Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien

Report of the Third Session of the IOTC Working Party on Ecosystems and Bycatch

(previously the Working Party on Bycatch)

Seychelles, 11 - 13 July 2007

TABLE OF CONTENTS

1. OPENING OF THE MEETING AND ADOPTION OF THE AGENDA

1. The third Meeting of the Working Party on Ecosystems and Bycatch (WPEB), formerly the Working Party on Bycatch, was opened on 11 July 2007 in Victoria, Seychelles, by the caretaker Chairperson Mr Kevin McLoughlin.

2. Mr McLoughlin welcomed the participants (Appendix I) and the agenda for the Meeting was adopted as presented in Appendix II.

3. The list of documents presented to the meeting is given in Appendix III.

4. The WPEB acknowledged the new terms of reference for the Working Party on Ecosystems and Bycatch that were adopted by the Commission at its 11th Session (Appendix IV).

2. REVIEW OF THE DATA ON ECOSYSTEMS AND BYCATCH

2.1 STATUS OF IOTC DATABASES

Data currently available on bycatch species (IOTC-2006-WPBy-03)

5. Given the lack of new information reported to the Secretariat since 2006, the 2006 report on the status of the IOTC databases was re-presented to the WPEB.

6. The collection and reporting of data on bycatch has been uneven over time and as a consequence, the data held in the IOTC database are very incomplete. Non-tuna species that have catches recorded in the IOTC database are listed in Table 1.

7. Most of the bycatch data held by IOTC relates to sharks; however, several factors combine to make it difficult to estimate the total catches of sharks in the Indian Ocean. For example, the catches of sharks, when reported, typically represent only the sharks that were retained on board, and in many cases, they refer to dressed weights and no indication is given on the type of processing that took place. Furthermore, in the past, when only fins were retained on board, fishers rarely recorded the weights or numbers of sharks from which the fins were taken.

8. To date, the IOTC Secretariat has not received any reports from members or cooperating parties on the amounts of sea birds, sea turtles or other fauna caught incidentally by their vessels, although some information has been presented in papers to the first two sessions of the WPEB. Most of the information that is available comes from research programmes or from other Regional Fishery Bodies, such as the CCSBT. These data refer in most cases to the catches of seabirds or other species by longline fisheries in specific areas and periods. The WPEB recalled the adoption of IOTC Resolutions intending to mitigate the catches of these species and/or promoting the collection and reporting of data and further encouraged all IOTC members and cooperating parties to increase the amount of information available in the future.

9. Observer programmes are one of the most important sources of data on bycatch species. The WPEB noted that coverage by observer programmes in the Indian Ocean is currently very low which means that it is unable to provide reliable estimates of the overall total catch of non-target species. Furthermore, the IOTC Secretariat does not currently hold data from any of the observer programmes operating in the Indian Ocean.

Table 1. *Non-tuna species that have catches recorded in the IOTC Database.*

Gear	Species	Espèce
Purse Seine	Species Aggregates	*Agrégés d'espèce*
Baitboat	Blue mackerel	*Maquereau tacheté*
	Dogtooth tuna	*Bonite à gros yeux*
	Striped bonito	*Bonite oriental*
	Species Aggregates	*Agrégés d'espèce*
Gillnet	Blue shark	*Peau bleue*
	Oceanic whitetip shark	*Requin océanique*
	Shortfin mako	*Taupe bleue*
	Silky shark	*Requin soyeux*
	Species Aggregates	*Agrégés d'espèce*
	Dogtooth tuna	*Bonite à gros yeux*
	Indian mackerel	*Maquereau des Indes*
	Striped bonito	*Bonite oriental*
	Species Aggregates	*Agrégés d'espèce*
Line	Blacktip reef shark	*Requin pointes noires*
	Blue shark	*Peau bleue*
	Broadnose sevengill shark	*Platnez*
	Copper shark	*Requin cuivre*
	Dusky shark	*Requin de sable*
	Shortfin mako	*Taupe bleue*
	Smooth hammerhead	*Requin marteau commun*
	Smooth-hound	*Emissole lisse*
	Tope shark	*Requin-hâ*
	Species Aggregates	*Agrégés d'espèce*
	Kanadi kingfish	*Thazard kanadi*
	Common dolphinfish	*Coryphène commune*
	Dogtooth tuna	*Bonite à gros yeux*
	Striped bonito	*Bonite oriental*
	Species Aggregates	*Agrégés d'espèce*
Longline	Angular rough shark	*Centrine communes*
	Bigeye thresher	*Renard a gros yeux*
	Blue shark	*Peau bleue*
	Bonnethead, hammerhead sharks	*Requins marteau*
	Broadnose sevengill shark	*Platnez*
	Copper shark	*Requin cuivre*
	Dusky shark	*Requin de sable*
	Longfin mako	*Petite taupe*
	Oceanic whitetip shark	*Requin océanique*
	Porbeagle	*Requin-taupe commun*
	Scalloped hammerhead	*Requin marteau halicorne*
	Shortfin mako	*Taupe bleue*
	Silky shark	*Requin soyeux*
	Smooth hammerhead	*Requin marteau commun*
	Smooth-hound	*Emissole lisse*
	Tiger shark	*Requin tigre commun*
	Tope shark	*Requin-hâ*
	Species Aggregates	*Agrégés d'espèce*
	Barracudas	*Brochets de mer*
	Black escolar	*Escolier noir*
	Butterfly kingfish	*Thon papillon*
	Common dolphinfish	*Coryphène commune*
	Dogtooth tuna	*Bonite à gros yeux*
	Oilfish	*Ruvet*
	Rainbow runner	*Comète saumon*
	Species Aggregates	*Agrégés d'espèce*
Other	Species Aggregates	*Agrégés d'espèce*
	Blue mackerel	*Maquereau tacheté*
	Dogtooth tuna	*Bonite à gros yeux*
	Indian mackerel	*Maquereau des Indes*
	Striped bonito	*Bonite oriental*
	Species Aggregates	*Agrégés d'espèce*

2.2 REVIEW OF THE INFORMATION AVAILABLE ON THE INCIDENTAL CATCH OF NON-TARGET SPECIES IN THE INDIAN OCEAN BY THE IOTC SECRETARIAT

A review of the information on Bycatch in the Indian Ocean (IOTC-2007-WPEB-11)

10. This document reviewed the information available on the incidental catch of non-target species in the Indian Ocean. This work was requested by the Scientific Committee and the Working Party on Bycatch and undertaken by the IOTC Secretariat. In an effort to assess the extent of the bycatch issue, data collection programmes were contacted in six IOTC members: Australia, the United Kingdom – for the British Indian Ocean Territory, the European Community (representing France, Spain, Italy and Portugal), Japan, Madagascar and China, two Cooperating Non Contracting Parties, Indonesia and South Africa, and Non Governmental Organizations (NGOs) WWF and BirdLife. Other CPCs were contacted but did not provide any data. The main bycatch from all fishing gears is sharks. Seabirds were reported in the catches of longline gears only. Turtle interactions remain poorly documented and reported, but catches occur in longline fisheries and in purse-seine fisheries when using Fish Aggregation Devices (FADs).

11. More institutions than expected were found to collect data on bycatch but the quality of the information recovered remains generally low due to the poor resolution of the data collected (i.e. it is generally not recorded by gear or species) and/or low coverage rates of the data collection. In some cases, delays or unwillingness of some institutions to give the authorization for data transmission made it difficult to get the raw data.

2.3 GENERAL PAPERS PRESENTED

Catch and distribution of bycatch species and discards from the Spanish tropical purse-seine fishery (IOTC-2007-WPEB-05)

12. This document presented results about tuna discards, and the catch and distribution of species associated with free schools and floating objects. The data analysed came from 34 trips with observers from the Spanish Oceanographic Institute. A total of 1054 days fishing, including 863 sets were undertaken in the presence of observers. Data on tuna catches, discards and bycatch, by gear and year for the Spanish tropical purse-seine fleet between 2003 and 2006 are included. When fishing over objects skipjack tuna had the highest rate of discards, except for one year, when it was surpassed by frigate tuna. The most common bycatch associated with floating objects was small fish followed by sharks and billfishes. The most common bycatch associated with free schools was shark. Between 2003 and 2006 a total of 61 sea turtles were caught in fishing on FADs and 2 sea turtles were caught during fishing on free schools.

Comparison of bycatch species captured during daytime and nightime: preliminary results of longline experiments carried out in Seychelles waters (IOTC-2007-WPEB-16)

13. This document described the results of a study to compare bycatch that occurred during night sets and day sets. 69 fishing experiments using an instrumented longline (hook timer, temperature depth recorder) were carried out in Seychelles waters from December 2004 to May 2006 on board a small scale research longliner. Two types of sets were performed: some during night (setting at dusk and hauling at dawn) with shallow basket to principally target swordfish and some during day (inverse cycle of night set) with shallow and deep baskets to target tuna.

14. Results showed a difference between the two strategies in terms of species composition, quantity, and depth of catch. Day sets had more bycatch than night sets. Thirteen bycatch species were caught including sharks, sailfish, skipjack and black marlin, blue marlin and dolphinfish. Skipjack, oilfish and ocean sunfish were caught mainly during the nightime and oarfish and pomfret were mainly caught during the day. Lancetfish was the main bycatch species during daytime sets. By contrast sharks were the main bycatch at night. 13 species of sharks were captured with blue shark and silky shark being the most common. Catch rates ranged from less than 1 fish per 1000 hooks (ocean

sunfish, oarfish, pomfret) to almost 12 fish per 1000 hooks (for lancetfish). The mean catch rates for sailfish and sharks, respectively, were around 4 fish per 1000 hooks; however, the catch rate of sharks at night was 8 per 1000 hooks. Overall, setting in the daytime with some baskets targeting deeper layers does not appear to be an effective solution to reduce either bycatch or discards. On the contrary in these experimental fishing trips daytime sets had higher catches of bycatch.

2.4 DISCUSSIONS AND RECOMMENDATIONS ON DATA

Data related issues for bycatch

15. The following problems related to the data for the major bycatch species have been identified:

- Much shark catch data are not available: there is little information prior to the early 1970's available, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (the catches of sharks for which only the fins are kept on board or of sharks usually discarded because of their size or condition and are rarely recorded) or they reflect dressed weights instead of live weights.
- Poor resolution of shark catch data: the catches of sharks are usually not recorded by species or gear. Furthermore, the mis-identification of whole sharks is very common and identification of carcasses, fins or other products is difficult. Consequently, the estimates of shark catches by species are highly uncertain.
- Few shark size-frequency data are available: there is a paucity of length and weight data available for Indian Ocean shark species.
- There is little biological information on sharks available: there is a paucity of biological data available for Indian Ocean shark species. Some formulae to convert processed weight to round weight for sharks are available from the FAO but these usually do not cover fins. The IOTC Secretariat has been deriving length to weight relationships for IOTC species, including sharks.
- There is also a paucity of information on the catches of sea turtles, sea birds or other associated fauna. The only information available on the incidental catches of sea turtles, sea birds or other fauna by tuna and/or tuna-like fisheries in the Indian Ocean comes from observer programmes. While such programmes remain one of the most valuable sources information, the low coverage of observer programmes in the region currently restricts assessment of bycatch. Some information on the incidental catches of sea birds by some longline fleets operating in the Southern Indian Ocean is also available (from CCSBT).

16. The WPEB strongly encouraged CPC's to submit all relevant data on bycatch to IOTC Secretariat.

Using observers to collect data on bycatch

17. Recognising that the best opportunities for obtaining accurate data on bycatch are likely to come from observer programmes, the WPEB was encouraged by the ongoing implementation of national observer programmes. The WPEB strongly encourages further collaboration between observer programmes and expansion and implementation of new observer programmes for the Indian Ocean. The WPEB reiterated that the following attributes in any such programme are desirable:

- All the major fleets should be covered and the levels of coverage should be such that estimates of total catch have an acceptable precision, including those for rare species.
- Observers should focus on recording information on discards as the windows of opportunity for obtaining this information are much shorter than those for obtaining information on target species (some of which can be collected at the dock).

18. Furthermore, the WPEB strongly recommended that a high level of regional coordination be provided by the Commission covering data collection, data exchange, training and the development of guidelines for the operational aspects of such programmes.

19. The WPEB noted the recent publication on 'Best practices for collection of longline data to facilitate research and analysis to reduce bycatch of protected species' (IOTC2007-WPEB-INF03) and recommended that this be used to guide the collection of data on seabirds.

20. Information on the different categories of FADs used by the purse seine fisheries should be included in the data collected by the observers at sea, in order to determine if the diversity of bycatch species depends on the different types of FADs used.

General

21. The WPEB noted that considerable information on bycatch exists in the grey literature and efforts should be made by the Secretariat to create a bibliography of such documents. The WP also noted that considerable information on bycatch is likely to exist in port sampling documents.

22. The WPEB was informed that the ACAP (Agreement on the Conservation of Albatrosses and Petrels) bibliography can be made available to IOTC.

23. Some participants believed that there is potential to extract important bycatch information from the data recorded in the purse seine fisheries. The WPEB strongly recommended that the EU scientists examine these data and present their results to the next WPEB meeting.

24. The WPEB identified there is an urgent need to:

- Quantify the effects of fisheries on non-target species and overall on marine ecosystems.
- Develop mitigation measures to reduce adverse effects on these species.

3. SHARKS

3.1 PAPERS PRESENTED

Bycatch of sharks and incidental catches of sea turtle in the longline fishery of Indian waters as observed during tuna resources survey (IOTC-2007-WPEB-13-rev1)

25. Indian long line fisheries target yellowfin and bigeye tunas. Information on the bycatch species of these fisheries is obtained from surveys carried out by the Fishery Survey of India (FSI) vessels in the Indian EEZ. The major bycatch components are sharks and billfish. Turtles are encountered infrequently. This paper presents the catch details of sharks caught on the long lines operated by four survey vessels of the FSI during 2005 and 2006 in covering the Arabian Sea and the Bay of Bengal.

26. Among the bycatch of tuna fisheries sharks were found to be the major portion of the catch. 18 shark species belonging to 4 families were identified in the surveys. Sharks made up 20.83% of the total catch by number and 23.36% by weight. The percentages of sharks were highest in the Bay of Bengal, particularly in the Andaman & Nicobar waters. Among the different shark species, pelagic thresher shark (*Alopias pelagicus*), bigeye thresher shark (*A. superciliosus*) and blacktip shark (*Charcharhinus limbatus*) were the main species contributing to the catch. Incidental catches of sea turtles were also reported during the survey predominantly on the East coast.

Japanese longline observer activity in the Indian Ocean in 2006 (IOTC-2007-WPEB-12)

27. In 2006, Japan had scientific observers aboard 13 cruises undertaken in the southern bluefin tuna fishery. Four cruises were made on longliners in the lower latitude of the Indian Ocean. In this paper, the activities and observed results of these four cruises are briefly reviewed. In total, 88 longline operations (286,997 hooks) were observed in the period from May 2006 to February 2007. In the 1st, 3rd and 4th quarter, effort was mainly distributed off Sumatra and west off Australia, while the effort in the 2nd quarter was concentrated off Somalia. Through the whole period covered by onboard observers, 3,718 specimens comprising 17 teleost species and 4 elasmobranch species were observed. The elasmobranchs included crocodile shark (24), shortfin mako shark (9) blue shark (77) and sting ray (56). A total of 3,576 specimens were measured, and sex was recorded for 2,376 individuals. The highest catch rate was 4.72 per 1000 hooks for bigeye, followed by 3.20 of albacore, 2.28 of yellowfin, 0.66 of lancet fish. The highest catch rate among sharks was 0.268 per 1000 hooks for blue shark, followed by 0.083 for crocodile shark. Stingray was also relatively high, 0.195 per 1000 hooks.

Standardized CPUE for blue sharks caught by the Japanese tuna longline fishery in the Indian Ocean, 1971-2005 (IOTC-2007-WPEB-17)

28. A standardized CPUE for blue shark caught by the Japanese tuna longline fishery in the Indian Ocean was calculated using logbook data from the period 1971 to 2005. For much of this period, shark catches were not recorded by species, therefore all sharks were assumed to be blue sharks. The results from the analysis indicate relatively stable CPUE except for some relatively high catch rates in 1998 and 1999. Overall, the results of this analysis suggest that the stock status of blue sharks has not changed drastically over the past three decades in the high seas area of the Indian Ocean. The sharks caught in Indian Ocean high seas are supposed to mainly consist of blue shark (as in the other Oceans) but this has not yet been verified using observer data.

South Africa: Fin to trunk ratio (IOTC-2007-WPEB-19)

29. In line with IOTC Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC*, this document describes the results of a study undertaken in South Africa to review data on the ratio of fin-to-body weight of sharks. The fins exported from South Africa include the dorsal fin, both pectoral fins, ventral flaps and the caudal fin. The dorsal fin is considered to be the most valuable and buyers do not accept any excess flesh, therefore it is cut with a straight cut. Pectoral fins, on the other hand, are cut in a half moon shape to maximise the flesh on the fin and hence increase the weight. Anal fins are prepared by first removing a piece of flesh including the anal fin and the claspers in a male. In some species (e.g. blue sharks) processing frequently involves the removal of the belly flaps. The caudal fin is cut at the pre-caudal pit and therefore includes considerable flesh. In this study, whole sharks were returned to port to ensure accurate measurements and weights and crew undertook the processing to simulate processing at sea. The mean fin to dressed weight ratios differed between blue shark (15.91%, range 14.64%-17.84%, n=5) and mako shark (7.83%, range 6.55%-8.92%, n=18). The study had a very small sample size and so interpretation of the results is limited. However, the results in this study are similar to those reported in the Spanish surface longline fishery, but much higher than others e.g. the Portuguese observer program reported 6.6% FW:DW in blue sharks and studies undertaken in the North Atlantic and the Gulf of Mexico reported 4.5% for blue sharks and 2.9% for Mako sharks. Cutting techniques differ from fleet to fleet and even within a fleet. This will have a substantial impact on the fin to trunk weight ratio.

Large-scale experiment shows that banning wire leaders helps pelagic sharks and longline fishers (IOTC-2007-WPEB-15)

30. The performance of wire leaders, which some jurisdictions have banned to reduce shark mortality from pelagic longline fishing was assessed in the tuna fishery off Australia's east coast. Experiments were conducted on commercial vessels that deployed equal numbers of wire and nylon monofilament

leaders randomly along their longlines. Catch rates of several species, including sharks, were significantly lower on nylon than on wire leaders, probably because the nylon leaders could be severed. High bite-off rates indicated that as many animals escaped from nylon leaders as were caught on nylon leaders. The fate of escaped individuals is not known, although large sharks are more likely to survive than smaller animals. By contrast, catch rates of valuable bigeye tuna (*Thunnus obesus*) were higher on nylon than on wire leaders. Bigeye tuna are probably able to see wire leaders and avoid those hooks. The financial benefits of increased bigeye tuna catches outweigh the costs associated with banning wire leaders, such as increased rates of gear loss. Thus, banning wire leaders may be an effective way of reducing shark catches without reducing returns from tuna catches.

A Review of fin-weight ratios for sharks (IOTC-2007-WPEB-14)

31. This paper reviews studies on fin weight to carcass weight ratios of various shark species. There is a wide range of reported ratios both within and between species. This may be due to differences in the number and type of fins used in the calculations or in the type of carcass weight used. Variation in fin cutting practices may also lead to differences in calculated ratios. Criteria for calculating fin weight to carcass weight ratios, species-specific and fleet-specific ratios should be developed. However, there are practical difficulties in implementing species-specific ratios.

32. The development of universally-accepted criteria for calculating fin-carcass ratios would allow direct comparison of studies. This could be achieved through agreement of the following: a clear definition of dressed weight; the type of fins to be used in fin weight calculations; the fin-cutting technique to be used to remove fins from the shark; at what point fins and sharks are to be weighed. An accepted protocol for calculating fin to weight ratios would also allow global data to be pooled, thereby increasing sample size and providing greater confidence in calculated ratios.

Incidental and bycatches of sharks and turtles in the Reunion Island swordfish longline fishery in the Indian Ocean (1994-2000) (IOTC-2007-WPEB-03)

33. The Indian Ocean swordfish longline fishery based in Réunion Island started operating in 1991. Between 1994 and 2000. Ifremer collected data from voluntary logbooks and regular at-sea and port sampling programmes. 5885 longline sets were examined to quantify the catches of five major shark species caught by the domestic longline fleet between 1997 and 2000: blue shark, oceanic whitetip shark, shortfin mako, hammerhead sharks (scalloped hammerhead and smooth hammerhead combined).

34. Blue shark was dominant in the catch with an average of 180 t per year between 1997 and 2000; this represented between 75% and 88% of the total catch of sharks. Mean catch rates for blue shark, oceanic whitetip shark were significantly higher for the small sized vessels (less than 16 m) operating in the immediate vicinity of the island, during the whole period. Significant decreases of the catch rates were observed for these two species from 1998 to 2000, declining from 2.2 to 1.03 blue sharks per thousand hooks and from 0.13 to 0.07 oceanic whitetip sharks per thousand hooks as the fishing effort of this boat category increased twofold over the same period. Results using hook-timers indicated that 52 % of the blue shark and 59 % of the oceanic whitetip shark were retrieved dead and around 50% died within 6 to 8 hours after being hooked. 6,516 of the 13,325 blue sharks caught were released alive and it is estimated that after four months, 5,558 were still alive (41.5%). These survival results suggest that the levels of bycatch mortality for some species may be overestimated. The amount of size data recorded was very low for all the shark species and limits its use; nevertheless for blue shark the size ranged from 64 to 289 cm (FL), this average was 195.5 cm FL and about 40 % of specimens measured were less than the size of sexual maturity (i.e. <185 cm FL).

35. Between 1996 and 2000, the fishery recorded 97 interactions with turtles: 51 with leatherback, 30 with hawksbill and 16 with green turtles. The catch status of the turtles (alive or dead) when the gear was retrieved varied depending on the species, but in most of the cases, they were released alive. This study underscores the need to conduct experiments to gain information about long-term survival of released bycatch species.

Length-weight relationships, conversion factors and analyses of sex-ratio, by length-range, for several species of pelagic sharks caught in experimental cruises on board Spanish longliners in the South Western Indian Ocean during 2005 (IOTC-2007-WPEB-04)

36. This paper presents allometric relationships and sex ratios of the most abundant species of pelagic sharks collected during the Pilot Action (AP) by Spanish longliners and onboard observers in 2005. During this AP, two ships performed 539 sets and worked 531 916 hooks (comprising 5 hook types) kinds, baited with mackerel and squid, or squid-like species. From the total weight of fishes caught (75 species or groups of species), sharks and rays correspond to 45% of round weight (521 t): 11039 individuals. The main species caught, in number of individuals, were the blue shark, 60.3%, and the short-fin mako, 10.7%; the rest correspond to another species of sharks and rays.

37. Observers measured the length and weight of 2 311 blue sharks and obtained a total length – round weight relationship, described by the equation $W = 1.331 \times 10^{-6} \times TL^{3.204}$ for both sexes combined. Similarly, equations were presented for silky shark (*Carcharhinus falciformis*), whitetip shark (*Carcharhinus longimanus*), crocodile shark (*Pseudocarcharias kamoharai*), shortfin mako shark and 15 specimens of scalloped hammerhead shark (*Sphyrna lewini*). Comparing the fork length – round weight equations obtained for four of these six species of sharks with those ones proposed by another authors in Atlantic and Indian oceans, the results are very similar to the relationship that is actually agreed by the IOTC and two more equations for whitetip shark and crocodile shark are proposed. The relationship between length (total and fork) and dressed or carcass weight are also obtained for the four species more commercialized and some conversion factors between lengths and weights are proposed.

38. The sex of 5,990 blue sharks were recorded. Overall, 17% were females; however, in the specimens, smaller than 100 cm and higher than 345 cm, respectively, females comprised were over 50% of the individuals examined. By contrast, 60% of 1058 specimens of shortfin mako were females, with over 50% for most of the length classes and similar values in the quantity of females during all the quarters of the year.

3.2 DISCUSSIONS AND RECOMMENDATIONS RELATING TO SHARKS

Executive summaries on the status of shark resources (IOTC-2007-WPEB-06, 07, 08, 09, 10)

39. To progress the work on sharks the Secretariat provided draft Executive Summaries for five shark species for the consideration of the WPEB. These summaries were based on information compiled by the Secretariat and summarised in document IOTC-2006-SC-INF01.

40. The Executive Summaries for blue shark, silky shark, oceanic whitetip shark, shortfin mako shark and scalloped hammerhead shark (Appendix V) were endorsed by the WPEB which also recommended that they be put forward to the Scientific Committee for adoption.

41. The WPEB thanked the Secretariat for its work and encouraged scientists to further contribute to the contents of these documents. In the first instance, the WPEB recommended that distribution maps be added to the Executive Summaries.

Technical discussions on IOTC Resolution 05/05 concerning the conservation of sharks caught in association with fisheries managed by IOTC

42. The WPEB reviewed the technical aspects of IOTC Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* and recommended that following matters be addressed:

1. That the range of data expected for tuna and tuna-like species also be requested for sharks in accordance with the procedures and standards described in IOTC Resolution 01/05 *Mandatory statistical requirements for IOTC members*.
2. That the expectation of comprehensive assessments of sharks be more clearly signalled as a long-term goal and that other indicators of the status of sharks be identified and monitored until such time that a comprehensive assessment is possible.
3. The reason behind the 5% fin ratio definition in paragraph 4 is to prevent the finning of sharks. Reviews of fin ratios suggest there is a large variation in ratios from species to species, and within species due to different processing techniques. It was recognised that the only way to guarantee that sharks are not finned (and full utilisation of sharks is encouraged) is to require that the trunks be landed with the fins attached. There is evidence that 5% as a 'general' target is not inappropriate; however, paragraph 4 lacks clarity in terms of the weights being referred to (assumed to be dressed weight but not clear in the resolution), the fins included in the ratio and the cutting techniques. The WPEB recommended that additional information be put forward for consideration by the Scientific Committee.

43. The WPEB agreed that these matters should be put forward to the Scientific Committee for endorsement.

General

44. Following standard international practice, the term sharks is accepted by the WPEB to include both sharks and rays.

45. Noting that the shark catch statistics available to IOTC and FAO reflect only a very minor component of the actual catch, the WPEB strongly recommends immediate action regarding improvement of data collection and management of sharks including making more effort to obtain information for other sources; including national scientists, other tuna RFMO's, IUCN and fin trade data.

46. The WPEB acknowledged that more information on shark catches was a prerequisite to attempting a stock assessment on any of the species.

47. In review the WPEB agreed on the need to increase knowledge about what shark species are targeted and in what areas.

48. Seychelles informed the WPEB that the Seychelles National Plan of Action – sharks was close to completion and it is expected that it will be presented to the Scientific Committee in November 2007.

49. Australia informed the WPEB that Australia's National Plan of Action – sharks that was released in 2004 is to be reviewed in 2008. Furthermore, the NPOA was now highly influential in determining what shark research is undertaken in Australia.

50. The WPEB strongly recommended that shark research should be a major priority for national research bodies.

51. The WPEB was informed that 11 programmes on sharks are currently operating in the Indian Ocean. The WPEB requested that the Secretariat identify and contact the people involved in the projects and report back to the WP on the nature and extent of these projects at the next meeting. The WPEB also acknowledged the need for IOTC to strengthen its collaboration with the IUCN (the World conservation Union) shark group.

52. The WPEB noted that the upcoming meeting to identify and elaborate an option for international cooperation on migratory sharks under the Convention on Migratory Species (CMS) is to be held in Seychelles 11-13 December 2007. The WPEB strongly supported this meeting and looks forward to being informed about the outcomes.

53. The WPEB committed to work intersessionally to develop a list of priority shark species and status indicators to enable the resources be monitored to the extent possible. To this end the WPEB recommended that the following preliminary list (Table 1) be refined as a result of a risk analysis over the coming year. The WPEB agreed that given the level of exploitation of blue shark work on this species should commence immediately.

***Table 1**. Preliminary listing of Shark species of concern to IOTC*

Common name	Species	Code	IUCN	CITES	UNCLOS	CMS	Catch*	Life history*	Total
Manta ray	*Manta birostris*	MAN	1	-	-		2	3	6
Whale shark	*Rhincodon typus*	RHN	2	1	1	1	1	3	9
Pelagic thresher	*Alopias pelagicus*	PTH	2	-	1		1	3	7
Bigeye thresher	*Alopias superciliosus*	BTH	2	-	1		1	3	7
Thresher	*Alopias vulpinus*	ALV	2	-	1		1	3	7
Shortfin mako	*Isurus oxyrinchus*	SMA	2	-	1		2	3	8
Longfin mako	*Isurus paucus*	LMA	2	-	1		2	3	8
Crocodile shark	*Pseudocarcharias kamoharai*	PSK	1	-	-		2	2	5
Silvertip shark	*Carcharhinus albimarginatus*	ALS	-	-	1		1	2	4
Silky shark	*Carcharhinus falciformis*	FAL	1	-	1		3	2	7
Oceanic whitetip	*Carcharhinus longimanus*	OCS	2	-	1		2	2	7
Sandbar shark	*Carcharhinus plumbeus*	CCP	1	-	1		1	2	5
Tiger shark	*Galeocerdo cuvier*	TIG	1	-	1		1	2	5
Blue shark	*Prionace glauca*	BSH	1	-	1		3	1	6
Scalloped hammerhead	*Sphyrna lewini*	SPL	3	-	1		2	2	8

IUCN classifications EN = endangered - score = 3 VU = vulnerable - score = 2 NT = near threatened - score = 1 LC = least concern - score = 1	**CITES classifications** Listed in Appendix 2, score = 1	**UNCLOS classifications** Listed as a highly migratory species, score = 1
CMS classifications Listed in Appendix	**Relative Catch*** Relatively high – score = 3 Medium – score = 2 Relatively low - score = 1	**Life history characteristics*** Very highly vulnerable to fisheries, score = 3 Highly vulnerable to fisheries, score = 2 Vulnerable to fisheries, score = 1

*These are provisional scores based on best available information, and may be subject to change.

54. The WPEB recommended that the following work proposal be undertaken:

Recognizing that many CPCs have already developed National Plans of Actions for the Conservation and Management of Sharks (NPOA-Sharks) WPEB recommends the following actions:

1. Species identification and biological data collection:

a. IOTC to develop guidelines on sharks identification and data collection

b. CPCs, which conduct research cruises and observer programs are requested to develop a digital photo archive of shark species recorded during cruises and make it available to all CPCs through IOTC.

c. CPCs are requested to develop activities to collect data and obtain relationships between fin weight and body weight of sharks and report their results to IOTC as soon as they become available, but at the latest by 2010.

d. IOTC to develop a regional training module for observers and scientists aimed to improve shark biological data collection and precision.

e. These training activities will extend in future on all the bycatch species in line with IOTC's long-term goal to develop an ecosystem-based approach to fisheries management.

2. Fisheries statistics

a. Each CPC should submit existing fisheries statistics on bycatch, including historical fisheries data and fin trade data to IOTC as soon as they become available, but at the latest by 2009.

b. As required by IOTC Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC*, each CPC should, as a matter of priority, develop obligatory requirements in their national fisheries statistics systems to ensure collection of reliable statistics on shark catches and discards (by species in numbers of individuals and total weight) and submit these data to IOTC.

3. Research and management

a. Each CPC should identify the principal shark species involved in their national fisheries either as target species or as bycatch,

b. Those CPCs that have not yet prepared a NPOA-Sharks should do so.

c. Each CPC should identify research priorities for sharks involved in the national fisheries based on species life history traits and overall vulnerability to fishing pressure. National research as well as the list of endangered species developed by IUCN should be used for such needs.

d. Each CPC should identify their national needs and relevant funding requirements in order to highlight shark sustainability issues to the public and to International Funding Agencies.

e. Research on population and demographic structure of shark populations involved in the IOTC managed fisheries.

f. Submission of existing collections of biological data to IOTC at the finest level available (including data on length frequency distribution, sex ratio, fishing gear, time area strata).

4. Other actions

a. IOTC is requested to continue to enlarge the compilation of existing and published data on life history patterns of the sharks listed.

b. All CPCs to develop mitigation measures and fishing gear aimed at reducing non-targeted shark bycatch in the IOTC managed fisheries (e.g. circle hooks, shark scaring bait, and other shark-scaring devices).

c. When sufficient information is compiled, IOTC should coordinate a regional plan of action for conservation and management of sharks (RPOA-Sharks), with the active participation of CPCs.

4. SEABIRDS

4.1 PAPERS PRESENTED

Seabird and turtle bycatch in the South African pelagic longline fishery (IOTC-2007-WPEB-20)

55. This paper provided an update of seabird bycatch in the South African swordfish (*Xiphias gladius*) longline fishery. Data were collected by sea-fisheries observers on board pelagic longline vessels operating in the South African fishery. The information collected included seabird bycatch information (species, number and status), as well as gear (e.g. number of hooks, length of mainline etc.) and operational (time of set and position etc) information. South African vessels targeting swordfish use the American Longline system. The vessels set a total of 10.6 million hooks from 1998 to 2005, at an average of 1.3 million hooks per year. Fishing effort varies annually and by season. Effort peaked in 2002 at 2.6 million hooks; in 2005, 0.8 million hooks were set. Observer data was collected from 827 sets or 1 million hooks (10% of the total) from 1998 to 2005. Although these vessels target swordfish, they catch a combination of swordfish (22%), tunas (40%), blue sharks (24%) and mako sharks (3%). The vessels caught seabirds at a rate of 0.22 birds per 1000 hooks in the winter and 0.24 birds per 1000 hooks in the summer. White-capped albatrosses were the most commonly caught at a rate of 0.08 per 1000 hooks. Black-browed albatrosses and white-chinned petrels were caught at an average catch rate of 0.35 per 1000 hooks and yellow-nosed albatrosses at an average rate of 0.003 per 1000 hooks. Although catch rates for albatrosses were the highest on the west coast, a significant number of petrels were caught on the east coast i.e. in the Indian Ocean. Catch rates were highest when sets occurred during the day and over full moon periods when they were set at night. The average catch rate was 0.2 birds per 1000 hooks during full moon compared with an average of 0.05 birds per 1000 hooks outside of full moon periods.

Development of mitigation measures to reduce seabird mortality in pelagic longline fisheries (IOTC-2007-WPEB-18)

56. Fishing operations attract and provide a feeding opportunity for a range of pelagic seabird species. Their incidental mortality on these vessels has been well documented and mounting evidence suggests that this is the leading cause of observed decreases amongst albatross and petrel populations. Mitigation measures work by either keeping birds away from baited hooks (e.g. tori lines), reducing the time the hook is available to the birds (e.g. line weighting or line setting chutes), avoiding peak periods of bird foraging (e.g. night setting) or making vessels or bait less attractive to the birds. It is vital that these measures are simple, easy to implement and cost effective. This paper reviews a range of mitigation measures. Those methods tested and deemed effective include: setting lines at night; line weighting and reducing setting speeds; use of 'Tori' or bird-scaring lines; using frozen baits; and minimising discards (offal etc). Several methods are still under refinement, including: underwater setting chutes; underwater setting capsules; side setting; use of Fish oil; use of dyed baits; and bait casting machines. Methods tested and found ineffective included the use of live bait; and uses of water cannon. In conclusion. There is no one magic solution and a suite of measures should be used in combination to mitigate seabird bycatch. The choice may change from fishery to fishery depending gear configuration, preferred operation and species complexes involved.

Analysis of albatross and petrel distribution and overlap with longline fishing effort within the IOTC Area: results from the Global Procellariiform Tracking Database (IOTC-2007-WPEB-22)

57. This analysis has highlighted the importance of the IOTC area for albatross and petrel distribution, and the high degree of overlap between IOTC longline fishing effort and the distribution of albatrosses, particularly those breeding on islands in the Southern Indian Ocean. Seventeen of 18 southern hemisphere albatrosses forage in the Indian Ocean at some stage in their life cycle. The Critically Endangered Amsterdam Albatross and Endangered Indian yellow-nosed albatross are

endemic to the IOTC area, and both forage almost exclusively in the areas fished by longline IOTC fleets, close to the area of highest longline effort south of 30°S. Grey-headed, wandering and shy albatrosses also have a high degree of overlap with IOTC longline fishing effort.

58. The addition of tracking data from other colonies of grey-headed albatross in the Indian Ocean would probably increase the overlap identified, especially with the region of high-intensity longline effort between 80 and 90°E. Non-breeding black-browed and white-capped albatrosses are caught in large numbers by longline fisheries in the region, but tracking data area lacking. Other key data gaps include tracking data for Northern and Southern giant-petrels, both of which form part of the bycatch reported for the region and have substantial breeding colonies in the Indian Ocean, as well as non-breeding data for white-chinned petrels and Indian yellow-nosed and grey-headed albatrosses.

Coordination of mitigation research: report of the first meeting of the seabird bycatch working group, Agreement on the Conservation of Albatrosses and Petrels (IOTC-2007-WPEB-21)

59. This document reported on the first meeting of the Seabird Bycatch Working Group (SBWG). This working group was formed by the Agreement on the Conservation of Albatrosses and Petrels (ACAP) to provide advice to ACAP on actions that will assist in assessment, mitigation and reduction of negative interactions between fishing operations and albatrosses and petrels.

60. The SBWG considers that interactions with pelagic fisheries constitute the largest conservation threat to seabirds in the southern oceans, and although several seabird avoidance measures have been trialled to varying degrees, proven and accepted seabird avoidance measures require substantial improvement. The suitability of pelagic mitigation technologies for future research was assessed by assigning a priority ranking on a 5 point scale, according to criteria on potential effectiveness, practicality, and cost. Bird scaring lines, the bait setting capsule and side setting were ranked the highest priority for research. Weighted branchlines, the bait pod, smart hooks and circle hooks were high priorities; and blue dyed squid was of moderate priority. Research on technologies such as the underwater setting chute, night setting, line shooters, thawed bait, strategic offal discharge, blue-dyed fish, fish oil and bait casting machines, were considered a lower priority.

4.2 DISCUSSIONS AND RECOMMENDATIONS RELATING TO SEABIRDS

61. The ACAP seabird mitigation review (IOTC-2007-WPEB-21) was endorsed by the Working Party on Ecosystems and Bycatch as representing the current best scientific advice and the resulting list of mitigation measures and standards is attached as Table 2. The WPEB agreed to forward this information for the consideration of the Scientific Committee.

***Table 2**: Seabird mitigation measures and standards*

Mitigation measures	***Description***	***Minimum standard***
Night setting with minimum deck lighting	Setting and retrieving the gear at night shifts fishing operations to between nautical dawn and dusk, a time when the seabirds are less active and reduces the visibility of bait.	Setting restricted to between the hours of nautical dusk and nautical dawn, as set out in the Nautical Almanac tables for the relevant latitude, local time and date
Bird-scaring lines	A system of streamers is deployed to keep seabirds away from the areas where the longline enters the water.	A minimum aerial coverage of 100m is required for this measure to be effective. Deployment should occur prior to longlines entering the water. Current minimum standards for pelagic fisheries are based on CCAMLR Conservation Measure 25-02
Weighted branch lines	Weighted lines sink the baited hooks more rapidly and reduce the time the baited hooks are available to the birds.	60 g placed < 3 m from hook; or 100 g placed < 4 m from hook
Blue-dyed squid bait	Colouring bait reduces contrast with the water making it more difficult for the seabird to see.	Mix to standardized colour placard or specify (e.g. use 'Brilliant Blue' food dye (Colour Index 42090, also known as Food Additive number E133) mixed at 0.5% for a minimum of 20 minutes)
Management of offal discharge	Fishermen avoid discarding offal while the longline is being set to reduce the attraction of seabirds.	No discard of offal during setting. During line hauling, storage of waste is encouraged. If offal must discharged, this must occur on the opposite side of the vessel to the hauling bay.

62. A review of pelagic longline mitigation measures was also carried out by ACAP to identify knowledge gaps (Appendix VI). The review, based on published literature and expert opinion, showed that some of the measures currently prescribed by some RFMOs to minimize seabird mortality would benefit from further development and testing. The WPEB supported the research outlined in Appendix VI and encouraged scientists to contribute to this work.

63. Recent initiatives by two RFMOs to adopt a mitigation approach requiring fishers to select two measures, to be used in combination, from a ‘menu’ of seabird mitigation technical measures were described (IOTC-2007-WPEB-21). The WPEB noted that the paper recommended that IOTC give serious consideration to adopting a similar approach to manage seabird bycatch in its fisheries.

64. The WPEB supported this suggestion and identified a range of technical issues that might be considered in any future revision of Resolution 06/04 *On reducing incidental bycatch of seabirds in longline fisheries*:

- All vessels fishing south of 30°S to use at least two of the mitigation measures in Table 3, including at least one obligatory measure and one complementary measure.
- In other areas when bird abundance is high, vessels are to use at least one or more of the measures in Table 2.
- Mitigation measures used to conform to the minimum technical standards for the measure, as shown in Table 2

- Further guidelines for technical specifications when applying mitigation measures shown in Table 2 are provided in Appendix VII (i.e. guidelines for design and deployment of bird scaring (tori) lines).
- Regular reviews any new information on new or existing mitigation measures, or on seabird interactions from observer or other monitoring programs be undertaken by the WPEB and the Scientific Committee.

65. The WPEB agreed that these issues should be put forward to the Scientific Committee for endorsement.

66. Furthermore, the WPEB noted that the recommended seabird mitigation measures (Table 2) do not include line-throwing devices (line shooters and bait casting machines) because their effectiveness is not supported by empirical data. The WPEB noted that the use of the "American longline system" equipped with a line-throwing device by surface longline vessels targeting swordfish (under paragraph 4 of Resolution 06/04), may not be achieving the desired effect. The WPEB agreed that this issue should also be brought to the attention of the Scientific Committee at its next meeting.

Table 3: *Seabird mitigation measures*

	B. Complementary measures				
A. Obligatory measures	Night setting	Bird-scaring line	Weighted branch lines	Blue-dyed bait	Offal discharge control
Night setting with minimum deck lighting	■				
Bird-scaring lines		■			
Weighted branch lines			■		

5. SEA TURTLES

5.1 DISCUSSIONS AND RECOMMENDATIONS RELATING TO SEA TURTLES

67. The WPEB noted the work being undertaken to examine the efficacy of circle hooks in reducing the mortality of sea turtles (IOTC-2007-WPEB-INF04). The WPEB was informed that preliminary results using circle hooks in the longline fishery for swordfish were positive in that circle hooks appeared to have higher catch rates and retention rates for target species, and lower catches of sea turtles. Furthermore, Seychelles fishers have voluntarily switched to using circle hooks because of increased catches of their target species.

68. The WPEB was informed that the pieces of net hung below the FADs may be a significant cause of mortality of sea turtles by drowning. The WPEB recommended that net material should be replaced with other types of materials such as ropes or plastic hoods or straps.

69. The WPEB recommended that the following research be undertaken on sea turtles:

- Ongoing research to test the efficacy of circle hooks in reducing sea turtle mortality.
- Estimate the levels of sea turtle mortality due to various fishing methods, including long line, gillnests and purse seine. With respect to purse seine – also estimate the mortality caused by the use of FADs on sea turtles, by considering the various categories of FADs used by the PS fleets, in order to propose agreed mitigation measures to reduce this mortality.

- Describe the sources and scale of ghostfishing taking place in the Indian Ocean - including mortality due to lost FADs.

6. MARINE MAMMALS

6.1 DISCUSSIONS AND RECOMMENDATIONS RELATING TO MARINE MAMMALS

70. The WPEB discussed a range of topics on marine mammals and identified the following issues relating to the interactions between marine mammals and fisheries:

- There is a paucity of data on the bycatch of marine mammals within the IOTC Area.
- The major groups involved are cetaceans and seals (in the southern areas of the Indian Ocean).
- Cetaceans have known interactions with tuna fisheries as fishers may use them to locate tuna schools; and cetaceans are known predators of longline caught fish.
- Cetaceans are vulnerable to capture by the gillnet fisheries which operate in all coastal countries, in particular the major gillnet fisheries of India, Sri Lanka and those in the Arabian Sea.
- Cetaceans are major components of the pelagic ecosystem and they are direct predators of tuna and may compete for the same food as tunas.
- FADs may be a significant cause of mortality of marine mammals (IOTC-2007-WPEB-INF06).
- Any marine mammal found entangled in any FAD should be reported in accordance with the procedures and standards described in the IOTC Resolution 01/05 *Mandatory Statistical requirements for IOTC members*
- A large proportion of IOTC Area falls within the Indian Ocean Sanctuary (IOS) of the International Whaling Commission

71. While the WPEB agreed that marine mammals were, at this stage, a lower priority than sharks, sea birds and sea turtles, future work in this area is encouraged, in particular an assessment of the scale of the above issues. Furthermore, the WPEB agreed to include Marine Mammals as a permanent item on the agendas of future WPEB meetings and encouraged scientists to use this forum to present the results of research. Some recommendations for future work in this area included:

- Analysis of purse-seine fishery log-books in order to update the original information on marine mammal diversity and distribution within the IOWS as compiled for baleen whales by Robineau (1991) using data from the period 1982 to 1985
- Review the existing marine mammal data in the IOTC databases
- Encouragement of national scientists to make reports on the sightings made by observers of all marine mammals observed in operations within the IOTC.

7. ECOSYSTEM APPROACHES

7.1 PRESENTATIONS

72. The WPEB received an ad hoc presentation entitled ‘The new top predator’ providing a simplified overview of the major components in the pelagic ecosystems and considered the impacts of industrial fishing since the 1950’s (considering fishing as an act of predation). The presentation touched the effects of fishing on major biomass trends in pelagic food webs, top predators and pelagic prey.

73. An update of CLIOTOP (Climate Impacts on Top Predators), a regional program of GLOBEC, was presented. CLIOTOP is a ten-year program started in 2005 designed to coordinate research effort at a global scale, notably by organising and providing financial support for scientific meetings. Since November 2006, four working groups were held under CLIOTOP’s: umbrella: “Role of squids in pelagic marine ecosystems” (Hawaii, 14-17 November 2006, sponsored by PFRP), “Designing an

ocean mid-trophic automatic acoustic sampler" (Sete, France, 15-19 January 2007, sponsored by IRD), "The challenge of change: managing for sustainability of oceanic top predator species (Univ. California-Santa Barbara, 12-14 April 2007, sponsored by National Science Foundation-Community Building) and a workshop on modelling approach to integrate early-life history (Yokohama, Japan May 14-17 2007, sponsored by NRIFSF). CLIOTOP is also a contributor to the second international symposium on tagging and tracking marine fish with electronic devices, that will be held in San Sebastián, Spain 8-12 October 2007. The major step to come for CLIOTOP will be its 1st Open Science Symposium that will take place in La Paz, Open Science, Mexico, 3-7 December 2007. The WPEB recognised the benefit of CLIOTOP in the implementation of an ecosystem approach to fisheries management and recommended a close collaboration with CLIOTOP activities.

7.2 Discussions and recommendations relating to ecosystems

74. The WPEB recommended that analyses of the purse seine observer data be undertaken to compare species diversity over time – starting in the 1980's. This analysis should also examine the spatial interactions between whales and the fisheries with reference to the Indian Ocean whale sanctuary.

75. The WPEB also recommended that the data from the historical Soviet fishing operations in the Indian Ocean also be examined in an attempt to understand changes pelagic diversity, and also identify hotspots and which species are likely to interact with the fisheries.

8. ITEMS PUT FORWARD BY THE WPEB FOR CONSIDERATION BY THE SCIENTIFIC COMMITTEE IN 2007

1 The Executive Summaries (Appendix IV) for blue shark, silky shark, oceanic whitetip shark, shortfin mako shark and scalloped hammerhead shark for adoption.

2 Technical recommendations (Paragraph 42) relating to IOTC Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* for endorsement.

3 Work plan issues identified on Paragraphs 53 and 54 for endorsement

4 Best practice seabird mitigation measures and standards (Table 2) for endorsement.

5 Technical recommendations (Paragraph 64 and 66) relating to IOTC Resolution 06/04 *On reducing incidental bycatch of seabirds in longline fisheries* for endorsement.

9. OTHER BUSINESS

Election of a new chairperson for the WPEB

76. Mr Riaz Aumeeruddy was elected chairperson of the WPEB for the next biennium. The WPEB thanked the outgoing chairperson Mr Kevin McLoughlin for his work and guidance over the last three sessions.

10. ADOPTION OF THE REPORT

77. The Report of the Third Session of the Working Party on Ecosystems and Bycatch was reviewed and adopted by correspondence.

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APPENDIX II
AGENDA OF THE MEETING

1. **INTRODUCTION TO THE TERMS OF REFERENCE FOR THE IOTC WORKING PARTY ON ECOSYSTEMS AND BYCATCH (WPEB)** – see below

2. **REVIEW OF THE DATA ON BYCATCH**
   - Review of the data available in the IOTC database (Secretariat)
   - Review of the information available on incidental catch of non-target species in t Indian Ocean – A study undertaken by Pauline Gauffier in collaboration with the Secretariat (Secretariat)
   - Review availability of observer information (Request from SC in 2006)
   - Data from other sources

3. **SHARKS**
   - Papers as provided by participants
   - Review of any National Plans of Action for the reduction of shark bycatch in tuna fisheries
   - Review of any data on the ratio of fin-to-body weight of sharks (as per Resolution 05/05, para 4) –

     Last year the United Kingdom indicated to the SC that they would provide information to the Secretariat on the fin-body weight ratio of sharks caught in the British Indian Ocean Territories.
   - Advice on interactions between sharks and tuna fisheries in the Indian Ocean

4. **SEABIRDS**
   - Papers provided by participants
   - Review of any National Plans of Action for Reducing Incidental Catches of Seabirds in Longline Fisheries
   - Advice on interactions between seabirds and tuna fisheries in the Indian Ocean

5. **TURTLES**
   - Papers provided by participants
   - Review of any National Plans of Action for the reduction of turtle bycatch in tuna fisheries
   - Advice on interactions between turtles and tuna fisheries in the Indian Ocean

6. **MARINE MAMMALS**

7. **ECOSYSTEM APPROACHES**

8. **RESEARCH RECOMMENDATIONS AND PRIORITIES**

9. **OTHER BUSINESS**

APPENDIX III
LIST OF DOCUMENTS PRESENTED TO THE MEETING

Document	Title
IOTC-2007-WPEB-01	Draft agenda of the Working Party on Ecosystems and Bycatch
IOTC-2007-WPEB-02	WPEB List of documents
IOTC-2007-WPEB-03	Incidental and bycatches of sharks and turtles in the Reunion Island swordfish longline fishery in the Indian Ocean (1994-2000*). - Francois Poisson*
IOTC-2007-WPEB-04	Length-weight relationships, conversion factors and analyses of sex-ratio, by length-range, for several species of pelagic sharks caught in experimental cruises on board Spanish longliners in the South Western Indian Ocean during 2005. – *Javier Ariz, Alicia Delgado de Molina, Mª L. Ramos and Jose Carlos Santana*
IOTC-2007-WPEB-05	Catch and distribution of accessory species and discard in Spanish Tropical Purse Seine Fishery. - *Alicia Delgado de Molina, Javier Ariz, Jose Carlos Santana and Roberto Sarralde*
IOTC-2007-WPEB-06	Draft Executive Summary of the status of the blue shark resource. - Dated 11 July 2007
IOTC-2007-WPEB-07	Draft Executive Summary of the status of the silky shark resource. - Dated 11 July 2007
IOTC-2007-WPEB-08	Draft Executive Summary of the status of the oceanic whitetip shark resource. - Dated 11 July 2007
IOTC-2007-WPEB-09	Draft Executive Summary of the status of the shortfin mako shark resource. - Dated 11 July 2007
IOTC-2007-WPEB-10	Draft Executive Summary of the status of the scalloped hammerhead shark resource. - Dated 11 July 2007
IOTC-2007-WPEB-11	A review of the information on Bycatch in the Indian Ocean. - *IOTC Secretariat*
IOTC-2007-WPEB-12	Japanese longline observer activity in the Indian Ocean in 2006. – *Hiroaki Okamoto, Yasuko Semba, Hiroaki Matsunaga and Toshiyuki Tanabe*
IOTC-2007-WPEB-13-rev1	Bycatch of sharks and incidental catches of sea turtle in the long line fishery of Indian waters as observed during tuna resources survey. – *S. Varghese, V.S. Somvanshi and Sijo P. Varghese*
IOTC-2007-WPEB-14	A Review of Fin-weight Ratios for Sharks. - *Sheree Hindmarsh*
IOTC-2007-WPEB-15	Large-scale experiment shows that banning wire leaders helps pelagic sharks and longline fishers. - *Peter Ward, Emma Lawrence, Rebecca Darbyshire, and Sheree Hindmarsh.*
IOTC-2007-WPEB-16	Comparison of bycatch species captured during daytime and nightime: preliminarily results of longline experiments carried out in Seychelles waters. - *Caroline Gamblin, Bach Pascal and Vincent Lucas*
IOTC-2007-WPEB-17	Standardized CPUE for blue sharks caught by the Japanese tuna longline fishery in the Indian Ocean, 1971-2005. - *Hiroaki Matsunaga*
IOTC-2007-WPEB-18	Development of mitigation measures to reduce seabird mortality in pelagic longline fisheries. - *S.L. Petersen*
IOTC-2007-WPEB-19	South Africa: Fin to trunk ratio. - *Samantha Petersen, Dave Japp, Craig Smith & J du Plessis*
IOTC-2007-WPEB-20	Seabird and turtle bycatch in the South African pelagic longline fishery. - *Samantha Petersen*
IOTC-2007-WPEB-21	Coordination of mitigation research: report of the first meeting of the seabird bycatch working group, agreement on the conservation of albatrosses and petrels. - *Barry Baker*
IOTC-2007-WPEB-22	Analysis of albatross and petrel distribution and overlap with longline fishing effort within the IOTC area results from the Global *Procellariiform* Tracking database.
IOTC-2006-WPBy-03	Status of the IOTC databases for tropical tunas – *IOTC Secretariat*
IOTC-2007-WPEB-INF01	Compilation of information on blue shark (*Prionace glauca*), silky shark (*Carcharhinus falciformis*), Oceanic whitetip shark (*Carcharhinus longimanus*), Scalloped hammerhead (*Sphyrna lewini*) and shortfin mako (*Isurus oxyrinchus*) in the Indian Ocean. A working paper. - *IOTC Secretariat*
IOTC-2007-WPEB-INF02	Bycatch in the tuna purse-seine fisheries of the western Indian Ocean. - *Evgeny V. Romanov*
IOTC-2007-WPEB-INF03	Best practices for the collection of longline data… to reduce bycatch of protected species. *Dietrich et al* (Sydney conference)
IOTC-2007-WPEB-INF04	Do circle hooks reduce the mortality of sea turtles in pelagic longlines? A review of recent experiments. *Read.*
IOTC-2007-WPEB-INF05	Bycatch in the Soviet purse seine tuna fisheries on FAD associated schools in north equatorial areas of the western Indian Ocean. – *E. Romanov.*
IOTC-2007-WPEB-INF06	Preliminary report on ghostfishing phenomena by drifting FADs in the eastern Indian Ocean. - I Chanrachkij and A. loog-on. SEAFDEC Report TD/Res/78. 2003

APPENDIX IV
TERMS OF REFERENCE FOR THE IOTC WORKING PARTY ON ECOSYSTEMS AND BYCATCH (WPEB)

1. Monitoring

− Create and maintain an inventory of non-target, associated and dependent species caught by fleets targeting tuna and tuna-like species in the Indian Ocean.

− Improve conventional statistics (catch, effort, size) of species under the IOTC mandate that are caught incidentally in non-targeted fisheries.

− Monitor and improve information on interactions with species that are not under the IOTC mandate, with emphasis on those species of interest to the Commission and for which no Species Group has been established (e.g., sharks, sea turtles and sea birds).

− Facilitate access by scientists to oceanographic and environmental data.

2. Research

− Evaluate the relative impact of the different abiotic and biotic factors (including oceanographic and climate phenomena, directed and incidental fishing, predation, competition, pollutions and other human impacts) that affect the abundance, distribution and migration of IOTC species.

− Characterize main feeding and reproductive habitats of IOTC species.

− Characterize the volume, composition and disposition of non-target species that are caught incidentally in tuna and tuna-like fisheries within the IOTC Convention area.

− Investigate trophic interactions of IOTC species.

− Investigate the impact that changes in fishing gears or fishing technology have on the catch of target and non-target species.

3. Modelling

− Develop and monitor reference points and indicators that explicitly incorporate ecosystem considerations.

− Participate in the development of simulation, dynamic and statistical models focusing on mixed-fisheries, multi-species, bycatch and ecosystem issues.

4. Advice

− Develop mechanisms which can be used to better integrate ecosystem considerations into the scientific advice provided by Scientific Committee to the Commission.

− Investigate through operational models, potential benefits at an ecosystem level of alternative management strategies, such as time-area closures.

− Advise on the impacts of tuna and tuna-like fisheries on the populations of non-target species of interest to the Commission.

APPENDIX V

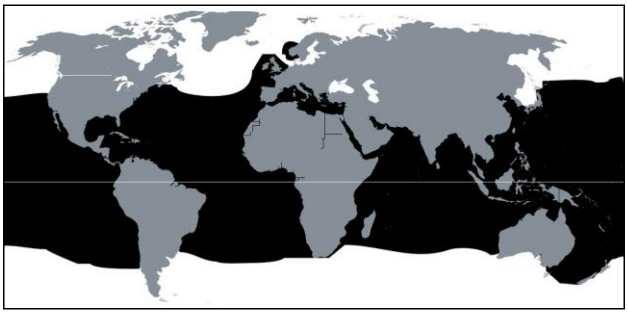
DRAFT EXECUTIVE SUMMARY OF THE STATUS OF THE SHARK RESOURCES

Draft executive summary of the status of the blue shark resource

As endorsed by the WPEB 20 July 2007

BIOLOGY

The blue shark (*Prionace glauca*) is common in pelagic oceanic waters throughout the tropical and temperate oceans worldwide. It has one of the widest ranges of all the shark species. It may also be found close inshore and in estuaries. Blue shark is most common in relatively cool waters (7 to 16°C) often close to the surface. In the tropical Indian Ocean, the greatest abundance of blue sharks occurs at depths of 80 to 220 m, in temperatures ranging from 12 to 25°C. The distribution and movements of blue shark are strongly influenced by seasonal variations in water temperature, reproductive condition, and availability of prey.



Map. *The worldwide distribution of the Blue shark*

The blue shark is often found in large single sex schools containing individuals of similar size. Adult blue sharks have no known predators; however, subadults and juveniles are eaten by both shortfin makos and white sharks as well as by sea lions. Fishing is likely to be a major contributor to adult mortality.

In the Atlantic Ocean, the oldest blue sharks reported were a 16 year old male and a 13 year old female. Longevity is estimated to be between 20-26 years of age and maximum size is around 3.8 m FL. Size increases when latitude decreases.

Sexual maturity is attained at 5 years of age in both sexes. Blue shark is a viviparous species, with a yolk-sac placenta. Once the eggs have been fertilised there is a gestation period of between 9 and 12 months. Litter size is quite variable, ranging from four to 135 pups and may be dependent on the size of the female. The average litter size observed from the Indian Ocean is 38. New-born pups are around 40 to 51 cm in length. Generation time is about eight years. In Indian Ocean, between latitude 2 ºN and 6 ºS, pregnant females are present for most of the year.

FISHERIES

Blue sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery). The blue shark appears to have a similar distribution to swordfish. Typically, the fisheries take blue sharks between 1.8-2.4 m fork length or 30 to 52 kg. Males are slightly smaller than the females. In other Oceans, angling clubs are known for organising sharks fishing competitions where blue sharks and mako sharks are targetted. Sport fisheries for sharks are apparently not so common in the Indian Ocean.

There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights.

In 2005, seven countries reported catches of blue sharks in the IOTC region. These are not given in this summary because their representativeness is highly uncertain. Apparently, as other shark stocks have declined less blue sharks are being discarded.

FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

AVAILABILITY OF INFORMATION FOR STOCK ASSESSMENT

There is little information on blue shark biology and no information is available on stock structure.

Possible fishery indicators:

1. **Trends in catches**: The catch estimates for blue shark are highly uncertain as is their utility in terms of minimum catch estimates.
2. **Nominal CPUE Trends:** Data not available. There are no surveys specifically designed to assess shark catch rates in the Indian Ocean. Trends in localised areas might be possible in the future (for example, from the Kenyan recreational fishery).
3. **Average weight in the catch by fisheries:** data not available
4. **Number of squares fished:** CE data not available

STOCK ASSESSMENT

No quantitative stock assessment has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

MANAGEMENT ADVICE

There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for blue shark in the Indian Ocean therefore the stock status is highly uncertain.

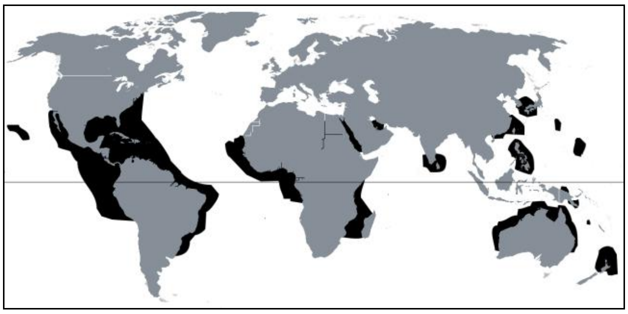
Blue sharks are commonly taken by a range of fisheries in the Indian Ocean and in some areas they are fished in their nursery grounds. Because of their life history characteristics – they are relatively long lived (16-20 years), mature at 4-6 years, and have relativity few offspring (25-50 pups every two years), the blue shark is vulnerable to overfishing.

DRAFT executive summary of the status of the silky shark resource

As endorsed by the WPEB 20 July 2007

BIOLOGY

The silky shark (*Carcharhinus falciformis*) is one of the most abundant large sharks inhabiting warm tropical and subtropical waters throughout the world.



Map. *The worldwide distribution of the Silky shark*

Although essentially pelagic, the silky shark is not restricted to the open ocean. It also ranges to inshore areas and near the edges of continental shelves and over deepwater reefs. Silky shark lives down to 500 m but has been caught as deep as 4000 m. Typically, smaller individuals are found in coastal. Small silky sharks are also commonly associated with schools of tuna.

Silky sharks often form mixed-sex schools containing similar sized individuals. Maximum age is estimated at 20+ years for males and 22+ years for females and maximum size is over 3 m long.

The age of sexual maturity is variable. In the Atlantic Ocean, off Mexico, silky sharks mature at 10-12 years. By contrast in the Pacific Ocean, males mature at around 5-6 years and females mature at around 6-7 year. The silky shark is a viviparous species with a gestation period of around 12 months. Females give birth possibly every two years. The number of pups per litter ranges from 9-14 in the western Indian Ocean, and 2-11 in the central Indian Ocean. Pups measure around 75-80 cm TL at birth and spend first their first few months in near reefs before moving to the open ocean. Generation time is estimated to be 8 years.

FISHERIES

Silky sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery). Sri Lanka has had a large fishery for small sized silky shark for over 40 years.

There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights.

Catches of silky shark in the IOTC region are not given in this summary because their representativeness is highly uncertain.

FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

AVAILABILITY OF INFORMATION FOR STOCK ASSESSMENT

There is little information available on silky shark biology and no information is available on stock structure.

Possible fishery indicators:

1. **Trends in catches**: The catch estimates for silky shark are highly uncertain as is their utility in terms of minimum catch estimates.
2. **Nominal CPUE Trends:** data not available
3. **Average weight in the catch by fisheries:** data not available
4. **Number of squares fished:** CE data not available

STOCK ASSESSMENT

No quantitative stock assessment has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

MANAGEMENT ADVICE

There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for silky shark in the Indian Ocean therefore the stock status is highly uncertain. Although the Sri Lankan fishery for small sized silky shark has been sustained for over 40 years, the level of catch over this period is uncertain.

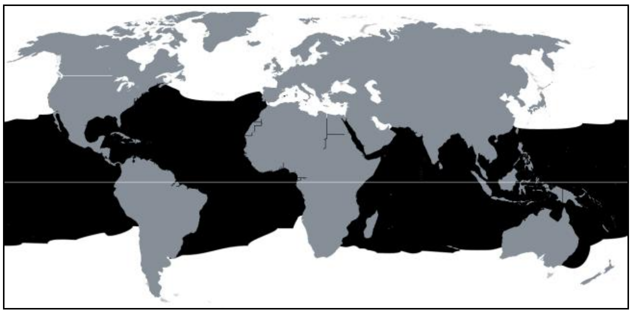
Silky sharks are commonly taken by a range of fisheries in the Indian Ocean and in some areas they are fished in their nursery grounds. Because of their life history characteristics – they are relatively long lived (over 20 years), mature at 6-12 years, and have relativity few offspring (<20 pups every two years), the silky shark is vulnerable to overfishing.

DRAFT executive summary of the status of the oceanic whitetip shark resource

As endorsed by the WPEB 20 July 2007

BIOLOGY

The oceanic whitetip shark (*Carcharhinus longimanus*) is one of the most common large sharks in warm oceanic waters. It is typically found in shallower waters near oceanic islands.



Map. *The worldwide distribution of the Oceanic Whitetip shark*

Oceanic whitetip sharks are relatively large sharks and grow to up to 4 m. Females grow larger than males. The maximum weight reported for this species is 167.4 kg.

Both males and females mature at around 4 to 5 years old or about 1.8-1.9 m TL. Oceanic whitetip sharks are viviparous. Litter sizes range from 1-15 pups, with larger sharks producing more offspring. Each pup is approximately 60-65 cm at birth. In the south western Indian Ocean, whitetips appear to mate and give birth in the early summer, with a gestation period which lasts about one year. The reproductive cycle is believed to be biennial. The locations of the nursery grounds are not well known but they are thought to be in oceanic areas.

The population dynamics and stock structure of the oceanic whitetip shark in the Indian Ocean are not known.

FISHERIES

Oceanic whitetip sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery).

There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights.

Catches of oceanic whitetip sharks in the IOTC region are not given in this summary because their representativeness is highly uncertain.

FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

AVAILABILITY OF INFORMATION FOR STOCK ASSESSMENT

There is little information available on oceanic whitetip shark biology and no information is available on stock structure.

Possible fishery indicators:

1. **Trends in catches**: The catch estimates for silky shark are highly uncertain as is their utility in terms of minimum catch estimates.
2. **Nominal CPUE Trends:** data not available
3. **Average weight in the catch by fisheries:** data not available
4. **Number of squares fished:** CE data not available

STOCK ASSESSMENT

No quantitative stock assessment has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

MANAGEMENT ADVICE

There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for oceanic whitetip shark in the Indian Ocean therefore the stock status is highly uncertain.

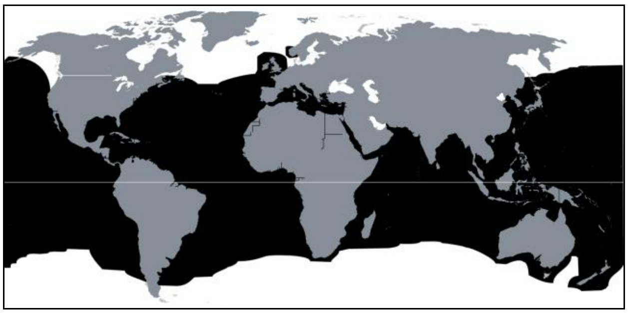
Oceanic whitetip sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived, mature at 4-5 years, and have relativity few offspring (<20 pups every two years), the oceanic whitetip shark is vulnerable to overfishing.

DRAFT executive summary of the status of the shortfin mako shark resource

As endorsed by the WPEB 20 July 2007

BIOLOGY

The shortfin mako shark (*Isurus oxyrinchus*) is widely distributed in tropical and temperate waters above 16°C. Makos prefer epipelagic and littoral waters from the surface down to depths of 500 meters. Shortfin mako is not known to school. It has a tendency to follow warm water masses polewards in the summer. Tagging results from the North Atlantic Ocean showed that makos migrated over long distances and this suggests that there is a single well-mixed population in this area. No information is available on stock structure of shortfin mako in Indian Ocean



Map. *The worldwide distribution of the Shortfin Mako shark*

The shortfin mako shark is a large and active shark and one of the fastest swimming shark species. It is known to leap out of the water when hooked and is often found in the same waters as swordfish. This species is at the top of the food chain, feeding on other sharks and fast-moving fishes such as swordfish and tunas.

The maximum age of shortfin makos in Northwest Atlantic Ocean is estimated to be over 24 years with the largest individuals reaching 4 m and 570 kg.

Sexual maturity is attained at 7 to 8 years or at around 2.7-3.0 m TL for females and 2.0-2.2 m TL for males. The length at maturity of female shortfin makos differs between the Northern and Southern hemispheres. The nursery areas are apparently in deep tropical waters. Female shortfin makos are ovoviviparous. Developing embryos feed on unfertilized eggs in the uterus during the gestation period which lasts 15-18 months. Litter size ranges from 4 to 25 pups, with larger sharks producing more offspring. Growth of the pups is very fast to reach 70 cm (TL) at birth. The gestation period is believed to last one year and the length of the reproductive cycle is around three years. Generation time is estimated to be 14 years.

FISHERIES

Shortfin mako sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery). In other Oceans, due to its energetic displays and edibility, the shortfin mako is considered one of the great gamefish of the world.

There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights.

Catches of shortfin mako sharks in the IOTC region are not given in this summary because their representativeness is highly uncertain.

FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

AVAILABILITY OF INFORMATION FOR STOCK ASSESSMENT

There is little information available on shortfin mako shark biology and no information is available on stock structure.

Possible fishery indicators:

1. **Trends in catches**: The catch estimates for shortfin mako are highly uncertain as is their utility in terms of minimum catch estimates.
2. **Nominal CPUE Trends:** data not available
3. **Average weight in the catch by fisheries:** data not available
4. **Number of squares fished:** CE data not available

STOCK ASSESSMENT

No quantitative stock assessment has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

MANAGEMENT ADVICE

There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for shortfin mako shark in the Indian Ocean therefore the stock status is highly uncertain.

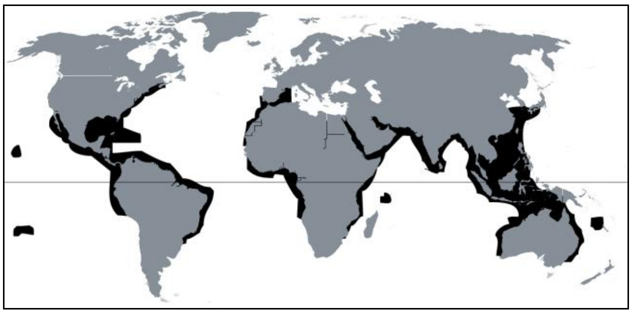
Shortfin mako sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (over 24 years), mature at 7-8 years, and have relativity few offspring (<30 pups every three years), the shortfin mako sharks is vulnerable to overfishing.

DRAFT executive summary of the status of the scalloped hammerhead shark resource

As endorsed by the WPEB 20 July 2007

BIOLOGY

The scalloped hammerhead shark (*Sphyrna lewini*) is widely distributed and common in warm temperate and tropical waters down to 275 m. It is also found in estuarine and inshore waters.



Map. *The worldwide distribution of the Scalloped Hammerhead shark*

In some areas, the scalloped hammerhead shark forms large resident populations. In other areas, large schools of small-sized sharks are known to migrate pole wards seasonally.

Scalloped hammerhead sharks feeds on pelagic fishes, other sharks and rays, squids, lobsters, shrimps and crabs.

The maximum age for Atlantic Ocean scalloped hammerheads is estimated to be over 30 years with the largest individuals reaching over 2.4 m.

Males in the Indian Ocean mature at around 1.4-1.65 m TL. Females mature at about 2.0 m TL. The scalloped hammerhead shark is viviparous with a yolk sac-placenta. The young are around 38-45 cm TL at birth, and litters consist of 15-31 pups. The reproductive cycle is annual and the gestation period is 9-10 months. The nursery areas are in shallow coastal waters.

FISHERIES

Scalloped hammerhead sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery).

There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights.

Catches of scalloped hammerhead sharks in the IOTC region are not given in this summary because their representativeness is highly uncertain.

FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

AVAILABILITY OF INFORMATION FOR STOCK ASSESSMENT

There is little information available on scalloped hammerhead shark biology and no information is available on stock structure.

Possible fishery indicators:

1. **Trends in catches**: The catch estimates scalloped hammerhead are highly uncertain as is their utility in terms of minimum catch estimates.
2. **Nominal CPUE Trends:** data not available
3. **Average weight in the catch by fisheries:** data not available
4. **Number of squares fished:** CE data not available

STOCK ASSESSMENT

No quantitative stock assessment has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

MANAGEMENT ADVICE

There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for scalloped hammerhead shark in the Indian Ocean therefore the stock status is highly uncertain.

Scalloped hammerhead sharks are commonly taken by a range of fisheries in the Indian Ocean. They are extremely vulnerable to gillnet fisheries. Furthermore, pups occupy shallow coastal nursery grounds, often heavily exploited by inshore fisheries. Because of their life history characteristics – they are relatively long lived (over 30 years), and have relativity few offspring (<31 pups each year), the scalloped hammerhead shark is vulnerable to overfishing.

APPENDIX VI

REVIEW OF SEABIRD BYCATCH MITIGATION MEASURES FOR PELAGIC LONGLINE FISHING AND IDENTIFICATION OF KNOWLEDGE GAPS

Mitigation measure	Scientific evidence for effectiveness in pelagic fisheries	Caveats /Notes	Need for combination	Research needs	Minimum standards
Night setting	Duckworth 1995; Brothers et al. 1999; Gales et al 1998; Klaer & Polacheck 1998; Brothers et al. 1999; McNamara et al. 1999; Gilman et al. 2005; Baker & Wise 2005.	Less effective during full moon, under intensive deck lighting or in high latitude fisheries in summer. Less effective on nocturnal foragers e.g. White-chinned Petrels (Brothers et al. 1999; Cherel et al. 1996).	Recommend combination with bird scaring lines and/or weighted branch lines	Data on current time of sets by WCPFC fisheries. Effect of night sets on target catch for different fisheries.	Night defined as nautical dark to nautical dawn
Side setting	Brothers & Gilman 2006; Yokota & Kiyota 2006.	Only effective if hooks are sufficiently below the surface by the time they reach the stern of the vessel. In Hawaii, side-setting trials were conducted with bird curtain and 45-60g weighted swivels placed within 0.5m of hooks. Japanese research concludes must be used with other measures (Yokota & Kiyota 2006).	Must be combined with other measures. Successful Hawaii trials use bird curtain plus weighted branch lines. In Southern Hemisphere, strongly recommend use wth bird scaring lines until side-setting is tested in the region.	Currently untested in the Southern Ocean against seabird assemblages of diving seabirds and albatrosses - urgent need for research. In Japan, NRIFSF will continue testing in 2007.	In Hawaii, side setting is used in conjunction with a bird curtain and 45 weighted swivel within 1m of the baited hook. Clear definition of side setting is required. Hawaiian definition is a minimum of 1 m forward of the stern.
Single bird scaring line	Imber 1994; Uozomi & Takeuchi 1998; Brothers et al. 1999; Klaer & Polacheck 1998; McNamara et al. 1999; Boggs 2001; CCAMLR 2002; Minami & Kiyota 2004. Melvin 2003.	Effective only when streamers are positioned over sinking baits. In pelagic fisheries, baited hooks are unlikely to sink beyond the diving depths of diving seabirds within the 150 m zone of the bird scaring line, unless combined with other measures such as line weighting or underwater setting. Entanglement with fishing gear can lead to poor compliance by fishers and design issues need to be addressed. In crosswinds, bird scaring line must be deployed from the windward side to be effective.	Effectiveness increased when combined with other measures e.g. weighted branch lines and/or night setting	Optimal design for pelagic fisheries under development: refine to minimise tangling, optimise aerial extent and positioning, and ease hauling/retrieval. Two studies in progress developing optimal bird scaring lines for pelagic fisheries including Washington Sea Grant and Global Guardian Trust in Japan. Controlled studies demonstrating their effectiveness in pelagic fisheries remain very limited.	Current minimum standards for pelagic fisheries are based on CCAMLR Conservation Measure 25-02
Mitigation measure	**Scientific evidence for effectiveness in pelagic fisheries**	**Caveats /Notes**	**Need for combination**	**Research needs**	**Minimum standards**
Paired bird scaring lines	Two streamer lines best in crosswinds to maximise protection of baited hooks (Melvin et al.	Potentially increased likelihood of entanglement - see above. Development of a towed device that keeps gear from	Effectiveness will be increased when combined with other measures. Recommend	Development and trialling of paired bird scaring line systems for	Current minimum standards for pelagic fisheries are based on CCAMLR

	2004).	crossing surface gear essential to improve adoption and compliance.	use with weighted branch lines and/or night setting	pelagic fisheries.	Conservation Measure 25-02
Weighted branch lines	Brothers 1991; Boggs 2001; Sakai et al. 2001; Brothers et al. 2001; Anderson & McArdle 2002; Gilman et al. 2003a; Robertson 2003; Lokkeborg & Robertson 2002, Hu et al. 2005.	Supplementary measure. Weights will shorten but not eliminate the zone behind the vessel in which birds can be caught. Even in demersal fisheries where weights are much heavier, weights must be combined with other mitigation measures (e.g. CCAMLR Conservation Measure 25-02).	Must be combined with other measures e.g. bird scaring lines and/or night setting	Mass and position of weight both affect sink rate. Further research on weighting regimes needed. Testing of safe-leads in progress. Where possible, effect on target catch as well as seabird bycatch should be evaluated. Research on use of integrated-weight branch lines (wire trace) in pelagic fisheries also needs further exploration.	Global minimum standards not yet established. Requirements now vary by fishery and vessel. Hawaii minimum requirements are 45g less than 1 m from hook. Australia requires 60 or 100g located 3.5 or 4 m from the hook, respectively.
Blue dyed bait	Boggs 2001; Brothers 1991; Gilman et al. 2003a; Minami & Kiyota 2001; Minami & Kiyota 2004; Lydon & Starr 2005. Double and Cocking, in press.	New data suggests only effective with squid bait (Double & Cocking). Onboard dyeing requires labour and is difficult under stormy conditions. Results inconsistent across studies.	Must be combined with bird scaring lines or night setting	Need for tests in Southern Ocean.	Mix to standardized colour placard or specify (e.g. use 'Brilliant Blue' food dye (Colour Index 42090, also known as Food Additive number E133) mixed at 0.5% for a minimum of 20 minutes)
Mitigation measure	**Scientific evidence for effectiveness in pelagic fisheries**	**Caveats /Notes**	**Need for combination**	**Research needs**	**Minimum standards**
Line shooter	Reduced bycatch of Northern Fulmar in trials of mitigation measures in North Sea, Lokkeborg & Robertson 2002; Lokkeborg 2003. Increased seabird bycatch in Alaska (Melvin et al. 2001).	Supplementary measure. No published data for pelagic fisheries. May enhance hook sink rates in some situations but unlikely to eliminate the zone behind the vessel in which birds can be caught. More data needed. Found ineffective in trials in North Pacific demersal longline fishery (Melvin et al. 2001).	Must be combined with other measures such as night setting and/or bird scaring lines or weighted branch lines	Data needed on effects on hook sink rates in pelagic fisheries.	Not established
Bait caster	Duckworth 1995; Klaer & Polacheck 1998.	Not a mitigation measure unless casting machines are available with the capability to control the distance at which baits are cast. This is necessary to allow accurate delivery of baits under a bird scaring line. Needs more development. Few commercially-available machines have this capability.	Not recommended as a mitigation measure.		

Mitigation measure	Scientific evidence for effectiveness in pelagic fisheries	Caveats /Notes	Need for combination	Research needs	Minimum standards
Underwater setting chute	Brothers 1991; Boggs 2001; Gilman et al. 2003a; Gilman et al. 2003b; Sakai et al. 2004; Lawrence et al. 2006.	For pelagic fisheries, existing equipment not yet sturdy enough for large vessels in rough seas. Problems with malfunctions and performance inconsistent (e.g. Gilman et al. 2003a and Australian trials cited in Baker & Wise 2005)	Not recommended for general application	Design problems to overcome	Not yet established
Management of offal discharge	McNamara et al. 1999; Cherel et al. 1996.	Supplementary measure. Definition essential. Offal attracts birds to vessels and where practical should be eliminated or restricted to discharge when not setting or hauling. Strategic discharge during line setting can increase interactions and should be discouraged. Offal retention and/or incineration may be impractical on small vessels.	Must be combined with other measures.	Further information needed on opportunities and constraints in pelagic fisheries (long and short term).	Not yet established for pelagic fisheries. In CCAMLR demersal fisheries, discharge of offal is prohibited during line setting. During line hauling, storage of waste is encouraged, and if discharged must be discharged on the opposite side of the vessel to the hauling bay.
Thawing bait	Brothers 1991; Duckworth 1995; Klaer & Polacheck; Brothers et al 1999.	Supplementary measure. Must be combined with other measures. If lines are set early morning, full thawing of all bait may create practical difficulties.		Evaluate sink rate of partially thawed bait.	

APPENDIX VII
SUGGESTED GUIDELINES FOR DESIGN AND DEPLOYMENT OF BIRD SCARING (TORI) LINES

Preamble

These guidelines are designed to assist in preparation and implementation of bird scaring line regulations for longline vessels. While these guidelines are relatively explicit, improvement in bird scaring line effectiveness through experimentation is encouraged. The guidelines take into account environmental and operational variables such as weather conditions, setting speed and ship size, all of which influence bird scaring line performance and design in protecting baits from birds. Bird scaring line design and use may change to take account of these variables provided that line performance is not compromised. Ongoing improvement in bird scaring line design is envisaged and consequently review of these guidelines should be undertaken in the future.

Bird Scaring Line Design

1. The bird scaring line shall be a minimum of 150 m in length and include an object towed at the seaward end to create tension to maximise aerial coverage. The object towed should be maintained directly behind the attachment point to the vessel such that in crosswinds the aerial extent of the bird scaring line is over the hookline. The section above water should be a strong fine line (e.g. about 3 mm diameter) of a conspicuous colour such as red or orange.

2. The above water section of the line should be sufficiently light that its movement is unpredictable to avoid habituation by birds and sufficiently heavy to avoid deflection of the line by wind.

3. The line is best attached to the vessel with a robust barrel swivel to reduce tangling of the line.

4. Streamers for the bird scaring line should be made of material that is conspicuous and produces an unpredictable lively action (e.g. strong fine line sheathed in red polyurethane tubing) suspended from a robust three-way swivel (that again reduces tangles) attached to the bird scaring line, and should hang just clear of the water.

5. There should be a maximum of 5-7 m between each streamer. Ideally each streamer should be paired.

6. The number of streamers should be adjusted for the setting speed of the vessel, with more streamers necessary at slower setting speeds.

Deployment of Bird scaring Lines

1. The line should be suspended from a pole affixed to the vessel. The bird scaring pole should be set as high as possible so that the line protects bait a good distance astern of the vessel and will not tangle with fishing gear. Greater pole height provides greater bait protection. For example, a height of around 7 m above the water line can give about 100 m of bait protection.

2. The bird scaring line should be set so that streamers pass over baited hooks in the water.

3. Deployment of multiple bird scaring lines is encouraged to provide even greater protection of baits from birds, particularly at times of high bird abundance or activity.

4. Because there is the potential for line breakage and tangling, spare bird scaring lines should be carried onboard to replace damaged lines and to ensure fishing operations can continue uninterrupted.