



CONVENTION ON MIGRATORY SPECIES

Distribution: General

UNEP/CMS/COP11/Doc.24.1.16
Rev.1
18 September 2014

English
Original: Spanish

11th MEETING OF THE CONFERENCE OF THE PARTIES
Quito, Ecuador, 4-9 November 2014
Agenda Item 24.1.1

PROPOSAL FOR THE INCLUSION OF THE SCALLOPED HAMMERHEAD SHARK (*Sphyrna lewini*) ON CMS APPENDIX II

Summary

The Government of Costa Rica and the Government of Ecuador have submitted a proposal for the inclusion of the Scalloped Hammerhead Shark (*Sphyrna lewini*) on CMS Appendix II for the consideration of the 11th Meeting of the Conference of the Parties (COP11), 4-9 November 2014, Quito, Ecuador.

The proposal is reproduced under this cover for a decision on its approval or rejection by the Conference of the Parties.

**PROPOSAL FOR INCLUSION OF SPECIES ON THE APPENDICES OF THE
CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES OF
WILD ANIMALS**

Abstract: The scalloped hammerhead shark (*Sphyrna lewini*) is listed as globally endangered on the IUCN's Red List. The principal conservation problem facing this species is its population decline. This problem, driven by the high economic value of its fins and the consumption of its meat, has led to the species being overfished during all stages of its lifecycle. *Sphyrna lewini* is a circumglobal shark species native to coastal warm temperate and tropical seas. Its highly migratory nature, slow growth, and lengthy gestation period place this common bycatch species at risk to fishing practices on the high seas, at oceanic congregation sites, and throughout coastal birth zones. Given these current fishing pressures, in addition to a lack of management strategies by RFMOs, high rates of *Sphyrna lewini* captures pose a serious threat to the species's survival. Because of difficulties in differentiating between the genus' species, estimates of trends in abundance are often grouped together as a complex. Abundance trend analyses of catch-rate data for the hammerhead complex of *Sphyrna lewini*, including *Sphyrna mokarran* and *Sphyrna zygaena*, have reported large declines, ranging from 60-99% over recent years. Given *S. lewini*'s present situation, one that includes its overutilization, inadequacy of existing regulatory mechanisms, and other natural or manmade threats, inclusion of the species in CMS Appendix II is necessary in order to begin to restore its populations.

- A. PROPOSAL:** Proposal for inclusion of the scalloped hammerhead shark, *Sphyrna lewini*, in the Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS)
- B. PROPONENT:** Government of Costa Rica, Ecuador

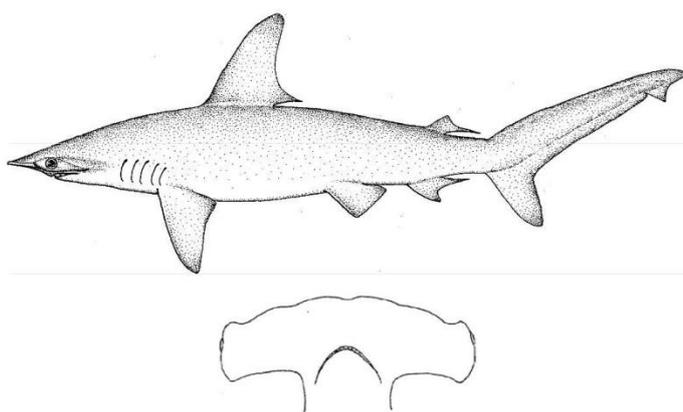


Figure 1. Sketch of the scalloped hammerhead. Source: Compango, 1984

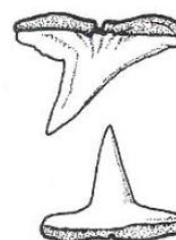


Figure 2. *S. lewini* teeth (Compango, 1984)

C. SUPPORTING STATEMENT

1. Taxon

- 1.1 Class:** Chondrichthyes, Subclass: Elasmobranchii
1.2 Order: Carcharhiniformes
1.3 Family: Sphyrnidae
1.4 Genus/Species: *Sphyrna lewini*
1.5 Common Names: English: Scalloped hammerhead shark
 French: Requin-marteau halicorne
 Spanish: Tiburón martillo común
 German: Bogenstirn-Hammerhai
 Italian: Squalo martello smerlato
 Portuguese: Tubarão-martelo-recortado

2. Biological data

The scalloped hammerhead is the second largest hammerhead shark, demonstrating a maximum total length of about 12 to 13.8 feet (370 to 420 cm) (Compagno, 1984). At birth, pups average 1.38 to 1.8 feet (42 to 55 cm) in length (Compagno, 1984). The body of the shark is fusiform, or spindle-shaped, with a large first dorsal fin and low second dorsal and pelvic fins. The front teeth of the scalloped hammerhead are straight, while the rest have oblique cusps (unlike the great hammerhead, which has serrated teeth) (figure 2). It can be distinguished from other hammerhead species by the presence of a marked indentation in the middle of the front of the head and two additional indents on each side.

2.1 Distribution

S. lewini is a circumglobal shark species residing in coastal warm temperate and tropical seas in the Atlantic, Pacific, and Indian Oceans between 46°N and 36°S. In the Western Atlantic Ocean the species is found from the United States' mid-Atlantic region to Uruguay, including the Gulf of Mexico and Caribbean Sea. In the Eastern Atlantic it is distributed from the Mediterranean Sea to Namibia. Sperone et al. (2012) documented the range extension of the species to the central Mediterranean off Southern Italy. Distribution in the Indo-Pacific Ocean includes South Africa and the Red Sea, throughout the Indian Ocean on both East and West coasts of India, along Australia's Western, Northern, and Eastern coasts, and extending into the western Pacific as far north as Japan and westward to Tahiti and Hawaii. *S. lewini* is also native to the Eastern Pacific Ocean from the coast of southern California (U.S.) to Ecuador and perhaps as far south as Southern Peru (figure 3).

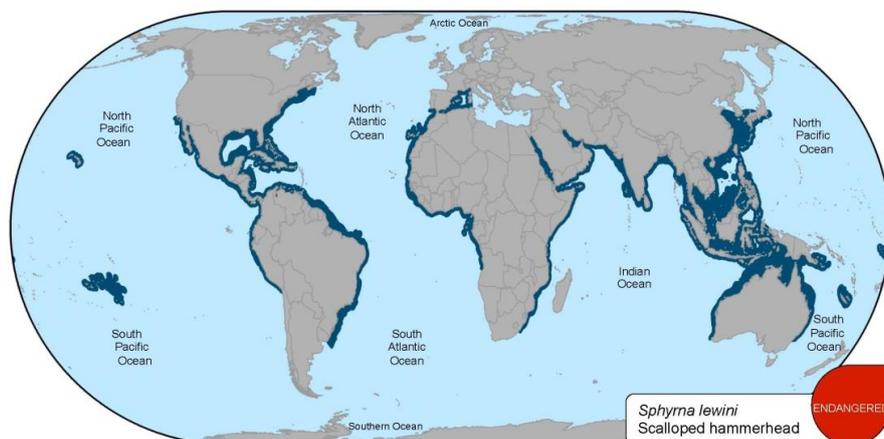


Figure 3. *S. lewini* distribution map. Source: IUCN

The IUCN recognizes five subpopulations of scalloped hammerheads distributed between the Eastern Central and Southeast Pacific, the Eastern Central Atlantic, the Northwest and Western Central Atlantic, the Southwest Atlantic, and the Western Indian Ocean (IUCN 2014). However, a recent study on its inclusion in the United States Endangered Species Act also identified a sixth population in the Indo-Pacific (Miller et al., 2013). Recent genetic studies have shown the differentiation with the *S. lewini* Atlantic populations to be between 3% and 7% (Quattro et al., 2006). These data were compared with morphometric studies that showed a variation in the number of precaudal vertebrae (the new species is called *Sphyrna gilberti* or Carolina Hammerhead) (Quattro et al., 2014). Given this global occurrence, it is found in the following FAO Fishing Areas: 21, 31, 34, 41, 47, 51, 57, 61, 71, 77, and 87 (figure 4) (CITES, 2013).

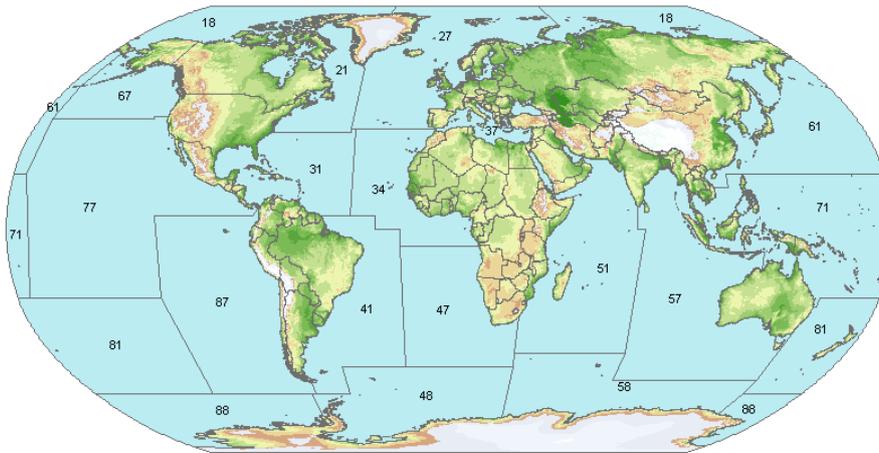


Figure 4. FAO Fishing Areas for *S. lewini*. Source: FAO

2.2 Population (see appendix 1 for more information)

The scalloped hammerhead is a long-lived, viviparous species, with the oldest known individuals estimated at 30.5 years, for both males and females (Piercy et al., 2007). Reproductive cycle analysis indicates an 8-12 month gestation period with the species producing relatively large litters ranging between 15-31 pups, followed by a one year resting period (Compagno, 1984). Individuals reach a size at first maturity between 170-198 cm (Castro, 2011). This may vary from population to population (see Table 1 in Miller et al., 2013).

Atlantic Ocean

Multiple data sources from the Atlantic Ocean have demonstrated substantial declines in populations of *S. lewini*. A standardized catch rate index of a hammerhead complex from commercial fishing logbook data in the U.S. pelagic longline fishery between 1986-2000 and from observer data between 1992-2005 estimated a decline of 89% (Baum et al., 2003), while pelagic longline observer data indicated that *Sphyrna* spp. declined by 76% between 1992-2005 (Camhi et al., 2009). Figure 5 is a visual representation of results from the Baum et al. (2003) Northwestern Atlantic study.

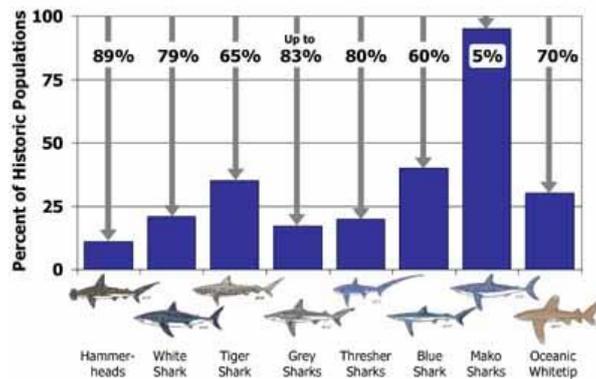


Figure 5. Depletion of various shark types in the Northwest Atlantic. Source: Baum et al. 2003. Available at: <http://www.sharklife.co.za>.

Standardized catch per unit effort (CPUE) from a shark-targeted, fishery-independent survey off North Carolina (U.S.A.) from 1972-2003 indicated a decline of *S. lewini* by 98% over this 32 year time period (Myers et al., 2007). Off South Carolina (U.S.A.), Ulrich (1996) reported a 66% decrease in population size between population estimates for 1983-1984 and 1991-1995. However, time series analysis conducted since 1995 suggested the Northwest Atlantic population may be stabilized but at a very low level (Carlson et al., 2005). An assessment for the hammerhead complex in the northwest Atlantic Ocean, utilising catch and population trend data from multiple studies, found a 72% decline in abundance from 1981-2005 (Jiao et al., 2008).

Also in the northwest Atlantic Ocean, Hayes et al. (2009) conducted the most recent assessment using two surplus production models. From this study, population size in 1981 was estimated to be between 142,000 and 169,000 sharks, but decreased to about 24,000 animals in 2005 (an 83-85% reduction).

The recent observation in the western North and South Atlantic Oceans of a rare hammerhead shark closely related to but evolutionary distinct from *S. lewini* suggests that this new lineage had been previously combined in catch data and assessments with *S. lewini* (Quattro et al., 2006; Pinhal et al., 2011; Naylor et al., 2012). As a result, populations may be lower than previously reported.

A meta-analysis of multiple times series from various gear types in the Mediterranean Sea suggest declines of the hammerhead shark complex of up to 99.9% in different time periods, in one case since the early 19th century (Ferretti et al., 2008). Elsewhere in the eastern Atlantic Ocean, data indicating trends in abundance are generally not available. However, it is suggested that similar population trends for hammerheads (grouped) documented in the Northwest Atlantic could be expected in the northeast and Eastern central Atlantic. This is because longline fleets in these areas exert comparable fishing effort, and effort is seen to shift from Western to Eastern Atlantic waters (Buencuerpo et al., 1998).

In the southwest Atlantic Ocean off Brazil, data from fisheries targeting hammerhead sharks indicates bottom gillnet CPUE declined by 80% from 2000-2008 (FAO, 2010). The targeted hammerhead fishery was abandoned after 2008 because the species had become rare (CITES, 2013). Also off Brazil, CPUE analyses of inshore fisheries indicate adult female *S. lewini* decreased between 60-90% from 1993-2001 (Vooren et al., 2005). However, nominal CPUE from commercial fishing logbook data of the hammerhead shark complex caught by the Brazilian tuna longline fleet from 1978-2007 indicated a relatively stable trend (CITES,

2013). This indicates that declines may be more severe in inshore areas where *S. lewini* are more common.

Industrial landings of the hammerhead shark complex (mainly *S. lewini* and *S. zygaena*) in the State of Santa Catarina, south of Brazil, were of 6.7 t in 1989, coming to a peak of 570 t in 1994, due to the fast development of net fishing. Later, a decrease occurred to 202 t in 1998, 353 t in 2002 and 381 t in 2005 (CITES, 2013). Lastly, in 2008, production reached only 44 t without ever recovering to 1994 levels. However Vooren et al. (2005) comment that fishing statistics are only related to landed carcasses and thus the true extension of catches is unknown.

In Brazil's southeast, catch statistics include *S. lewini* and *S. zygaena* in the category of "hammerhead sharks", of which about 80% are *S. lewini* (CITES, 2013). CPUE reductions (kg/trip) of 96% and 93% were observed for this "category" from bottom gillnet and longline vessels, respectively, in the State of Santa Catarina (Kotas et al., 2005).

Utilizing analysis of covariance models and generalized linear models applied to gill net fishing along the south coasts of Brazil, Kotas et al. (2008) found a catch and CPUE decline of over 80% for the hammerhead shark complex during 1995 to 2005.

Samples of hammerhead sharks taken between 1995 and 2008 from the operating longline and gill net vessels in the ports of Itajaí and Ubatuba (South and Southeast of Brazil) indicated that *S. lewini* is suffering high mortality levels from fishing during its entire life cycle, in other words, from the birth zones (hammerheads' total lengths (LT) between 50 and 60 cm) through the continental shelf where the juveniles and adults live, and sub-adults (60 to 180 cm LT), as well as in the open sea on the slopes and borders of the continental shelf where the adults occur (180 to 370 LT). Until 2008, vessels with drift nets normally caught hammerheads between 70 and 370 cm LT (mode 180 cm) (CITES, 2013). This unsustainable model of fishing exploitation on the different sizes of *S. lewini* (newborn-juveniles-adults) caused by economic pressure of hammerhead fins for the international market is the main cause of the population reduction of the hammerhead sharks in south and Southeast of Brazil.

The industrial deep fishing with gill nets in the south of Brazil is a great threat to recruiting coastal hammerheads. Samples from disembarkations of this fleet in the port of Itajaí, Santa Catarina State, between 2008 and 2009 indicated catches of *S. lewini* newborn and juveniles sized (LT) between 43.7 and 137.5 cm. The mean size caught was 70.2 cm (LT) (n = 1019). Biologic observations between 1993 and 2006 of *S. lewini* caught with gillnets, longline and seines along the south coast of Brazil indicated that males of this species matured at 140 cm, with 100% mature above 250 cm LT (CITES, 2013). Galina and Vooren (2005) found sizes of the first reproduction of *S. lewini* at 192 cm (males) and 204 cm (females).

The fishing effort concentrated in spring and summer (reproduction period of this species), as well as in the birth zones in shallow waters and mating areas on the slope banks, provoked a fast decline on the catches of *S. lewini* in the southeast and south of Brazil to the end of 1990 (Kotas 2004; Vooren et al. 2005). This phenomenon made the fishing of this species economically unviable (Kotas et al., 2001).

Vooren et al. (2005) observed the industrial fleet's landings in the port of Rio Grande (Rio Grande do Sul State) between June 2002 and July 2003, where *S. zygaena* occurred in 25% of gillnet fleet captures and 9% of purse seine captures. However, these authors affirm that the

CPUE of hammerhead sharks caught in gillnets diminished drastically, declining from 0.37 t per trip in 2000 to 0.13 t per trip in 2002.

Pacific Ocean

In Mexico, populations, catches and offloadings of various shark populations have diminished (Soriano et al 2011). Shark catches indicate a sustained decline in the last ten years (DOF, 2012). The general trend of production of sharks in the states of Sinaloa and Sonora oscillates, with a clear negative trend (INP 2000). In Sonora, a maximum of 7,000 t were caught in 1980, declining to 3,000 t in 2000, while in Sinaloa a maximum of 5,000 t were caught in 1980, declining to 1,500 t in 2000 (INP 2000).

In the Mexican Pacific Ocean, the CPUE of the longline fishing fleet (100 fish hooks) for *S. lewini* showed a declining trend of 0.19 in 1987 to 0.03 in 1999 (INP 2000). In the Gulf of Tehuantepec the captures of *S. lewini* declined from the maximum of 300 t in 1997 to a few tons in 2006 (Carta Nacional Pesquera 2010). From 2008 to 2010, the annual catch of *S. lewini* in the south zone of the Mexican Pacific showed a declining trend (Soriano et al 2011).

Off Central America, large hammerheads were formerly abundant in coastal waters but were reported to be depleted in the 1970s (Cook, 1990). In the Eastern Pacific, *S. lewini* were found in a series of separate and potentially small populations (Nance et al., 2011). With the small-scale fisheries mainly catching juveniles, the inshore schools of juvenile sharks are particularly vulnerable to even the simplest fishing methods, causing population collapses along near coastal areas in Costa Rica according to artisanal fisher testimonials (Bystrom & Cardenas-Valenzuela, in press). Consequently, *S. lewini* are far less abundant than in the past (Nance et al., 2011). Myers et al. (2007) determined a 71% decline in *S. lewini* populations in the Cocos Island National Park (Costa Rica) from 1992-2004, despite this area being designated a “zero catch zone.” In general, the catch of sharks in Costa Rica shows a decrease of 60% in the relative abundance since 1991 up to 2001 (Arauz et al., 2004).

In Colombia, although there is capture data of the species in industrial and artisanal fisheries there is no information of CPUE, which makes it difficult to infer population trends; nevertheless, it is evident that the majority of captured individuals (73.7%) are captured below the maturity size (200 cm LT) calculated for the species in the Colombian Pacific (Tapiero, 1997; Mejía-Falla & Navia, 2011), also, Mejía-Falla & Navia (2010) noted the decrease of juveniles in the shrimp trawling fishery between 1995 and 2004, and having no reports of the species in 2007. In the Colombian Pacific Mejia-Falla & Navia (2010) found a nearly complete collapse of juveniles caused by the national shrimp trawl fleet between 1995-2004.

In Ecuador, catch records for combined *S. lewini*, *S. mokarran*, and *S. zygaena* indicated a peak in landings of approximately 1000 t in 1996, followed by a decline through 2001 (Herrera et al. 2003). Landings of *S. lewini* caught by artisanal longline and driftnet fleets in the Port of Manta (which accounts for 80% of shark landings in Ecuador) were about 160 t in 2004, 96 t in 2005, and 82 t in 2006 (Martínez-Ortíz et al., 2007).

The incidental catch of *S. lewini* by tuna vessels which use purse seine nets in the Eastern Pacific show a declining trend from a peak of 1,009 specimens in 2002 to 247 specimens in 2011 (CIAT, 2012). In addition, the specimens of *S. mokarran* peaked at 189 in 2003 and

declined to 21 in 2011, while *S. zygaena* peaked at 1,205 in 2004 and declined to 436 in 2011 (CIAT, 2012).

An independent assessment of shark catch in the Queensland Shark Control Program – designed to examine long-term trends (44 year dataset) in shark stocks – found that catch rates of hammerheads had decreased by more than 85% since the onset of the program (44 year dataset). The preliminary results of this study suggest an overall long-term decline of hammerheads in the Cairns and Townsville regions, where the study was focused (Simpfendorfer, 2005). Noriega et al. (2011) analysed data from 1996-2006 from mesh net and drumline fisheries in Northeastern Australia from the Queensland Shark Control Program and found a significant decline in *S. lewini* female total length but an increase in CPUE.

Indian Ocean

During 1978 to 2003, CPUE of *S. lewini* in shark nets deployed off the beaches of Kwa-Zulu Natal, South Africa, declined significantly from approximately 5.5 sharks/km net/year to approximately 2 sharks/km net/year (Dudley & Simpfendorfer, 2006). This trend data indicate a decline of ~ 64% over a 25-year period. Dudley & Simpfendorfer (2006) also reported large catches of newborn *S. lewini* by prawn trawlers on the Tugela Bank, South Africa, ranging from an estimated 3,288 sharks in 1989 to 1,742 sharks in 1992.

Although there have been few formal assessments of hammerhead populations in Western Australia, a 50-75% decline in hammerhead CPUE was observed in the WA North Coast Shark Fishery for 2004-2005 compared to 1997-1998 (Heupel & McAuley 2007).

For the Indian Ocean, there is a lack of available data, no quantitative stock assessment, and no fishery indicators for *S. lewini*. As a result, the stock status is highly uncertain. Often taken in a range of fisheries in the Indian Ocean, *S. lewini* is vulnerable to these fisheries, particularly the gillnet fishery. Inshore fisheries often exploit the pups found in the shallow coastal nursery grounds. If current fishing effort is maintained or increased, further declines in biomass and productivity will occur. (IOTC, 2005).

2.3 Habitat

The scalloped hammerhead is a coastal and semi-oceanic pelagic shark. The species is found over continental and insular shelves, as well as in adjacent deep water (Ebert et al., 2013). Scalloped hammerheads range from intertidal inshore areas and estuaries to offshore waters of depths up to 900 feet (275 meters) (Castro, 2011). Although they regularly swim at these depths during nocturnal hunting (Ketchum et al, 2014), they have been shown to swim as deep as 1000m to the anoxic layer (Jorgensen et al., 2009). Juveniles live in inshore areas, migrating out to deeper waters as they grow, while adults have been shown to aggregate at seamounts and oceanic islands (Hearn et al., 2010).

2.4 Migrations

S. lewini is an aggregating seasonally-migratory species in parts of its distribution, often times schooling in great numbers at small islands and seamounts before moving out into the open sea (Ketchum et al., 2014). *Sphyrna lewini* is the only hammerhead species known to school. Developing individuals perform horizontal migrations from inshore bays to pelagic habitats

(Ketchum et al., 2014). The pups of this species tend to stay in coastal zones, near the bottom, occurring at high concentrations during summer in estuaries and bays (Clarke, 1971; Bass et al., 1975). The species segregates by sex and in the Gulf of Mexico and Northern Australia pregnant females, bigger than 1.5m, were observed migrating to shallow coastal areas to give birth while males, less than 1 m long, are found over the continental shelf. In addition to cross-shelf migration, long-shelf migration of hammerheads has been observed in South Africa and Northern Australia. Great schools of juvenile hammerheads were observed migrating to higher latitudes during summertime (Stevens & Lyle, 1989), supporting the conclusions of Duncan et al (2006) that nursery populations linked by continuous coastlines have high connectivity. There is connectivity of *S. lewini* in the Eastern Pacific between Malpelo Island, Colombia, Cocos Island, Costa Rica, and the Galapagos Islands, Ecuador according to Bessudo et al. (2011) who recorded individuals migrating between Malpelo and Cocos (627 km) and between Cocos and the Galapagos Islands (710 km) a month later. Ketchum et al. (2014) also reported the movement of adult females between the Galapagos Islands and Cocos.

3. Threat data

3.1 Direct threats to the population

Because the *Sphyrna* genus contains eight species, differentiating difficulties of *S. lewini*, *S. mokarran*, and *S. zygaena* exist. In fact, an amalgamation of catch records and estimates of trends in abundance list hammerheads as a complex. Regional abundance trend analyses of catch-rate data specific to *S. lewini* and to this hammerhead complex have reported large declines in abundance ranging from 83-85% over recent years with local estimates as high as 99% (Hayes et al., 2009).

While some harvest of *S. lewini* occurs for its meat – usually of juveniles by coastal artisanal fisheries – this species is highly desired for the shark fin trade because of its fin size and high fin ray count (i.e. ceratotrichia) (Rose, 1996). Individuals are caught in a variety of fisheries including small-scale commercial fisheries, industrialized coastal fisheries (shrimp trawls), as well as offshore pelagic fisheries. Hammerheads are generally not a target species but suffer high bycatch and at vessel mortality (Morgan & Burgess, 2007). Recent increases in overall longline effort along with the large increase in the purse-seine fishery have resulted in large increases in fishing mortality over the last two decades (Williams & Terawasi, 2011). Figures 5 and 6 shows total family landings along with two individual species including *S. lewini*.

Species	Global Landings (tons)										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
(<i>Sphyrnidae</i> spp.)	2053	2282	2101	1773	1038	3131	3574	4963	4541	4306	5786
<i>Sphyrna lewini</i>	262	515	798	425	492	328	224	202	158	109	336
<i>Sphyrna zygaena</i>	37	27	40	119	207	298	183	321	380	134	65

Figure 6. Worldwide landings of Sphyrnidea spp, *S. lewini*, and *S. zygaena*. Source: FAO catch statistics for 2000-2009

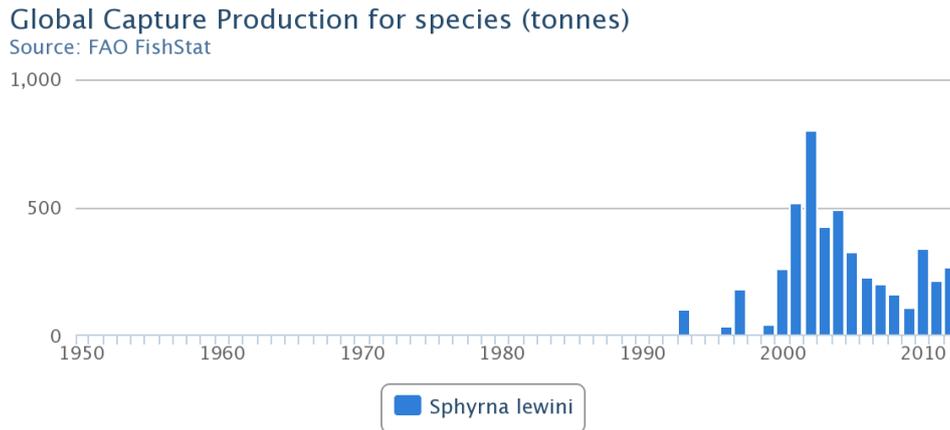


Figure 7. Global capture production for *S. lewini*. Source: FAO FishStat

S. lewini was found to be a highly vulnerable species in a study evaluating the impact of Atlantic longline pelagic fishing on 12 shark species between 1995 and 2012 (Gallagher et al., 2014). On the basis of operational aspects of fishing gear and the breeding characteristics of the 12 relevant species, the study found that *S. lewini* was one of three species that displayed the highest mortality (with a survival rate of just 42.3%) (Gallagher et al., 2014). *S. lewini* is more vulnerable than other more resilient shark species as it is an obligate ram ventilator, which means it has to move constantly in order to breathe.

Atlantic Ocean

In the Northwest Atlantic Ocean, *S. lewini* are targeted and caught as bycatch by bottom and pelagic longline fisheries, as well as by coastal gillnet fisheries. In the U.S. longline shark permit holders reported hammerhead sharks as composing the majority of their migratory species catch (U.S. Department of Commerce, 2011). In Belize, hammerheads were fished heavily by longline fisheries in the 1980s and early 1990s (CITES, 2013). Interviews with fishers indicate that the abundance and size of Sphyrnids have declined dramatically in the past ten years as a result of overexploitation, leading to a halt in the Belize-based shark fishery (CITES, 2013). However, hammerhead fishing pressure remains high through illegal, unregulated, and unreported (IUU) fisheries (CITES, 2013). In fact IUU shark fishing is a global concern with the practice skewing catch statistics (Fisher et al., 2012).

In Brazil *S. lewini* faces fishing pressure over its entire distribution and in all its life phases by coastal and continental shelf fisheries that target juveniles (Vooren & Lamónaca 2003; Vooren et al. 2005; Kotas et al., 2005; Doño, 2008) and more industrialized fisheries whose catch includes adults along the borders of the continental shelf (Zerbini & Kotas, 1998; Kotas et al., 2008;). As a result of this combined fishing pressure, *S. lewini* abundance in this region has decreased markedly (Kotas et al., 1998; Vooren et al., 2005).

S. lewini is caught by both inshore artisanal fisheries and offshore European fisheries operating along the coast of Western Africa. A study of bycatch rates in European industrial freeze trawlers targeting small pelagic fish off Mauritania from 2001 to 2005 showed that the hammerhead complex represented 42% of total bycatch during this period (Zeeberg et al.,

2006). The Subregional Workshop for Sustainable Management of Sharks and Rays in West Africa (26-28 April, 2000 in St Louis) noted the high threat to sharks in the West African region and a noticeable decline in the CPUE of total sharks and rays. Walker et al. (2005) also noted that there was concern for *S. lewini* off Mauritania, whose fisheries catches exclusively juveniles. Increased targeting of sharks began in the 1970s when a Ghanaian fishing community settled in Gambia and established a commercial network throughout the region that encouraged local fishermen to target sharks for exportation to Ghana. By the 1980s, many fishermen were specializing in catching sharks, resulting in a decline in overall shark populations (Walker et al., 2005).

S. lewini is also frequently caught by driftnet and gillnet fisheries along the Western African coast from Mauritania to Sierra Leone (CITES, 2013). A specialized artisanal fishery for carcharhinid and sphyrid species was introduced in Sierra Leone in 1975, and since then fishing pressure has been continuous (CITES, 2013). Mauritania just began reporting catches to FAO and their 2010 catch is the highest reported by any country since 2003.

Pacific Ocean

Throughout the Eastern Pacific Ocean, juvenile *S. lewini* are heavily exploited in directed fisheries and are also taken as bycatch by shrimp trawlers and coastal fisheries targeting teleost fish. Increased fishing pressure from international longline fleets in the Eastern central Pacific and Southeast Pacific, driven by increasing demand for fins, is of concern. Furthermore, as traditional and coastal fisheries in Central America are depleted, domestic fleets have increased pressure at adult aggregating sites such as Cocos Island and the Galapagos Islands, or along the slopes of the continental shelf where high catch rates of juveniles can be obtained (Vargas & Arauz, 2001).

In Mexico, *S. lewini* is one of the main shark species caught in artisanal fisheries (Rustrian, 2010). In Oaxaca it is considered the most important commercial shark species and has dominated the catch in this region, representing 64% of the artisanal shark catch (Bejarano-Alvarez, 2007). In Michoacán, hammerhead sharks represent 70% of the shark catch, and effort is directed at juveniles and pregnant females in the breeding zones. Since hammerhead populations are sensitive to changes in structure and size, Anislado-Tolentino (2001) suggested that *S. lewini* has reduced the size at first maturity, naturally occurring consequence and indicator of overfishing. Anislado-Tolentino (2001) also found the exploitation rate to be 0.66, indicating that the capture of hammerheads is of more than half the population, leading to overexploitation in the region.

Based on information provided from each country, *S. lewini* represented 51% of the total catch of sharks, mostly neonates, in 2009 in Central America. During this study, El Salvador was found to catch the most *S. lewini*, particularly juveniles. In 2009, Siu Navarro (2012) concluded that fishing in nursery areas has a negative effect on the species' biomass.

In Colombia this species is captured regularly in drift net fisheries, although it is also captured in hand lines and longlines, shrimp trawling fishery in all of its life stages, indicating a major threat to this species (Mejia-Falla & Navia, 2011).

Indian Ocean

S. lewini are often targeted by semi-industrial, artisanal, and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish and purse seine fisheries)

in the Indian Ocean. There is little information on the fisheries prior to the early 1970s, and some countries refuse to collect shark data. Other countries collect data, but do not report it to the Indian Ocean Tuna Commission. It appears that significant catches of sharks have gone unrecorded in several countries and many catch records likely under-represent the actual catches of sharks. *S. lewini* is captured in various fisheries throughout the Western Indian Ocean. Countries with major fisheries for sharks include the Maldives, Kenya, Mauritius, Seychelles and United Republic of Tanzania where sharks are considered fully to over-exploited (Young, 2006).

S. lewini is one of five dominant species in the Oman shark catch. Henderson et al. (2007) surveyed landings sites in Oman between 2002 and 2003 and reported a notable decline in catches of *S. lewini* in 2003, and informal interviews with fishermen reveal a general trend of declining shark catches over the last number of years, particularly large pelagic species (Henderson et al., 2007). *S. lewini* was one of the main shark species caught by foreign longliners licensed to fish in Mozambican waters in 2010 and by the longliner fleet based in the Island Reunión (IOTC 2011).

Inshore fishing pressure is intense throughout Southeast Asia and juveniles and neonates are heavily exploited, with large numbers of immature sharks caught in other areas (SEAFDEC, 2006). Off Indonesia, *S. lewini* is a target and bycatch species of shark longline, tuna gillnet, and trawl fisheries in several areas of this region (White et al., 2006; SEAFDEC, 2006). Foreign vessels are also reported to target sharks in Eastern Indonesian waters (Clarke and Rose 2005). Given the marked declines in this species' abundance in areas for which data are available, there is reason to suspect that declines have also occurred in other areas of the Indian Ocean and Western Pacific, where fishing pressure is high.

India responded to the U.S. range state consultation request and provided the following information. *S. lewini* is caught in floating and bottom gillnets, floating longlines and hook and lines in India. It is utilized fresh and dried-salted for human consumption, the liver is processed for oil, and fins have high export value. During 2000-2002, *S. lewini* contributed 8.1% of total shark landings at Cochin Fisheries Harbor, with a size range of 1.2 to 1.5 m. From 2007-2011 *S. lewini* contributed 8.1 to 16.1% of total shark landings at Cochin with size generally declining over time. Present landings shows an increasing trend, but with large quantities of small sharks being landed, this is a sign of overexploitation.

3.2 Habitat destruction

Coastal ecosystems that serve as nurseries for multiple species of sharks including hammerheads face both environmental and anthropogenic threats to their integrity (Knip et al., 2010). Environmental threats include fluctuations in temperature and salinity due to rising water temperatures and other climate change factors (Masselink et al., 2008) while fishing practices (Pauly et al., 1998) and habitat degradation and loss caused by human settlement initiatives including dredging, construction, pollution and deforestation are among the major man made threats to coastal shark populations (Suchanek, 1994; Vitousek et al., 1997). And it is this decline of great sharks from coastal ecosystems that has caused trophic cascades with marked ecological consequences (Baum & Myers, 2004).

3.3 Indirect threats (ecosystem contaminants)

High levels of ecosystem contaminants (PCBs, organo-chlorines and heavy metals) that bio-accumulate and are bio-magnified at high trophic levels are associated with infertility in

sharks (Stevens et al. 2005). High levels of chlorinated OH-PCBs were dominant in *S. lewini* in Japan's coastal waters (Nomiyama et al., 2011). Escobar-Sanchez et al. (2010) found mercury levels in *S. zygeana* taken from the Mexican Pacific were within food safety levels. However, in a more recent study by Maz-Courrau et al. (2012), *S. zygeana* mercury levels in the Baja California Peninsula were above the limit specified by the Mexican government for human consumption.

3.4 Threats related to migration

S. lewini's relocation into open ocean areas makes scalloped hammerheads very susceptible to fisheries (Ketchum et al., 2014). *S. lewini* is taken as catch and bycatch in domestic fisheries within Exclusive Economic Zones and in multinational fisheries on the high seas. The species' migratory patterns between shallow coastal areas and deep water open ocean zones makes it susceptible to a variety of gear types used by different large scale commercial and small scale fisheries.

Because *S. lewini* regularly migrate between the EEZs of different Range States and into the high seas, no part of any stock can benefit fully from any management measures that are introduced within its waters by a single Range State. The regional protections afforded by some regional fisheries management organizations (RFMOs) will reduce some of the threat from the longline and purse seine fisheries targeting tuna and swordfish, but these measures do not offer full protection from every fishery within the region.

3.5 National and international utilisation

S. lewini juvenile meat, often marketed under other commonly consumed fish names is consumed locally in Central America. According to Vannuccini (1999), countries documented to consume hammerhead meat (usually salted or smoked) include Mexico, Mozambique, Philippines, Seychelles, Spain, Sri Lanka, China (Taiwan), Tanzania, and Uruguay. The species' jaws and teeth are also collected and sold as marine curiosities. Liver oil is also a commodity extracted from the species (CITES, 2013). However, the principal driver of catch and then trade in this species is the international demand for shark fins.

Finning

Hammerhead shark fins are highly desired in the international trade because of the fin size and high needle (ceratotrichia) count (Rose, 1996). According to Japanese fin guides (Nakano, 1999), *S. zygaena* fins, which are morphologically similar to *S. lewini*, are thin and falcate with the dorsal fin height longer than its base. Because of the higher value associated with the larger triangular fins of hammerheads, traders sort them separately from carcharhinid fins, which are often lumped together. An assessment of the Hong Kong SAR shark fin market has revealed that various Chinese market categories contain fins from hammerhead species: "Bai Chun" (*S. lewini*), "Gui Chun" (*S. zygaena*), "Gu Pian" (*S. mokarran*), and the general category "Chun Chi" containing both *S. lewini* and *S. zygaena* in an approximately 2:1 ratio, respectively. DNA tests on shark fins obtained from the Hong Kong market revealed that approximately 6 percent of the identified fins were from the hammerhead complex (Clark et al., 2006b). From this information, scientists have estimated that 1.3 million to 2.7 million scalloped and smooth hammerheads are exploited for the fin trade every year, an amount equivalent to a biomass of 49,000–90,000t (Clarke et al., 2006a).

Recreational hammerhead fishing also occurs in some coastal zones including the entire Southeast

coasts of the United States and in Southern Brazil from November to March (summer).

Illegal trade

There is little regulation of trade in these species, and the extent of illegal trade activities is unknown. While CITES lists *S. lewini*, *S. mokarran*, and *S. zygaena* in Appendix II, its implementation was delayed 18 months (September 2014) and five countries filed reservations (Canada, Guyana, Japan, Yemen) (CITES, 2014).

Most RFMO regulations and some national laws prohibit finning sharks at sea (discarding the carcass and transshipping the fins at sea). With the exception of finning sharks at sea, which is prohibited under most Regional Fisheries Management Organizations' regulations and some national laws, there is little control of trade in this species (however, see 2010 ICCAT provision below). Other countries have an outright ban on the trade of sharks. For example, The Bahamas banned the sale, import, and export of sharks, shark parts, and shark products within its waters. The Maldives and Marshall Islands also prohibit the trade of sharks, while Honduras has declared a moratorium on shark fishing in the country's waters. In addition, Guam and the Commonwealth of the Northern Mariana Islands (U.S. territories) both prohibit the sale or trade of shark fins within their waters. ICCAT members are prohibited from retaining, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of hammerhead sharks from the family Sphyrnidae (except *S. tiburo*). While developing coastal States are exempt from this prohibition, they are to ensure that Sphyrnidae do not enter international trade. Thus, there should be no trade occurring from ICCAT fisheries. To date, the ICCAT Compliance Committee has not reviewed the contracting Parties' implementation of this measure. All ICCAT Parties have not reported on their domestic implementation, so their level of international trade that may be out of compliance is unknown. It is likely possible that neither potential exporting nor importing countries of these products have not implemented domestic regulations to monitor or prevent such trade. Furthermore, not all potential importing countries are parties to ICCAT and may not be aware of or required to comply with this measure.

Hammerhead sharks have been documented in IUU fishing activities. For example, about 120 longline vessels were reportedly operating illegally in coastal waters of the western Indian Ocean prior to 2005, and this number was expected to increase (IOTC 2005). These vessels were primarily targeting *Sphyrna* spp and *Rhynchobatus djiddensis* for their fins (Dudley and Simpfendorfer, 2006). Illegal fishing by industrial vessels and shark finning are reported in other areas of the Indian Ocean (Young, 2006).

There has also been a large increase in IUU fishing in Northern Australia in the last few years (J. Stevens, pers. obs.).

Illegal fishing around the Galapagos is conducted by local fishermen and artisanal and industrial fleets from continental Ecuador and abroad, often targeting sharks for their fins.

Lack & Sant (2008) compiled an assessment on illegal hammerhead shark fishing (non-declared nor regulated) extracted from the available literature. These authors found *Sphyrna* spp. and silky shark (*Carcharhinus falciformis*) to be the most frequently cited species taken in illegal fishing. More recent acts of illegal fishing in 2011 include whale shark carcasses found in the Malpelo Wildlife Sanctuary (Colombia).

In Belém, Northern Brazil, in May 2012, a surveillance operation apprehended a non-declared load of over 7 tons of fins of several species, without their respective carcasses. Through the photos of the apprehension it is possible to distinguish “tall” fins taken from hammerhead sharks.

National and international tourism

The diving tourist industry has grown in recent decades, with the current direct economic impact of diving with *Manta* spp. estimated at USD 140 million per year (O’Malley et al., 2013). At the national level, there are clear examples of the importance of hammerhead sharks for the diving industry. As in the Marine Reserve, shark diving is estimated to bring in between USD 1.2 million and USD 7.4 million to many local and regional economies (Rowat & Engelhardt, 2007; Norman & Catlin, 2007; Catlin et al., 2010; Martin & Hakeem, 2006). In the Galapagos, the frequency of shark observations and the number observed on each trip suggest that each shark (of any species) could be directly generating around US\$ 34,000 per year for monitored tourist activity.

4. Protection status and needs

4.1 National protection status

In 1998, the Environmental Agency of the Brazilian Government (IBAMA – Brazilian Institute for the Environment and the Natural Renewable Resources) made a first effort to control finning (taking the fins and discharging the carcasses of hammerhead sharks) (Portaria IBAMA 121 dated 24/08/1998), prohibiting that practice in all operating vessels in Brazilian waters (Kotas et al., 2005; Kotas et al., 2000). As the execution of this law proved to be difficult, it was recommended to unload the carcasses with the fins attached to the hammerhead bodies (as well as for other shark species). In 2004 the Normative Instruction MMA nº 05 was published establishing the list of fauna endangered by extinction and the over-exploited species in Brazil. *S. lewini* and *S. zygaena* are listed among the over-exploited species.

Honduras decreed its national waters as a “Shark Sanctuary” in July 18, 2011, prohibiting capture of all species of sharks and the practice of finning.

S. lewini should benefit from legislation enacted by French Polynesia (2006), Palau (2003, 2009), Maldives (2010), Honduras (2011), The Bahamas (2011), Tokelau (2011), and the Marshall Islands (2011) to prohibit shark fisheries throughout their Exclusive Economic Zones. Other countries have protected areas where no shark fishing is allowed, such as Cocos Island (Costa Rica), Malpelo Sanctuary (Colombia), and the marine reserve of Galapagos Islands (Ecuador). Countries including the United States, Chile, and Costa Rica require sharks to be landed with their fins naturally attached. Shark finning bans implemented by 21 countries, the European Union, and nine RFMOs could also help reduce some shark mortality (Camhi et al., 2009).

In the United States, *S. lewini* are managed as part of the Atlantic Large Coastal Shark Complex with a separate stock assessment. It is overfished and undergoing overfishing (NMFS 4th Quarter 2011 stock status). A new stock assessment for the Northwestern Atlantic was released in April 2011 Under the Magnuson Stevens Act there is a two year deadline to implement a rebuilding plan to end overfishing. The stock assessment estimated that a total allowable catch (TAC) of 2,853 scalloped hammerhead sharks per year (or 69 percent of the 2005 catch) would allow a 70 percent probability of rebuilding to MSY in 10

years. *S. mokarran* and *S. zygaena* are also part of the Atlantic Large Coastal Shark Complex, but are assessed at the complex level. The overfished and overfishing status of this complex is unknown as of the 4th quarter of 2011 (NMFS 4th Quarter 2011 stock status). For all three species there are quotas, limited entry, time-area closures, recreational bag limits, and the requirement that all sharks be offloaded from vessels with their fins naturally attached. Finning in U.S. waters was banned in December 2001 with passage of the Shark Finning Prohibition Act. The requirement to land sharks with their fins naturally attached was adopted in January 2011 with passage of the Shark Conservation Act. In August 2011, the United States published a final rule to prohibit the retention of great, smooth and scalloped hammerhead sharks caught in associations with ICCAT fisheries.

In an effort to help stop the illegal finning occurring in the Galapagos, the Ecuadorian Government issued a decree in 2004 prohibiting fin export from Ecuador. In 2007, Executive Decree No. 486 was enacted to regulate the incidental catch of sharks, their trade and export in continental Ecuador. In 2013, Ministerial Agreement No. 116 prohibited the catch of *S. lewini* and *S. zygaena* hammerhead sharks over 1.2 metres.

In Ecuador through Executive Decree No. 486 issued in July 2007 and reformed in February 2008, Ecuador issued the regulations for the incidental catch of sharks, their trade and export in continental Ecuador, which prohibited: the direct fishing of sharks, the use of fishing gear and systems which are employed specifically to catch sharks and the practice of “finning”. Also, Ecuador established the policy of conservation and management of shark resources through the implementation of the National Plan of Action for the Conservation and Management of Sharks in Ecuador.

In Morocco, management measures include a total catch limit of 5%, log requirements, a ban on handling sharks on board and prohibition of finning and oil extraction. In 1998, the IBAMA in Brazil made a first attempt to control finning (IBAMA portaria 121 of 24 August 1998), by banning the practice on all vessels operating in Brazilian waters (Kotas et al., 2000; Kotas et al., 2005). The implementation of this law proved difficult, and another one enacted at a later date required the unloading of bodies with fins intact for hammerhead and other shark species. The new law was enacted in 2004 (Normative Memorandum MMA No. 5). Brazil also implemented minimum size restrictions for *S. lewini* and *S. zygaena*.

4.2 International protection status

Hammerheads are listed in Annex I of UNCLOS and should be subject to its provisions concerning fisheries management in international waters. Also of relevance is the FAO International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks) which recommends that RFMOs carry out regular shark population assessments and that member States cooperate on joint and regional shark management plans. Countries which are implementing IPOA-Sharks are Argentina, Brazil, Colombia, Costa Rica, Ecuador, France, Japan, Malaysia, Mexico, New Zealand, Portugal, Spain, Thailand, U.K., and USA. Like other sharks, however, international regulations for hammerheads are limited and few countries regulate hammerhead shark fishing. It is prohibited to retain onboard, tranship, land, store, sell, or offer for sale any part of whole carcass of any hammerhead shark of the family Sphyrnidae within the fisheries covered by the Convention area of ICCAT (2010) (except for the *S. tiburo*). Although Developing coastal States are exempt from this prohibition, they are to ensure that hammerhead sharks do not enter into international trade. RFMOs have adopted finning bans, which require full utilization of captured sharks and encourage the live release of incidentally

caught sharks. If effectively enforced, this measure could help to reduce the number of hammerheads killed exclusively for their fins. Regulations by RFMOs only pertain to the entities that are contracting Parties and to the fisheries that are within the scope of the Convention; thus the catch and trade of hammerhead sharks is largely unmanaged and unregulated.

In 2008, the European Community proposed a prohibition on retention of all hammerhead species under ICCAT, but the measure met with opposition and was defeated. Most Regional Fisheries Management Organizations have implemented finning bans which, if effectively enforced, could reduce the number of hammerheads killed exclusively for their fins. RFMOs with finning bans are: ICCAT, GFCM, IOTC, IATTC, NAFO, SEAFO, WCPFC, CCAMLR, and NEAFC. In November 2011, the eight member countries of the Central American Integration System (SICA: Belize, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua and Panama) adopted a common binding regulation outlawing shark finning. Unlike finning bans in many countries, the Regulation OSP-05-11 (effective 1 January 2012) applies not only to domestic and foreign vessels that catch and land sharks in SICA countries, but also to vessels fishing in international waters that fly the flag of a SICA member country. Member governments can only permit landing sharks when the fins are still naturally attached to the whole body or to a portion of the shark body. In 2011, ICCAT adopted a recommendation that requires any party that does not report species-specific shark data to submit a data collection improvement plan to the SCRS by July 2012 (Recommendation 11-08). To date, the ICCAT Compliance Committee has not reviewed the contracting Parties' implementation of this measure. All ICCAT Parties have not reported on their domestic implementation, so their level of international trade that may be out of compliance is unknown. It is possible that importing and exporting countries of these products have not implemented domestic regulations to monitor or prevent such trade.

Furthermore, not all potential importing countries are parties to ICCAT and may not be aware of or required to comply with this measure IOTC resolution 08/04 requires logbook records of catch from longline vessels and Recommendation 11/06 expands that requirement to all purse seine, gillnet and pole and line fishing vessels. The IOTC rejected a hammerhead retention ban.

S. lewini, *S. mokarran*, and *S. zygaena* were added to Appendix II of CITES in March 2013, but implementation has yet to begin.

The Council of the European Union adopted a proposal to amend Regulation (EC) No 1185/2003 on the removal of fins of sharks. Since 6 June 2013 sharks' fins must remain attached on board vessels.

4.3 Additional protection needs

Extensive global fishing, coastal development, and human population growth all present seemingly insurmountable threats to the survival of *S. lewini*. Proactive, precautionary policy decisions are needed to attenuate the steep declines in the species' populations witnessed over the past few decades. An Appendix II listing for *S. lewini* would offer an unequivocal statement of concern for the species and commitment towards population rebuilding strategies.

5. **Range states**

5.1 Party Range States

- Angola; Antigua and Barbuda; Australia (Queensland, Western Australia); Benin; Cameroon; Cape Verde; Congo; Costa Rica; Côte d'Ivoire; Cuba; Djibouti; Ecuador; Egypt; Equatorial Guinea; Eritrea; France (French Guiana, Guadeloupe, New Caledonia); Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; Honduras; India; Iran; Liberia; Mauritania; Netherlands (Aruba); Nigeria; Pakistan; Panama; Philippines; Sao Tomé and Príncipe; Saudi Arabia; Senegal; South Africa; Togo; United Kingdom (Anguilla, Cayman Islands), Uruguay; Yemen

5.2 Non-party range states

- Bahamas; Bahrain; Barbados; Belize; Brazil; China; Colombia; Dominica; Dominican Republic; El Salvador; Grenada; Guyana; Haiti; Indonesia; Iraq; Jamaica; Japan; Kuwait; Maldives; Mexico; Myanmar; Namibia; Nicaragua; Oman; Qatar; Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Sierra Leone; Suriname; Taiwan, Province of China; Thailand; Trinidad and Tobago; United Arab Emirates; United States (Alabama, California, Delaware, Florida, Georgia, Hawaiian Is., Louisiana, Maryland, Mississippi, New Jersey, North Carolina, Puerto Rico, South Carolina, Texas, Virginia); Venezuela, Bolivarian Republic of; Viet Nam.

6. **Comments from Range States**

7. **Additional Remarks**

8. **References**

- Anislado-Tolentino, V. and C. Robinson-Mendoza. 2001. Age and growth for the scalloped hammerhead shark, *Sphyrna lewini* (Griffith and Smith, 1834) along the Central Pacific coast of Mexico. *Ciencias Marinas* 27:501–520.
- Arauz, R., Y. Cohen, J. Ballester, A. Bolaños & M. Pérez. 2004. Decline of Shark Populations in the Exclusive Economic Zone of Costa Rica. International Symposium on Marine Biological Indicators for Fisheries Management. UNESCO, FAO. Paris, France. March, 2004.
- Bass, A.J., D'Aubrey, J.D. and N. Kistnasamy. 1975. Sharks of the east coast of southern Africa. III. The families Carcharidae (excluding *Mustelus* and *Carcharhinus*) and Sphyrnidae. South African Association for Marine Biological Research. Oceanographic Research Institute Investigational Report 38: 1-100.
- Baum, J.K., Myers, R.A., Kehler, D.G., Worm, B., Harley, S.J. and Doherty, P.A. 2003. Collapse and Conservation of Shark Populations in the Northwest Atlantic. *Science* 299: 389-392.
- Baum, J.K. & Myers, R.A. 2004. Shifting baselines and the decline of pelagic sharks in the Gulf of Mexico. *Ecology Letters* 7: 135–145.
- Bejarano-Alvarez, O.M. 2007. Biología reproductiva del tiburón martillo *Sphyrna lewini* (Griffith y Smith, 1834) en Salina Cruz, Oaxaca, Mexico. Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, Maestro Tesis. 29 Mayo, 2007.
- Bessudo, S. & German Andres Soler & A. Peter Klimley & James T. Ketchum & Alex Hearn & Randall Arauz. 2011. Residency of the scalloped hammerhead shark (*Sphyrna lewini*) at Malpelo Island and evidence of migration to other islands in the Eastern Tropical Pacific *Environ Biol Fish* 91: 165–176.

- Buencuerpo, V., Rios, S. and Moron, J. 1998. Pelagic sharks associated with the swordfish, *Xiphias gladius*, fishery in the eastern North Atlantic Ocean and the Strait of Gibraltar. *Fishery Bulletin* 96:667–685.
- Bystrom, A. & P. Cardenas-Valenzuela. In press. Percepción de los pescadores artesanales del distrito de Bejuco (Guanacaste, Costa Rica) sobre la sostenibilidad del uso de líneas de fondo. *Desenvolvimento e Meio Ambiente*.
- Camhi, M.D., S.V. Valenti, S.V. Fordham, S.L. Fowler and C. Gibson. 2009. The Conservation Status of Pelagic Sharks and Rays: Report of the IUCN Shark Specialist Group Pelagic Shark Red List Workshop. IUCN Species Survival Commission Shark Specialist Group. Newbury, UK. x + 78p.
- Carlson, J.K., I.E. Baremore, and D.M. Bethea. 2005. The direct shark gillnet fishery, catch and bycatch 2004. National Marine Fisheries Service, Southeast Fisheries Science Center, PCB-05-01. Panama City, FL.
- Carta Nacional Pesquera. 2010 Diario Oficial de la Federación 2 de diciembre, 2010. SAGARPA Acuerdo por el que se da a conocer la Carta Nacional Pesquera.
- Castro, J. 2011. *The sharks of North America*. Oxford University Press. New York. 613 pp.
- Clarke, T.A. 1971. The ecology of the scalloped hammerhead shark, *Sphyrna lewini*, in Hawaii. *Pacific Science* 25: 133-144.
- Clarke, S. and Rose, D.A. 2005. Regional Fisheries and Trade. In: Fowler, S. L., Cavanagh, R. D., Camhi, M., Burgess, G. H., Cailliet, G. M., Fordham, S. V., Simpfendorfer, C. A. and Musick, J. A. (eds), *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes*. Status Survey. , pp. 24-29. IUCN/ SSC Shark Specialist Group, IUCN, Gland, Switzerland and Cambridge, UK.
- Clarke, S.C. et al. 2006(a). Global estimates of shark catches using trade records from commercial markets. *Ecology Letters* 9(10):1115–1126.
- Clarke, S.C. et al. 2006(b). Identification of shark species composition and proportion in the Hong Kong shark fin market based on molecular genetics and trade records. *Conservation Biology* 20(1): 201-211.
- Compagno, L.J.V., FAO species catalogue. Vol. 4. 1984 *Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 2. Carcharhiniformes*. FAO Fish.Synop. 125 (4): 545-546.
- Convención Interamericana del Atún Tropical (CIAT). 2012. Información estadística Number of hammerhead sharks captured in purse seine observer trips in the EPO, Class 6 vessels. Data preparation date: June 15, 2012
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). 2010. Proposal to include Hammerhead, Sandbar, and Dusky Sharks in Appendix II. Fifteenth meeting of the Conference of Parties, 13-25 March 2010. May 13, 2014. <http://www.cites.org/eng/cop/15/prop/E-15-Prop-15.pdf>
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). 2013. Proposal to include scalloped hammerhead sharks and lookalike species in Appendix II. CoP16. Bangkok, Thailand.
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). 2014. Reservation entered by parties. May 16, 2014. <http://cites.org/eng/app/reserve.php>
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). 2013. Proposal to include Hammerhead Sharks in Appendix II. Sixteenth meeting of the Conference of Parties, 3-14 March 2013.
- Cook, S. 1990. Trends in Shark Fin Markets: 1980, 1990, and Beyond. *Chondros*, 15 March. Pg 3.
- Cortés E. 1999. Standardized diet compositions and trophic levels of sharks. *ICES Journal of Marine Science* 56:707–17.
- Diario Oficial de la Federación (DOF). 2012. Acuerdo por el que se modifica el Aviso por el que se da a conocer el establecimiento de épocas y zonas de veda para la pesca de diferentes especies de la fauna acuática en aguas de jurisdicción federal de los Estados Unidos Mexicanos, publicado el 16 de marzo de 1994 para establecer los periodos de veda de pulpo en el Sistema Arrecifal Veracruzano, jaiba en Sonora y Sinaloa, tiburones y rayas en el Océano Pacífico y tiburones en el Golfo de México.
- Doño, F. 2008. Identificación y caracterización de áreas de cría del tiburón Martillo (*Sphyrna* spp.) en las costas de Uruguay. Tesis de Licenciatura, Facultad de Ciencias, Universidad de la República de

- Uruguay.
- Dudley, S. and Simpfendorfer, C. 2006. Population status of 14 shark species caught in the protective gillnets off KwaZulu-Natal beaches, South Africa, 1978-2003. *Marine and Freshwater Research* 57: 225-240.
- Duncan KM1, Martin AP, Bowen BW, DE Couet HG. 2006. Global phylogeography of the scalloped hammerhead shark (*Sphyrna lewini*). *Mol Ecol.* 15(8): 2239-2251.
- Ebert, D.A.; S. Fowler & L Compango. 2013. *Sharks of the World* Wild Nature Press, Plymouth. 528 pp.
- Escobar-Sánchez, O., F. Galván-Magaña & R. Rosiles-Martínez. 2010. Mercury and Selenium Bioaccumulation in the Smooth Hammerhead Shark, *Sphyrna zygaena* Linnaeus, from the Mexican Pacific Ocean. *Bulletin of Environmental Contamination and Toxicology* 84(4): 488-491.
- Espinoza E & D Figueroa. 2001. The role of sharks in the Galapagos Islands tourism industry. Informe interno Estacion Cientifica Charles Darwin. Islas Galapagos, Ecuador. 7 pp.
- Ferretti, F., R.A. Myers, F. Serena and H.K. Lotze. 2008. Loss of large predatory sharks from the Mediterranean Sea. *Conservation Biology* 22:952-964.
- Fischer, J., Erikstein, K., D'Offay, B., Barone, M. & Guggisberg, S. 2012. Review of the Implementation of the International Plan of Action for the Conservation and Management of Sharks. FAO Fisheries and Aquaculture Circular No. 1076. Rome, FAO. 120 pp.
- Food and Agriculture Organization of the United Nations (FAO). 2010. Report of the third FAO Expert Advisory Panel for the Assessment of Proposals to Amend Appendices I and II of CITES Concerning Commercially-exploited Aquatic Species. Rome, 7–12 December 2009. FAO Fisheries Report. No. 925. Rome, FAO. 144 p
- Food and Agriculture Organization of the United Nations (FAO). 2014. Major fishing areas. May 13, 2014. <http://www.fao.org/fishery/area/search/en>
- Galina, A.B. and Vooren, C.M. 2005. Captura de fêmeas grávidas de *Sphyrna lewini* (Griffith & Smith, 1834) com rede de emalhe na costa do Rio Grande do Sul, durante o verão de 2004/2005. In: II Congresso Brasileiro de Oceanografia, 9-12 de outubro de 2005 (Resumos). Vitória, ES.
- Gallagher, A.J., Orbesen, E.S., Hammerschlag, N. and J.E. Serafy. 2014. Vulnerability of oceanic sharks as pelagic longline bycatch. *Global Ecology and Conservation*. <http://dx.doi.org/10.1016/j.gecco.2014.06.003>.
- Hayes, C.G., Y. Jiao & E. Cortes. 2009. Stock assessment of scalloped hammerhead sharks in the Western North Atlantic Ocean and Gulf of Mexico. *North American Journal of Fisheries Management*.
- Hearn, A., J. Ketchum, A.P. Klimley, E. Espinoza & C. Peñaherrera. 2010. Hotspots within hotspots? Hammerhead shark movements around Wolf Island, Galapagos Marine Reserve. *Marine Biology*. Vol 157(9):1899-1915.
- Henderson, A.C., J.L. McIlwain, H.S. Al-Oufia, and S. Al-Sheiliah. 2007. The Sultanate of Oman shark fishery: Species composition, seasonality and diversity. *Fisheries Research* 86: 159-168.
- Herrera, Marco., Patricia Zarate and Nikita Gaibor. 2003. Los tiburones en la pesquería del Ecuador. Instituto Nacional de Pesca, Ecuador y Estación Científica Charles Darwin. Unpublished report
- Heupel, M. R. and McAuley, R. B. 2007. Sharks and Rays (Chondrichthyans) in the North-west Marine Region. Report to Department of the Environment and Water Resources, National Oceans Office Branch. Hobart, Tasmania.
- Indian Ocean Tuna Commission (IOTC). 2005. Information on shark finning fisheries. IOTC-2005-S9-08[EN]. IOTC, Victoria, Seychelles.
- Indian Ocean Tuna Commission (IOTC). 2011. Report of the Seventh Session of the IOTC Working Party on Ecosystems and Bycatch. Lankanfinolhu, North Malé Atoll, Republic of Maldives, 24-27 October 2011. IOTC-2011-WPEB07-R[E]: 99 pp.
- Instituto Nacional de Pesca (INP). 2000. Sustentabilidad y pesca responsable en México: Evaluación y Manejo. Instituto Nacional de la Pesca, Sagarpa. 111 pp.
- International Union for the Conservation of Nature (IUCN). 2014. IUCN Red List of Threatened Species. Version 3.1. April 21, 2014. <http://www.iucnredlist.org/>
- Jiao, Y., C. Hayes, and E. Cortés. 2008. Hierarchical Bayesian approach for population dynamics modelling of fish complexes without species-specific data. *ICES Journal of Marine Science* 66: 367 - 377.
- Jorgensen SJ, AP Klimley and F Muhlia-Melo. 2009. Scalloped hammerhead shark *Sphyrna lewini*,

- utilizes deep-water hypoxic zone in the Gulf of California. *Journal of Fish Biology* 74: 1682-1687.
- Ketchum, J. T., A. Hearn, A. P. Klimley, C. Peñaherrera, E. Espinoza, S. Bessudo, G. Soler, and R. Arauz. 2014. /Inter island movements of scalloped hammerhead sharks (*Sphyrna lewini*) and seasonal connectivity in a marine protected area of the eastern tropical Pacific. *Mar Bio. International Journal on Life in Oceans and Coastal Waters*. DOI 10.1007/s00227-014-2393-y
- Knip, D.M., M.R. Heupel & C.A. Simpfendorfer. 2010. Sharks in nearshore environments: models, importance, and consequences. *Marine Ecology Progress Series* 402: 1-11.
- Kotas, J.E., Santos, S. dos, Guedes de Azevedo, V., Meneses de Lima, J.H., Neto, J.D. and Lin, C.F. 2000. Observations of shark bycatch in the monofilament longline fishery off southern Brazil and the National Ban on Finning. Abstract available at: <<http://www.pacfish.org/sharkcon/documents/kotas.html>>.
- Kotas, J.E., M. Petrere Jr., dos Santos, S., G. de Azevedo, M. da Rocha Gamba, P.C. Conolly, R.C. Mazzoleni, M. Hostim-Silva, J. Pereira. 2001. Driftnets in southern Brazil. Capítulo da tese de doutoramento. Escola de Engenharia de São Carlos. CRHEA – USP. 66 p.
- Kotas, J.E. 2004. Dinâmica de populações e pesca do tubarão-martelo *Sphyrna lewini* (Griffith & Smith, 1834), capturado no mar territorial e zona econômica exclusiva do sudeste-sul do Brasil. PhD Thesis. São Paulo University – USP. 375 p.
- Kotas, J.E., Petrere, M., Jr., Azevedo, V.G. de, Santos, S. 2005. A pesca de emalhe e de espinhel-de-superfície na Região Sudeste-Sul do Brasil. Série documentos Revizee: Score Sul. 72 p.
- Kotas, J.E., Petrere, M. Jr., Fiedler, F., Mastrochirico, V. & Sales, G. 2008. A pesca de emalhe-de-superfície de Santa Catarina direcionada à captura dos tubarões-martelo, *Sphyrna lewini* (Griffith & Smith 1834) e *Sphyrna zygaena* (Linnaeus 1758). *Atlântica*, Rio Grande, 30(2) 113-128.
- Lack, M. and Sant, G. (2008). Illegal, unreported and unregulated shark catch: A review of current knowledge and action. Department of the Environment, Water, Heritage and the Arts and TRAFFIC, Canberra.
- Martínez-Ortíz J, F Galván-Magaña, M Carrera-Fernández, D Mendoza-Intriago, C Estupiñán-Montaño & L Cedeño-Figueroa. 2007. Abundancia estacional de Tiburones desembarcados en Manta - Ecuador / Seasonal abundance of Sharks landings in Manta - Ecuador. En: Martínez-Ortíz J. & F. Galván-Magaña (eds). Tiburones en el Ecuador: Casos de estudio / Sharks in Ecuador: Case studies. EPESPO - PMRC. Manta - Ecuador. 9 - 27.
- Masselink G, Austin M, Tinker J, O'Hare T & Russell P. 2008). Cross-shore sediment transport and morphological response on a macrotidal beach with intertidal bar morphology, Truc Vert, France. *Mar Geol* 251:141–155
- Maz-Courrau, A., C. López-Vera, F. Galván-Magaña, O. Escobar-Sánchez, R. Rosiles-Martínez, A. Sanjuán-Muñoz. 2012. Bioaccumulation and Biomagnification of Total Mercury in Four Exploited Shark Species in the Baja California Peninsula, Mexico. *Bulletin of Environmental Contamination and Toxicology* 88(2) 129-134.
- Mejía-Falla, P.A. y A.F. Navia. 2010. Efectos de la pesca de arrastre sobre la estructura del ensamblaje de elasmobranchios costeros del Pacífico colombiano. En: Memorias del II Encuentro colombiano sobre conductos. Cali, Colombia. 64 p.
- Mejía-Falla, P.A. y Navia, A.F. 2011. Estadísticas pesqueras de tiburones y rayas en el Pacífico colombiano. Documento Técnico Fundación SQUALUS No FS0111. 70 p.
- Miller M.H., J. Carlson, P. Cooper, D. Kobayashi, M. Namack and J. Wilson. 2013. Status Review Report: Scalloped Hammerhead Shark (*Sphyrna lewini*). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 125p
- Morgan A. and G.H. Burgess. 2007. At-vessel fishing mortality for six species of sharks caught in the northwest Atlantic and Gulf of Mexico. *Gulf and Caribbean Research* 19(2):1-7.
- Myers, R.A., J.K. Baum, T.D. Shepherd, S.P. Powers, and C.H. Peterson. 2007. Cascading effects of the loss of apex predatory sharks from a coastal ocean. *Science*, 30 March 007, 315: 1846-1850.
- Nakano, H. 1999. Characterization of morphology of shark fin products. A guide of the identification of shark fin caught by the tuna longline fishery. Fisheries Agency of Japan.
- Nance, H.A., Klimley, P., Galvan-Magana, F., Martinez-Ortiz, J., Marko, P.B. 2011. Demographic processes underlying subtle patterns of population structure in the scalloped hammerhead shark, *Sphyrna lewini*. *Plos One* 6 (7): 1-12.
- Naylor, G.J.P. et al. 2012. A DNA sequence-based approach to the identification of shark and ray species

- and its implications for global elasmobranch diversity and parasitology. *Bulletin of the American Museum of Natural History* 367:1-262.
- Nomiyama, K., Y. Uchiyama, S. Horiuchi, A. Eguchi, H. Mizukawa, S.H. Hiratac, R. Shinohara, S. Tanabe. 2011. Organohalogen compounds and their metabolites in the blood of Japanese amberjack (*Seriola quinqueradiata*) and scalloped hammerhead shark (*Sphyrna lewini*) from Japanese coastal waters. *Chemosphere* 85(3): 315-321.
- Noriega, R. et al. 2011. Trends in annual CPUE and evidence of sex and size segregation of *Sphyrna lewini*: Management implications in coastal waters of northeastern Australia. *Fisheries Research*, 110 (3): 472-477.
- O'Malley M.P., Lee-Brooks K., Medd H.B. 2013. The Global Economic Impact of Manta Ray Watching Tourism. *PLoS ONE* 8(5): e65051.
- Pauly D, Christensen V, Dalsgaard J, Froese R, Torres F (1998) Fishing down marine food webs. *Science* 279: 860–863.
- Peñaherrera, C, Y. Llerena, I. Keithl 2013. Percepciones sobre el valor economico de los tiburones para el turismo de buceo diario y el comercio en la isla de Sata Cruz Pp.xx-xx. En: Informe Galapagos 2011-2012. DPNG, CGREG, FCD Y GC. Puerto Ayora, Galapagos, Ecuador. Piercy, A.N., Carlson, J.K., Sulikowski, J.A. and Burgess, G. 2007. Age and growth of the scalloped hammerhead shark, *Sphyrna lewini*, in the north-west Atlantic Ocean and Gulf of Mexico. *Marine and Freshwater Research* 58: 34-40.
- Pinhal, D., Shivji, M.S., Vallinoto, M., Chapman, D.D., Gadig, O.B.F., and Martins, C. 2011. Cryptic hammerhead shark lineage occurrence in the western South Atlantic revealed by DNA analysis. *Mar Biol*, Online First, 23, December 2011.
- Quattro, J.M. Evidence of cryptic speciation within hammerhead sharks (genus *Sphyrna*). *Marine Biology*. 148:1143-1155.
- Quattro, J.M., Stoner, D.S., Driggers, W.B. III, Anderson, C.A., Priede, K.A., Hoppman, E.C., Campbell, N.H., Duncan, K.M. & Grady, J.M. (2006) Genetic evidence of cryptic speciation within hammerhead sharks (genus *Sphyrna*). *Marine Biology*, 148, 1143–1155. <http://dx.doi.org/10.1007/s00227-005-0151-x>
- Quattro, J.M. Driggers, W.B.III, Grady, J.M., Ulrich, G.F. & M.A. Roberts (2013) *Sphyrna gilbert* sp. Nov., a new hammerhead shark (Carcharhiniformes, Sphyrnidae) from the western Atlantic Ocean. *Zootaxa* 3702(2):159-178
- Rose, D. A. 1996. Shark fisheries and trade in the Americas, Volume 1: North America. Traffic, Cambridge, U.K
- Rustrian, J.Z. 2010. Edad y crecimiento del tiburón martillo *Sphyrna lewini* (Griffith and Smith 1834) en la Costa Sur de Oaxaca, Mexico. Instituto Politecnico Nacional, Centro Interdisciplinario de Ciencias Marinas, Maestro Tesis, 21 Septiembre, 2010.
- Shing, C.A.C. 1999. Shark fisheries in the Caribbean: the status of their management including issues of concern in Trinidad and Tobago, Guyana and Dominica. *FAO Fisheries Technical Paper (FAO) no. 378*.
- Simpfendorfer, C.A., Cavanagh, R.D., Tanaka, S. and Ishihara, H. 2005. Northwest Pacific. In: Fowler, S. L., Cavanagh, R. D., Camhi, M., Burgess, G. H., Cailliet, G. M., Fordham, S. V., Simpfendorfer, C. A. and Musick, J. A. (eds), *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. Status Survey*. pp. 150-160. IUCN/ SSC Shark Specialist Group, IUCN, Gland, Switzerland and Cambridge, UK.
- Soriano-Velasquez, S.R., J.L. Castillo Geniz, D. Acal Sánchez, H. Santana Hernández, J. Tovar Ávila, C. Ramirez Santiago, L. González Ania, A. Liedo Galindo, y D. Corro Espinosa. 2011 Dictamen Técnico para Considerar Zonas Específicas para la Aplicación de vedas de tiburón y rayas en el Pacífico Mexicano. Instituto Nacional de la Pesca. SAGARPA. Abril 2011.
- Southeast Asian Fisheries Development Center (SEAFDEC). 2006. Report on the Study on Shark Production, Utilization and Management in the ASEAN Region 2003-2004. Southeast Asian Fisheries Development Center Bangkok, Thailand.
- Sperone, E. et al. 2012. Spatiotemporal patterns of distribution of large predatory sharks in Calabria (central Mediterranean, southern Italy). *Acta Adriatica* 53:13-24.
- Stevens, J.D. and J.M. Lyle. 1989. The biology of three hammerhead sharks (*Eusphyrna blochii*, *Sphyrna mokarran* and *S. lewini*) from Northern Australia. *Australian Journal of Marine and Freshwater Research* 40: 129-146.

- Stevens, J. 2005. Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes (eds S.L. Fowler, R.D. Cavanagh, M. Camhi, G.H. Burgess, G.M. Cailliet, S.V. Fordham, C.A. Simpfendorfer and J.A. Musick). IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.
- Suchanek TH (1994) Temperate coastal marine communi- ties—biodiversity and threats. *Am Zool* 34:100–114
- Tapiero, L. 1997. Contribución al conocimiento de la biología y dinámica poblacional de *Sphyrna lewini* (Pisces: Chondrichthyes) en el Pacífico colombiano. Tesis Biol., Univ. Valle, Cali. 143 pp.
- Ulrich, G.F. 1996 “Fishery independent monitoring of large coastal sharks in South Carolina (1993-1995), final report” U.S. NOAA and Interjurisdictional Fisheries Act NA47FI0347-01.
- United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, “Draft Environmental Assessment, Regulatory Impact Review, and Initial Regulatory Flexibility Analysis for a Proposed Rule to Implement the 2010 International Commission for the Conservation of Atlantic Tunas Recommendations on Sharks,” April 2011.
- Vannuccini, S. 1999. Shark utilization, marketing and trade. FAO Fisheries Technical Paper No. 389. FAO. Rome. 470 pp.
- Vargas R., and R. Arauz. 2001. Reporte Técnico de la pesca de palangre de fondo en el talúd continental de Costa Rica. Programa Restauración de Tortugas Marinas PRETOMA. Not published.
- Vitousek PM, Mooney HA, Lubchenco J, Melillo JM (1997). Human domination of earth’s ecosystems. *Science* 277: 494–499
- Vooren, C.M. & Lamónaca, A.F. 2003. Unpublished results of Project “Salvar Seláquios do Sul do Brasil - SALVAR”, available on request. Research Contract FURG/CNPq-PROBIO 0069-00/02. Rio Grande, Fundação Universidade Federal do Rio Grande - FURG.
- Vooren, C.M., Klippel, S. and Galina, A.B. 2005. Biología e status conservação dos tubarão-martelo *S. lewini* e *S. zygaena*, pp: 97-112. In: Vooren. C. M. and Klippel, S. (eds) Ações para a conservação de tubarões e raias no sul do Brasil. Igaré, Porto Alegre.
- Walker, P., Cavanagh, R.D., Ducrocq, M. and Fowler, S.L. 2005. Northeast Atlantic. In: Fowler, S. L., Cavanagh, R. D., Camhi, M., Burgess, G. H., Cailliet, G. M., Fordham, S. V., Simpfendorfer, C. A. and Musick, J. A. (eds), *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. Status Survey*. pp. 71-94. IUCN/ SSC Shark Specialist Group, IUCN, Gland, Switzerland and Cambridge, UK.
- White, W.T., Last, P.R., Stevens, J.D., Yearsley, G.K., Fahmi and Dharmadi. 2006. Economically Important Sharks and Rays of Indonesia. ACIAR Publishing, Canberra, 329.
- Williams, P., and P. Terawasi. 2011. Overview of tuna fisheries in the western and central Pacific Ocean, including economic condition – 2010. WCPFC-SC7-2011/GN WP-1.
- Young, C. 2006. Review of the state of world marine capture fisheries management: Indian Ocean. In: FAO Fisheries Technical Paper, pp. 458. Rome. FAO.
- Zeeberg, J.J., A. Corten & E. de Graaf. 2006. Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa. *Fisheries Research* 78: 186–195.
- Zerbini, A.N. and Kotas, J.E. 1998. A Note on Cetacean Bycatch in Pelagic Driftnetting off Southern Brazil. Report of the International Whaling Commission. Cambridge, U.K.

Appendix I

Population dynamics of *S. lewini*

Growth curve (von Bertalanffy k)	0.13 year ⁻¹ (M, Atlantic NW) 0.09 year ⁻¹ (F, Atlantic NW) 0.13 year ⁻¹ (M, Eastern Pacific) 0.15 year ⁻¹ (F, Eastern Pacific) 0.22 year ⁻¹ (M, Western Pacific) 0.25 year ⁻¹ (F, Western Pacific)	Piercy et al, (2007) Tolentino y Mendoza (2001) Chen et al (1990)
Length as first maturity	131 cm FL (M, Atlantic NW) 180-200 cm FL (F, Atlantic NW) 152 cm FL (M, Western Pacific) 161 cm FL (F, Western Pacific) 108-123 cm FL (M, Australia) 154 cm FL (F, Australia) 138-154 cm FL (M, Atlantic SW) 184 cm FL (F, Atlantic SW) 135 cm FL (M, Indo-Pacífico)	Tolentino y Mendoza (2001) Chen et al (1988) Stevens y Lyle (1989) Hazin et al (2001) White et al (2008)
Age at first maturity	6 year (M, Atlantic NW) 15-17 year (F, Atlantic NW)	CITES, 2013
Life span	30.5 year (Atlantic NW) 12.5 year (Eastern Pacific) 14 year (Western Pacific)	Piercy et al (2007) Tolentino y Mendoza (2001) Chen et al (1990)
Gestation period	8-12 months (Global)	Chen et al (1988) Hazin et al (2001) White et al (2008)
Reproductive cycle	2 year	Chen et al (1988) Hazin et al (2001) White et al (2008)
Average clutch size	Área de distribución normal =12-41 23 (Atlantic NW) 14 (Atlantic SW) 25-26 (Indo-Pacific)	Chen et al (1988) Hazin et al (2001) White et al (2008) Tapiero (1997)
Growth rate (r)	0.09 year ⁻¹	Cortés et al (2009)

Appendix II

Global *S. lewini* population trends

Year	Site	Data set	Tendencies	Reference
1972-2003	Atlantic NW	Independent fisheries study (CPUE)	Reduction of	Myers et al (2007)
1992-2003	Atlantic NW	Pelagic longline onboard data (CPUE)	Reduction of 89%*	Baum et al (2003)
1992-2005	Atlantic NW	Commercial longline observer program (CPUE)	Reduction of 76%*	Baum et al (2003)
1983-1984 y 1991-1995	Atlantic NW.	Independent fisheries study (CPUE)	Reduction of 66%	Ulrich (1996)
1994-2005	Atlantic NW	Commercial driftnet observer program (CPUE)	Reduction of 25%*	Carlson et al (2005)
1994-2005	Atlantic NW	Shark longline observer program (CPUE)	Increase of 56%*	Hayes et al (2009)
1995-2005	Atlantic NW	Independent fisheries study (CPUE)	Reduction of 44%*	Ingram et al (2005)
1981-2005	Atlantic NW	Stock assessment (CPUE)	Reduction of 72%*	Jiao et al (2008)
1981-2005	Atlantic NW	Stock assessment (CPUE)	Reduction of 83%*	Hayes et al (2009)
1898-1922 1950-2006 1978-1999 1827-2000	Mediterranean	Longline sightings (CPUE)	Reduction of 99%*	Ferretti et al (2008)
1993-2001	Pacific SW	Landings	Reduction of 60-90%	Vooren et al (2005)
1992-2004	Eastern Pacific	Sightings	Reduction of 71%*	Myers et al (2007)
2004-2006	Eastern Pacific	Landings	Reduction of 51%	Martínez-Ortiz et al (2007)
1963-2007	Western Pacific	Beach sein (CPUE)	Reduction of 85%	de Jong y Simpfendorfer (2009)
1978-2003	Western Indian	Beach sein (CPUE)	Reduction of 64%*	Dudley y Simpfendorfer (2006)
1997-1998 y 2004-2005	Eastern Pacific	Catch (CPUE)	Reduction of 50-75%	Heupel y McAuley (2007)