CHAPTER 2.2.1.2 SHORTFIN MAKO	AUTHORS: J. Valeiras and E. Abad (IEO)	LAST UPDATE: Sept 4, 2006

2.2.1.2 Description of Shortfin Mako (SMA)

1. Names

1. a. Classification and Taxonomy

Species name: *Isurus oxyrinchus* Rafinesque, 1810
ICCAT species code: SMA
ICCAT names: Shortfin mako (English), Taupe bleue (French), Marrajo dientuso (Spanish)

According to Compagno (2001), the shortfin mako is classified as follows:

- Phylum: Chordata
- Subphylum: Vertebrata
- Superclass: Gnathostomata
- Class: Chondrichtyes
- Subclass: Elasmobranchii
- Superorder: Galeomorphi
- Order: Lamniformes
- Family: Lamnidae

1. b. Common names

List of vernacular names used by different countries according to ICCAT, FAO and Fishbase (www.fishbase.org).

The list of countries is not exhaustive and some local names might not be included.

Adriatic: Psina cavlozuba, Psina dugonoska.
Albania: Peshkagen tonil.
Australia: Blue pointer, Mackerel shark, Mako shark, Shortfin mako, Snapper shark.
Azores Islands: Mako, Marracho, Rinquim, Shortfin mako, Marrajo criollo.
Bahamas: Mako.
Brazil: Anequim, Cação-anequim, Cação-atum, Cação-atun, Cação-moro, Mako, Sombreiro, Tubarão-sombreiro.
Cambodia: Chlarm.
Canary Islands: Janequín, Marrajo.
Cape Verde: Anequim, Marracho, Peixe-ruim, Tubarão, Tubarão-anequim, Tubarão-azul.
Chile: Marrajo, Tiburón.
China Main: 灰鯖鯊, 尖吻鯖鯊, Hui qing sha.
Chinese Taipei: 灰鯖鮫.
Colombia: Carito.
Congo Republic: Moussodji.
Cuba: Atlantic mako, Cane de mare, Dentuda, Dentuse, Dientuse, Dientuso azul, Mackerel porbeagle, Pesce tondo.
Cyprus: Skyllopsaro.
Czech Republic: Žralok mako krátkoploutvý.
Denmark: Almindelig makohaj, Makrelhaj, Sildehaj.
Ecuador: Tinto.
Egypt: Deeba.

Finland: Makrillihai.
France: Lamie, Mako, Marache, Requin-taupe bleu, Taupe bleu, Taupe bleue.
Germany: Blauhai, Mako, Makohai, Makrelenhai.
Greece: Ρυγχοκαρχαρίας, Καρχαρίας, Carcharias, Rynchocarcharias, Rynchokarcharias, Σκυλόψαρο.
Guyana: Pointed nose shark, Sharp-nosed shark, Sharpnose mackerel shark.
India: Ganumu sora, Ganumu sorrah, Ganumu-sorrah, Shortfin mako, Shortfin shark.
Iran: Kooseh-e-vahshi.
Israel: Amlez.
Italy: Cagna, Cagnia, Cagnizzo, Canesca, Cani di mari, Cani di mari de Messina, Caniscu, Cranicia, Meanto, Muanto, Ossirina, Ossirina dello apallanzani, Pisci tunnu, Piscicani, Squalo mako, Tunnu palamitu.
Japan: Aozame, Morozame, Awozame.
Korea Republic: Ch'ong-sang-a-ri.
Lebanon: Qarsh.
Malta: Pixxiplamptu, Pixxitondu, Shortfin mako, Squalo mako.
Mauritius: Bleu pointu, Blue shark, Mako, Peau bleue, Requin bleu, Requin maquereau, Requin-tigre.
Mexico: Mako, Tiburón marrajo, Alecrín.
Morocco: Al karch.
Mozambique: Anequin barbatana curta.
Namibia: Kortvin-mako.
Netherlands Antilles: Mako, Spitssnuitmakreelhaai, Tribon blou, Tribon mula,
Netherlands: Haringhaai, Kortvinmakreelhaai.
New Zealand: Mako, Mako shark, Ngutukao, Shortfin mako.
Nicaragua: Marrajo dientuso.
Niue: Mako paala, Mako shark.
Norway: Makrellhai.
Papua New Guinea: Shortfin mako.
Peru: Mako, Tiburón bonito.
Philippines: Pating.
Poland: Rekin ostronosy.
Portugal: Marracho-azul, Tubarao-anequim, Tubarão-anequim.
Puerto Rico: Mako, Tiburon carite.
Romania: Rechin macrou.
Samoa: Aso-polota.
Senegal: Gisandoo, Guissando, Requin maquereau, Sidi, Walandol.
Somalia: Cawar.
South Africa: Kortvin-mako, Shortfin mako, Porpoise shark, Blue porpoise shark, Sharpnose mako, Mambone, Moro.
Spain: Atunero, Cane de mare, Diamante, Dientuso, Maco, Marrajo, Marrajo dientuso, Solraig, Tiburón azujelo, Tiburón bonito, Tiburón carito, Tinto.
St Helena: Dog shark, Mackerel shark, Shortfin mako.
Suriname: Haai, Sartji.
Sweden: Mako, Makrillhaj.
Tahiti: Ma'o a'ahí.
Tanzania: Papa nyamarasi, Papa nyamzani, Papa sumbwi.
Trinidad Tobago: Sharp-nosed shark, Sharpnose mackerel shark.
Turkey: Canavar baligi, Dikburun, Dikburuncanavar baligi, Sivriburuncanavar baligi.
UK: Atlantic mako, Bonito shark, Sharp-nose mackerel shark, Sharp-nosed mackerel shark, Shortfin mako, Shortfinned mako.
USA: Blue pointer, Mackerel shark, Mako, Mako shark, Shortfin mako, Bonito shark.
Venezuela: Tiburón carite.
Vietnam: Cá Nhám mõm nhọm.

2. Identification

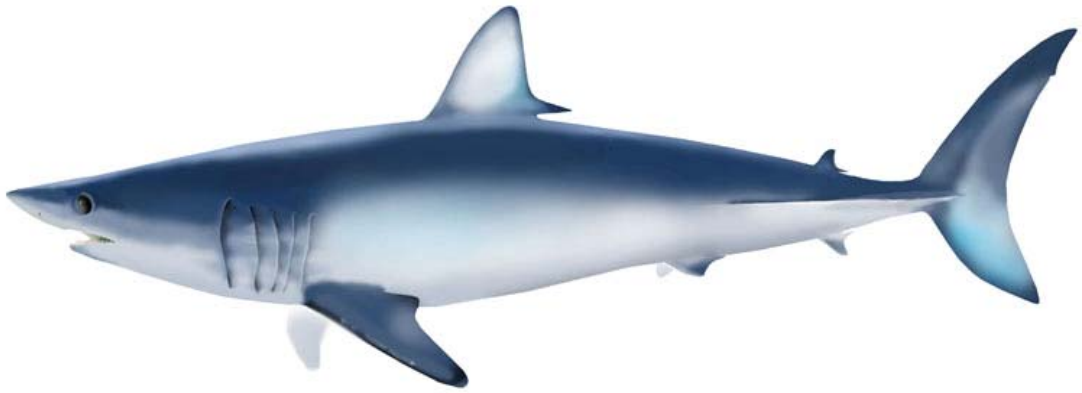

Figure 1. Drawing of a shortfin mako (by A. López, 'Tokio').

Characteristics of *Isurus oxyrinchus* (see Figure 1 and Figure 2). (Mostly from Compagno, 2001).

Shortfin mako maximum size in Atlantic is 396cm, estimated maximum total length about 408 (Compagno, 2001).

Colour:

- Dorsolateral coloration brilliant blue or purplish in life, lighter metallic sides.
- Ventral surface of body usually white.
- Head: White below underside of snout in young and adults. Dark in mako from Azores ('marrajo criollo'). Dark colour of head partially covering gill septa, lower part of second and third gill septa white.
- First dorsal fin with pale centre (more obvious in young than adults).

External:

- Spindle-shaped body.
- Long and acutely conical snout.
- Large first dorsal fin and small second dorsal and anal fins.
- Origin of first dorsal fin over or just behind the pectoral free rear tip.
- Pectoral fins rather narrow-tipped and with anterior margins less than head length.
- Strong keel on caudal peduncle without secondary keels
- Large blade-like teeth without cusplets or serrations.
- Lower anterior teeth strongly protruding and horizontal on jaws even when mouth is closed.

Internal:

- Vertebrae: 182 to 195, mostly below 190
- Cranium with rostral cartilages neither swollen nor hypercalcified.
- Intestinal valve count 47 to 54.

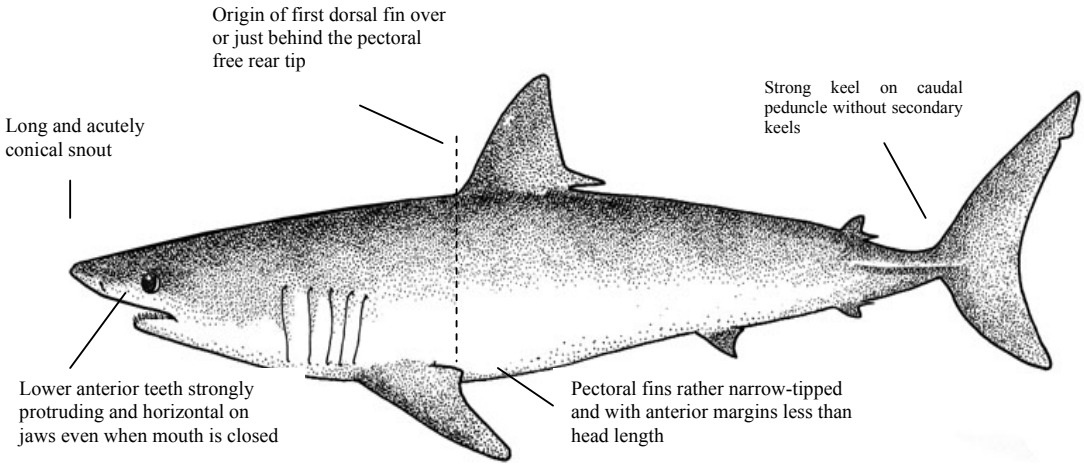

Figure 2. Synthesis of the most outstanding characteristics of shortfin mako (by A. López, 'Tokio').

3. Distribution and population ecology

3. a. Geographical distribution

Coastal and oceanic, circumglobal in temperate and tropical waters **(Figure 3)**. Distributed at Western Atlantic from Gulf of Maine to southern Brazil. In East Atlantic from Norway to west coast of South Africa, including Mediterranean Sea.

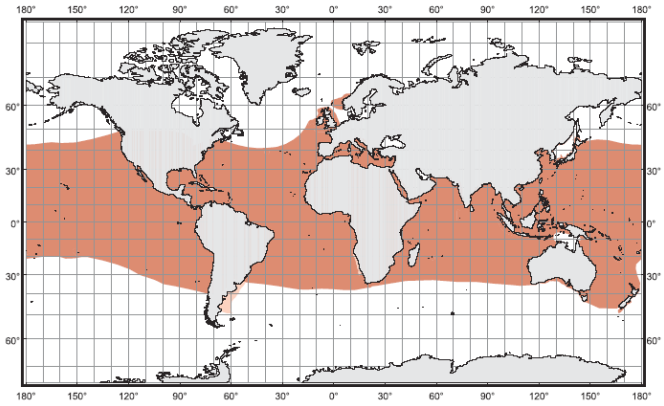

Figure 3. Geographical distribution of *Isurus oxyrinchus* (from Compagno 2001).

3. b. Habitat preferences

Shortfin mako is an epipelagic species occurring in offshore waters in tropical and warm-temperate seas within the 16°C in both hemispheres, mostly caught at a range of water temperatures of 17-22ºC. In southeastern United States waters archived tag data indicated a depth range of 0 to 556 m in ambient temperatures between 10.4 and 28.6 degree C. The shortfin mako demonstrated a diel pattern of vertical movement defined by greater mean depths and larger depth ranges during daylight hours (Loefer 2005).

3. c. Migrations

The shortfin mako is a highly migratory species in Atlantic. This species is the fastest shark and a very active fish. Movements of sharks in North Atlantic are known from tagging data programs. Casey and Kohler (1992) suggested that makos may travel up the Gulf Stream and around the Sargasso Sea to return to the East Coast of North America, with few crossing the Mid-Atlantic Ridge and reaching European waters. In the extreme

northern and southern parts of its range, has a tendency to follow movements of warm water masses polewards in the summer.
From tagging data in the Atlantic would indicate that migration is restricted to within each hemisphere or in the vicinity there of, with generally no trans-equatorial migration being seen until they approach the equatorial limits (Mejuto *et al*. 2005).

4. Biology

4. a. Growth

Biological data on age and growth of shortfin mako in Atlantic water are incomplete and several characteristics remain unknown. Shortfin makos are born at approximately 63 cm FL (Castro 1983, Mollet *et al.* 2000) and grow to 370 cm FL (Bigelow and Schroeder 1948). Age estimates were obtained for the shortfin mako in the western North Atlantic by Pratt and Casey (1983). Non-validated age estimates for the mako in the western North Atlantic were determined using four methods (temporal length-month analysis, tag/recapture data, length-frequency data, and vertebral band counts). Based on consistency between methods, they assumed that two growth rings were formed each year on the vertebral central of shortfin makos, though Cailliet *et al.* (1983) suggested that one ring per year was formed. The biannual theory of band periodicity in lamnoids has been under continued debate and is under revision using updated techniques and increased sample sizes with an emphasis on obtaining validation (Natanson 2002). Recent studies on radiocarbon signature of vertebral growth band of one shortfin mako sample (Campana *et al.* 2002) supported the hypothesis that one band pair is produced per year. Recent age and growth study of Shortfin mako shark in North Pacific Ocean caught by Japanese longline (Senba 2003) supports one growth band pair per year hypothesis but resulting growth curve was intermediate of existing hypothesis (Takeuchi *et al*. 2005). New ageing results from Campana *et al.* (2005) indicate that the species grows more slowly than was reported previously, thus making the population less productive and more susceptible to overexploitation than has been reported. The ICCAT Subcommittee on By-catches assumed the sex combined growth curve of Senba for assessment purposes (Anon. 2005).

Table 1. Growth parameters for shortfin mako (L∞ in cm, K in y-1, t0 in y).

Growth Parameter			Area	Reference	Sex	Method
L∞	k	t_0				
310	0.084	-3.083	Pacific	Senba (2003)	All	Vertebrae
310	0.13	-1.77	Pacific	Senba (2003)	Females	Vertebrae
282	0.18	-1.35	Pacific	Senba (2003)	Males	Vertebrae

4. b. Length-Weight relationship

Published length-weight relationships for several geographical areas in Atlantic are showed in **Table 2**.

Table 2. Published shortfin mako length-weight relationships.

Equation	N	FL range (cm)	Area	Reference
RW=0.0000052432 $FL^{3.1407}$	2081	65-338	Northwest Atlantic	Kohler et al., 1995
W= 7.2999 x TL (m) $^{3.224}$	63	-	western North Atlantic	Mollet et al., 2000
W= 6.824 x TL (m) $^{3.137}$	64	-	southern Hemisphere	Mollet et al., 2000
DW= 0.000002808 $FL^{3.202}$	17	70-175	Northeast Atlantic	García-Cortés and Mejuto, 2002
DW= 0.00001222 $FL^{3.895}$	166	95-250.	Tropical East Atlantic	García-Cortés and Mejuto, 2002
DW= 0.0000252 $FL^{2.76}$	22	120-185	Tropical Central Atlantic	García-Cortés and Mejuto, 2002
DW= 0.00003114 $FL^{2.724}$	97	95-240	Southwest Atlantic	García-Cortés and Mejuto, 2002

4. c. Reproduction

Biological data on reproduction of shortfin mako in Atlantic water are incomplete and several facts remain unknown.

Spawning

A temporal analysis of uterus width index and gonadosomatic index of pregnant and postpartum females indicated that the reproductive cycle is three years. Embryo length-at-capture data predicted a gestation period of 15-18 months and late winter to mid-spring parturition in both hemispheres (Mollet *et al.* 2000).
Maturity

Stevens (1983) reports size at maturity for male and female shortfin makos as 179 and 258 cm FL, respectively. A median size at maturity of females from the western North Atlantic is given as 275 cm FL. This is larger than that of females from the Southern Hemisphere (252 cm FL) (Mollet *et al.* 2000). Stillwell (1990) suggested that makos achieved adult size in 4.5 years for males and 7 years for females.

Sex ratio

Sex ratio 1:1 held true until approximately 240 cm FL, after which there was a shift to a preponderance of females (Casey and Kohler 1992). Overall, information on adults larger than 240 cm FL is extremely sparse, but a few males and females exceeding this size have been reported from both the western (Casey and Kohler 1992) and eastern Atlantic (Mejuto 1985). Sex ratio data provided by Mejuto and Garcés (1984) for mako sharks taken in the eastern Atlantic longline fishery shows that for the area between Spain and the Azores, there are a much higher percentage of males at sizes of more than 200 cm FL (male/female sex ratio of 1:0.4). In western Mediterranean, sex ratio is close to 1:0.9 with a slight dominance of females (de la Serna *et al.* 2002).

This species segregates by size and sex during various times of their life history (juveniles, adult females and males) (Kohler *et al.* 2002).

Fecundity

Size at birth was approximately 70 cm total length (TL) and litter size varied from 4 to 25, increasing with maternal size (Mollet *et al.* 2000).

4. d. Diet

The shortfin mako primarily feeds on other fishes, with a wide variety of prey recorded. Prey items are typically much smaller than the mako, and off South Africa range between 10 and 35% of the length of the predator. However, Stillwell (1990) suggested that large makos shifted to large prey near their own size, with swordfish (*Xiphias*) weighing 180 kg or more being commonly taken by large and presumably adult makos (males about 136 kg and females 337 kg) in the western North Atlantic.

The mako eats both pelagic and demersal bony fish and elasmobranchs. In the western North Atlantic, bluefish are the most important food and comprise about 78% of the shortfin mako's diet (Stillwell and Kohler 1982). Off South Africa elasmobranchs were the most important prey, followed by teleosts and cephalopods (squid), but in the western North Atlantic teleosts were the most important prey while elasmobranchs were virtually unrepresented. Off southern Brazil, Teleostei as *Brama brama* and *Lepidocybium flavobrunneum* predominate in stomach contents (Vaske-Junior and Rincon-Filho 1998). Cephalopods are important prey and include a variety of inshore and oceanic and deep-benthic squids. Other food includes sea turtles, small cetaceans and invertebrates. In the northwest Atlantic, analysis of stable isotope analysis in tissues, showed evidence of a cephalopod to bluefish (*Pomatomus saltatrix*) diet switch in the shortfin mako in spring (MacNeil 2005).

From prey types and other information, makos apparently feed at or near the surface and well below it, and may feed on bottom prey when close inshore. Stillwell and Kohler (1982) estimated that a 68 kg mako might consume about 2 kg of prey per day, and could eat about 8 to 11 times its body weight per year. Stillwell (1990) suggested that makos might consume up to 15 times their weight per year.

4. e. Physiology

This species are endothermic and maintain higher temperatures than surrounding water temperatures in musculature, brain, eyes and viscera with countercurrent vascular heat exchangers (Carey and Teal 1969; Carey *et al.* 1985; Carey 1982, 1992; Block and Carey 1985). Body muscle may run 1 to 10°C higher than ambient temperature depending on water.

5. Fisheries biology

5. a. Populations/Stock structure

Casey and Kohler (1992) hypothesized that the western North Atlantic makos form a separate population or stock to those in the eastern Atlantic although intermixing is possible as shown by crossings to the Azores and Europe. There are problems in understanding the population structure of western North Atlantic makos because large adults, particularly females, are little-known in the area although juveniles are abundant. The ICCAT Subcommittee on By-catches assumed three different stocks in Atlantic: North, South and Mediterranean (Anon. 2005).

5. b. Description of fisheries: catches and effort

Pelagic sharks are an important by-catch of longline fisheries that target tunas, billfishes and swordfishes. The SCRS Sub-Committee on By-catches of ICCAT began an assessment of pelagic sharks in 2001. Shortfin mako are caught in a variety of gears in the Atlantic Ocean, Gulf of Mexico, and Caribbean, including longlines, gillnets, handlines, rod and reel, trawls, trolls, and harpoons, but they are mostly caught as by-catch in pelagic longline fisheries targeting tuna and swordfish and sometimes targeted. There are also recreational fisheries in some countries like the United States, Canada, UK, and Ireland (Anon. 2005).

Total catch is probably underestimated **(Figure 4)** due to misreporting of by-catches as well as the probably inadequate reporting of several fisheries landing (Anon. 2005). ICCAT reported nominal annual catches reach 6,275 t in 2003. Average estimated landings from 1981 to 2004 is 2,336 t.

Regarding the stock assessment, there are uncertainties of the stock status of both North and South Atlantic shortfin mako since the available data are quite uninformative and due to the uncertain data on life history parameters of the species. For the North Atlantic shortfin mako it is likely that they have historically experienced some level of stock depletion as suggested by the historical CPUE trend. It is possible than current stock be below biomass at MSY in the North Atlantic as trends in CPUE suggests depletions of fifty percent or more could have occurred. For the South Atlantic shortfin mako, the stock may have decreased since 1971, but the magnitude of decline appears less than in the North Atlantic. The current biomass may be above the biomass at MSY, but due to the lack of a clear signal from the catch rates, there is a wider variety of possible historical stock trends. The range of estimates includes depletions from almost none, to levels close to biomass at MSY, indicating the stock might currently be fully exploited (Anon. 2005). In the Mediterranean, there is an absolute dominance of juveniles short fin makos in the recent Mediterranean catches (de la Serna et al., 2002; Megalofonou *et al*. 2005). Historical data indicate that shortfin mako was an abundant species in the Mediterranean Sea along the past century (Kosic 1903) and historical records in the Eastern Mediterranean reported large matured shortfin makos (Soldo and Jardas 2000).

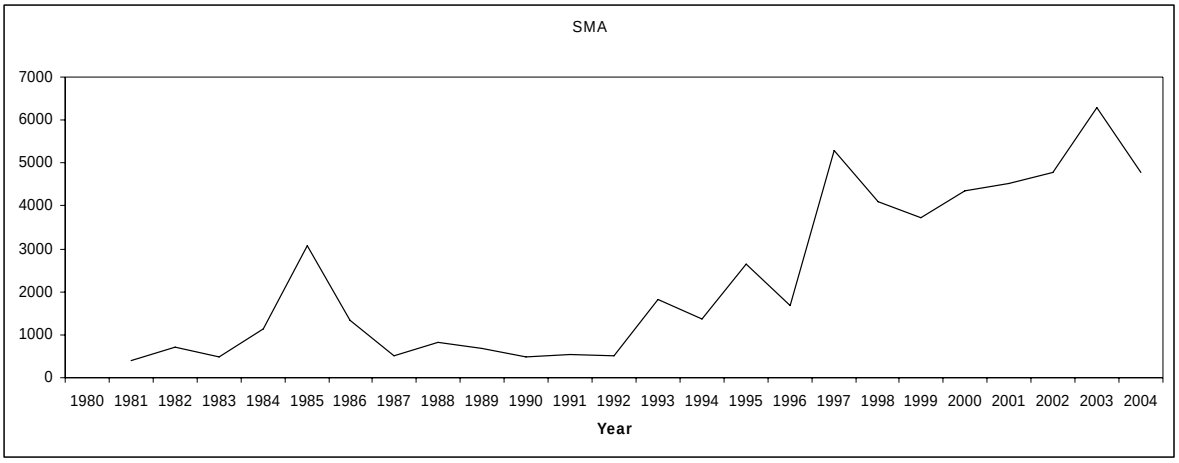

Figure 3. Nominal catch of shortfin mako in the Atlantic Ocean communicated to ICCAT (t).

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