2011)	1246.48
	Heard & McDonald Islands	0.02	(Watson, 2011)	-
	Jarvis Island	3.95	(Watson, 2011)	-
	Johnston Atoll	8.75	(Watson, 2011)	-
	Kiribati	625.82	(FAO, 2011)	625.82
	Lord Howe Island	9.60	(Watson, 2011)	-
	Macquarie Island	0.20	Estimated	-
	Marshall Islands	0.22	Estimated	-
	Nauru	0.79	(*Sea Around Us* Project, 2011)	0.60
	New Caledonia	25.00	(*Sea Around Us* Project, 2011)	21.14
	New Zealand	12529.46	(FAO, 2011; Watson, 2011)	13946.56
	Niue	0.28	Estimated	-
	Norfolk Island	19.60	(Watson, 2011)	-
	Northern Marianas	1.00	(*Sea Around Us* Project, 2011)	-
	Palau	0.13	Estimated	-
	Palmyra & Kingman	19.42	(Watson, 2011)	-
	Papua New Guinea	0.39	Estimated	-
	Pitcairn	0.06	Estimated	-
	Samoa	97.37	(FAO, 2011)	97.37
	Solomon Islands	5.65	(FAO, 2011)	5.65
	Tokelau	3.97	(*Sea Around Us* Project, 2011)	-
	Tonga	1.61	(*Sea Around Us* Project, 2011)	-
	Tuvalu	12.96	(*Sea Around Us* Project, 2011)	-
	Vanuatu	13.69	(FAO, 2011)	13.69
	Wake Island	0.10	Estimated	-
	Wallis and Futuna Islands	1.43	(*Sea Around Us* Project, 2011)	-
Total	**Oceana total**	**22802.98**	**-**	**24042.27**
S. America	Argentina	12894.28	(FAO, 2011; Watson, 2011)	13576.15
	Brazil	10939.42	(FAO, 2011; Watson, 2011)	9536.73
	Chile	550.28	(FAO, 2011; Watson, 2011)	1040.40
	Colombia	317.46	(FAO, 2011; Watson, 2011)	448.10
	Desventuradas Islands	68.72	(Watson, 2011)	-
	Ecuador	6523.00	(Jacquet, 2008; *Sea Around Us* Project, 2011	2632.40
	Falkland Is. (Malvinas)	2.38	(FAO, 2011)	2.38
	French Guiana	1336.25	(*Sea Around Us* Project, 2011)	99.40
	Galapagos Islands	320.01	(Watson, 2011)	-
	Guyana	1671.08	(*Sea Around Us* Project, 2011)	1033.59
	Juan Fernandez, Felix & Ambrosio Islands	52.63	(FAO, 2011; Watson, 2011)	-
	Peru	7604.49	(FAO, 2011; Watson, 2011)	6675.10
	South Georgia / Sandwich Island	0.42	Estimated	-
	Suriname	141.41	(FAO, 2011)	141.41
	Trindade & Martin Vaz Island	207.77	(Watson, 2011)	-
	Uruguay	1726.56	(FAO, 2011; Watson, 2011)	2033.09
	Venezuela	3261.43	(FAO, 2011; Watson, 2011; Mendoza, 2011)	6320.30
Total	**South America total**	**47617.58**	**-**	**43539.05**
High Seas	**High Seas**	**78616.44**	**(Watson, 2011)**	**9256.80**
TOTAL	**TOTAL**	**567787.28**		**439197.30**

Appendix 5: Summary of major features of the Ecopath ecosystem models used in the analyses of trophic interactions. Eco. type = ecosystem type.

Model name	Eco. type	Years	No. of groups	Shark groups	Reference(s)
Alaska Prince William Sound	Coastal		48	Sharks	Okey and Pauly (1999)
Australia South East Shelf	Shelf	2000	41	Dogfish, Large pel. sharks, Med. pel. sharks	Fulton *et al*. (2005)
Azores	Coastal	1997	44	Sharks, Large sharks, Medium sharks	Guénette and Morato (2001)
Barents Sea	Shelf	1995	41	Sharks	Blanchard *et al*. (2002)
Bay of Bengal	Bay	1984-1986	15	Sharks	Mustafa (2003)
Bay of Biscay 1970	Coastal	1970	37	Large sharks, Small sharks	Ainsworth *et al*. (2001)
Bay of Biscay 1998	Coastal	1998	37	Large sharks, Small sharks	Ainsworth *et al*. (2001)
Brunei	Coastal	1989	13	Large predators	Silvestre *et al*. (1993)
Cantabrian Sea	Shelf	1994	28	Dogfish	Sanchez and Olaso (2004)
Cape Verde	Coastal	1981-1985	25	Demersal sharks, Pelagic sharks	Stobberup *et al*. (2004)
Caribbean Sea	Shelf	1986	29	Coastal and demersal sharks and rays, Pelagic sharks	Morissette *et al*. (2009)
Central Atlantic 1950s	Shelf	1950s	38	Pelagic sharks	Vasconcellos and Watson (2004)
Central Atlantic 1990s	Shelf	1990s	38	Pelagic sharks	Vasconcellos and Watson (2004)
Central North Pacific	Oceanic	1990-1998	31	Brown Sharks, Large sharks	Cox et al. (2002)
Chesapeake Bay 1950	Bay	1950	45	Other elasmobranchs, Sandbar shark	Christensen *et al*. (in prep.)
Chesapeake Bay Present	Bay	2010	45	Other elasmobranchs, Sandbar shark	Christensen *et al*. (in prep.)
Coral Reef Mexican Caribbean	Reef	1990	18	Sharks and rays	Arias-Gonzalez (1998)
Eastern Scotian Shelf 1980s	Shelf	1980s	39	Dogfish	Bundy (2005)
Eastern Scotian Shelf 1990s	Shelf	1990s	39	Dogfish	Bundy (2005)
Eastern Tropical Pacific	Oceanic	1960-2000	39	Large Sharks	Olson and Watters (2003)
English Channel 1973	Shelf	1973	45	Basking sharks, Rays and dogfish, Sharks	Stanford and Pitcher (2004)
Galapagos	Coastal	2000	43	Sharks	Okey et al. (2004a)
Gambia 1986	Shelf	1986	23	Sharks	Mendy (2004)
Gambia 1992	Shelf	1992	23	Sharks	Mendy (2004)
Gambia 1995	Shelf	1995	23	Sharks	Mendy (2004)
Great Barrier Reef	Reef	1997	25	Large sharks and rays	Gribble (2005)
Guinée 1985	Shelf	1985	44	Large coastal sharks, Large pel. sharks, Med. coastal sharks, Med. pel. sharks	Diallo et al. (2004)
Guinée 1998	Shelf	1998	44	Large coastal sharks, Large pel. sharks, Med. coastal sharks, Med. pel. sharks	Diallo *et al*. (2004)
Guinée Bissau	Shelf	1990-1992	32	Pelagic sharks	Amorim *et al*. (2004)
Gulf of Mexico	Shelf	1980s	15	Sharks	Browder (1993)

Model name	**Eco. type**	**Years**	**No. of groups**	**Shark groups**	**Reference(s)**
Gulf of Thailand	Coastal	1997	40	Sharks	FAO/FISHCODE (2001)
High Barents Sea (Final) 1990	Shelf	1990	41	Sharks	Blanchard *et al.* (2002)
High Barents Sea (Juvs) 1990	Shelf	1990	16	Large pelagic carnivores	Blanchard *et al.* (2002)
Jalico Colima	Shelf	-	-	-	Galvan-Pina (2005)
Looenew	Reef	1980s	20	Sharks and rays	Venier and Pauly (1997)
Low Barents Sea (Juvs) 1995	Shelf	1995	16	Large pelagic carnivores	Blanchard *et al.* (2002)
Mauritania 1980	Shelf	1987	38	Large (inv) sharks, Large pred. sharks	Sidi and Guénette (2004)
Mauritania 1990	Shelf	1998	38	Large (inv) sharks. Large pred. sharks	Sidi and Guénette (2004)
Mauritania Banc D'Arguin	Shelf	1988-1998	22	Large sharks, small sharks	Sidi and Samba (2004)
Mid Atlantic Bight	Shelf	2000	55	Coastal sharks, Spiny dogfish	Okey (2001)
Monterey	Bay	1980s	16	Carnivorous fish	Olivieri *et al.* (1993)
Moorea Barrier Reef	Reef	1971-1989	46	Fish piscivores	Arias-Gonzalez (1997)
Moorea Fringing Reef	Reef	1971-1989	43	Fish piscivores	Arias-Gonzalez (1997)
Morocco	Shelf	1980s	38	Large demersal sharks and rays, pel. sharks, Small demersal sharks and rays	Stanford *et al.* (2001)
Newfoundland Grand Banks 1900	Shelf	1900	50	Dogfish	Heymans and Pitcher (2002b)
Newfoundland Grand Banks 1980	Shelf	1985-1987	31	Large pelagic feeders	Bundy (2001)
Newfoundland Grand Banks 1980	Shelf	1985-1987	50	Dogfish	Heymans (2003)
Newfoundland Grand Banks 1990	Shelf	1994-1996	50	Dogfish	Heymans (2003)
North Atlantic 1950s	Shelf	1950s	38	Pelagic sharks	Vasconcellos and Watson (2004)
North Atlantic 1990s	Shelf	1990s	38	Pelagic sharks	Vasconcellos and Watson (2004)
Northern Benguela 1956	Shelf	1956	32	Sharks	Heymans (2007)
Northern Gulf of St.Lawrence 1980	Coastal	1985-1987	32	Large pelagics	Morissette *et al.* (2003)
Northern Gulf of St.Lawrence 1990	Coastal	1994-1996	32	Large pelagics	Savenkoff *et al.* (2004a)
North Sea	Shelf		32	Other predators	Christensen (1995)
Northwest Africa	Coastal	1986	27	Sharks	Morissette *et al.* (2010)
Rivers Inlet 1950	Coastal	1951-1955	32	Spiny dogfish	Watkinson (1999)
Rivers Inlet 1990	Coastal	1951-1955	32	Spiny dogfish	Watkinson (1999)
SanMiguel Bay	Bay	1992-1994	16	Large predators	Bundy (1997)
San Pedro Bay Leyte	Bay	1994-1995	16	Sharks	Campos (2003)
Sene-Gambia	Shelf	1990	18	Sharks	Samb and Mendy (2004)
Sierra Leone 1964	Shelf	1964	44	Large coastal sharks and rays, Large deep sharks and rays, Med. coastal sharks and rays, Med.	Heymans and Vakily (2004)

Model name	Eco. type	Years	No. of groups	Shark groups	Reference(s)
				deep sharks and rays	
Sierra Leone 1978	Shelf	1978	44	Large coastal sharks and rays, Large deep sharks and rays, Med. coastal sharks and rays, Med. deep sharks and rays	Heymans and Vakily (2004)
Sierra Leone 1990	Shelf	1990	44	Large coastal sharks and rays, Large deep sharks and rays, Med. coastal sharks and rays, Med. deep sharks and rays	Heymans and Vakily (2004)
South Brazil	Shelf	1998-1999	25	Sharks and rays	Gasalla and Rossi-Wongtschowski, (2004)
South Atlantic Continental Shelf	Shelf		42	Sharks (and alligators)	Okey and Pugliese (2001)
South Brazil Bight	Shelf	1998-1999	25	Sharks and rays	Gasalla and Rossi-Wongtschowski, (2004)
Southern Brazil	Shelf	1950	13	Sharks	Vasconcellos and Gasalla (2001)
Southern Gulf of St. Lawrence 1980	Coastal	1985-1987	30	Large pelagics	Savenkoff *et al.* (2004b)
Southern Gulf of St. Lawrence 1990	Coastal	1994-1996	30	Large pelagics	Savenkoff *et al.* (2004b)
Southwest Coast of India	Shelf	1994-1996	11	Large predators	Vivekanandan *et al.* (2003)
Strait of Georgia	Shelf	1980s	27	Dogfish	Mackinson (1996)
Venezuela	Shelf	1980s	16	Small sharks	Mendoza (1993)
West Coast of Sabah	Coastal	1972	29	Large predators	Garces et al. (2003)
Wes Coast of Sarawak	Coastal	1972	29	Large predators	Garces et al. (2003)
West Coast of Peninsula Malaysia	Coastal	1980s	15	Large predators	Liew and Chan (1987)
West Coast of Vancouver Island	Coastal	1990s	15	Dogfish	Martell (2002)
Western English Chanel	Shelf	1995	50	Basking shark, Dogfish, Sharks	Stanford and Pitcher (2004)
West Florida Shelf	Shelf	2000	59	Coastal sharks	Okey et al. (2004b)
Western Gulf of Mexico	Coastal	1970s	24	Sharks	Arreguin-Sanchez *et al.* (1993a)
West Greenland Shrimp Pond	Coastal	1990-1992	12	Other bottom fish	Pedersen (1994)
Yucatan	Shelf	1980s	21	Sharks	Arreguin-Sanchez *et al.* (1993b)

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