Report of the Fifteenth Session of the IOTC Scientific Committee

Mahé, Seychelles, 10–15 December 2012

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ACRONYMS

ACAP	Agreement on the Conservation of Albatrosses and Petrels
aFAD	Anchored fish aggregation device
AIC	Akaike Information Criterion
ASPIC	A Stock-Production Model Incorporating Covariates
B	Biomass (total)
B_{MSY}	Biomass which produces MSY
BRD	Bycatch reduction device
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CE	Catch and effort
CI	Confidence interval
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CoC	Compliance Committee
CPCs	Contracting parties and cooperating non-contracting parties
CPUE	catch per unit effort
current	Current period/time, i.e. $F_{current}$ means fishing mortality for the current assessment year
CV	Coefficient of variance
EBSA	Ecologically or biologically significant marine areas
EEZ	Exclusive Economic Zone
ERA	ecological risk assessment
EU	European Union
F	Fishing mortality; F_{2010} is the fishing mortality estimated in the year 2010
FAD	Fish Aggretation device
FAO	Food and Agriculture Organization of the United Nations
FL	Fork length
F_{MSY}	Fishing mortality at MSY
GIS	Geographic information system
GLM	Generalised liner model
GVP	Gross value of production
HCR	Harvest control rule
HBF	Hooks between floats
HS	Harvest strategy
HSF	Harvest strategy framework
HSP	Commonwealth Fisheries Harvest Strategy Policy 2007
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
IOSEA	Indian Ocean - South-East Asian Marine Turtle Memorandum
IOSSS	Indian Ocean Swordfish Stock Structure
IPA	International Plan of Action
ITQ	Individual transferable quota
IUCN	International Union for the Conservation of Nature
IUU	Illegal, unregulated and unreported (fishing)
LJFL	Lower-jaw fork length
LRP	Limit reference point
LL	Longline
LSTLV	Large-scale tuna longline fishing vessel
M	Natural Mortality
MEY	Maximum economic yield
MFCL	Multifan-CL
MOU	Memorandum of understanding
MP	Management procedure
MPA	Marine Protected Area
MPF	Meeting Participation Fund
MSE	Management strategy evaluation
MSY	Maximum sustainable yield
n.a.	Not applicable
NGO	Non-governmental organization
NPOA	National plan of action
OFCF	Overseas Fishery Cooperation Foundation of Japan

OM	Operating model
OT	Oversears Territory
PS	Purse seine
PSA	Productivity Susceptibility Analysis
PSAT	Pop-up satellite tag
q	Catchability
RBC	Recommended biological catch
RFMO	Regional fisheries management organisation
ROP	Regional Observer Programme
ROs	Regional Observer Scheme
RTTP-IO	Regional Tuna Tagging Project of the Indian Ocean
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY
SC	Scientific committee
SCAF	Standing Committee on Administration and Finance
SE	Standard error
SIOFA	Southern Indian Ocean Fisheries Agreement
SWIOFC	South West Indian Ocean Fisheries Commission
SWIOFP	South West Indian Ocean Fisheries Project
SS3	Stock Synthesis III
SSB	Spawning stock biomass
TAC	Total allowable catch
TAE	Total allowable effort
Taiwan,China	Taiwan, Province of China
TCAC	Technical Committee on Allocation Criteria
TEP	Threatened, endangered or protected (species)
TOR	Terms of reference
tRFMO	tuna Regional Fishery Management Organization
TRP	Target reference point
TrRP	Trigger reference point
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNGA	United Nations General Assembly
VME	Vulnerable marine ecosystems
VMS	Vessel Monitoring System
WP	Working Party of the IOTC
WPB	Working Party on Billfish
WPEB	Working Party on Ecosystems and Bycatch
WPDCS	Working Party on Data Collection and Statistics
WPFC	Working Party on Fishing Capacity
WPM	Working Party on Methods
WPNT	Working Party on Neritic Tunas
WPTmT	Working Party on Temperate Tunas
WPTT	Working Party on Tropical Tunas

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EXECUTIVE SUMMARY

The Fifteenth Session of the Indian Ocean Tuna Commission's (IOTC) Scientific Committee (SC) was held on Mahé, Seychelles, from 10 to 15 December 2012. A total of 54 individuals attended the Session, comprised of 46 delegates from 21 Member countries and 0 delegates from Cooperating Non-Contracting Parties, as well as 9 observers and invited experts.

NOTING that Table 1 in this report provides an overview of the stock status and management advice for each species under the IOTC mandate as well as species directly impacted by fisheries for tuna and tuna-like species, the SC **AGREED** to an Executive Summary for each species or species group as detailed below.

The following are a subset of the complete recommendations from the SC15 to the Commission, which are provided at Appendix XXXVIII.

Tuna – Highly migratory species

The SC **RECOMMENDED** that the Commission note the management advice developed for each tropical and temperate tuna species as provided in the Executive Summary for each species.

- Albacore (*Thunnus alalunga*) – Appendix IX
- Bigeye tuna (*Thunnus obesus*) – Appendix X
- Skipjack tuna (*Katsuwonus pelamis*) – Appendix XI
- Yellowfin tuna (*Thunnus albacares*) – Appendix XII

Billfish

The SC **RECOMMENDED** that the Commission note the management advice developed for each billfish species as provided in the Executive Summary for each species:

- Swordfish (*Xiphias gladius*) – Appendix XIII
- Black marlin (*Makaira indica*) – Appendix XIV
- Blue marlin (*Makaira nigricans*) – Appendix XV
- Striped marlin (*Tetrapturus audax*) – Appendix XVI
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XVII

Tuna and mackerel – Neritic species

The SC **RECOMMENDED** that the Commission note the management advice developed for each neritic tuna species as provided in the Executive Summary for each species:

- Bullet tuna (*Auxis rochei*) – Appendix XVIII
- Frigate tuna (*Auxis thazard*) – Appendix XIX
- Kawakawa (*Euthynnus affinis*) – Appendix XX
- Longtail tuna (*Thunnus tonggol*) – Appendix XXI
- Indo-Pacific king mackerel (*Scomberomorus guttatus*) – Appendix XXII
- Narrow-barred Spanish mackerel (*Scomberomorus commerson*) – Appendix XXIII

Sharks

The SC **RECOMMENDED** that the Commission note the management advice developed for a subset of shark species commonly caught in IOTC fisheries for tuna and tuna-like species:

- Blue sharks (*Prionace glauca*) – Appendix XXIV
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix XXV
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix XXVI
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix XXVII
- Silky sharks (*Carcharhinus falciformis*) – Appendix XXVIII
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XXIX
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XXX

Marine turtles

The SC **RECOMMENDED** that the Commission note the management advice developed for marine turtles, as provided in the Executive Summary encompassing all six species found in the Indian Ocean:

- Marine turtles – Appendix XXXI

Seabirds

The SC **RECOMMENDED** that the Commission note the management advice developed for seabirds, as provided in the Executive Summary encompassing all species commonly interacting with IOTC fisheries for tuna and tuna-like species:

- Seabirds – Appendix XXXII

Report of the Eighth Session of the Working Party on Ecosystems and Bycatch (WPEB08)

Data reporting requirements

(para.89) **NOTING** that despite the mandatory reporting requirements detailed in Resolutions 05/05, 10/02, 10/06, 12/03 and 12/04, bycatch data remain largely unreported by CPCs and the SC **RECOMMENDED** that the Compliance Committee and the Commission address this non-compliance by taking steps to develop mechanisms which would ensure that CPCs fulfil their bycatch reporting obligations.

Gillnet fisheries of the Indian Ocean

(para.90) The SC **NOTED** that gillnet fisheries are expanding rapidly in the Indian Ocean, with gillnets often being longer than 2.5 km in contravention with UN and IOTC Resolutions, and that their use is considered to have a substantial impact on marine ecosystems. **NOTING** that in 2012 the Commission adopted Resolution 12/01 on the implementation of the precautionary approach, the majority of the SC **RECOMMENDED** that the Commission freeze catch and effort by gillnet fisheries in the Indian Ocean in the near future, until sufficient information has been gathered to determine the impact of gillnet fleets on IOTC stocks and bycatch species caught by gillnet fisheries targeting tuna and tuna-like species, noting that the implementation of any such measure would be difficult.

Sharks – Status of catch statistics and data reporting

(para.99) **NOTING** that Resolution 10/02 *mandatory statistical requirements for IOTC members and Cooperating Non-Contracting Parties (CPC's)*, makes provision for data to be reported to the IOTC on "*the most commonly caught shark species and, where possible, to the less common shark species*", without giving any list defining the most common and less common species, and recognising the general lack of shark data being recorded and reported to the IOTC Secretariat, the SC **RECOMMENDED** that Resolution 10/02 is revised in order to include the list of most commonly caught elasmobranch species (Table 3) for which nominal catch data shall be reported as part of the statistical requirement for IOTC CPCs.

Sharks – Inclusion of two additional shark species to the list of mandatory data requirements for longline gear (Res 12/03)

(para.110) The SC **RECOMMENDED** that, in line with Recommendation 12/15 on the best available science, the list of shark species (or groups of species) for longline gear under Resolution 12/03 should be supplemented by two other shark species which were estimated to be at risk in longline fisheries by the ERA conducted in 2012, the silky shark (*Carcharinus falciformis*) and the oceanic whitetip shark (*Carcharinus longimanus*). The SC **ADVISED** the Commission to define the most appropriate means of collecting this additional information, considering the limitations of both options (logbooks and/or regional observer scheme) presented in paragraphs 108 and 109.

Sharks – Fin to body weight ratio

(para.111) The SC **ADVISED** the Commission to consider, that the best way to encourage full utilisation of sharks, to ensure accurate catch statistics, and to facilitate the collection of biological information, is to revise the IOTC Resolution 05/05 *concerning the conservation of sharks caught in association with fisheries managed by IOTC* such that all sharks must be landed with fins attached (naturally or by other means) to their respective carcass. However, the SC **NOTED** that such an action would have practical implementation and safety issues for some fleets and may degrade the quality of the product in some cases. The SC **RECOMMENDED** all CPCs to obtain and maintain the best possible data for IOTC fisheries impacting upon sharks, including improved species identification.

Sharks – Wire leaders/traces

(para.113) On the basis of information presented to the SC in 2011 and in previous years, the SC **RECOGNISED** that the use of wire leaders/traces in longline fisheries may imply targeting of sharks. The SC therefore **RECOMMENDED** to the Commission that if it wishes to reduce catch rates of sharks by longliners it should prohibit the use of wire leaders/traces.

Marine turtles – Data and reporting requirements

(para.114) The SC **RECOMMENDED** that IOTC Resolution 12/04 *on the conservation of marine turtles* is strengthened to ensure that CPCs report annually on the level of incidental catches of marine turtles by species, as provided at Table 6.

Report of the Fourth Session of the Working Party on Methods (WPM04)

Capacity building

(para.128) The SC **RECOMMENDED** that the IOTC Secretariat coordinate the development and delivery of several training workshops focused on providing assistance to developing CPCs to better understand the MSE process, including how reference points and harvest control rules are likely to function in an IOTC context. The implications of IOTC Resolution 12/01 *on the implementation of the precautionary approach* and IOTC Recommendation 12/14 *on interim target and limit reference points* should be incorporated into the workshop. The SC **REQUESTED** that the Commission's budget incorporate appropriate funds for this purpose.

Report of the Second Session of the Working Party on Neritic Tunas (WPNT02)

(para.165) The SC **RECOMMENDED** that the Commission note that neritic tuna and tuna-like species under the IOTC mandate have become as important or more important as the three tropical tuna species (bigeye tuna, skipjack tuna and yellowfin tuna) to most IOTC coastal states with a total estimated catch of 605,359 t being landed in 2011, and as a result, should be receiving appropriate management resources from the IOTC. In fact, neritic tuna species are in many cases, the major commercial tuna and tuna-like species being exploited by the majority of Indian Ocean coastal states and as such, should be given the same status in terms of time and resource investment.

Matters common to Working Parties

Capacity building activities

(para.177) The SC **RECOMMENDED** that the Commission increase the IOTC Capacity Building budget line so that capacity building workshops/training can be carried out in 2013 and 2014 on the collection, reporting and analyses of catch and effort data for neritic tuna and tuna-like species. Where appropriate this training session shall include information that explains the entire IOTC process from data collection to analysis and how the information collected is used by the Commission to develop Conservation and Management Measures.

Dedicated workshop on CPUE standardisation

(para.189) **NOTING** the combined recommendations from the WPB, WPTmT and WPTT to hold a dedicated workshop on CPUE standardisation, the SC **RECOMMENDED** that a dedicated, informal workshop on CPUE standardisation, including issues of interest for other IOTC species, should be carried out before the next round of stock assessments in 2013. The terms of reference (TORs) for the workshop are provided in Appendix VII. Where possible it should include a range of invited experts, including those working on CPUE standardisation in other ocean/RFMOs, in conjunction with scientists from main tuna fishing countries, and supported by the IOTC Secretariat. The IOTC Secretariat shall include a budget item for this workshop, for the consideration of the Commission.

On Interim Target and Limit Reference Points

(para.194) **NOTING** the completion of the MSE work on tropical tunas is likely to take several years, and that the lack of data or information to improve the work on formal stock assessments should not hinder the application of the Precautionary Approach, the SC **RECOMMENDED** that the Commission consider the adoption of the interim target and limit reference points as a Resolution. Furthermore, interim harvest controls rules should be considered by the Commission for adoption in the Resolution.

Employment of a Fisheries Officer (Science)

(para.195) **NOTING** the rapidly increasing scientific workload at the IOTC Secretariat, including a wide range of additional science related duties assigned to it by the SC and the Commission, and that the current Fishery Officer supporting the IOTC scientific activities will depart at the end of February 2013, the SC strongly **RECOMMENDED** that the Commission approve the hiring of a Fishery Officer (Science) to work on a range of matters in support of the scientific process, including but not limited to science capacity building, bycatch and regional observer schemes.

Review of the Draft, and Adoption of the Report of the Fifteenth Session of the Scientific Committee

(para.251) The SC **RECOMMENDED** that the Commission consider the consolidated set of recommendations arising from SC15, provided at Appendix XXXVIII.

TABLE 1. Status summary for species of tuna and tuna-like species under the IOTC mandate, as well as other species impacted by IOTC fisheries.

Stock	Indicators	Prev[1]	2010	2011	2012	Advice to the Commission
Temperate and tropical tuna stocks: These are the main stocks being exploitation by industrial, and to a lesser extent, artisanal fisheries throughout the Indian Ocean, both on the high seas and in the EEZ of coastal states.						
Albacore *Thunnus alalunga*	Catch 2011: 38,946 t Average catch 2007–2011: 41,609 t MSY (80% CI)): 33,300 t (31,100–35,600 t) F_{2010}/F_{MSY} (80% CI): 1.33 (0.9–1.76) SB_{2010}/SB_{MSY} (80% CI): 1.05 (0.54–1.56) SB_{2010}/SB_{1950} (80% CI): 0.29 (n.a.)	2007				Maintaining or increasing effort in the core albacore fishing grounds is likely to result in further declines in albacore biomass, productivity and CPUE. The impacts of piracy in the western Indian Ocean has resulted in the displacement of a substantial portion of longline fishing effort into the traditional albacore fishing areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on albacore will decline in the near future unless management action is taken. <click here for full stock status summary>
Bigeye tuna *Thunnus obesus*	Catch in 2011: 87,420 t Average catch 2007–2011: 101,639 t SS3[3] / ASPM[4] MSY (1000 t): 114 t (95–183 t) / 103 t (87–119 t) [2]F_{curr}/F_{MSY}: 0.79 (0.50–1.22) / 0.67 (0.48–0.86) [2]SB_{curr}/SB_{MSY}: 1.20 (0.88–1.68) / 1.00 (0.77–1.24) [2]SB_{curr}/SB_0: 0.34 (0.26–0.40) / 0.39	2008				The recent declines in longline effort, particularly from the Japanese, Taiwan,China and Republic of Korea longline fleets, as well as purse seine effort have lowered the pressure on the Indian Ocean bigeye tuna stock, indicating that current fishing mortality would not reduce the population to an overfished state in the near future. <click here for full stock status summary>
Skipjack tuna *Katsuwonus pelamis*	Catch 2011: 398,240 t Average catch 2007–2011: 435,527 t MSY (1000 t): 478 t (359–598 t) F_{2011}/F_{MSY}: 0.80 (0.68–0.92) SB_{2011}/SB_{MSY}: 1.20 (1.01–1.40) SB_{2011}/SB_0: 0.45 (0.25–0.65)					The recent declines in catches are thought to be caused by a recent decrease in purse seine effort as well as due to a decline in CPUE of large skipjack tuna in the surface fisheries. Catches in 2010 (428,000 t) and 2011 (398,240 t) as well as the average level of catches of 2007–2011 (435,527 t) are below MSY targets though may have exceeded them in 2005 and 2006. <click here for full stock status summary>
Yellowfin tuna *Thunnus albacares*	Catch 2011: 302,939 t Average catch 2007–2011: 302,064 t MSY (1000 t): 344 (290–453) F_{2010}/F_{MSY}: 0.69 (0.59–0.90) SB_{2010}/SB_{MSY}: 1.24 (0.91–1.40) SB_{2010}/SB_0: 0.38 (0.28–0.38)	2008				The decrease in longline and purse seine effort in recent years has substantially lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality has not exceeded the MSY-related levels in recent years. If the security situation in the western Indian Ocean were to improve, a rapid reversal in fleet activity in this region may lead to an increase in effort which the stock might not be able to sustain, as catches would then be likely to exceed MSY levels. <click here for full stock status summary>

Stock	Indicators	Prev[1]	2010	2011	2012	Advice to the Commission
Billfish: These are the billfish stocks being exploitation by industrial and artisanal fisheries throughout the Indian Ocean, both on the high seas and in the EEZ of coastal states. The marlins and sailfish are not usually targeted by most fleets, but are caught and retained as byproduct by the main industrial fisheries. They are important for localised small-scale and artisanal fisheries or as targets in recreational fisheries.						
Swordfish (whole IO) *Xiphias gladius*	Catch 2011: 19,631 t Average catch 2007–2011: 21,870 t MSY: 29,900–34,200 t F_{2009}/F_{MSY}: 0.50–0.63 SB_{2009}/SB_{MSY}: 1.07–1.59 SB_{2009}/SB_0: 0.30–0.53	2007				The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality would not reduce the population to an overfished state. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current levels until 2019 (<11% risk that $B_{2019} < B_{MSY}$, and <9% risk that $F_{2019} > F_{MSY}$). <click here for full stock status summary>
Swordfish (southwest IO) *Xiphias gladius*	Catch 2011: 6,559 t Average catch 2007–2011: 6,939 t MSY: 7,100 t–9,400 t F_{2009}/F_{MSY}: 0.64–1.19 SB_{2009}/SB_{MSY}: 0.73–1.44 SB_{2009}/SB_0: 0.16–0.58					The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. However, in 2010, catches exceeded the maximum recommended by the WPB09 and SC14 in 2011 (6,678 t), with 8,046 t caught in this region. The WPB09 estimated that there is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at 2009 levels (<25% risk that $B_{2019} < B_{MSY}$, and <8% risk that F2019 > F_{MSY}). There is a risk of reversing the rebuilding trend if there is any increase in catch in this region. <click here for full stock status summary>
Black marlin *Makaira indica*	Catch 2011: 6,890 t Average catch 2007–2011: 6,292 t MSY (range): unknown					Longline catch and effort for black marlin in recent years has continued to increase to a total of 7,021 tonnes in 2010. Although a lower catch of 6,890 tonnes was caught in 2011, the pressure on the Indian Ocean stock as a whole remains highly uncertain. Thus, there remains insufficient information to evaluate the effect this will have on the resource. <click here for full stock status summary>
Blue marlin *Makaira nigricans*	Catch 2011: 12,115 t Average catch 2007–2011: 9,443 t MSY (range): unknown					The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, although 2011 catches increased substantially to 12,115 t. There is insufficient information to evaluate the effect this will have on the resource at this point in time. Given the concerning results obtained from the preliminary stock assessments carried out in 2012 for blue marlin, the data and other inputs for stock assessment urgently needs to be revised so that a new assessment may be carried out in 2013. <click here for full stock status summary>
Striped marlin *Tetrapturus audax*	Catch 2011: 1,885 t Average catch 2007–2011: 2,245 t MSY (range): unknown					The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is insufficient information to evaluate the effect this will have on the resource. Given the concerning results obtained from the preliminary stock assessments carried out in 2012 for striped marlin, the data and other inputs for stock assessment urgently needs to be revised so that a new assessment may be carried out in 2013. <click here for full stock status summary>
Indo-Pacific Sailfish *Istiophorus platypterus*	Catch 2011: 32,503 t Average catch 2007–2011: 27,103 t MSY (range): unknown					The increase in longline catch and effort in recent years is a substantial cause for concern for the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. <click here for full stock status summary>

Stock	Indicators	Prev[1]	2010	2011	2012	Advice to the Commission
Neritic tunas and mackerel: These six species have become as important or more important as the three tropical tuna species (bigeye tuna, skipjack tuna and yellowfin tuna) to most IOTC coastal states with a total estimated catch of 605,359 t being landed in 2011. They are caught primarily by coastal fisheries, including small-scale industrial and artisanal fisheries. They are almost always caught within the EEZs of IO coastal states. Historically, catches were often reported as aggregates of various species, making it difficult to obtain appropriate data for stock assessment analyses.						
Bullet tuna *Auxis rochei*	Catch 2011: 4,949 t Average catch 2007–2011: 2,961 t MSY (range): unknown					The continued increase of annual catches for these species are likely to have further increased the pressure on the Indian Ocean stocks as a whole, however there is not sufficient information to evaluate the effect this will have on the resources. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted. • bullet tuna <click here for full stock status summary> • frigate tuna <click here for full stock status summary> • kawakawa <click here for full stock status summary> • longtail tuna <click here for full stock status summary> • Indo-Pacific king mackerel <click here for full stock status summary> • narrow-barred Spanish mackerel <click here for full stock status summary>
Frigate tuna *Auxis thazard*	Catch 2011: 83,210 t Average catch 2007–2011: 75,777 t MSY (range): unknown					
Kawakawa *Euthynnus affinis*	Catch 2011: 143,393 t Average catch 2007–2011: 134,314 t MSY (range): unknown					
Longtail tuna *Thunnus tonggol*	Catch 2011: 177,795 t Average catch 2007–2011: 134,871 t MSY (range): unknown					
Indo-Pacific king mackerel *Scomberomorus guttatus*	Catch 2011: 49,832 t Average catch 2007–2011: 44,457 t MSY (range): unknown					
Narrow-barred Spanish mackerel *Scomberomorus commerson*	Catch 2011: 146,180 t Average catch 2007–2011: 130,476 t MSY (range): unknown					

Sharks: Although sharks are not part of the 16 species directly under the IOTC mandate, sharks are frequently caught in association with fisheries targeting IOTC species. Some fleets are known to actively target both sharks and IOTC species simultaneously. As such, IOTC Members and Cooperating non-Contracting Parties are required to report information at the same level of detail as for the 16 IOTC species. The following are the main species caught in IOTC fisheries, although the list is not exhaustive.						
Blue shark *Prionace glauca*	Reported catch 2011: 9,540 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 9,452 t Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on sharks will decline in these areas in the near future, and may result in localised depletion. • blue shark <click here for full stock status summary> • oceanic whitetip shark <click here for full stock status summary> • scalloped hammerhead shark <click here for full stock status summary> • shortfin mako shark <click here for full stock status summary> • silky shark <click here for full stock status summary> • bigeye thresher shark <click here for full stock status summary> • pelagic thresher shark <click here for full stock status
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2011: 388 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 347 t Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					
Scalloped hammerhead shark *Sphyrna lewini*	Reported catch 2011: 120 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 36 t Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					
Shortfin mako *Isurus oxyrinchus*	Reported catch 2011: 1,361 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 1,207 t					

	Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					summary>
Silky shark *Carcharhinus falciformis*	Reported catch 2011: 3,353 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 1,396 t Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					
Bigeye thresher shark *Alopias superciliosus*	Reported catch 2011: 330 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 68 t Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2011: 10 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 4 t Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					

[1] This indicates the last year taken into account for assessments carried out before 2010

[2]Current period ($_{curr}$) = 2009 for SS3 and 2010 for ASPM.

[3]Central point estimate is adopted from the 2010 SS3 model, percentiles are drawn from a cumulative frequency distribution of MPD values with models weighted as in Table 12 of 2010 WPTT report (IOTC–2010–WPTT12–R); the range represents the 5th and 95th percentiles.

[4]Median point estimate is adopted from the 2011 ASPM model using steepness value of 0.5 which is the most conservative scenario (values of 0.6, 0.7 and 0.8, which are more optimistic, are considered to be as plausible as these values but are not presented for simplification); the range represents the 90 percentile Confidence Interval.

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	(yellow)	(green)
Not assessed/Uncertain	(grey)	

1. OPENING OF THE SESSION

1. The Fifteenth Session of the Indian Ocean Tuna Commission's (IOTC) Scientific Committee (SC) was held on Mahé, Seychelles, from 10 to 15 December 2012. A total of 54 individuals attended the Session, comprised of 46 delegates from 21 Member countries and 0 delegates from Cooperating Non-Contracting Parties, as well as 9 observers and invited experts. The list of participants is provided at Appendix I.

2. The meeting was opened on 10 December, 2012 by the Chair Dr. Tom Nishida (Japan) who welcomed participants to the Seychelles. The Chair informed participants that the Vice-Chair Mr. Jan Robinson was unable to attend the Session and sent his apologies.

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

3. The SC **ADOPTED** the Agenda provided at Appendix II. The documents presented to the SC are listed in Appendix III.

4. **NOTING** that the current FAO rules regarding the time permissible for FAO interpreters to cover sessions of IOTC bodies (FAO interpreters are restricted to a maximum of two, three hour sessions in a single day which would include any short breaks taken by participants), the SC **REQUESTED** that the SC Chair write to the FAO office concerned and indicate that this rule is a serious obstruction to the efficient working of IOTC meetings. The letter should include a request that a short 15 minute break should be allowed in the FAO rules, which would not be counted towards each three hour interpretation block.

3. ADMISSION OF OBSERVERS

5. The SC **NOTED** that at the Sixteenth Session of the Commission, Members decided that its subsidiary bodies should be open to participation by observers from all those who have attended the current and/or previous sessions of the Commission. Applications by new Observers should continue to follow the procedure as outlined in Rule XIII of the IOTC Rules of Procedure.

6. The SC **ADMITTED** the following observers to the Fifteenth Session of the SC:
   - Indian Ocean – South-East Asian Marine Turtle Memorandum of Understanding (IOSEA)
   - International Seafood Sustainability Foundation (ISSF)
   - Overseas Fishery Cooperation Foundation of Japan (OFCF)
   - Marine Stewardship Council (MSC)
   - World Wide Fund for Nature (a.k.a World Wildlife Fund, WWF)

Invited experts

7. The SC **ADMITTED** the invited experts from Taiwan,China, under Rule X.4 and XIII.9 of the IOTC Rules of Procedure, which states that the Commission may invite experts, in their individual capacity, to enhance and broaden the expertise of the SC and of its Working Parties.

4. DECISIONS OF THE COMMISSION RELATED TO THE WORK OF THE SCIENTIFIC COMMITTEE

8. The SC **NOTED** paper IOTC–2012–SC15–03 which outlined the decisions and requests made by the Commission at its Sixteenth Session, held from 22–26 April 2012, specifically relating to the work of the SC, including the 15 Conservation and Management Measures (13 Resolutions and two Recommendations) adopted during the Session. The SC **AGREED** to develop advice in response to each of the requests made by the Commission during the current Session.

9. The SC **NOTED** paper IOTC–2012–SC15–04 which outlined a number of Commission decisions, in the form of previous Resolutions that require a response from the SC in 2012, and **AGREED** to develop advice to the Commission in response to each request during the current session.

5. SCIENCE RELATED ACTIVITIES OF THE IOTC SECRETARIAT IN 2012

10. The SC **NOTED** paper IOTC–2012–SC15–05 which provided an overview of the work undertaken by the IOTC Secretariat in 2012, including the following key activities: 1) Second Working Party on Neritic Tunas; 2) Second stock assessment for skipjack tuna; and 3) the continued increase in participation at IOTC scientific meetings by developing coastal states, including via the submission of working papers.

11. The SC **NOTED** with thanks, the contributions of the staff of the IOTC Secretariat to the science process in 2012, in particular via support to the working party and SC meetings, facilitation of the IOTC Meeting Participation Fund, improvements in the quality of some of the data sets being collected and submitted to the IOTC Secretariat, preparation of the bycatch species identification guides, and through the facilitation of invited experts to raise the standard of IOTC meetings.

Meeting Participation Fund (MPF)

12. The SC **NOTED** that the Commission, at its 16th Session adopted revised rules of procedure for the administration of the IOTC Meeting Participation Fund (MPF). As the main goal of the MPF is to increase the participation of developing CPCs to scientific meetings of IOTC, and in line with paragraph 6 of Resolution 10/05, applications to the MPF are only eligible if the applicant intends to produce and present a working paper relevant to the working party that he/she wishes to attend, or a CPC National Report if the meeting is the SC.

13. The SC **NOTED** that the increased attendance by national scientists from developing CPCs to IOTC Working Parties and the SC in 2012 (46 in 2012; 33 in 2011) was partly due to the IOTC MPF, adopted by the Commission in 2010 (Resolution 10/05 *on the establishment of a Meeting Participation Fund for developing IOTC Members and non-Contracting Cooperating Parties*), and **RECOMMENDED** that the Commission maintain this fund into the future.

14. The SC **NOTED** that the MPF is currently funded through accumulated IOTC budgetary funds and voluntary contributions by CPCs. The Commission may need to develop and implement a procedure for supplying funds to the MPF in the future, as detailed in Resolution 10/05.

15. The SC **RECOMMENDED** that the rules of procedure for the administration of the IOTC meeting participation fund be modified to include funding for Chairs and Vice-Chairs from IOTC developing coastal states, noting that without access to this fund, the ability of developing coastal state scientists to offer their services as Chairs and Vice-Chairs will be very limited. The same rules for document provision shall apply to Chairs and Vice-Chairs funded by the MPF.

16. The SC **NOTED** that for 2011 and 2012, all MPF recipients developed and presented at least one working paper or National Report, relevant to the meeting in which the Commission funded their attendance. The papers presented to IOTC meetings by MPF recipients have continued to improve in quality as a direct result of improved attendance and participation by scientists from developing coastal states.

IOTC-OFCF Project, 2012

17. The SC **NOTED** paper IOTC–2012–SC15–INF01, which outlined the key activities undertaken by the IOTC-OFCF project in 2012. The Memorandum of Understanding between the IOTC and the Overseas Fishery Cooperation Foundation of Japan (OFCF) was initiated in April 2002, with the aim of providing technical guidance to developing countries in the IOTC area of competence, in particular to improve data collection methods and the quality of fisheries statistics being reported to the IOTC Secretariat. Phases I and II of the project ran for eight consecutive years. At the end of Phase II the IOTC and the OFCF considered the implementation of a new Phase with the objective of addressing the concerns of the Commission regarding the quality of the data available for several important artisanal fisheries in the region. Following consideration of the proposal, the OFCF agreed to initiate Phase III of the project, of which, the terms of reference focused on strengthening observer schemes.

18. The SC **THANKED** Japan and the IOTC Secretariat for providing financial and technical support to assist the implementation of the IOTC Observer Scheme in coastal countries of the IOTC area of competence and **RECOMMENDED** that Japan consider an extension of IOTC–OFCF Project activities in the future.

Glossary of scientific terms, acronyms and abbreviations

19. **NOTING** paper IOTC–2012–SC15–INF03 which provided a glossary of scientific terms, acronyms and abbreviations, and report terminology, for the most commonly used scientific terms in IOTC reports and Conservation and Management Measures (CMM), the SC **ENCOURAGED** all authors of papers to be submitted to the IOTC to use the definitions contained in the glossary. The SC indicated that it may wish to modify these incrementally in the future.

Species data catalogues

20. **NOTING** paper IOTC–2012–SC15–INF04 which provided data catalogues for IOTC species and CPCs landing those species, the SC **THANKED** the IOTC Secretariat for preparing the IOTC Data Catalogues, on the quality of nominal catch, catch-and-effort, and size frequency data, and **REQUESTED** that the IOTC Secretariat updates the Catalogues as new information become available.

21. The SC **EXPRESSED** concern that in spite of the efforts by some CPCs and the IOTC Secretariat to improve the quality of data collection, management and reporting in the IOTC area of competence, the quality of the data in the IOTC database appears to be worsening. The decline in data quality observed may be associated with the onset of piracy in the western tropical area in 2007, leading to a drop in the activities and catches of some industrial fleets that have traditionally reported higher quality data.

Pilot project: Improvements to data collections from artisanal fisheries

22. The SC **NOTED** paper IOTC–2012–SC15–38 which provided an overview of the pilot project to improve data collection for tuna, sharks and billfish from artisanal fisheries in the Indian Ocean. Specifically, the project aimed at revising catch statistics for India, Indonesia and Sri Lanka from 1950 to 2011.

23. The SC **ACKNOWLEDGED** the excellent work undertaken by the consultant in collaboration with the IOTC Secretariat in undertaking this thorough, difficult and highly valuable work, including the identification of deficiencies in data collection and reporting by India, Indonesia and Sri Lanka.

24. The SC **NOTED** the comments from various participants which highlighted that data collection and reporting abilities by CPCs are highly variable. CPCs indicated that they are committed to continue to update and improve data collection and reporting systems as resources permit.

25. The SC **NOTED** the difficulties that some CPCs had to provide the information requested by the consultant which usually originate on fragmented data collection and management systems, and the difficulties that some countries have to put together this information. The SC **STRESSED** the need for all CPCs to establish data collection and management systems so as fisheries statistics can be produced for the whole country and as per the mandatory reporting requirements for all CPCs.

IOTC website development

26. The SC **NOTED** the work undertaken by the IOTC Secretariat and a company to complete the new IOTC website. The new website is expected to go live in early March, 2013 once it has been populated with all historical IOTC documents and related material.

6. NATIONAL REPORTS FROM CPCS

27. The SC **NOTED** the 26 National Reports presented by CPCs (Contracting parties and cooperating non-contracting parties) for the meeting, the abstracts of which are provided at Appendix IV. The following matters were raised in regard to the content of specific reports:
    - **Australia**: The SC **NOTED** that catch statistics for sharks in Australian recreational fisheries in the IOTC area of competence are not well estimated at present, although improvements are being made. The SC also noted that no skipjack tuna was caught by Australian vessels in the IOTC area of competence in 2012, as purse seine vessels limited their targeting to southern bluefin tuna.
    - **Belize**: National Report not presented orally as Belize was absent from the SC15 meeting.
    - **China**: Nil comments.
    - **Comoros**: The SC **NOTED** that the current tagging research program funded by the South West Indian Ocean Fisheries Program (SWIOFP) in the Comoros will cease at the end of March 2013, once the current funding arrangement concludes.
    - **Eritrea**: The SC **EXPRESSED** its disappointment that Eritrea did not provide a National Report and **REQUESTED** that the SC Chair remind Eritrea to fulfil its reporting obligations to the IOTC.
    - **European Union** (EU): The SC **NOTED** that the EU report does not include shark discards by some of the EU longline fleets for 2011, as requested by the SC in the National Report template. The EU indicated that the information is provided in historical documents provided to the working parties. In a question regarding the EU observer program which resumed in 2011 for purse seine vessels, the EU indicated that the current coverage rate is approximately 10%, although coverage is limited to areas which are not impacted by piracy activities (most of the western Indian Ocean).
    - **France (territories)**: Nil comments.
    - **Guinea**: The SC **EXPRESSED** its disappointment that Guinea did not provide a National Report and **REQUESTED** that the SC Chair remind the Guinea to fulfil its reporting obligations to the IOTC.

- **India**: The SC **NOTED** the slightly improved situation by India in regard to the mandatory data reporting requirements, as well as the consultations underway with various stakeholders to further improve data collection and reporting. However, substantial improvements remain to be made and higher quality data needs to be provided by India in 2013.
- **Indonesia**: The SC **NOTED** that although the proportion of longline catches of tuna and tuna-like species by Indonesia has continued to increase, catch and effort data as per IOTC requirements is yet to be reported (spatial distribution of catch and effort). Indonesia will provide catch and effort statistics by species, gear and location in accordance with IOTC recording and reporting requirements. The SC **NOTED** that, to date, Indonesia has not reported catch-and-effort data to the IOTC Secretariat, and the provision of size frequency data was discontinued in 2010. The SC **REQUESTED** Indonesia to make the necessary arrangements for this information to be reported in the future.
- **Iran, Islamic Republic of**: The SC **NOTED** that since 2007 the area of operation for I.R. Iran gillnet and purse seine vessels has been substantially reduced as a direct result of piracy activities in the western Indian Ocean. In response to a comment which highlighted the fact that although the I.R. Iran has provided preliminary catch, effort, and size data, by type of vessel, gear, year, month and Province, the data remains incomplete, as it has not been reported by IOTC requirements. I.R. Iran was encouraged to complete this information and report data as per IOTC reporting requirements (Resolution 10/02) in 2013. The I.R. Iran indicated that the lack of bigeye tuna in the reported catch of both purse seine and gillnet vessels was probably due to species identification issues and that it would continue to improve reporting from its purse seine and gillnet fleets.
- **Japan**: The SC **NOTED** the size frequency samples collected on longliners from Japan come from different fishing platforms, including samples collected on training vessels and samples collected from the commercial fishery, by fishers and scientific observers. For this reason, Japan was reminded of the need to provide separate series of size frequency samples, by type of sampler and sampling platform, and assess which dataset(s) are representative of Japan‘s longline fishery. Japan acknowledged the conflicting estimates of average weight derived from operational catch and size frequency datasets for its longline fisheries and the concerning effect that the problems identified may have on the assessments of tuna and billfish species. Japan indicated that in order to clarify these issues, it will endeavour to identify deficiencies in the size sampling program. Japan also indicated that it would provide a breakdown of its shark catches in the 2013 National Report to the SC, specifically on the numbers of sharks retained and discarded by species.
- **Kenya**: Nil comments.
- **Korea, Republic of**: The SC **NOTED** that the electronic logbooks currently in use by Korean vessels operating in the IOTC area of competence are reporting near real-time data (once logbooks are completed, they are submitted via email to the responsible regulatory authority). In response to a question about the levels of shark discarding by longline vessels from the R.O. Korea, it was indicated that current discard rates are being calculated based on observed rates from 2010, due to a lack of scientific observers being deployed on vessels in recent years.
- **Madagascar**: Nil comments.
- **Malaysia**: Nil comments.

  Maldives, Republic of: The SC **CONGRATULATED** the Maldivian pole and line fishing industry on achieving Marine Stewardship Council (MSC) certification of their pole and line fishery, thereby becoming the first Indian Ocean fishery for tuna or tuna-like species to receive certification according to the MSC standards. The Maldives indicated that it would be willing to share its experiences with other IOTC CPCs and thanked all stakeholders, the MSC, the Conformity Assessment Body, and NGOs. The Maldives efforts and leadership role in driving sustainable management of tuna fisheries in the Indian Ocean, and their commitment to improve the management of the Indian Ocean skipjack fishery through their strong participation in the IOTC was acknowledged. Certification of this fishery constitutes an example of the benefits of improved governance focused on sustainability.
- **Mauritius**: The SC **NOTED** that the artisanal fleet of Mauritius around FADs is mainly targeting albacore at depths of around 300 m.
- **Mozambique**: Nil comments.
- **Oman, Sultanate of**: National Report not presented orally as Oman was absent from the SC15 meeting.
- **Pakistan**: The SC **EXPRESSED** its disappointment that Pakistan did not provide a National Report and urged Pakistan to fulfil its reporting obligations to the IOTC.
- **Philippines**: National Report not presented orally as the Philippines was absent from the SC15 meeting.
- **Seychelles, Republic of**: Nil comments.

- **Sierra Leone**: The SC **EXPRESSED** its disappointment that Sierra Leone did not provide a National Report and urged Sierra Leone to fulfil its reporting obligations to the IOTC.
- **Sri Lanka**: The SC **NOTED** that as Sri Lanka produced catch data based on port sampling, almost none of the total catch taken by Sri Lankan vessels can be accurately assigned to either the EEZ of Sri Lanka or the high seas, or at any other spatial scale. The lack of spatial data has a negative impact on stock assessments for IOTC species, for instance when we considered that Sri Lanka is ranked first for skipjack tuna catches in the IOTC area of competence. However, improvements have been made by Sri Lanka to its data collection, monitoring and reporting systems, and Sri Lanka indicated that as the logbook program expands, the improved data will be provided to the IOTC Secretariat.
- **Sudan**: The SC **NOTED** the importance of using correct terminology when discussing IOTC species, in particular when describing catch of tuna and mackerel species under the IOTC mandate.
- **Tanzania, United Republic of**: The SC **EXPRESSED** its disappointment that Tanzania did not provide a National Report and urged Tanzania to fulfil its reporting obligations to the IOTC.
- **Thailand**: Nil comments.
- **United Kingdom (OT)**: The SC **NOTED** the excellent quality of the size frequency data collected by the recreational fishing of the UK(OT) and encouraged other IOTC CPCs to collect similar data from their sport fishery.
    i. The SC **NOTED** the following statement made by the Republic of Mauritius:

    "The Government of the Republic of Mauritius does not recognize the so-called "British Indian Ocean Territory" ("BIOT") which the United Kingdom purported to create by illegally excising the Chagos Archipelago from the territory of Mauritius prior to its accession to independence. This excision was carried out in violation of international law and United Nations General Assembly Resolutions 1514 (XV) of 14 December 1960, 2066 (XX) of 16 December 1965, 2232 (XXI) of 20 December 1966 and 2357 (XXII) of 19 December 1967.

    The Government of the Republic of Mauritius reiterates that the Chagos Archipelago, including Diego Garcia, forms an integral part of the territory of the Republic of Mauritius under both Mauritian law and international law.

    The Government of the Republic of Mauritius does not also recognize the existence of the 'marine protected area' which the United Kingdom has purported to establish around the Chagos Archipelago in breach of international law, including the provisions of the United Nations Convention on the Law of the Sea (UNCLOS). On 20 December 2010, Mauritius initiated proceedings against the United Kingdom under Article 287 of, and Annex VII to, the United Nations Convention on the Law of the Sea to challenge the legality of the 'marine protected area." The dispute is currently before the Arbitral Tribunal constituted under Annex VII to UNCLOS.

    ii. The SC **NOTED** the following statement made by the United Kingdom: "The UK has no doubt about its sovereignty over the British Indian Ocean Territory which was ceded to Britain in 1814 and has been a British dependency ever since. As the UK Government has reiterated on many occasions, we have undertaken to cede the Territory to Mauritius when it is no longer needed for defence purposes."
- **Vanuatu**: The SC **EXPRESSED** its disappointment that Vanuatu did not provide a National Report and urged Vanuatu to fulfil its reporting obligations to the IOTC.
- **Yemen**: The SC **WELCOMED** the Yemen to the IOTC as its newest Member, however the SC **EXPRESSED** its disappointment that Yemen did not provide a National Report or attend the SC meeting in 2012, and urged Yemen to fulfil its reporting obligations to the IOTC.
- **Senegal**: National Report not presented orally as Senegal was absent from the SC15 meeting.
- **South Africa, Republic of**: National Report not presented orally as South Africa was absent from the SC15 meeting.

28. The SC **NOTED** the report provided by the Invited Experts from Taiwan,China which outlined fishing activities in the IOTC area of competence.

Recommendation/s

29. **NOTING** that the Commission, at its 15th Session, expressed concern regarding the limited submission of National Reports to the SC, and stressed the importance of providing the reports by all CPCs, the SC **RECOMMENDED** that the Commission note that in 2012, 26 reports were provided by CPCs, up from 25 in 2011, 15 in 2010 and 14 in 2009 (Table 2).

30. The SC **REMINDED** CPCs that the purpose of the National Reports is to provide relevant information to the SC on fishing activities of Members and Cooperating Non-Contracting Parties operating in the IOTC area of

competence. The report should include all fishing activities for species under the IOTC mandate as well as sharks and other byproduct / bycatch species as required by the IOTC Agreement and decisions by the Commission. The submission of a National Report is mandatory, irrespective if a CPC intends on attending the annual meeting of the SC and shall be submitted no later than 15 days prior to the SC meeting.

31. The SC **REQUESTED** that the CPCs who did not submit a National Report in 2012 (Seven: Eritrea, Guinea, Pakistan, Sierra Leone, Tanzania, Vanuatu and Yemen), do so in 2013. The report is intended to provide a summary of the main features of the tuna and billfish fisheries for Members and Cooperating Non-Contracting Parties. As such, it does not replace the need for submission of data according to the IOTC Mandatory Data Requirements listed in the relevant IOTC Resolution [currently 10/02].

TABLE 2. CPC submission of National Reports to the SC from 2005 to 2012.

CPC	2005	2006	2007	2008	2009	2010	2011	2012
Australia	Green	Green	Green	Green	Green	Green	Green	Green
Belize	n.a.	n.a.	Red	Red	Red	Red	Green	Green
China	Green	Green	Green	Green	Green	Green	Green	Green
Comoros	Red	Red	Red	Red	Red	Green	Green	Green
Eritrea	Red	Red	Red	Red	Red	Red	Red	Red
European Union	Green	Green	Green	Green	Green	Green	Green	Green
France (territories)	Green hash	Green hash	Green hash	Green hash	Green hash	Green hash	Green	Green
Guinea	Red	Red	Red	Red	Red	Red	Red	Red
India	Red	Green	Green	Red	Green	Green	Green	Green
Indonesia	n.a.	n.a.	Red	Red	Red	Red	Green	Green
Iran, Islamic Republic of	Red	Red	Red	Red	Red	Red	Green	Green
Japan	Green	Green	Green	Green	Green	Green	Green	Green
Kenya	Red	Red	Green	Green	Green	Green	Green	Green
Korea, Republic of	Green	Green	Green	Green	Green	Green	Green	Green
Madagascar	Red	Red	Red	Red	Green	Green	Green	Green
Malaysia	Red	Red	Red	Red	Red	Red	Green	Green
Maldives, Republic of	n.a.	n.a.	n.a.	n.a.	Green	Green	Green	Green
Mauritius	Red	Red	Red	Green	Green	Green	Green	Green
Mozambique	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Green	Green
Oman, Sultanate of	Red	Red	Red	Red	Red	Red	Red	Green
Pakistan	Red	Red	Red	Red	Red	Red	Red	Red
Philippines	Red	Red	Red	Red	Red	Red	Red	Green
Seychelles, Republic of	Green	Green	Green	Green	Green	Green	Green	Green
Sierra Leone	n.a.	n.a.	n.a.	Red	Red	Red	Red	Red
Sri Lanka	Red	Green	Green	Red	Red	Red	Green	Green
Sudan	Red	Red	Red	Red	Red	Red	Red	Green
Tanzania, United Republic of	n.a.	n.a.	Red	Red	Red	Red	Green	Red
Thailand	Green	Green	Green	Green	Green	Green	Green	Green
United Kingdom (OT)	Green	Green	Green	Green	Green	Green	Green	Green
Vanuatu	Red	Red	Red	Red	Red	Red	Green	Red
Yemen	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Red
Senegal*	Red	Red	Red	Red	Red	Red	Green	Green
South Africa, Republic of*	Green	Red	Green	Green	Green	Red	Green	Green

*Cooperating non-contracting party in 2012. Green = submitted. Red = not submitted. Green hash = submitted as part of EU report, although needed to be separate. n.a. = not applicable (not a CPC in that year).

Discussions on improving/modifying the National Reporting template

32. The SC **AGREED** that the National Reporting template should be maintained in its current format for 2013 and be reviewed annually for potential improvements.

Status of development and implementation of Nation Plans of Action for seabirds and sharks

33. The SC **NOTED** paper IOTC–2012–SC15–06 which provided the SC with the opportunity to update and comment on the current status of development and implementation of National Plans of Action for seabirds and sharks by each CPC.

34. The SC **NOTED** the adoption of an *Action Plan for reducing incidental catches of seabirds in fishing gears* by the EU in 2012 (IOTC–2012–SC15–INF07). The new Plan focuses on longline and gillnet fisheries where seabird bycatch are known to be highest, although other gears such as trawls and purse seines are also covered by the plan. It entails a wide range of elements under 30 recommended actions that are a combination of binding and non-binding measures. The rules will apply to EU fishing vessels inside and outside EU waters as well as non-EU vessels operating in EU waters. A copy of the Plan may be obtained from the EU or the IOTC Secretariat.

35. The SC **NOTED** that the original purpose of the FAO National Plans of Action for Seabirds (NPOA-Seabirds) in 1998 was to address concerns about longline fishing. However, recent information has shown significant concerns about seabird bycatch in several other capture fisheries, especially gillnet fishing. The 2009 FAO Best Practice Technical Guidelines, developed to assist in the preparation of NPOA-Seabirds, explicitly includes advice on longline, trawl and gillnet fisheries.

36. The SC **NOTED** that species such as cormorants and migratory shearwaters (which are common in coastal waters of many IOTC coastal states), are known to be especially vulnerable to bycatch in gillnet fisheries. CPCs operating gillnet fisheries were strongly **ENCOURAGED** to go through an NPOA-Seabirds assessment exercise. BirdLife International has previously offered assistance to CPCs wishing to assess the impacts of gillnet fishing in their national fisheries.

37. The SC **NOTED** the current status of development and implementation of Nation Plans of Action for sharks and **RECOMMENDED** that all CPCs without an NPOA-Sharks expedite the development and implementation of their NPOA-Sharks, and to report progress to the WPEB in 2013, recalling that NPOA-Sharks are a framework that should facilitate estimation of shark catches, and development and implementation of appropriate management measures, which should also enhance the collection of bycatch data and compliance with IOTC Resolutions.

38. The SC **RECOMMENDED** that the Commission note the updated status of development and implementation of National Plans of Action for sharks and seabirds, by each CPC as provided at Appendix V.

7. REPORTS OF THE 2012 IOTC WORKING PARTY MEETINGS

7.1 Report of the Fourth Session of the Working Party on Temperate Tunas (WPTmT04)

39. The SC **NOTED** the report of the Fourth Session of the Working Party on Temperate Tunas (IOTC–2012–WPTmT04–R), including the consolidated list of recommendations provided as an appendix to the report.

Data available at the Secretariat for temperate tuna species

40. The SC **NOTED** the main albacore data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI of the WPTmT04 report (IOTC–2012–WPTmT04–R), and **RECOMMENDED** that the CPCs listed in the appendix, make efforts to remedy the data issues identified and to report back to the WPTmT at its next meeting.

41. The SC **EXPRESSED** concern that, in recent years, the quality of data on albacore in the IOTC database has worsened. The reason for this was likely to be driven by drops in activity and catches of longliners flagged to Taiwan,China, for which nominal catch and catch-and-effort data are considered to be of good quality; while the uncertainty in the total catches of albacore estimated for longliners flagged to Indonesia has increased, which have accounted for around 40% or more of the total catches of albacore in the Indian Ocean in recent years.

42. **NOTING** that, to date, Indonesia has not provided catch-and-effort data for longliners under its flag, while size data are not available since 2009, the SC **URGED** Indonesia to further strengthen sampling efforts on its coastal and offshore fisheries in early 2013, in particular monitoring of frozen albacore, and continue cooperation with the IOTC Secretariat in order to better determine the catches of albacore by the Indonesian longline fleet.

43. The SC **EXPRESSED** concern on the lack of information regarding the landing ports of the Indonesian longline fleet operating in the high seas and **REQUESTED** Indonesia to provide detailed information, with cooperation from the port countries, to the WPTmT at its next session.

44. The SC **NOTED** that following a request by the Ministry of Fisheries of Mauritius, the IOTC-OFCF Project had provided assistance for an independent evaluation of data collection and reporting systems in Mauritius, in particular evaluation of catch, effort, and size data collection systems for albacore, as recommended by the SC in 2011. The SC **THANKED** Mauritius and the IOTC-OFCF Project for this initiative and **RECOMMENDED** that the Project considers extending support in the future to assist Mauritius to address the recommendations issuing from the evaluation, where possible.

Indonesian longline fishery for albacore

45. **NOTING** the ongoing review of Indonesian catches of albacore being carried out by the IOTC Secretariat in consultation with the Directorate General of Capture Fisheries (DGCF) of Indonesia, and that current catch estimates for Indonesia are derived from reports of albacore imports into canning factories cooperating with the ISSF, the SC **REQUESTED** that the IOTC Secretariat and Indonesia continue cooperation to finalise the review and report final estimates of catches of albacore to the next meeting of the WPTmT.

Chinese longline fishery for albacore

46. The SC **NOTED** that in recent years, the reported catches of albacore from longliners flagged to China fishing in the Indian Ocean have increased markedly and although this may originate from a change in targeting by some vessels, it may also be the consequence of some fishing companies over-reporting catches of albacore in the logbooks during those years. In this regard, the SC **REQUESTED** that China assess the reliability of statistics of albacore available since 2010 for its fleet and report findings to the next meeting of the WPTmT, including new estimates, where required, in particular in the south-west Indian Ocean where the specific composition of the catch appears unrealistic.

Sampling coverage

47. The SC **REQUESTED** that as a matter of priority, India, Indonesia and Japan increase sampling coverage to attain at least the coverage levels recommended by the Commission, including:
    - catches sampled or observed for at least 5% of the vessel activities, including collection of catch, effort and size data for IOTC species and main bycatch species;
    - implementation of logbook systems for offshore fisheries.

    The information collected through the above activities should allow India, Indonesia and Japan to estimate catches by gear and species.

48. The SC **RECOMMENDED** that IOTC CPCs having fleets targeting albacore or ports where albacore landings are high, in particular Mauritius and Indonesia, make every possible effort to collect biological information on albacore in the future. In this regard China informed the SC about the difficulties that Chinese observers are experiencing to collect biological samples of albacore onboard longliners flagged to China. China indicated that it would make every possible effort to maintain data collection at reasonable levels in the future.

Stock assessments

49. The SC **NOTED** the advice from the WPTmT that although the output of the ASPM model was most likely to numerically and graphically represent the current status of albacore in the Indian Ocean, this does not represent an endorsement of the ASPM model over the other models used in 2012, as there are still substantial problems with the ASPM model, and the WPTmT considers all of the models to be equally informative of stock status.

50. **NOTING** that the Taiwan,China indices of abundance used by the WPTmT for the assessment of albacore covered the period from 1984 to 2010, despite the fact that catch-and-effort data for this fleet are available from the late 1960's, the SC **RECOMMENDED** that the WPTmT uses a standardised CPUE series using the complete catch-and-effort data series in the future.

Parameters for future analyses: CPUE standardisation and stock assessments

51. **NOTING** that the areas used in the various CPUE standardisations undertaken in 2012 were very different from one analysis to another, and that there is a need to define core area(s) for the CPUE standardisation of albacore, the SC **REQUESTED** that scientists from CPCs with longline fisheries for albacore, work together to explore their data and defined such core areas, well in advance of the next WPTmT meeting.

52. The SC **AGREED** that there is value in undertaking a number of different modelling approaches to facilitate comparison, and **RECOMMENDED** that spatially structured integrated models, which are capable of more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simpler production models, be carried out for the next WPTmT, as data and resources permit.

Stock structure of albacore

53. The SC **NOTED** paper IOTC–2012–SC15–INF02 which provided an outline of a project aimed at examining the genetic structure and life history of albacore, in particular spatial and temporal diversity, abundance and migratory range, including possible exchanges with the southern Altantic Ocean.

54. **NOTING** that the results of the Project may be of great assistance to the work of the WPTmT, the SC **REQUESTED** that all applicable CPCs cooperate with the research scientists undertaking the study. It was also considered important to carry out tagging studies on albacore as a complement to any genetic study.

55. The SC **REQUESTED** that the WPTmT assess the feasibility of implementing a tagging Project in the future and present results to the next meeting of the SC, **NOTING** that such a project would require the support of ICCAT as the southern stocks of albacore could be shared across the boundaries of the IOTC and ICCAT.

7.2 Report of the Tenth Session of the Working Party on Billfish (WPB10)

56. The SC **NOTED** the report of the Tenth Session of the Working Party on Billfish (IOTC–2012–WPB10–R), including the consolidated list of recommendations provided as an appendix to the report.

57. The SC **NOTED** the progress made regarding blue marlin and striped marlin stock status determination and reiterated the need for further work on these stocks in 2013.

58. The SC **NOTED** that a range of quantitative modelling methods were applied to blue marlin and striped marlin in 2012: ASPIC surplus production model, Bayesian production model and surplus production model with varying catchability (see report of the WPB10 for descriptions). The results from the blue marlin and striped marlin assessment should be considered preliminary, for future comparison only and not for the development of management advice.

59. The SC **NOTED** the work undertaken by EU,Portugal, which allowed the presentation of a standardised CPUE series for swordfish targeted by EU,Portugal longline fleet was appreciated.

60. The SC **NOTED** that SWIOFP is currently undertaking a research project on swordfish using pop-up archival tags that may shed additional light on the degree of connectivity between swordfish in the southwest and the broader Indian Ocean. **NOTING** the level of fishing activities and catches of swordfish in the southwest Indian Ocean, the SC **AGREED** that a separate executive summary for swordfish in the southwest Indian Ocean be provided to the Commission, noting that work is currently in progress to determine the level of connectivity of swordfish between areas of the Indian Ocean.

61. The SC **NOTED** the outstanding contributions of the invited expert for the meeting, Dr. Humber Andrade, both prior to and during the WPB10 meeting. The SC also **NOTED** the contribution of Dr. Humber Andrade and, due to his specific expertise, it would be highly beneficial to facilitate his participation at the next meeting of the WPB in 2013.

Data available at the Secretariat for billfish species

62. The SC **NOTED** the main billfish data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI of the WPB10 report (IOTC–2012–WPB10–R), and **RECOMMENDED** that the CPCs listed in the appendix, make efforts to remedy the data issues identified and to report back to the WPB at its next meeting.

63. The SC **NOTED** that the quality of the data available at the IOTC Secretariat on marlins is likely to be compromised by species misidentification and **REQUESTED** that CPCs review their historical data in order to identify and correct potential identification problems that are detrimental to any analysis of the status of the stocks.

Length-age keys

64. The SC **RECOMMENDED** that as a matter of priority, CPCs that have important fisheries catching billfish (EU, Indonesia, Japan,Sri Lanka and Taiwan,China,) to collect and provide basic or analysed data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, by sex and area.

Catch, Catch-and-effort, Size data

65. The SC **REQUESTED** that the EU,Spain improve the status of catch-and-effort data for marlins and sailfish and its provision to the IOTC Secretariat.

66. The SC **REQUESTED** that the EU,Spain longline fleet provide the IOTC Secretariat with catch-and-effort and size data of marlins and sailfish by time and area strata, noting that this is already a mandatory reporting requirement.

67. The SC **REQUESTED** that Japan resume size sampling on its commercial longline fleet, and that Taiwan,China provide size data for its fresh longline fleet to attain the minimum recommended by the Commission (1 fish by metric ton of catch by type of gear and species).

68. The SC **REQUESTED** that Indonesia and India provide catch-and-effort and size frequency data for their longline fleets.

69. The SC **REQUESTED** that CPCs having artisanal and semi-industrial fleets, in particular Iran, Pakistan andSri Lanka, provide catch and effort as well as size data as per IOTC requirements for billfish caught by their fleets.

70. **NOTING** that not all CPCs are collecting size data using standard measurements, the SC **AGREED** that only lower-jaw to fork length, eye to fork length or pectoral to second dorsal length are taken by fishers, samplers and observers for billfish species.

71. The SC **REQUESTED** that the EU record and report information on catches of billfish, by species, for its purse seine fisheries.

Data inconsistencies

72. Noting the progress made to date, the SC **REQUESTED** that the IOTC Secretariat finalise the study aimed at assessing the consistency of average weights derived from the available catch and effort data, as derived from logbooks, and size data provided by EU,Spain, Japan, Seychelles and Taiwan,China and to report final results at the next WPB meeting.

73. The SC **RECOMMENDED** that as a matter of priority, India, Iran and Pakistan provide catch-and-effort data and size data for billfish, in particular for gillnet fisheries, as soon as possible, noting that this is already a mandatory reporting requirement.

Sports fisheries

74. **NOTING** the increasing importance of sports fisheries in the total catch of marlin and sailfish species, the WPB **REQUESTED** that the IOTC Secretariat develop a list of contacts of Institutes, Foundations and NGOs implementing tagging programs of large pelagic fishes in the Indian Ocean and to summarise this information for presentation at the next WPB meeting.

Sri Lankan billfish landings

75. The SC **NOTED** that to date, Sri Lanka has been unable to provide accurate statistics for billfish species to the IOTC Secretariat, due to poor species identification and low levels of sampling coverage for its coastal and offshore fisheries. The SC **ACKNOWLEDGED** that in Sri Lanka billfish are often landed cut into pieces and separated upon arrival at Sri Lankan landing stations which creates difficulties in obtaining accurate length measurements.

76. The SC **AGREED** that as a matter of priority, Sri Lanka increase sampling coverage to attain at least the coverage levels recommended by the Commission (1 fish by metric ton of catch by type of gear and species), including:
    - catches sampled or observed for at least 5% of the vessel activities for coastal fisheries, including collection of catch, effort and size data for IOTC species and main bycatch species;
    - implementation of logbook systems for offshore fisheries that incorporate species level information requirements for billfish, as per IOTC Resolution 12/03.

    The information collected through the above activities should allow Sri Lanka to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

77. The SC **AGREED** that a means to improve the quality of size frequency data from Sri Lanka, would be for billfish size data to be collected from logbooks, as well as measurements collected by observers on vessels fishing on the high seas, rather than sampling at landing sites.

Madagascar's billfish landings

78. **NOTING** that the longline fishery in Madagascar is a new and developing fishery, the SC **RECOMMENDED** that Madagascar ensure that it develops and implements a data collection system, including sampling, logbooks and observers, which would adequately cover the entire fishery.

Maldives billfish landings

79. The SC **NOTED** the attendance of the Maldives at the WPB for the first time and that the aggregated data presented were preliminary and was a useful contribution to the work of the WPB. However, disaggregated finer scale data would need to be provided to the IOTC Secretariat if the data is to be fully utilised by the WPB.

80. The SC **NOTED** that the level of capture of marlins from the Maldivian artisanal fishery appears to be very high compared to the total catches reported for the Indian Ocean and **RECOMMENDED** that the Maldives provide a review of its landings of each marlin species at the next WPB meeting

81. The SC **RECOMMENDED** that the Maldives implement data collection systems, through logbooks and sampling for its fisheries that incorporate species level information requirements for billfish, as per IOTC Resolution 12/03. The information collected should allow the Maldives to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

Mozambique billfish landings

82. **NOTING** that at present no scientific observers are being placed on board foreign flagged vessels licensed to fish in the Mozambique EEZ, the SC **RECOMMENDED** that Mozambique make it a licensing requirement for any foreign vessels fishing in the Mozambique EEZ to take on board scientific observers and to report the data collected as per IOTC requirements. Foreign vessels fishing in the Mozambique EEZ should ensure that scientific observers are brought onboard as per IOTC requirements.

Review of fleet dynamics

83. The SC **RECOMMENDED** that both Japan and Taiwan,China undertake a complete historical review of their longline data and to document the changes in fleet dynamics for presentation at the next WPB meeting. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data.

Parameters for future analyses: stock assessments

84. **NOTING** that the current time frames for data exchange do not allow enough time to conduct thorough stock assessment analyses, and this could have a detrimental effect on the quality of advice provided by the WPB, the SC **AGREED** that exchanges of data (CPUE indices and coefficient of variation) should be made as early as possible, but no later than 30 days prior to a working party meeting, so that stock assessment analysis can be provided to the IOTC Secretariat no later than 15 days before a working party meeting, as per the recommendations of the SC, which states: "*The SC also ENCOURAGED data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and RECOMMENDED that data to be used in stock assessments, including CPUE standardisations be made available not less than 30 days before each meeting by CPCs*." (IOTC–2011–SC14–R; p68)

Indian Ocean Swordfish Stock Structure project (IOSSS)

85. The SC **NOTED** that although the results of the IOSSS project did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches.

Swordfish: European Union longline fisheries CPUE indices

86. The SC **RECOMMENDED** that scientists from the EU undertake a revised CPUE analysis for their longline fleets, and consider combining the analysis prior to the next WPB meeting where swordfish will be dealt with as a priority.

Non-compliance matters

87. **NOTING** that despite the mandatory reporting requirements detailed in Resolutions 10/02 and 12/03 data on billfish fisheries, in particular for the marlins, remain largely unreported by CPCs, the SC **RECOMMENDED** that the Compliance Committee and the Commission note these non-compliance matters, develop mechanisms to ensure that CPCs fulfil their reporting obligations.

7.3 Report of the Eighth Session of the Working Party on Ecosystems and Bycatch (WPEB08)

88. The SC **NOTED** the report of the Eighth Session of the Working Party on Ecosystems and Bycatch (IOTC–2012–WPEB08–R), including the consolidated list of recommendations provided as an appendix to the report. The SC **EXPRESSED** its satisfaction on the large attendance and participation by national scientists working on ecosystem and bycatch topics (48 participants) which resulted in the presentation of 40 working documents.

Data reporting requirements

89. **NOTING** that despite the mandatory reporting requirements detailed in Resolutions 05/05, 10/02, 10/06, 12/03 and 12/04, bycatch data remain largely unreported by CPCs and the SC **RECOMMENDED** that the Compliance Committee and the Commission address this non-compliance by taking steps to develop mechanisms which would ensure that CPCs fulfil their bycatch reporting obligations.

Gillnet fisheries of the Indian Ocean

90. The SC **NOTED** that gillnet fisheries are expanding rapidly in the Indian Ocean, with gillnets often being longer than 2.5 km in contravention with UN and IOTC Resolutions, and that their use is considered to have a substantial impact on marine ecosystems. **NOTING** that in 2012 the Commission adopted Resolution 12/01 on the implementation of the precautionary approach, the majority of the SC **RECOMMENDED** that the Commission freeze catch and effort by gillnet fisheries in the Indian Ocean in the near future, until sufficient information has been gathered to determine the impact of gillnet fleets on IOTC stocks and bycatch species caught by gillnet fisheries targeting tuna and tuna-like species, noting that the implementation of any such measure would be difficult.

91. The SC **RECOMMENDED** that the Commission considers allocating funds to support a regional review of the data available for gillnet fleets operating in the Indian Ocean. The scientists from all CPCs having gillnet fleets in the Indian Ocean should provide at the next session of the WPEB, a report summarising the known information on bycatch in their gillnet fisheries, including sharks, marine turtles and marine mammals, with estimates of their likely order of magnitude where more detailed data are not available.

92. The SC **RECOMMENDED** that the Commission allocate funds to carry out training for CPCs having gillnet fleets on species identification, bycatch mitigation and data collection methods and also to identify other potential sources of assistance to carry out such activities.

93. The SC **EXPRESSED** its support for the two observer projects currently being implemented by WWF in Pakistan, funded by the Australian Government (from 2010–2013 and 2012–2014 respectively), to monitor bycatch levels and interactions with cetaceans in the gillnet fishery. While these projects are aimed at assessing the impacts of gillnet fishing on cetaceans, data is also being collected on all catch, including tuna, finfish, sharks and marine turtles. The projects are province-specific and the aim is for 40% fleet coverage and use both beach and vessel surveys for data collection. The projects have strong community engagement through workshops, awareness campaigns and the establishment community conservation groups. Action plans will also be developed. A third project on tuna catch monitoring in the Pakistan Miani Hor Marine Protected Area, funded by the WWF Smart Fishing Initiative, will also include an element on gillnet bycatch. WWF will keep the WPEB and the SC updated with the results of these projects in 2013.

Sharks

Status of catch statistics and data reporting

94. The SC **NOTED** the status of catch statistics for the main species of sharks, by major fisheries (gears), for the period 1950–2011 (Appendix VI) and **EXPRESSED** strong concern as the information on retained catches and discards of sharks contained in the IOTC database remains very incomplete for most fleets despite their mandatory reporting status, and that catch-and-effort as well as size data are essential to assess the status of shark stocks.

95. The SC **NOTED** the main shark data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VIII of the WPEB08 report (IOTC–2012–WPEB08–R), and **RECOMMENDED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPEB at its next meeting, noting the status and type of datasets that need to be provided for sharks, and other bycatch species provided at Appendix IX of the WPEB08 report (IOTC–2012–WPEB08–R).

96. **NOTING** that the information on retained catches and discards of sharks contained in the IOTC database remains very incomplete for most fleets despite their mandatory reporting status, and that catch-and-effort as well as size data are essential to assess the status of shark stocks, the SC **RECOMMENDED** that all CPCs collect and report catches of sharks (including historical data), catch-and-effort and biological data on sharks, as per IOTC Resolutions, so that more detailed analysis can be undertaken for the next WPEB meeting.

97. **NOTING** that there is extensive literature available on pelagic shark fisheries and interactions with fisheries targeting tuna and tuna-like species, in countries having fisheries for sharks, and in the databases of governmental or non-governmental organisations, the SC **AGREED** on the need for a major data mining exercise in order to compile data from as many sources as possible and attempt to rebuild historical catch series of the most commonly caught shark species. In this regard, the SC **RECOMMENDED** that the Commission allocates funds for this activity, in the 2013 IOTC budget.

98. The SC **NOTED** the absence of information on shark catches from artisanal fisheries in Mozambique and **RECOMMENDED** that information on shark catches from those fisheries is collected and reported in due course.

99. **NOTING** that Resolution 10/02 *mandatory statistical requirements for IOTC members and Cooperating Non-Contracting Parties (CPC's)*, makes provision for data to be reported to the IOTC on "*the most commonly caught shark species and, where possible, to the less common shark species*", without giving any list defining the most common and less common species, and recognising the general lack of shark data being recorded and reported to the IOTC Secretariat, the SC **RECOMMENDED** that Resolution 10/02 is revised in order to include the list of most commonly caught elasmobranch species (Table 3) for which nominal catch data shall be reported as part of the statistical requirement for IOTC CPCs.

TABLE 3. List of the most commonly caught elasmobranch species

Common name	**Species**	Code
Manta and devil rays	Mobulidae	MAN
Whale shark	*Rhincodon typus*	RHN
Thresher sharks	*Alopias spp.*	THR
Mako sharks	*Isurus spp.*	MAK
Silky shark	*Carcharhinus falciformis*	FAL
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS
Blue shark	*Prionace glauca*	BSH
Hammerhead shark	Sphyrnidae	SPY
Other Sharks and rays	–	SKH

Mitigation measures

100. The SC **RECOMMENDED** research and development of mitigation measures to minimise bycatch of the oceanic whitetip shark and its unharmed release for all types of fishing gears, and that CPCs with data on oceanic whitetip sharks (i.e. total annual catches, CPUE time series and size data) make these available to the next WPEB meeting.

Shark mortality in relation with the use of drifting FADs

101. The SC **NOTED** the presentation of the information paper IOTC–2012–SC15–INF05 on ghost fishing of silky sharks by drifting FADs.

102. The SC **NOTED** the recommendation from the WPEB on the basic principles for FAD construction that would minimise entanglement of marine turtles (FADs refers to man-made floating objects, drifting or anchored, built for the purpose of fishing pelagic fishes). In addition, new information presented during the SC indicated that entanglement of sharks (primarily silky sharks) occurs frequently when the sub-surface FAD components are made of netting. The estimated shark mortality from these entanglements is likely to be higher than the incidental catch hauled onboard. Furthermore, FAD designs should minimise both marine turtle and shark entanglement. Some CPCs are already using drifting FADs with designs aimed at reducing the entanglements of marine animals. Regardless of the uncertainty in the magnitude of the problem, the SC **AGREED** that the solution is clear and simple and would involve constructing FADs without netting material.

103. The SC **RECOMMENDED** that the Commission note the following in regards to the request to the SC outlined in paragraph 11 of Resolution 12/04, on FAD design:

   c) *Develop improved FAD designs to reduce the incidence of entanglement of marine turtles, including the use of biodegradable materials*

   Only non-entangling FADs, both drifting and anchored, should be designed and deployed to prevent the entanglement of sharks, marine turtles or any other species, based on the following three basic principles:

   1. The surface structure of the FAD should not be covered, or only covered with non-meshed material.
   2. If a sub-surface component is used, it should not be made from netting but from non-meshed materials such as ropes or canvas sheets.
   3. To reduce the amount of synthetic marine debris, the use of natural or biodegradable materials (such as Hessian canvas, hemp ropes, etc.) for drifting FADs should be promoted.

Ecological risk assessment

104. The SC **NOTED** paper IOTC–2012–SC15–INF10 which provide the results of a preliminary ecological risk assessment (ERA) of shark species caught in the Indian Ocean by longline and purse seine gears, which was a request made by the Commission at its 15th Session in 2011. The SC **RECOGNISED** the highly valuable information provided by this ERA which produced a ranked list of the most vulnerable shark species to longline and purse seine gears as detailed below.

105. The SC **NOTED** the list of the 10 most vulnerable shark species to longline gear (Table 4) and purse seine gear (Table 5), as determined by the productivity susceptibility analysis, compared to the list of shark species/groups required to be recorded for each gear, contained in Resolution 12/03 o*n the recording of catch and effort by fishing vessels in the IOTC area of competence*.

TABLE. 4. List of the 10 most vulnerable shark species to longline gear compared to the list of shark species/groups required to be recorded in logbooks, as listed in Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*.

PSA vulnerability ranking	Most susceptible shark species to longline gear	FAO Code	Shark species listed in IOTC Resolution 12/03 for longline gear	FAO Code
1	Shortfin mako (*Isurus oxyrinchus*)	SMA	Blue shark (*Prionace glauca*)	BSH
2	Bigeye thresher (*Alopias superciliosus*)	BTH	Mako sharks (*Isurus* spp.)	MAK
3	Pelagic thresher (*Alopias pelagicus*)	PTH	Porbeagle shark (*Lamna nasus*)	POR
4	Silky shark (*Carcharhinus falciformis*)	FAL	Hammerhead sharks (*Sphyrna* spp.)	SPN
5	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS		
6	Smooth hammerhead (*Sphyrna zygaena*)	SPZ		
7	Porbeagle (*Lamna nasus*)	POR		
8	Longfin mako (*Isurus paucus*)	LMA		
9	Great hammerhead (*Sphyrna mokarran*)	SPM		
10	Blue shark (*Prionace glauca*)	BSH		

TABLE. 5. List of the 10 most vulnerable shark species to purse seine gear compared to the list of shark species/groups required to be recorded in logbooks, as listed in Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*.

PSA vulnerability ranking	Most susceptible shark species to purse seine gear	FAO Code	Shark species listed in IOTC Resolution 12/03 for purse seine gear	FAO Code
1	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS	Whale sharks (*Rhincodon typus*)	RHN
2	Silky shark (*Carcharhinus falciformis*)	FAL		
3	Shortfin mako (*Isurus oxyrinchus*)	SMA		
4	Great hammerhead (*Sphyrna mokarran*)	SPM		
5	Pelagic stingray (*Pteroplatytrygon violacea)*	PLS		
6	Scalloped hammerhead (*Sphyrna lewini*)	SPL		
7	Smooth hammerhead (*Sphyrna zygaena*)	SPZ		
8	Longfin mako (*Isurus paucus*)	LMA		
9	Dusky shark (*Carcharhinus obscurus*)	DUS		
10	Tiger shark (*Galeocerdo cuvier*)	GAC		

106. The SC **NOTED** that although the gillnet fleet is responsible for around 68 % of the total shark catches in the Indian Ocean, there was no data available on gillnet effort distribution nor information from observers on shark size frequencies and post-capture mortality which would allow an ERA to be carried out for sharks caught by gillnet and, hence, to analyse the effect of gillnet fishing on shark. If this information were to become available in the future, then an ERA should be carried out.

Inclusion of two additional shark species to the list of mandatory data requirements for longline gear (Res 12/03)

107. The SC **EXPRESSED** concern that two species, the silky shark (*Carcharinus falciformis*) and the oceanic whitetip shark (*Carcharinus longimanus*) respectively ranked 4th and 5th in terms of vulnerability to longline gear by the ERA, are not contained in the list of shark species (or groups of species) to be recorded in log books under Resolution 12/03.

108. The SC **ACKNOWLEDGED** that catch data for all shark species (or group of species) listed in Resolution 12/03 for longline gear and the two additional shark species mentioned in paragraph 107, should be collected by the most appropriate means and submitted to the IOTC Secretariat. The SC **NOTED** that some CPCs considered that logbooks, supplemented by observer data (field samplers data for artisanal fishing vessels), as the most appropriate way of capturing the information, whereas other CPCs considered that such data collection would preferably be conducted under the IOTC Regional Observer Scheme because of some practical difficulties, and a possible negative effect on data quality by requiring the additional data to be collected through logbooks and frequent changes to the logbook format.

109. The SC **NOTED** that identification cards are now available to assist fishers, observers and field samplers to identify shark species. The SC also **REITERATED** its concern on the paucity of observer (or field sampler) data submitted to the IOTC Secretariat by the CPCs and on the poor spatial coverage of the observed trips compared to the spatial extent of the fishery, which prevent any reliable analysis of bycatch data, including sharks.

110. The SC **RECOMMENDED** that, in line with Recommendation 12/15 on the best available science, the list of shark species (or groups of species) for longline gear under Resolution 12/03 should be supplemented by two other shark species which were estimated to be at risk in longline fisheries by the ERA conducted in 2012, the silky shark (*Carcharinus falciformis*) and the oceanic whitetip shark (*Carcharinus longimanus*). The SC **ADVISED** the Commission to define the most appropriate means of collecting this additional information, considering the limitations of both options (logbooks and/or regional observer scheme) presented in paragraphs 108 and 109.

Fin to body weight ratio

111. The SC **ADVISED** the Commission to consider, that the best way to encourage full utilisation of sharks, to ensure accurate catch statistics, and to facilitate the collection of biological information, is to revise the IOTC Resolution 05/05 *concerning the conservation of sharks caught in association with fisheries managed by IOTC* such that all sharks must be landed with fins attached (naturally or by other means) to their respective carcass. However, the SC **NOTED** that such an action would have practical implementation and safety issues for some fleets and may degrade the quality of the product in some cases. The SC **RECOMMENDED** all CPCs to obtain and maintain the best possible data for IOTC fisheries impacting upon sharks, including improved species identification.

112. The SC **NOTED** that it will soon be mandatory for all EU fleets to land all sharks caught during fishing operations with fins naturally attached.

Wire leaders/traces

113. On the basis of information presented to the SC in 2011 and in previous years, the SC **RECOGNISED** that the use of wire leaders/traces in longline fisheries may imply targeting of sharks. The SC therefore **RECOMMENDED** to the Commission that if it wishes to reduce catch rates of sharks by longliners it should prohibit the use of wire leaders/traces.

Marine turtles

Data and reporting requirements

114. The SC **RECOMMENDED** that IOTC Resolution 12/04 *on the conservation of marine turtles* is strengthened to ensure that CPCs report annually on the level of incidental catches of marine turtles by species, as provided at Table 6.

TABLE 6. Marine turtle species reported as caught in fisheries within the IOTC area of competence.

Common name	Scientific name
Flatback turtle	*Natator depressus*
Green turtle	*Chelonia mydas*
Hawksbill turtle	*Eretmochelys imbricata*
Leatherback turtle	*Dermochelys coriacea*
Loggerhead turtle	*Caretta caretta*
Olive ridley turtle	*Lepidochelys olivacea*

115. The SC **NOTED** paper IOTC–2012–WPEB08–35 which provided results of a study on the EU and France(OT) purse seine fleet interactions with marine turtles in the Indian Ocean. The observer data showed a low level of interactions with marine turtles and an even lower mortality rate associated with set on FADs.

116. The SC **NOTED** that the lack of data from most CPCs on interactions and mortalities of marine turtles in the Indian Ocean is a substantial concern, resulting in an inability of the WPEB to estimate levels of marine turtle bycatch. There is an urgent need to quantify the effects of fisheries for tuna and tuna-like species in the Indian Ocean on marine turtle species, and it is clear that little progress on obtaining and reporting data on interactions with marine turtles has been made. This data is necessary to allow the IOTC to respond and manage the adverse effects on marine turtles, and other bycatch species.

117. The SC **NOTED** that it is mandatory for marine turtles (in number) to be recorded on logbooks for purse seine and gillnet but not for longline and **RECOMMENDED** that marine turtles, as a group, be added to Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*, in Annex II (Record once per set/shot/operation) paragraph 2.3 (SPECIES) for longline gear.

118. **NOTING** that Resolution 10/02 does not make provisions for data to be reported to the IOTC on marine turtles, the SC **RECOMMENDED** that Resolution 10/02 is revised in order to make the reporting requirements coherent with those stated in Resolution 12/04 on the conservation of marine turtles.

Ecological Risk Assessment Marine Turtles

119. The SC **NOTED** paper IOTC–2012–SC15–INF09 Rev_1 which provide result on a preliminary Ecological Risk Assessment (ERA) and Productivity Susceptibility Analysis (PSA) of marine turtle populations overlapping with IOTC fisheries.

120. The SC **NOTED** that the analyses were based on data provided by Australia, EU,France, France(OT), EU,Portugal and South Africa, supplemented by bibliographic sources. The most threatened species by longline and gillnet are the hawksbill turtle, loggerhead turtle and leatherback turtle, to varying degrees across the sub-populations. The study identified several sources of uncertainties in the data (e.g. species identification, post release survival, gillnet fishing effort and interactions with marine turtles, and size data lacking).

121. The SC **RECOGNISED** the quality of the work undertaken and the highly valuable information provided by this ERA, but **AGREED** that the assessment would benefit greatly from the inclusion of complete data from more IOTC fleets and that mortality rate of marine turtles in gillnet fisheries is likely to be underestimated as it is based on data from an Atlantic gillnet fishery which is not directly comparable. The SC **NOTED** the importance of gillnet fisheries in the Indian Ocean which land an estimated 500,000 t of tuna and tuna-like species each year.

122. **NOTING** that only a few CPCs have made data available to the consultant, the SC **RECOMMENDED** that all IOTC CPCs contact the scientist leading the ERA in order to refine and complete the analysis before the next WPEB meeting.

123. The SC **RECOMMENDED** that the IOTC Secretariat include an additional 20 day consultancy in the 2013 IOTC budget for the Commission's consideration, so that the Ecological Risk Assessment for marine turtles may be continued and that new information received may be incorporated.

Requests contained in IOTC Conservation and Management Measures

124. The SC **RECOMMENDED** that the Commission note the following in regards to the requests to the SC outlined in paragraph 11 of Resolution 12/04:

    a) *Develop recommendations on appropriate mitigation measures for gillnet, longline and purse seine fisheries in the IOTC area*

    Gillnet: The absence of data for marine turtles on effort, spatial deployment and bycatch in the IOTC area of competence makes any recommendation regarding mitigation measures for this gear premature. Improvements in data collection and reporting of marine turtle interactions with gillnets, and research on the effect of gear types (i.e. net construction and colour, mesh size and soak times) are necessary.

    Longline: Current information suggests inconsistent spatial catches (i.e. high catches in few sets) and by gear/fishery. The most important mitigation measures relevant for longline fisheries are to:

    1. Support further research into the effectiveness of circle hooks as part of a multiple species approach, so as to avoid, as far as possible, promoting a mitigation measure for one bycatch taxon that might exacerbate bycatch problems for other taxa.
    2. Release live animals after careful dehooking/disentangling/line cutting (see handling guidelines in the IOTC marine turtle identification cards).

    Purse seine: see c) below

    b) *Develop regional standards covering data collection, data exchange and training*

    1. The development of standards using the IOTC guidelines for the implementation of the Regional Observer Scheme should be undertaken, as it is considered the best way to collect reliable data related to marine turtle bycatch in the IOTC area of competence.
    2. The Chair of the WPDCS to work with the IOSEA MoU Secretariat, which has already developed regional standards for data collection, and revise the observer data collection forms and observer reporting template as appropriate, as well are current recording and reporting requirements through IOTC Resolutions, to ensure that the IOTC has the means to collect quantitative and qualitative data on marine turtle bycatch.

3. Encourage CPCs to use IOSEA expertise and facilities to train observers and crew to increase post-release survival rates of marine turtles.

c) *Develop improved FAD designs to reduce the incidence of entanglement of marine turtles, including the use of biodegradable materials*

1. Refer to paragraph 103 above.

Collaboration with IOSEA

125. The SC **NOTED** that the collaboration between the IOTC and the IOSEA could be formalised in 2013, in particular for the revision of the Executive Summary on marine turtles and **AGREED** that both Secretariats' should continue working closely together.

7.4 Report of the Fourth Session of the Working Party on Methods (WPM04)

126. The SC **NOTED** the report of the Fourth Session of the Working Party on Methods (IOTC–2012–WPM04–R), including the consolidated list of recommendations provided as an appendix to the report.

Capacity building

127. The SC **REQUESTED** that the Chair of the Commission includes an agenda item for each Commission meeting, which would provide Commissioner's with annual updates and explanatory material to ensure they are kept abreast of the methods and processes being undertaken as part of the broader IOTC MSE process.

128. The SC **RECOMMENDED** that the IOTC Secretariat coordinate the development and delivery of several training workshops focused on providing assistance to developing CPCs to better understand the MSE process, including how reference points and harvest control rules are likely to function in an IOTC context. The implications of IOTC Resolution 12/01 *on the implementation of the precautionary approach* and IOTC Recommendation 12/14 *on interim target and limit reference points* should be incorporated into the workshop. The SC **REQUESTED** that the Commission's budget incorporate appropriate funds for this purpose.

Implicit and explicit objectives

129. The SC **AGREED** that the role of managers and stakeholders is to identify management objectives, acceptable levels of risk of exceeding limit reference points (LRP), and the criteria against which their performance should be evaluated. The role of IOTC scientists is to identify candidate target reference points (TRP) and LRP (e.g. those contained in Recommendation 12/14 *on interim target and limit reference points*), evaluate candidate TRPs and LRPs, options for harvest control rules (HCR), and the performance of identified candidate HCRs.

130. The SC **AGREED** that management objectives should explicitly state the goals for the fishery, and that some of these objectives may conflict with one another (e.g. maximising total allowable catch (TAC) versus minimising the risk of low population levels). Where possible, the Commission should be made aware of any conflicting management objectives which they agree upon so that Commissioners set priorities among objectives throughout the MSE process.

Work on MSE development

131. The SC **ENDORSED** the workplan for the development of the IOTC MSE process, provided at Appendix IV of the WPM report (IOTC–2012–WPM04–R), and encouraged national scientists to participate in the process.

132. The SC **AGREED** that the interim reference points detailed in IOTC Recommendation 12/14 should act as benchmarks for developing HCRs and theoretical management actions as part of the MSE process, as reference points alone are not sufficient to provide a full implementation of the precautionary approach.

133. The SC **NOTED** that HCRs are the tools used to operationalise management objectives through the use of reference points in an attempt to best meet the Commission's overall objectives, and that Resolution 12/01 *on the implemention on the implementation of the precautionary approach* allows for adoption of provisional HCR by the Commission. Therefore, clearly stated management objectives from the Commission will be critical because they will guide the refinement of the interim reference points and define the success of a future harvest strategy for IOTC stocks.

134. The SC **RECOMMENDED** that the Commission allocate funds in the 2013 and 2014 IOTC budgets, for an external expert on MSE to be hired for 30 days per year, to supplement the skill set available within IOTC CPCs, and for the establishment of a participation fund to cover the planned WPM workshops.

135. The SC **NOTED** that the Maldives indicated their full support to this process of development and evaluation of management plans, and their offer to fund an expert in MSE to join the WPM development team.

Date and place of the Fifth Session of the WPM

136. The SC **NOTED** that while the MSE process was still in its early stages of development, there was no pressing need to hold a WPM meeting in 2013, as the work to be undertaken was of a highly technical nature and would require the involvement of a very limited number of experts in the field of development and implementation of population and fishery models for MSE. Thus, as suggested in the MSE workplan, two workshops composed of experts actively involved in the development work should be held in 2013 to continue the development of the MSE process. The WPM has indicated that it would like to hold the first workshop in April, at the EC JRC, Italy, and the second immediately prior to the meeting of the WPTT at the same venue. A document will then be presented to the next session of SC on the progress of the MSE process.

7.5 Report of the Fourteenth Session of the Working Party on Tropical Tunas (WPTT14)

137. The SC **NOTED** the report of the Fourteenth Session of the Working Party on Tropical Tunas (IOTC–2012–WPTT14–R), including the consolidated list of recommendations provided as an appendix to the report.

Indian Ocean tuna tagging symposium

138. The SC **NOTED** that the Indian Ocean Tuna Tagging Symposium was held in Mauritius with 80 participants (30 October to 2 November 2012), immediately following the IOTC WPTT, in order to present the results of analyses of the tagging data gathered during the Indian Ocean Tuna Tagging Programme (IOTTP). Thirty-five presentations were made during this symposium, providing a wide range of new results on the biology of the three tropical tuna species (bigeye tuna, skipjack tuna and yellowfin tuna), e.g. movements and mixing rates, growth and natural mortality by sex, movement to areas with high incidence of FADs soon after tagging, etc. Most of these results offer a new set of biological data that differ to a certain extent from some of the parameters used by national scientists for current stock assessments. The presentations also dealt with the exploitation rates of the three tropical tuna species. These new results will allow improvements of the stock assessments for the tropical tuna species in the future. Furthermore, the results presented at the symposium will be submitted and published in a special issue of the journal Fisheries Research. All necessary efforts should be undertaken by national scientists in order to ensure the success of the publication as it will increase the visibility of IOTC research activities and of the IOTTP.

Data availability

139. **NOTING** that the main tropical tuna data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI of the WPTT report (IOTC–2012–WPTT14–R), the SC **RECOMMENDED** that the CPCs listed in the appendix, make efforts to remedy the data issues identified and to report back to the WPTT at its next meeting.

140. **NOTING** that the Maldivian skipjack tuna catch is not separated by association type, i.e. aFAD or free schools, and therefore the proportion of skipjack tuna caught under aFADs around the Maldives is unknown, the SC **RECOMMENDED** that the Maldivian data collection system is further improved in order to account for the association of the reported catch, as this could improve the standardisation of the pole-and-line CPUE.

141. **NOTING** that there were discrepancies in catch, effort and notably size data (low sampling rate, uneven distribution of sampling in regard to the spatial extent of the fishery) in the Japanese and Taiwan,China tropical tuna data sets, the SC **RECOMMENDED** they review the data to assess reasons for discrepancies identified by the IOTC Secretariat and to report results at the next meeting of the WPTT, including a comparison of length frequency data samples collected from commercial, research and training vessels.

Bigeye tuna

142. The SC **NOTED** that although no new assessment was undertaken for bigeye tuna in 2012, revised stock status indicators (e.g. standardised CPUE series) do not show any substantial differences from those carried out in 2011 that would warrant a change in the overall stock status advice.

143. The SC **NOTED** that additional information (i.e. growth, natural mortality) on bigeye tuna was presented during the tagging symposium held immediately following the WPTT14. The new results are not yet included in the executive summary for this species as they have yet to be considered by the WPTT. New analysis and other information should be considered by the WPTT in 2013, including but not limited to the latitudinal movement of adult bigeye tuna, the possible verification of a two-stanza growth curve, the different maximum size of males and females (larger males) and the low natural mortality now estimated for bigeye tuna. The results arising from the tagging research will likely be of major importance in the future stock assessment analysis of the bigeye tuna stock. Any new information on bigeye tuna biology verified by the WPTT should be incorporated in the next Executive Summary for bigeye tuna in 2013.

144. The SC **NOTED** the issues identified with the stock assessment carried out in 2011, as detailed in the Executive Summary for bigeye tuna (Appendix X).

Skipjack tuna

145. The SC **ACKNOWLEDGED** the excellent work undertaken by the IOTC Secretariat and other collaborators in undertaking the second fully quantitative assessment of skipjack tuna in the Indian Ocean. Further improvements in the assessment will be made by improving the way in which the tagging data and abundance indices are incorporated. Natural mortality and growth also need to be incorporated in an appropriate way.

146. **NOTING** that concerns were expressed on the ability of both the Maldives pole and line CPUE and the EU purse seine CPUE to reflect the dynamics of the stock, and given their major role in driving the current stock assesment results, the SC **RECOMMENDED** that further investigation is carried out for both CPUE series prior to the next WPTT meeting, and during the planned WPM workshop on CPUE standardisation.

147. The SC **RECOMMENDED** further investigation of the existing data to produce an improved standardised CPUE series for the FAD-associated school skipjack tuna fishery in the Indian Ocean, and for information on these matters to be presented to the next meeting of the WPTT.

148. **NOTING** that the areas used in the various CPUE standardisations undertaken in 2012 varied, the SC **AGREED** that there is a need to define core area(s) for each gear (pole-and-line and purse seine) for the CPUE standardisation of skipjack tuna and **RECOMMENDED** that scientists from CPCs with pole-and-line, and purse seine fisheries for skipjack tuna, work together to explore their data in a manner to advance CPUE standardisation work for the next meeting of the WPTT in 2013, and defined such core areas for each gear, well in advance of the next WPTT meeting in 2013.

149. **NOTING** that the tagging data is now more complete and available, including the tagging experiment results from Maldives in the 1990s the SC **RECOMMENDED** effective use of tagging data in the new assessment including any revision on the estimates of mortality and growth rates from the tagging data.

150. **NOTING** the use and application of interim target and limit reference points, the SC **RECOMMENDED** that the Kobe II strategy matrix should include the risk levels associated with those reference points. Furthermore, the SC **AGREED** that the probability of breaching the interim limit reference points for skipjack tuna of $1.5*F_{MSY}$ and $0.4*SB_{MSY}$ is very low and this information should be added to the Executive Summary.

151. The SC **AGREED** that the advice on the status of skipjack tuna in 2012 may be derived from the integrated assessment models used in 2012. Model formulations were explored by the WPTT to ensure that various plausible sources of uncertainty were explored and represented in the final stock status advice.

152. The SC **NOTED** a series of issues identified with the stock assessment carried out in 2012, as detailed in the Executive Summary for skipjack tuna (Appendix XI). Briefly, these include, but are not limited to the following, noting that the reader is referred to the skipjack tuna Executive Summary for a detailed description:
    - In general the indicators obtained for skipjack tuna in the assessment are partially conflicting and highly variable. The average size indicators from the purse seine fleets have dropped for both free and associated schools in recent years. In the long term, however, there does not appear to be an overall major change in mean weight. For the pole-and-line fishery, the average weight indices have also been decreasing over the last three years. However, the gillnet fishery showed an increasing trend during recent years.
    - The catch rates on associated schools are increasing for both the EU,Spain and EU,France fleets. It is difficult to interpret these results, however, it seems that the increase in catch rate is associated with a decrease in effort which could be interpreted as a positive signal. It is possible that the high catch rates for associated schools may be caused by hyperstability (i.e. the aggregating effect of the FADs is masking decreasing population numbers), which is not relevant for free schools of tuna.
    - The advice on the status of skipjack tuna in 2012 was derived from models using an integrated statistical assessment method from 2011 and 2012. Model formulations were explored to ensure that various plausible sources of uncertainty were explored and represented in the final result. In general, the data did not seem to be sufficiently informative to justify the selection of any individual model, and the results of different model runs were presented.

Yellowfin tuna

Japanese – Catch-per-unit-of-effort (CPUE)

153. The SC **NOTED** that changes in gear configuration during the early 1990’s appears to have had the effect of increasing the ratio of yellowfin tuna in the Japanese longline catch when compared to bigeye tuna. Other factors

associated with targeting shifts could be explored in more detail (e.g. NHFCL might not always be the best indicator of hook depth or targeting). Understanding the interactions among NHFCL, fine-scale oceanographic condition, and gear shape under the water might bring further improvement of the CPUE standardisation. Further examination of those issues in the future.

Stock Assessment

154. The SC **NOTED** that a range of quantitative modelling methods were applied to the yellowfin tuna assessment in 2012, ranging from the non-spatial, age-structured production model (ASPM) to the age and spatially-structured Multifan-CL and SS3 analysis.

155. The SC **AGREED** that the management advice for yellowfin tuna should be based on the 2012 MFCL stock assessment using the base case analysis with short term recruitment and alternative steepness of the stock-recruitment relationship of 0.7, 0.8 and 0.9 and the ASPM based case using steepness of 0.9. A limitation of the ASPM model is that it is not spatially structured and thus does not allow integration of tagging data within the model, although it does externally by using the improved catch-at-age table and natural mortality estimates based on tagging data.

156. The SC **NOTED** a series of issues identified with the MFCL stock assessment carried out in 2012, as detailed in the Executive Summary for yellowfin tuna (Appendix XII). Briefly, these include, but are not limited to the following, noting that the reader is referred to the yellowfin tuna Executive Summary for a detailed description:
    - A strong temporal decline in recruitment and in biomass within the eastern equatorial region (Region 5).
    - The model estimates limited movement between the two equatorial regions.
    - Similarly, movement rates between the western equatorial region and the Arabian Sea (Region 1) were estimated to be very low.
    - The model estimated that fishing mortality rates within the western equatorial region did not increase during the 2002–2006 period to the extent that would be anticipated given the large increase in catch from the purse seine fishery during that period (on average 470,000 t: well above all estimated MSY values).

157. The SC **NOTED** similarities of yellowfin tuna stocks of the Eastern Pacific Ocean and the Indian Ocean, but results of the assessments in these two areas give wide-ranging differences in the stock behaviour. The SC **AGREED** that a comparative study be done to investigate this issue further.

158. The SC **AGREED** that a comparative analysis on the Multifan-CL / SS3 assessments in both the Indian Ocean and East Pacific Ocean should be performed by a small group of experts (at least the IOTC consultant and the IATTC expert) working jointly. The objective of this comparative work is to understand why the biomass estimated by the models differ by a ratio 1:10 when many parameters driving the assessment are very similar, i.e. spatial extent of the fishery, estimated MSY, size range of fish caught and growth pattern. One of the aims would be to understand why such differences exist in order to revisit some of the basic assumptions of the models. Therefore, the SC **RECOMMENDED** that the Commission consider funding this proposed work which would need to cover one consultant airfare (up to US$6,000), DSA (up to US$350 per day – 7 days), plus an FAO consultancy rate of US$450 per day (7 days). The total amount requested for this comparative study is US$11,600) per consultant.

159. The SC **AGREED** that the review on stock status of yellowfin tuna in 2013 should firstly examine the report of the above-mentioned comparative analysis if available, noting that the 2013 IOTC budget will not be approved until May 2013. It should also include a discussion on major structural changes which could be proposed for the full assessment which will be undertaken in the coming years, for instance covering a number of topics such as: revision of spatial stratification, including the possibility of using smaller areas, input the latest findings in growth patterns and the differential growth between males and females, age-specific natural mortality, input more age classes (12 instead of 7) and spatial dynamics exhibited by tag-recovery data.

Taiwan, China – Catch-per-unit-of-effort (CPUE)

160. The SC **NOTED** that data from Taiwanese vessels flagged to India was not used in the analysis, the SC **RECOMMENDED** that national scientists from Taiwan,China work with the IOTC Secretariat to gain a better estimate of catch in the Bay of Bengal.

Stock assessment consultant

161. The SC **NOTED** the excellent work done by Mr. Adam Langley (consultant) and his contributions and expertise on integrated stock assessment models, and **RECOMMENDED** that his engagement be renewed for the coming year.

Parameters for future analyses: Yellowfin tuna CPUE standardisation and stock assessments

162. **NOTING** that the areas used in the various CPUE standardisations undertaken in 2012 were very different from one analysis to another, the SC **AGREED** that there is a need to define core area(s) for the CPUE standardisation of yellowfin tuna and **RECOMMENDED** that scientists from CPCs with longline and purse seine fisheries for yellowfin tuna, work together to explore their data and define such core areas, well in advance of the next WPTT meeting in 2013.

Development of priorities for an Invited Expert at the next WPTT meeting

163. The SC **RECOMMENDED** the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPTT in 2013, by an Invited Expert:
    - CPUE analysis and standardisation
    - Tuna tagging data analysis
    - Tuna stock assessment models

    Where possible the Invited Expert should attend both the proposed CPUE workshop and the Working Party in 2013, noting that Invited Experts are unpaid.

7.6 Report of the Second Session of the Working Party on Neritic Tunas (WPNT02)

164. The SC **NOTED** the report of the Second Session of the Working Party on Neritic Tunas (IOTC–2012–WPNT02–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 35 participants, up from 28 in 2011, including 10 recipients of the MPF (9 in 2011).

165. The SC **RECOMMENDED** that the Commission note that neritic tuna and tuna-like species under the IOTC mandate have become as important or more important as the three tropical tuna species (bigeye tuna, skipjack tuna and yellowfin tuna) to most IOTC coastal states with a total estimated catch of 605,359 t being landed in 2011, and as a result, should be receiving appropriate management resources from the IOTC. In fact, neritic tuna species are in many cases, the major commercial tuna and tuna-like species being exploited by the majority of Indian Ocean coastal states and as such, should be given the same status in terms of time and resource investment.

166. **NOTING** that monofilament gillnets are recognised to have highly detrimental impacts on fishery ecosystems, as they are non-selective, and that the use of monofilament gillnets have already been banned in a large number of IOTC CPCs, the SC **RECOMMENDED** that the IOTC Secretariat facilitate a review of the use of monofilament gillnets by IOTC CPCs to i) determine the number of CPCs using then, ii) estimate total catch and bycatch, etc., taken by monofilament gillnets in comparison to other net material, and iii) to report the findings at the next WPNT meeting.

IOTC database for neritic tunas

167. The SC **NOTED** the main data issues that are considered to negatively affect the quality of the statistics for neritic tunas available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI of the WPNT02 report, and **RECOMMENDED** that the CPCs listed in the appendix, make efforts to remedy the data issues identified and to report back to the WPNT at its next meeting.

168. The SC **NOTED** that some CPCs have data collection systems that do not include provisions for the sampling of neritic tuna species, as required by the Commission, and **RECOMMENDED** that the existing sampling systems are extended to facilitate data collection for neritic tunas, by species, so as to fulfil their mandatory reporting requirements regarding those species. The SC further **NOTED** that some CPCs have fisheries directed at neritic tuna species and may require assistance with the implementation of data collection for those fisheries and **RECOMMENDED** that such CPCs contact the IOTC Secretariat for further guidance.

169. The SC **RECOMMENDED** that the IOTC Secretariat request that any datasets for neritic tuna species held by SWIOFP, or any other parties, be provided to the IOTC Secretariat before the next meeting of the WPNT.

170. **NOTING** that the nominal catch data (NC) for India, Indonesia and Thailand provided at the WPNT02 meeting were found to conflict with the NC data history provided by these countries in recent years, and for catch-and-effort data for most of the history of the gillnet fleet, the SC **RECOMMENDED** that India, Indonesia and Thailand liaise with the IOTC Secretariat to provide a fully justified revised catch history which will replace the data currently held by the IOTC Secretariat before the next WPNT meeting.

Data set availability

171. **NOTING** that some CPCs, in particular from India, Indonesia and Thailand, have collected large data sets on neritic tuna species over long time periods, the SC **RECOMMENDED** that this data, as well as data for other

CPCs, be submitted to the IOTC Secretariat as per the requirements adopted by IOTC Members in Resolution 10/02. This would allow the WPNT to develop stock status indicators or comprehensive stock assessments of neritic tuna species in the future.

Requests for guidance from CPCs

172. The SC **ENDORSED** the request from coastal CPCs having fisheries targeting neritic tunas that the IOTC Secretariat coordinate the different research activities developed and implemented at national and regional levels if appropriate, with the aiming of determining the stock structure and more generally, the status of neritic tuna stocks in the IOTC area of competence.

Stock structure

173. The SC **NOTED** that in the absence of reliable evidence relating to stock structure bullet tuna, frigate tuna, kawakawa, longtail tuna, Indo-Pacific king mackerel and narrow-barred Spanish mackerel are assumed to exist as single stocks throughout the Indian Ocean, until proven otherwise. The need for genetic and tagging studies on neritic tunas in order to further define the stock structure of neritic tunas was identified.

Priorities for an Invited Expert at the next WPNT meeting

174. The SC **RECOMMENDED** the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPNT in 2013, by an Invited Expert:
    - Expertise: stock structure/connectivity; including from regions other than the Indian Ocean; data poor assessment approaches.
    - Priority areas for contribution: kawakawa, longtail tuna and narrow-barred Spanish mackerel biology, ecology and fisheries.

7.7 Summary discussion of matters common to Working Parties

Capacity building activities

175. The SC **NOTED** paper IOTC–2012–SC15–INF08 which provided the SC with an opportunity to consider the science capacity building activities tentatively planned by the IOTC Secretariat for 2013 and 2014 that will revolve around four core topics:
    - Connecting science and management in the IOTC process
    - Basic stock assessment training
    - Advanced stock assessment courses with IOTC Member countries and international experts
    - Experimental design, analysis of ecological data and computational methods in quantitative ecology

    The target audience for these workshops will vary depending on the topic, from national scientists to middle managers who support IOTC Commissioners, from developing coastal states in interpreting scientific advice from the SC.

176. The SC **ENDORSED** the science capacity building activities planned by the IOTC Secretariat in 2013 and 2014.

177. The SC **RECOMMENDED** that the Commission increase the IOTC Capacity Building budget line so that capacity building workshops/training can be carried out in 2013 and 2014 on the collection, reporting and analyses of catch and effort data for neritic tuna and tuna-like species. Where appropriate this training session shall include information that explains the entire IOTC process from data collection to analysis and how the information collected is used by the Commission to develop Conservation and Management Measures.

Funding for Chairs and Vice-Chairs to attend IOTC meetings

178. The SC **RECOMMENDED** that the IOTC Secretariat include a proposed budget line in the IOTC budget for 2013 and all future years, that would cover the travel expenses of Chairs and Vice-Chairs from developing countries (and developed countries when they are not attached to any national institutions) who are otherwise unable to obtain funding to support their attendance at their respective working party meeting, and for a Chair or Vice-Chair to attend the SC meeting each year.

IOTC species identification cards

Billfish identification cards

179. **NOTING** that the IOTC Secretariat has developed identification cards for billfish species at the request of the WPB and SC, but no funds have yet been allocated to print the cards, the SC **RECOMMENDED** that the Commission allocate funds in the 2013 budget to print sets of identification cards for the billfish species, noting that the total estimated printing costs for the first 1000 sets of the identification cards is around a maximum of

US$6,700 (Table 7). The IOTC Secretariat shall seek funds from potential donors to print additional sets of the identification cards at US$5,500 per 1000 sets of cards.

TABLE 7. Estimated production and printing costs for 1000 sets of billfish species identification cards

Description	Unit price	Units required	Total
Printing plates / plate	US$100	12	1,200
Printing /1000 sets	US$5500	1	5,500
Total estimate (US$)			**6,700**

Shark, marine turtle and seabird identification cards

180. The SC **EXPRESSED** its appreciation to the IOTC Secretariat for the finalisation of the identification cards for sharks, marine turtles and seabirds which have been developed, produced and are being circulated to some CPCs. These identification cards should be used by observers, field samplers as well as fishers in order to improve the identification and reporting of bycatch species.

181. The SC **RECOMMENDED** that the Commission allocate additional funds in 2013 to print further sets of the shark, seabird and marine turtle identification cards developed by the IOTC Secretariat, noting that expected costs are in the vicinity of US$6,000 per 1000 sets of cards.

Tunas and mackerels

182. The SC **AGREED** that the development of species identification cards for all tunas under the IOTC mandate (three tropical tuna, two temperate tuna and six neritic tuna and mackerel species), at various life history stages interacting with IOTC fisheries, urgently needs to be developed to improve species identification and data quality being submitted to the IOTC Secretariat.

183. The SC **RECOMMENDED** that the Commission allocate funds in the 2013 budget to develop and print sets of identification cards for the three tropical tuna, two temperate tuna, and six neritic tuna and seerfish species under the IOTC mandate, noting that the total estimated production and printing costs for the first 1000 sets of the identification cards is around a maximum of US$16,200 (Table 8). The IOTC Secretariat shall seek funds from potential donors to print additional sets of the identification cards at US$5,500 per 1000 sets of cards.

TABLE 8. Estimated production and printing costs for 1000 sets of tuna species identification cards (11 species of tropical, temperate and neritic tunas and mackerels)

Description	Unit price	Units required	Total
Purchase images	US$100	22 (2 per species, plus 2 covers)	2,200
Contract days	US$350	20	7,000
Printing plates / plate	US$100	15	1,500
Printing /1000 sets	US$5500	1	5,500
Total estimate (US$)			**16,200**

Fishing hook identification cards

184. Noting the continued confusion in the terminology of various hook types being used in IOTC fisheries, (e.g. tuna hook vs. J-hook; definition of a circle hook), the SC **RECOMMENDED** that the IOTC Secretariat develop an identification guide for hooks and pelagic gears used in IOTC fisheries, as staffing and financial resources permit, and to distribute the guide to all CPCs once completed. The SC also **AGREED** that circle hooks are defined by hooks having their point turned at least 90° from their shank.

Identification cards – general

185. The SC **RECOMMENDED** that IOTC CPCs translate, print and disseminate the identification cards to their observers and field samplers (Resolution 11/04), and as feasible, to their fishing fleets targeting tuna, tuna-like and shark species. This would allow accurate observer, sampling and logbook data on tuna and tuna-like species to be recorded and reported to the IOTC Secretariat as per IOTC requirements.

186. The SC **NOTED** the commitment made by the WWF Smart Fishing Initiative to fund the reproduction of additional bycatch species identification cards. The SC **AGREED** that translation and printing in Persian may best serve the IOTC at this time.

CPUE discussion summary

187. The SC **EXPRESSED** concern that the majority of the important recommendations issued by the SC to the various working parties in previous years in regards to CPUE standardisation have often not been addressed, and that there was no major progress on these issues during the past two years. Therefore, the SC **RECOMMENDED** that the scientists in charge of this work make every possible effort to consider those

guidelines in future CPUE standardisation work in order to improve the quality of CPUE series which are essential to stock assessments.

188. **NOTING** that a set of 'core areas' which are likely to be robust to frequent fluctuations of external factors, may be more informative than using all of the data available, especially when other species were being targeted, the SC **RECOMMENDED** that 'core areas' be identified and agreed to by each working party so as to facilitate and monitor population abundance trends across all fleets. This should be carried out intersessionally and presented at the proposed longline CPUE workshop, to be held in the second quarter of 2013.

Dedicated workshop on CPUE standardisation

189. **NOTING** the combined recommendations from the WPB, WPTmT and WPTT to hold a dedicated workshop on CPUE standardisation, the SC **RECOMMENDED** that a dedicated, informal workshop on CPUE standardisation, including issues of interest for other IOTC species, should be carried out before the next round of stock assessments in 2013. The terms of reference (TORs) for the workshop are provided in Appendix VII. Where possible it should include a range of invited experts, including those working on CPUE standardisation in other ocean/RFMOs, in conjunction with scientists from main tuna fishing countries, and supported by the IOTC Secretariat. The IOTC Secretariat shall include a budget item for this workshop, for the consideration of the Commission.

Risk-based approaches to determining stock status

190. The SC **RECOMMENDED** that the IOTC Secretariat facilitate a process to provide the necessary information to the SC so that it may consider the Weight-of-Evidence approach to determine species stock status, as an addition to the current approach of relying solely on fully quantitative stock assessment techniques.

Working Party Reports

191. **NOTING** that the report of the WPTmT, WPB and WPTT do not include trends of recruitment or biomass, as estimated from the different assessments, the SC **REQUESTED** that the working parties include this information in their future reports.

192. **NOTING** that in 2012 the Commission had adopted Recommendation 12/14 *On interim target and limit reference points*, the SC **AGREED** that as a complement to the information in the KOBEII Strategy Matrix for each species could include estimates on the likelihood of the different scenarios exceeding limit reference points.

Incorporation of the risk levels associated with reference points

193. **NOTING** that Resolution 12/01 *on the implementation of the precautionary approach* was adopted by the Commission in 2012, and that provisional reference points have been adopted in Recommendation 12/14 *on interim target and limit reference points*, the SC **AGREED** that future Kobe II strategy matrices should show the levels of risk of breaching the reference points and that the Executive Summaries for tropical tuna species incorporate explanatory text in this regard.

On Interim Target and Limit Reference Points

194. **NOTING** the completion of the MSE work on tropical tunas is likely to take several years, and that the lack of data or information to improve the work on formal stock assessments should not hinder the application of the Precautionary Approach, the SC **RECOMMENDED** that the Commission consider the adoption of the interim target and limit reference points as a Resolution. Furthermore, interim harvest controls rules should be considered by the Commission for adoption in the Resolution.

Employment of a Fisheries Officer (Science)

195. **NOTING** the rapidly increasing scientific workload at the IOTC Secretariat, including a wide range of additional science related duties assigned to it by the SC and the Commission, and that the current Fishery Officer supporting the IOTC scientific activities will depart at the end of February 2013, the SC strongly **RECOMMENDED** that the Commission approve the hiring of a Fishery Officer (Science) to work on a range of matters in support of the scientific process, including but not limited to science capacity building, bycatch and regional observer schemes.

Chairs and Vice-Chairs of the Working Parties

196. The SC **RECOMMENDED** that the Commission note and endorse the Chairs and Vice-Chairs for each of the IOTC Working Parties, as provided in Appendix VIII.

8. Examination of the Effect of Piracy on Fleet Operations and Subsequent Catch and Effort Trends

197. The SC **NOTED** that the Commission, at its 15th Session '*recognized that piracy activities in the western Indian Ocean, have had substantial negative consequences on the activities of some fleets, as well as the level of observer coverage in these areas. The Commission requests that the Scientific Committee assess the effect of piracy on fleet operations and subsequent catch and effort trends*' (para. 40 of the S15 report).

198. The SC **NOTED** that the Commission, at its 16th Session, further '*recognised the severe impact of piracy acts on humanitarian, commercial and fishing vessels off the coast of Somalia and noted that the range of the attacks extended towards almost all of the western Indian Ocean, notably toward Kenya and Seychelles, with attacks being reported in their respective EEZ.*' (para. 124 of the S16 report).

199. The SC **NOTED** that although no specific analysis of the impacts of piracy on fisheries in the Indian Ocean were presented at IOTC working party meetings in 2012, many papers demonstrated some level of impact on fishing operations in the western Indian Ocean (Somali Basin) and other areas as a result of relocated fishing effort. Specifically, that there has been a substantial displacement of effort into traditional albacore fishing areas, thereby increasing fishing pressure on this species. In recent years, the proportion of fishing effort of the Japanese longline fleet sharply decreased in the north-western Indian Ocean (off the Somalia coastline), while fishing effort increased in the area south of 25°S, especially off western Australia, where catch rates of albacore are higher (Fig. 1). Similarly, as a direct result of piracy activities in the western Indian Ocean, many of the vessels from the I.R. Iran targeting tropical tuna species on the high seas have moved back to the EEZ of I.R. Iran and are now targeting neritic tuna and tuna-like species. This has resulted in substantial increases in the total catch and effort of neritic tuna and tuna-like species under the IOTC mandate.

200. The SC **NOTED** that the number of active vessels in the IOTC area of competence have declined substantially since 2008 (Fig. 2), and that this was likely due to the impact of piracy activities in the western Indian Ocean. The impacts appear to have been greatest on the longline fleets with effort having declined to negligible levels in recent years by most fleets (Figs. 2 and 3). Fishing effort of the purse seine fleet has also shifted east by at least 100 miles compared to the historic distribution of effort and piracy was reported to also be playing a role in determining the behaviour of small-scale fishing vessels which have declined in the region.

201. The SC **NOTED** that there has also been a substantial reduction in total effort due to piracy, evident from the decline in total effort from all major fleets (Fig. 1). In the first half of 2011, 11 vessels from Taiwan,China, moved to the Atlantic Ocean and 2 to the Pacific Ocean. However, in the second half of 2011, 5 vessels returned from the Atlantic Ocean, and 1 vessel returned from the Pacific Ocean. In 2012, the trend has been reversed, with a total of 15 vessels being transferred from the Atlantic Ocean back to the Indian Ocean. Similarly, 6 vessels from Taiwan,China have been transferred from the Pacific Ocean back to the Indian Ocean in 2012. Japan reported a reduction of ~140 vessels since 2006, with 85 remaining in 2011 (preliminary), which corresponds to a decrease of total catch of about 80% (for bigeye tuna and yellowfin tuna combined). In recent years, the proportion of fishing effort of the Japanese longline fleet sharply decreased in the north-western Indian Ocean (off the Somalia coastline), while fishing effort increased in the area south of 25°S, especially off western Australia. The Rep. of Korea reported that one longline vessel was hijacked in 2006 and this had resulted in a large reduction (50%) of the number of Rep. of Korean active vessels, from 26 in 2006 to 7 in 2011; while the remaining vessels moved to the Southern Indian Ocean. The number of EU and associated purse seiners has also decreased from 51 in 2006 to 34 in 2011 (a 33% of reduction).

202. The SC **NOTED** that given the potential impacts of piracy on fisheries in other areas of the Indian Ocean through the relocation of longliners to other fishing grounds, specific analysis should be carried out and presented at the next WPTT and WPTmT meetings by CPCs most affected by these activities, including Japan, Rep. of Korea and Taiwan,China. For example, longline fishing effort has been redistributed to traditional albacore fishing grounds in recent years, thereby further increasing fishing pressure on the albacore stock (see IOTC–2012–WPTmT04–R).

203. The SC **NOTED** that reports from Thailand, China and Taiwan,China that longline vessels from some fleets appear to be moving back towards the central Indian Ocean in 2012, as a direct result of increased CPUE being recorded in these areas. This movement back into the area vacated due to piracy activities should be closely monitored and reported at the SC and the working party meetings in 2013.

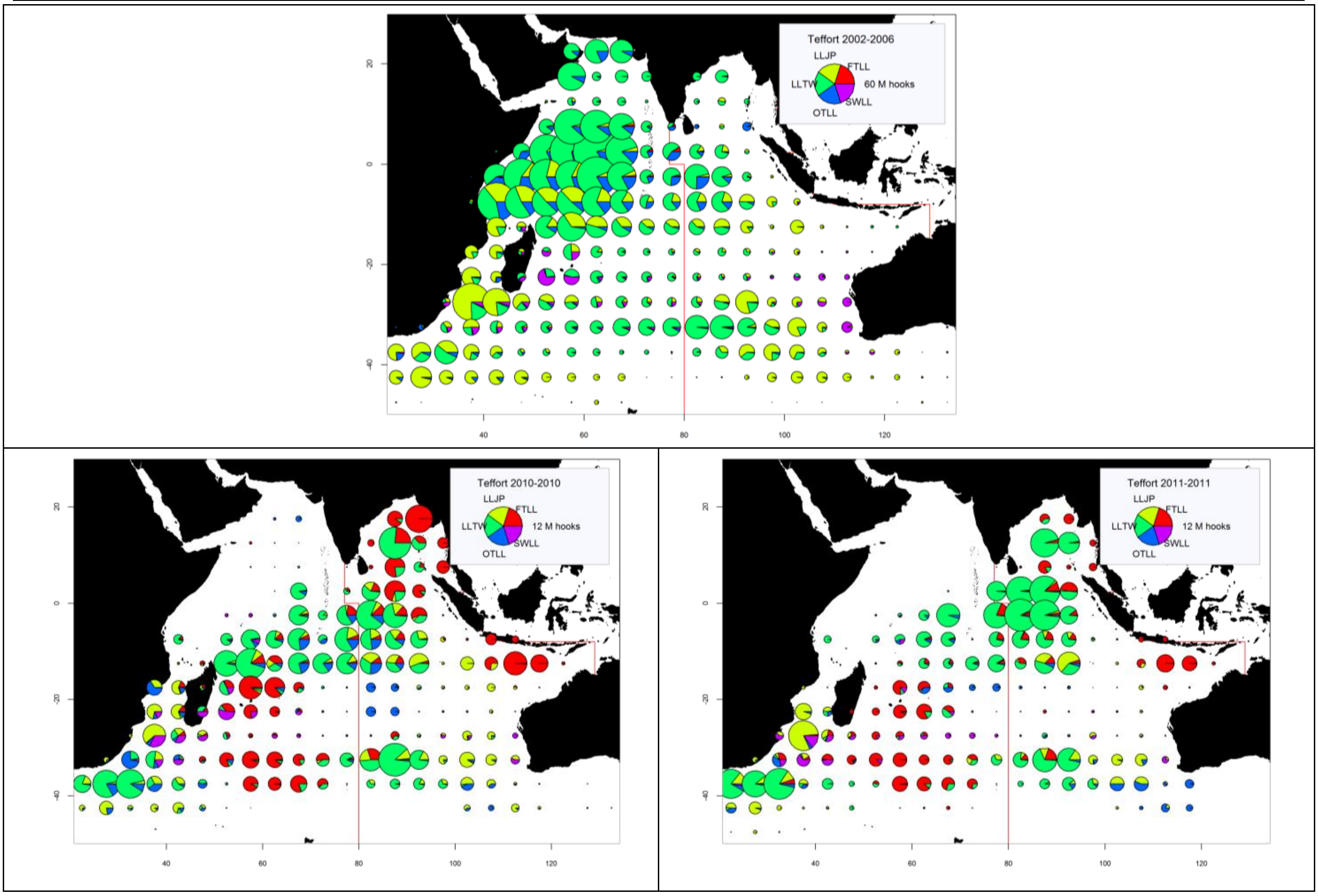
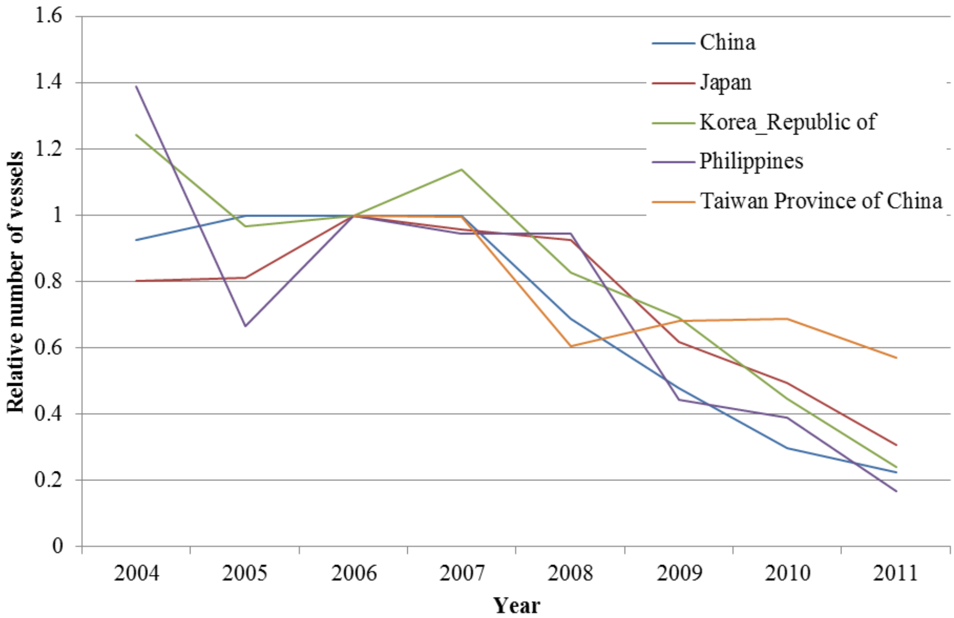


Fig. 1. The geographical distribution of fishing effort (millions of hooks) as reported for the longline fleets of Japan (LLJP), Taiwan,China (LLTW), fresh-tuna longline (FTLL), other longline (OTLL), and longline directed at swordfish (SWLL), in the IOTC area of competence, 2002–06, and 2010–11. The red line represents the boundary between western and eastern Indian Ocean regions. LLJP (light green): deep-freezing longliners from Japan; LLTW (dark green): deep-freezing longliners from Taiwan,China; SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets); FTLL (red): fresh-tuna longliners (China, Taiwan,China and other fleets; OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, South Korea and various other fleets).



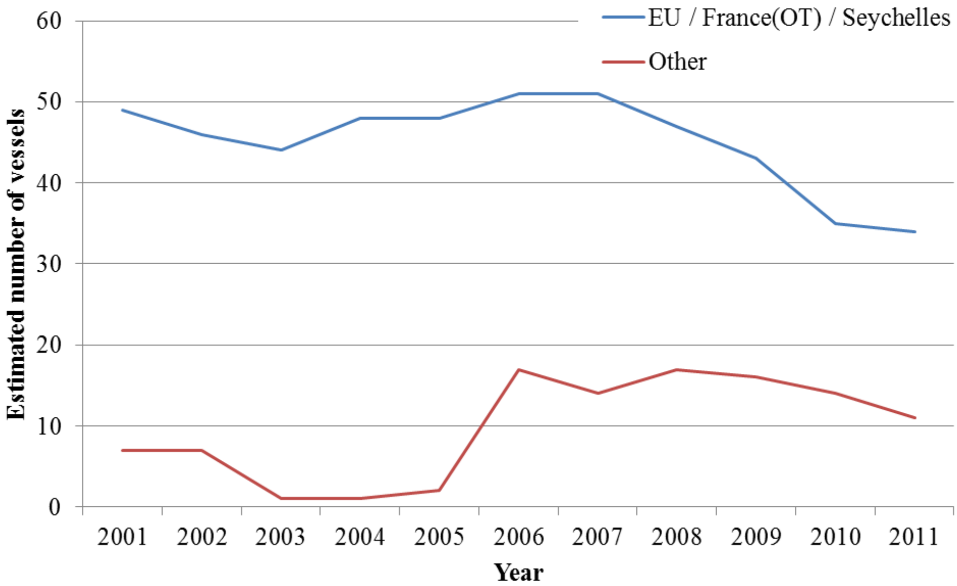


Fig. 2. The change in the relative number of some active longline fleets since 2004 (upper – numbers have been scaled to the number of active vessels in 2006) and estimated numbers of active purse seine vessels from 2001 to 2011 (lower) in the Indian Ocean.

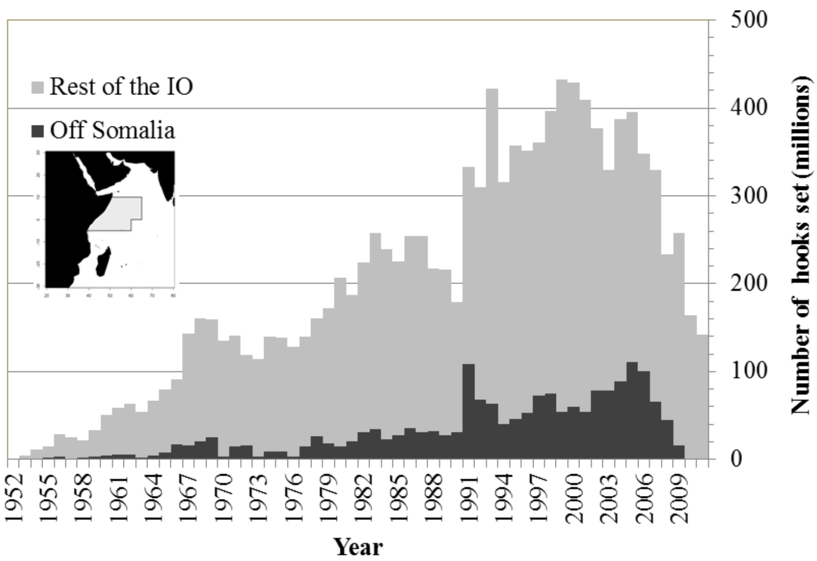


Fig. 3. The total number of hooks set (in millions), by year and geographical area: off the Somalia coastline (area shown in the insert) and for the rest of the Indian Ocean (IO), from 1952 to 2011.

204. The SC **RECOMMENDED** that given the lack of quantitative analysis of the effects of piracy on fleet operations and subsequent catch and effort trends, and the potential impacts of piracy on fisheries in other areas of the Indian Ocean through the relocation of longliners to other fishing grounds, specific analysis should be carried out and presented at the next WPTT meeting by the CPCs most affected by these activities, including Japan, Republic of Korea and Taiwan,China. The Chair of the WPTT shall facilitate the analysis and report back to the SC in 2013.

205. The SC **NOTED** the following statement from the I.R. Iran on combating piracy and developing international guidelines to fishing vessel navigation and compensation:

“*The appearance of piracy in recent years in some part of the world, especially in the Indian Ocean, has caused concerns and has had negative impacts on fishing activities. Unfortunately many vessels have been attacked by pirates and have been seriously damaged. From 2008 up to now, unfortunately 50 fishing vessels of Islamic Republic of Iran have been attacked in the Indian Ocean by pirates, who have caused the loss of seven vessels and drowning of nine crewmen. In the meantime the loss of vessels and crew due to a lack of insurance coverage, have not been compensated. Other vessels are not immune from damage or new attacks in the future. The result of this situation is clearly visible in our catch composition and quantity. The Islamic Republic of Iran as a country has experienced lot of pirate attacks and officially requests that the IOTC and its Scientific Committee take anti-piracy steps. I.R. of Iran proposes the* *establishment of an ad hoc working group. This working group should prepare an anti-piracy guideline. It is anticipated that through these works and by the developed guidelines and other necessary coordination, the issue of supporting fishermen and fishing vessels against piracy and compensation of their damages will be considered and followed up in the future. Also in this way all responsible international organizations, particularly FAO and the IMO, are expected to support and cooperate with CPCs.*"

9. STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN

206. **NOTING** that Table 1 in this report provides an overview of the stock status and management advice for each species under the IOTC mandate as well as species directly impacted by fisheries for tuna and tuna-like species, the SC **AGREED** to an Executive Summary for each species or species group as detailed below.

9.1 Tuna – Highly migratory species

207. The SC **RECOMMENDED** that the Commission note the management advice developed for each tropical and temperate tuna species as provided in the Executive Summary for each species.
    - Albacore (*Thunnus alalunga*) – Appendix IX
    - Bigeye tuna (*Thunnus obesus*) – Appendix X
    - Skipjack tuna (*Katsuwonus pelamis*) – Appendix XI
    - Yellowfin tuna (*Thunnus albacares*) – Appendix XII

208. The SC **AGREED** that the Chairs of the IOTC Working Parties should ensure that where possible, all KOBE plots should be presented in a standardised format for the consideration of the SC.

209. The SC **NOTED** paper IOTC–2012–SC15–12 which provided an overview of the biology, stock status and management of southern bluefin tuna (*Thunnus maccoyii*), and thanked CCSBT for providing it.

9.2 Billfish

210. The SC **RECOMMENDED** that the Commission note the management advice developed for each billfish species as provided in the Executive Summary for each species:
    - Swordfish (*Xiphias gladius*) – Appendix XIII
    - Black marlin (*Makaira indica*) – Appendix XIV
    - Blue marlin (*Makaira nigricans*) – Appendix XV
    - Striped marlin (*Tetrapturus audax*) – Appendix XVI
    - Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XVII

9.3 Tuna and mackerel – Neritic species

211. The SC **RECOMMENDED** that the Commission note the management advice developed for each neritic tuna species as provided in the Executive Summary for each species:
    - Bullet tuna (*Auxis rochei*) – Appendix XVIII
    - Frigate tuna (*Auxis thazard*) – Appendix XIX
    - Kawakawa (*Euthynnus affinis*) – Appendix XX
    - Longtail tuna (*Thunnus tonggol*) – Appendix XXI
    - Indo-Pacific king mackerel (*Scomberomorus guttatus*) – Appendix XXII
    - Narrow-barred Spanish mackerel (*Scomberomorus commerson*) – Appendix XXIII

10. STATUS OF MARINE TURTLES, SEABIRDS AND SHARKS IN THE INDIAN OCEAN

10.1 Sharks

212. The SC **RECOMMENDED** that the Commission note the management advice developed for a subset of shark species commonly caught in IOTC fisheries for tuna and tuna-like species:
    - Blue sharks (*Prionace glauca*) – Appendix XXIV
    - Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix XXV
    - Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix XXVI
    - Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix XXVII
    - Silky sharks (*Carcharhinus falciformis*) – Appendix XXVIII
    - Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XXIX
    - Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XXX

10.2 Marine turtles

213. The SC **RECOMMENDED** that the Commission note the management advice developed for marine turtles, as provided in the Executive Summary encompassing all six species found in the Indian Ocean:
    - Marine turtles – Appendix XXXI

10.3 Seabirds

214. The SC **RECOMMENDED** that the Commission note the management advice developed for seabirds, as provided in the Executive Summary encompassing all species commonly interacting with IOTC fisheries for tuna and tuna-like species:
    - Seabirds – Appendix XXXII

11. IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME

215. The SC **NOTED** paper IOTC–2012–SC15–33 Rev_3 which provided an update on the national implementation of the IOTC regional observer scheme (ROS) for each IOTC CPC, noting that the ROS started on 1st July 2010 (Resolution 09/04 superseded by Resolution 10/04 and Resolution 11/04).

216. The SC **NOTED** that 12 CPCs have submitted their list of accredited observers and only seven CPCs have submitted observer trips reports. A total of 38 observer trip reports have been submitted to the IOTC Secretariat: 11 reports for 2010, 23 reports for 2011 and 4 reports for 2012. The SC **NOTED** that these reports are very unevenly distributed among CPCs. In 2011, the only full year of implementation of the ROS to date, it was estimated from the reports and effort data available, that only two CPCs have achieved the minimum 5% observer coverage required in Resolution 11/04.

217. The SC **EXPRESSED** its strong concern regarding the low level of reporting to the IOTC Secretariat of both the observer trip reports and the list of accredited observers since the start of the ROS in July 2010. Such a low level of implementation and reporting is detrimental to the work of the SC, in particular regarding the estimation of incidental catches of non-targeted species, as requested by the Commission. In particular, the SC **NOTED** that the IOTC Regional Observe Programme could be a significant source of potential data for marine turtles (e.g. sex and species composition, etc.) for some longline and gillnet fisheries.

218. The SC **RECOMMENDED** that all IOTC CPCs urgently submit, and keep up-to-date, their list of accredited observers to the IOTC Secretariat and implement the requirements of Resolution 11/04 *on a Regional Observer Scheme*, which states that:

    "The observer shall, within 30 days of completion of each trip, provide a report to the CPCs of the vessel. The CPCs shall send within 150 days at the latest each report, as far as continuous flow of report from observer placed on the longline fleet is ensured, which is recommended to be provided with 1°x1° format to the Executive Secretary, who shall make the report available to the Scientific Committee upon request. In a case where the vessel is fishing in the EEZ of a coastal state, the report shall equally be submitted to that Coastal State." (para. 11)

219. The SC **NOTED** that the timely submission of observer trip reports to the IOTC Secretariat is necessary to ensure that the SC is able to carry out the tasks assigned to it by the Commission, including the analysis of accurate and high resolution data, in particular for bycatch, which would allow IOTC scientists to better assess the impacts of fisheries for tuna and tuna-like species on bycatch species.

220. The SC **RECOMMENDED** that the Commission consider how to address the lack of implementation of observer programmes by CPCs for their fleets and reporting to the IOTC Secretariat as per the provision of Resolution 11/04 *on a Regional Observer Scheme*, noting the update provided in Appendix XXXIII.

221. The SC **RECOGNISED** that the implementation of national observer programmes is not a simple task, e.g. due to piracy activities, and that the financial and human costs involved in the deployment of observers are important to consider, in particular for CPCs with large fishing fleets. However, the SC **AGREED** that the minimum observer coverage of 5% set out by Resolution 11/04 is already below the minimum necessary coverage estimated by simulations, and that it should not be lowered.

12. OUTLOOK ON TIME-AREA CLOSURES

222. The SC **NOTED** that the Commission, at its 16th Session, adopted Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*, which superseded Resolution 10/01. Contained within Resolution 12/13 is a requirement that the SC will provide at its 2012 and 2013 plenary session, the following:

a) *an evaluation of the closure area, specifying in its advice if a modification is necessary, its basic scientific rationale with an assessment of the impact of such a closure on the tropical tuna stocks, notably yellowfin and bigeye tuna*
b) *an evaluation of the closure time periods, specifying in its advice if a modification is necessary, its basic scientific rationale with an assessment of the impact of such a closure on the tropical tuna stocks, notably yellowfin and bigeye tuna*

223. The SC **NOTED** paper IOTC–2011–SC14–39 presented to the SC in 2011, which provided an evaluation of the IOTC time-area closure by estimating what the maximum potential loss of catches would be under different scenarios of time-area closure, as estimated from the catch statistics of the IOTC. The estimation was based on the historical IOTC database as no information was available for the specific closed periods of 2011 (February for longline, November for purse seine) when the measure took effect. The longline effort had already been entirely redistributed to other areas and the purse seine data for November were not yet available when the paper was prepared, nor at the date of the SC.

224. The SC **NOTED** that the results obtained from the study are similar to the analysis carried out for the SC in 2010, which emphasized that catch reduction expected from the current time-area closure were negligible. It was further recalled that the results were also supported by paper IOTC–2011–SC14–40 which provided a preliminary investigation into the effects of the network of Indian Ocean MPAs on yellowfin tuna with particular emphasis on the IOTC time-area closure. The results of the study indicated that the current network including an IOTC closure of only two, one month closures (one month for purse seine and one month for longline), is likely to have little impact on stock status, whether effort is eliminated or redistributed. The study examined scenarios to investigate the impacts of a 12 month closure of the current IOTC time-area closure. Some benefits to the status of yellowfin tuna stocks were predicted if it is assumed that effort (and catch) is eliminated, but where effort is redistributed such a closure had negligible impact on stock status.

225. The SC reiterated its previous **RECOMMENDATION** that the Commission note that the current closure is likely to be ineffective, as fishing effort will be redirected to other fishing grounds in the Indian Ocean. The positive impacts of the moratorium within the closed area would likely be offset by effort reallocation. For example, the WPTmT noted that longline fishing effort has been redistributed to traditional albacore fishing grounds in recent years, thereby further increasing fishing pressure on this stock.

226. **NOTING** that the objective of Resolution 12/13 is to decrease the overall pressure on the main targeted stocks in the Indian Ocean, in particular yellowfin tuna and bigeye tuna, and also to evaluate the impact of the current time/area closure and any alternative scenarios on tropical tuna populations, the SC reiterated its previous **RECOMMENDATION** that the Commission specify the level of reduction or the long term management objectives to be achieved with the current or alternative time area closures and/or alternative measures, as these are not contained within the Resolution 12/13. This will, in turn, guide and facilitate the analysis of the SC, via the WPTT in 2013 and future years.

227. **NOTING** the lack of research examining time-area closures in the Indian Ocean by the WPTT in 2011 and 2012, as well as the slow progress made in addressing the Commission request, the SC reiterated its **RECOMMENDATION** that the SC Chair begins a consultative process with the Commission in order to obtain clear guidance from the Commission about the management objectives intended with the current or any alternative closure. This will allow the SC to address the Commission request more thoroughly.

13. IMPACTS OF CATCHING BIGEYE TUNA AND YELLOWFIN TUNA JUVENILES AND SPAWNERS

228. The SC **NOTED** that the Commission, at its 16th Session, adopted Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*, which superseded Resolution 10/01. Contained within Resolution 12/13 is a requirement that the SC will provide at its 2012 and 2013 plenary session, the following:

c) *an evaluation of the impact on yellowfin and bigeye tuna stocks by catching juveniles and spawners taken by all fisheries. The Scientific Committee shall also recommend measures to mitigate the impacts on juvenile and spawners*

229. The SC **NOTED** that the most direct measure of impact of fishing fleets on juveniles could be obtained by looking at the catches of juvenile yellowfin tuna and bigeye tuna by gear, as presented in Table 9 below. It should be noted that the estimates of catches of juvenile fish are doubtful for some gears, for which catch-at-length information is severely limited or almost non-existent. The SC reiterated its **AGREEMENT** from 2011,

that the WPTT should provide the SC with multi-gear yield-per-recruit estimates for all stocks assessed in 2013, as this is another useful indicator of the impact of each gear on potential yields.

TABLE 9. Catches of juvenile yellowfin tuna and bigeye tuna by gear.

Yellowfin tuna Gear type*	Total catch (mt)	% Juveniles of catch within gear	% Juveniles total juvenile catch
BB	18438	85	13.97
GN	84305	40	30.06
HD	32728	25	7.29
LL	94610	2	1.69
TL	21297	37	7.02
FS	92957	3	2.49
LS	69128	60	36.98
OT	1516	37	0.50
TOTAL	414979	27	100
Bigeye tuna Gear type	**Total catch (mt)**	**% Juveniles of catch within gear**	**% Juveniles total juvenile catch**
BB	1070	70	3.44
GN	445	15	0.31
HD	27	1	0.00
LL	99535	1	4.57
TL	1079	41	2.03
FS	6425	13	3.83
LS	21990	84	84.80
OT	241	92	1.02
TOTAL	130813	17	100

(*) BB : baitboat / GN : Gillnet / HD : Handline / LL : Longline / TL : Troll / FS : Purse seine free schools / LS : Purse seine FAD schools / OT : Others

230. The SC **NOTED** that the existing statistics on catches of juvenile fish by species obtained by the various purse seine fleets fishing on FADs, in both numbers, size (length) and weight, provide a measure of their impact on the stocks, and the corresponding effort statistics (number of boats, GRT and fishing days), give an indication of the capacity of this fleet, which engages, although not exclusively, on the FAD fishery.

231. The SC **NOTED** however, that the fishery statistics available for many fleets, in particular for coastal fisheries, are not accurate enough for a comprehensive analysis as has been repeatedly noted in previous WPTT and SC reports. In particular, the SC **RECOMMENDED** that all CPCs catching yellowfin tuna should undertake scientific sampling of their yellowfin tuna catches to better identify the proportion of bigeye tuna catches. Therefore, the SC **RECOMMENDED** the countries engaged in those fisheries to take immediate actions to reverse the situation of fishery statistics reporting to the IOTC Secretariat.

232. The SC **NOTED** that a complete analysis of the likely impact of the juveniles caught by any fishery in the Indian Ocean and of any management plan should be carried out within the context of the work on MSE that the SC has agreed to carry out in the future. This could, if necessary, also quantify the impact of such measures not only on the stocks, but also on the fleets, including likely economic impact on activities dependent on the fleets affected.

233. The SC **ADVISED** the Commission that the Western and Central Pacific Fisheries Commission has implemented since 2009 a FAD closure for the conservation of yellowfin tuna and bigeye tuna juveniles. The SC **REQUESTED** further investigation of the feasibility and impacts of such a measure, as well as other measures, in the context of Indian Ocean fisheries and stocks.

14. PROGRESS ON THE IMPLEMENTATION OF THE RECOMMENDATIONS OF THE PERFORMANCE REVIEW PANEL

234. The SC **NOTED** paper IOTC–2012–SC15–34 which provided an update on progress regarding Resolution 09/01 *on the performance review follow–up*.

235. The SC **RECOMMENDED** that the Commission note the updates on progress regarding Resolution 09/01 *on the performance review follow–up*, as provided at Appendix XXXIV.

15. SCHEDULE AND PRIORITIES OF WORKING PARTY AND SCIENTIFIC COMMITTEE MEETINGS FOR 2013 AND TENTATIVELY FOR 2014

Research Recommendations and Priorities

236. The SC **NOTED** paper IOTC–2012–SC15–35 which outlined the proposed priorities for IOTC Working Parties and SC meetings for 2013 and tentatively for 2014.

237. The SC **NOTED** the proposed workplans and priorities of each of the Working Parties and **AGREED** to the revised workplans as outlined in Appendix XXXV. The Chairs and Vice-Chairs of each working part shall ensure that the efforts of their working party is focused on the core areas contained within the appendix, taking into account any new research priorities identified by the Commission at its next Session.

238. The SC **ADOPTED** a revised assessment schedule for the tuna and tuna-like species under the IOTC mandate, as well as the current list of key shark species of interest, as outlined in Appendix XXXVI. Following the uncertainty remaining in the bigeye tuna assessment carried out for the previous WPTT meetings in 2010 and 2011, the WPTT **AGREED** that bigeye tuna would be the priority species for stock assessments in 2013. Only stock status indictors (i.e standardised CPUE series) should be updated for skipjack tuna and yellowfin tuna.

Schedule of meetings for 2013 and 2014

239. **NOTING** paper IOTC–2012–SC15–36 which outlined the proposed schedule for IOTC Working Parties and SC meetings for 2013 and tentatively for 2014, the SC **AGREED** that despite the current overfishing status of albacore, there was no urgent need to hold a WPTmT in 2013, but rather that national scientists working on albacore shall produce updated stock status indicators (i.e. standardised CPUE indices) for presentation at the next SC meeting.

240. The SC **NOTED** the options provided to it by the WPEB, highlighting that as quantitative information on sharks becomes available, there should be the possibility for simple stock status analyses based on fisheries and biological indicators. Expertise in stock assessment from other IOTC working parties, e.g. the WPTT or the WPB, would be of value for such analyses. The SC **AGREED** that the WPEB should be retained in its current form, but that the Chair shall ensure that each five day meeting alternatives its core focus among the species covered under its mandate.

241. **NOTING** the difficulty of carrying out stock assessments for three tropical tuna species in a single year, the SC **AGREED** to a revised assessment schedule on a two- or three-year cycle for the three tropical tuna species as outlined in Appendix XXXVI. Following the uncertainty remaining in the bigeye tuna assessment carried out for the previous WPTT meetings in 2010 and 2011, bigeye tuna would be the priority species for stock assessments in 2013, while only stock status indictors (i.e. standardised CPUE series) should be updated for skipjack tuna and yellowfin tuna, including the revision of the executive summaries to incorporate any new work being completed during the WPTT sessions.

242. The SC **AGREED** that while the MSE process was still in its early stages of development, there was no pressing need to hold a WPM meeting in 2013, as the work to be undertaken was of a highly technical nature and would require the involvement of a very limited number of experts in the field of development and implementation of population and fishery models for MSE. Thus, as suggested in the MSE workplan (contained in the WPM04 Report), two workshops composed of experts should be held in 2013 to continue the development of the MSE process. The Chair of the WPM shall present an update on progress made by the small working group at the next SC meeting.

243. The SC **RECOMMENDED** that the Commission endorse the schedule of Working Party and Scientific Committee meetings for 2013, and tentatively for 2014 (Table 10).

TABLE 10. Schedule of Working Party and Scientific Committee meetings for 2013, and tentatively for 2014.

Meeting	2013		2014 (tentative)	
	Date	**Location**	**Date**	**Location**
Working Party on **Neritic Tunas**	2–5 July (4d)	Bali, Indonesia or Tanzania	13–16 July (4d)	Bali, Indonesia or Tanzania
Working Party on **Temperate Tunas**	Nil	Nil	5–8 Aug (4d)	TBD

Working Party on **Ecosystems and Bycatch**	12–16 Sept (5d)	La Réunion	9–13 Sept (5d)	TBD
Working Party on **Billfish**	18–22 Sept (5d)	La Réunion	17–21 Sept (5d)	TBD
Working Party on **Tropical Tunas**	22–27 Oct (6d)	Bilbao or San Sebastián, Spain	21–26 Oct (6d)	TBD
Working Party on **Methods**	Nil	Nil	30 Nov (1d)	Victoria, Seychelles
Working Party on **Data Collection and Statistics**	29–30 Nov (2d)	Victoria, Seychelles	Nil	Nil
Scientific Committee	2–6 Dec (5d)	Victoria, Seychelles	1–5 Dec (5d)	Victoria, Seychelles
Working Party on **Fishing Capacity**	Nil	Nil	Nil	Nil

16. OTHER BUSINESS

16.1 Revised 'Guidelines for the Presentation of Stock assessment Models'

244. The SC **NOTED** paper IOTC–2012–SC15–37 which provided a revision to the previous *Guidelines for the Presentation of Stock Assessment Models* adopted by the SC in 2012, which attempt to ensure greater transparency and facilitate peer-review of models employed in the provision of advice on the status of species managed by the IOTC. Since 2010, the SC and the Commission have agreed to several additional elements to be provided in CPUE and stock assessment papers such as the Kobe management strategy matrix, Kobe plots and interim reference points.

245. The SC **ADOPTED** revised "*Guidelines for the Presentation of Stock Assessment Models*" provided at Appendix XXXVII, and requested that the guidelines be communicated to working party participants well in advance of each meeting to ensure that national scientists/authors of all future CPUE and stock assessment papers presented at IOTC working party meeting comply with the guidelines.

246. The SC **NOTED** the request by the EU that as resources permit, software should be obtained which would allow interested scientists to access and manipulate all stock assessment inputs and detailed outputs from the various assessments carried out by the IOTC working parties each year.

247. **NOTING** the conclusions and recommendation from the KOBE 3 meeting held in 2011,

> "*Kobe III participants **agreed** that the K2SM is a useful tool for evaluating management strategies or options, **provided that the uncertainties in assessments can be adequately quantified**. Participants acknowledged that **considerable work remains to be done** both to reduce uncertainty in stock assessments, and to develop common standards or guidelines for how uncertainty is reflected. Kobe III participants recommended that the scientific committees and bodies of the tRFMOs jointly develop methods to **better quantify the uncertainty** and understand how this uncertainty is reflected in the risk assessment inherent in the K2SM*."

the SC **RECOMMENDED** that in 2013, collaborative efforts be developed among tRFMO on this matter, by targeting the development of how to build K2SM with well estimated levels of uncertainty.

248. The SC **EXPRESSED** its reservations regarding the validity of some of the K2SM that are produced for the consideration of the IOTC working parties when the uncertainties are very large in the stock assessment results (for instance due to the increasing lack of data for major fisheries and due to the unknown cascading errors in the projections), it may be unrealistic to propose reliable K2SM for several of the Indian Ocean stocks.

16.2 GEF-financed global project on tuna fisheries: update and relevance to IOTC

249. The SC **NOTED** paper IOTC–2012–SC15–INF06 which provided an overview of the project: "Sustainable Management of Tuna Fisheries and Biodiversity Conservation in the Areas Beyond National Jurisdiction (ABNJ)" a project funded by the Global Environmental Facility (GEF) and led by the Food and Agriculture Organization (FAO), and scheduled to be operational from 2013 for a period of five years.

250. The SC **NOTED** that the project resources that will be made available under Components 1 (Promotion of sustainable management of tuna fisheries, including development of HCRs and implementation of the precautionary approach); and Component 2 (Reducing Ecosystem Impacts of Tuna Fishing) will accelerate the implementation of relevant recommendations of the SC.

17. Review of the Draft, and Adoption of the Report of the Fifteenth Session of the Scientific Committee

251. The SC **RECOMMENDED** that the Commission consider the consolidated set of recommendations arising from SC15, provided at Appendix XXXVIII.

252. The report of the Fifteenth Session of the Scientific Committee (IOTC–2012–SC15–R) was **ADOPTED** on 15 December 2012.

APPENDIX I
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APPENDIX II
AGENDA FOR THE FIFTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

Date: 10–15 December, 2012

Location: STC Conference Center, Victoria

Mahé, Seychelles

Time: 09:00 – 17:00 daily

Chair: Dr. Tsutomu Nishida; **Vice-Chair:** Mr. Jan Robinson

1. **OPENING OF THE SESSION** (Chair)
2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Chair)
3. **ADMISSION OF OBSERVERS** (Chair)
4. **DECISIONS OF THE COMMISSION RELATED TO THE WORK OF THE SCIENTIFIC COMMITTEE** (Secretariat)
5. **SCIENCE RELATED ACTIVITES OF THE IOTC SECRETARIAT IN 2012** (Secretariat)
6. **NATIONAL REPORTS FROM CPCs** (CPCs)
7. **REPORTS OF THE 2012 IOTC WORKING PARTY MEETINGS**
   - 7.1 IOTC–2012–WPTmT04–R: Report of the Fourth Session of the Working Party on Temperate Tunas
   - 7.2 IOTC–2012–WPB10–R: Report of the Tenth Session of the Working Party on Billfish
   - 7.3 IOTC–2012–WPEB08–R: Report of the Eighth Session of the Working Party on Ecosystems and Bycatch
   - 7.4 IOTC–2012–WPM04–R: Report of the Fourth Session of the Working Party on Methods
   - 7.5 IOTC–2012–WPTT14–R: Report of the Fourteenth Session of the Working Party on Tropical Tunas
   - 7.6 IOTC–2012–WPNT02–R: Report of the Second Session of the Working Party on Neritic Tunas
   - 7.7 Summary discussion of matters common to Working Parties (capacity building activities – stock assessment course; connecting science and management, etc.)
8. **EXAMINATION OF THE EFFECTS OF PIRACY ON FLEET OPERATIONS AND SUBSEQUENT CATCH AND EFFORT TRENDS** (Chair)
9. **STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN** (Chair)
   - 9.1 Tuna – Highly migratory species
   - 9.2 Tuna and mackerel – Neritic species
   - 9.3 Billfish
10. **STATUS OF MARINE TURTLES, SEABIRDS AND SHARKS IN THE INDIAN OCEAN** (Chair)
    - 10.1 Marine turtles
    - 10.2 Seabirds
    - 10.3 Sharks
11. **IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME** (Secretariat)
12. **OUTLOOK ON TIME-AREA CLOSURES** (Chair)
13. **IMPACT OF CATCHING BIGEYE TUNA AND YELLOWFIN TUNA JUVENILES AND SPAWNERS** (Chair)
14. **PROGRESS ON THE IMPLEMENTATION OF THE RECOMMENDATIONS OF THE PERFORMANCE REVIEW PANEL** (Secretariat)
15. **SCHEDULE AND PRIORITIES OF WORKING PARTY AND SCIENTIFIC COMMITTEE MEETINGS FOR 2013 AND TENTATIVELY FOR 2014** (Secretariat)
16. **OTHER BUSINESS** (Chair)
    - 16.1 Revised 'Guidelines for the Presentation of Stock Assessment Models'
    - 16.2 GEF-financed global project on tuna fisheries: update & relevance to IOTC
17. **REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE FIFTEENTH SESSION OF THE SCIENTIFIC COMMITTEE** (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2012–SC15–01a	Draft agenda of the Fifteenth Session of the Scientific Committee	✓ (5 September 2012)
IOTC–2012–SC15–01b	Draft annotated agenda of the Fifteenth Session of the Scientific Committee	✓ (25 November 2012)
IOTC–2012–SC15–02	Draft list of documents	✓ (11 September 2012)
IOTC–2012–SC15–03	Outcomes of the Sixteenth Session of the Commission (Secretariat)	✓ (14 November 2012)
IOTC–2012–SC15–04	Previous decisions of the Commission (Secretariat)	✓ (14 November 2012)
IOTC–2012–SC15–05	Report of the Secretariat – Activities in support of the IOTC science process in 2012 (Secretariat)	✓ (25 November 2012)
IOTC–2012–SC15–06	Status of development and implementation of National Plans of Action for seabirds and sharks (Secretariat)	✓ (14 November 2012)
IOTC–2012–SC15–07	Examination of the effects of piracy on fleet operations and subsequent catch and effort trends (Chair and Secretariat)	✓ (25 November 2012)
IOTC–2012–SC15–08	Status of the Indian Ocean Albacore Resource (ALB: *Thunnus alalunga*)	✓ (12 November 2012)
IOTC–2012–SC15–09	Status of the Indian Ocean bigeye tuna (BET: *Thunnus obesus*) resource	✓ (14 November 2012)
IOTC–2012–SC15–10	Status of the Indian Ocean skipjack tuna (SKJ: *Katsuwonus pelamis*) resource	✓ (14 November 2012)
IOTC–2012–SC15–11	Status of the Indian Ocean yellowfin tuna (YFT: *Thunnus albacares*) resource	✓ (14 November 2012)
IOTC–2012–SC15–12	Report on biology, stock status and management of southern bluefin tuna: 2012 (from CCSBT)	✓ (9 November 2012)
IOTC–2012–SC15–13	Status of the Indian Ocean bullet tuna (BLT: *Auxis rochei*) resource	✓ (24 November 2012)
IOTC–2012–SC15–14	Status of the Indian Ocean frigate tuna (FRI: *Auxis thazard*) resource	✓ (24 November 2012)
IOTC–2012–SC15–15	Status of the Indian Ocean kawakawa (KAW: *Euthynnus affinis*) resource	✓ (25 November 2012)
IOTC–2012–SC15–16	Status of the Indian Ocean longtail tuna (LOT: *Thunnus tonggol*) resource	✓ (25 November 2012)
IOTC–2012–SC15–17	Status of the Indian Ocean Indo-Pacific king mackerel (GUT: *Scomberomorus guttatus*) resource	✓ (24 November 2012)
IOTC–2012–SC15–18	Status of the Indian Ocean narrow-barred Spanish mackerel (COM: *Scomberomorus commerson*) resource	✓ (25 November 2012)
IOTC–2012–SC15–19	Status of the Indian Ocean Swordfish (SWO: *Xiphias gladius*) resource	✓ (13 November 2012)
IOTC–2012–SC15–20	Status of the Indian Ocean black marlin (BLM: *Makaira indica*) resource	✓ (12 November 2012)
IOTC–2012–SC15–21	Status of the Indian Ocean blue marlin (BUM: *Makaira nigricans*) resource	✓ (12 November 2012)
IOTC–2012–SC15–22	Status of the Indian Ocean striped marlin (MLS: *Tetrapturus audax*) resource	✓ (13 November 2012)
IOTC–2012–SC15–23	Status of the Indian Ocean Indo-Pacific sailfish (SFA: *Istiophorus platypterus*) resource	✓ (12 November 2012)
IOTC–2012–SC15–24	Status of marine turtles in the Indian Ocean	✓ (12 November 2012)
IOTC–2012–SC15–25	Status of seabirds in the Indian Ocean	✓ (12 November 2012)
IOTC–2012–SC15–26	Status of the Indian Ocean blue shark (BSH: *Prionace glauca*)	✓ (9 November 2012)
IOTC–2012–SC15–27	Status of the Indian Ocean oceanic whitetip shark (OCS: *Carcharhinus longimanus*)	✓ (9 November 2012)

Document	Title	Availability
IOTC–2012–SC15–28	Status of the Indian Ocean scalloped hammerhead shark (SPL: *Sphyrna lewini*)	✓ (12 November 2012)
IOTC–2012–SC15–29	Status of the Indian Ocean shortfin mako shark (SMA: *Isurus oxyrinchus*)	✓ (12 November 2012)
IOTC–2012–SC15–30	Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*)	✓ (12 November 2012)
IOTC–2012–SC15–31	Status of the Indian Ocean bigeye thresher shark (BTH: *Alopias superciliosus*)	✓ (12 November 2012)
IOTC–2012–SC15–32	Status of the Indian Ocean pelagic thresher shark (PTH: *Alopias pelagicus*)	✓ (12 November 2012)
IOTC–2012–SC15–33 Rev_2	National Implementation of the regional observer scheme by CPCs (Secretariat)	✓ (14 November 2012) ✓ (29 November 2012) ✓ (6 December 2012)
IOTC–2012–SC15–34	Update on progress regarding Resolution 09/01 – on the performance review follow–up (Secretariat and Chair)	✓ (25 November 2012)
IOTC–2012–SC15–35 Rev_1	Proposed priorities for Working Party's and the Scientific Committee for 2013 and 2014 (Chair & Secretariat)	✓ (25 November 2012) ✓ (6 December 2012)
IOTC–2012–SC15–36	Proposed schedule of Working Party and Scientific Committee meetings for 2013 and 2014 (Secretariat)	✓ (13 November 2012)
IOTC–2012–SC15–37	Revision: 'Guidelines for the Presentation of Stock Assessment Models' (Chair & Secretariat)	✓ (25 November 2012)
IOTC–2012–SC15–38	Pilot project to improve data collection for tuna, sharks and billfish from artisanal fisheries in the Indian Ocean. Part II: Revision of catch statistics for India, Indonesia and Sri Lanka (1950-2011). Assignment of species and gears to the total catch and issues on data quality (G. Moreno, M. Herrera and L. Pierre)	✓ (25 November 2012)
Working Party Reports		
IOTC–2012–WPTmT04–R	Report of the Fourth Session of the Working Party on Temperate Tunas	✓ (7 September 2012)
IOTC–2012–WPB10–R	Report of the Tenth Session of the Working Party on Billfish	✓ (10 October 2012)
IOTC–2012–WPEB08–R	Report of the Eighth Session of the Working Party on Ecosystems and Bycatch	✓ (8 October 2012)
IOTC–2012–WPM04–R	Report of the Fourth Session of the Working Party on Methods	✓ (23 October 2012)
IOTC–2012–WPTT14–R	Report of the Fourteenth Session of the Working Party on Tropical Tunas	✓ (14 November 2012)
IOTC–2012–WPNT02–R	Report of the Second Session of the Working Party on Neritic Tunas	✓ (23 November 2012)
National Reports – Members		
IOTC–2012–SC15–NR01	Australia	✓ (21 November 2012)
IOTC–2012–SC15–NR02	Belize	✓ (30 July 2012)
IOTC–2012–SC15–NR03 Rev_1	China	✓ (19 November 2012) ✓ (12 December 2012)
IOTC–2012–SC15–NR04	Comoros	✓ (29 November 2012)
IOTC–2012–SC15–NR05	Eritrea	NOT RECEIVED
IOTC–2012–SC15–NR06	European Union	✓ (4 December 2012)
IOTC–2012–SC15–NR07	France	✓ (7 December 2012)
IOTC–2012–SC15–NR08	Guinea	NOT RECEIVED
IOTC–2012–SC15–NR09	India	✓ (12 November 2012)
IOTC–2012–SC15–NR10 Rev_1	Indonesia	✓ (2 December 2012) ✓ (9 December 2012)
IOTC–2012–SC15–NR11	Iran, Islamic Republic of	✓ (28 November 2012)
IOTC–2012–SC15–NR12	Japan	✓ (6 December 2012)
IOTC–2012–SC15–NR13	Kenya	✓ (25 November 2012)
IOTC–2012–SC15–NR14 Rev_1	Korea, Republic of	✓ (25 November 2012) ✓ (9 December 2012)
IOTC–2012–SC15–NR15	Madagascar	✓ (5 December 2012)

Document	Title	Availability
IOTC–2012–SC15–NR16	Malaysia	✓ (1 December 2012)
IOTC–2012–SC15–NR17	Maldives, Republic of	✓ (27 November 2012)
IOTC–2012–SC15–NR18 Rev_1	Mauritius	✓ (29 November 2012) ✓ (7 December 2012)
IOTC–2012–SC15–NR19	Mozambique	✓ (25 November 2012)
IOTC–2012–SC15–NR20	Oman, Sultanate of	✓ (5 December 2012)
IOTC–2012–SC15–NR21	Pakistan	NOT RECEIVED
IOTC–2012–SC15–NR22	Philippines	✓ (10 December 2012)
IOTC–2012–SC15–NR23	Seychelles, Republic of	✓ (4 December 2012)
IOTC–2012–SC15–NR24	Sierra Leone	NOT RECIEVED
IOTC–2012–SC15–NR25	Sri Lanka	✓ (23 November 2012)
IOTC–2012–SC15–NR26 Rev_1	Sudan	✓ (18 October 2012) ✓ (5 December 2012)
IOTC–2012–SC15–NR27	Tanzania	NOT RECEIVED
IOTC–2012–SC15–NR28 Rev_2	Thailand	✓ (22 November 2012) ✓ (6 December 2012) ✓ (12 December 2012)
IOTC–2012–SC15–NR29	United Kingdom	✓ (23 November 2012)
IOTC–2012–SC15–NR30	Vanuatu	NOT RECEIVED
IOTC–2012–SC15–NR31	Yemen	NOT RECEIVED
National Reports – Cooperating non-Contracting Parties		
IOTC–2012–SC15–NR32	Senegal	✓ (7 December 2012)
IOTC–2012–SC15–NR33	South Africa, Republic of	✓ (28 November 2012)
Information Papers		
IOTC–2012–SC15–INF01	IOTC-OFCF Project activities in 2012: Progress Report (S. Fujiwara and M. Herrera)	✓ (8 November 2012)
IOTC–2012–SC15–INF02	Analysis of the genetic structure and life history of albacore tuna in terms of diversity, abundance and migratory range at the spatial and time scales: Project GERMON (GEnetic stRucture and Migration Of albacore tuNa) (N. Nikolic and J. Bourjea)	✓ (24 November 2012)
IOTC–2012–SC15–INF03	Glossary of scientific terms, acronyms and abbreviations, and report terminology	✓ (25 November 2012)
IOTC–2012–SC15–INF04	IOTC Species data catalogues (IOTC Secretariat)	✓ (30 November 2012)
IOTC–2012–SC15–INF05	Ghost fishing of silky sharks by drifting FADs: highlighting the extent of the problem (J. Filmalter, L. Dagorn and M. Capelo)	✓ (4 December 2012)
IOTC–2012–SC15–INF06	GEF-financed global project on the "Sustainable Management of Tuna Fisheries & Biodiversity Conservation in the Areas Beyond National Jurisdiction (ABNJ): update & relevance to IOTC	✓ (4 December 2012)
IOTC–2012–SC15–INF07	Action Plan for reducing incidental catches of seabirds in fishing gears (European Union)	✓ (5 December 2012)
IOTC–2012–SC15–INF08	Draft: Building science capacity and understanding among IOTC members	✓ (5 December 2012)
IOTC–2012–SC15–INF09 Rev_1	Ecological Risk Assessment (ERA) and Productivity Susceptibility Analysis (PSA) of sea turtles overlapping with fisheries in the IOTC region (N. Ronel, R. Wanless, A. Angel, B. Mellet and L. Harris)	✓ (25 November 2012) ✓ (5 December 2012)
IOTC–2012–SC15–INF10 Rev_1	Preliminary Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC) (H. Murua, R. Cohelo, M.N. Santos, H. Arrizabalaga, K. Yokawa, E. Romanov, J.F. Zhu, Z.G. Kim, P. Bach, P. Chavance, A. Delgado de Molina and J. Ruiz)	✓ (5 December 2012) ✓ (10 December 2012)
IOTC–2012–SC15–INF11	Comments for IOTC Scientific Committee on CITES draft proposals to amend Appendixes I and II (WPEB)	✓ (12 December 2012)

APPENDIX IV
NATIONAL REPORT ABSTRACTS

Australia

Pelagic longline and purse seine are the two main fishing methods used by Australian vessels to target tuna and billfish in the Indian Ocean Tuna Commission (IOTC) Area of Competence. In 2011, two Australian longliners from the Western Tuna and Billfish Fishery operated in the IOTC Area of Competence. They caught 5.8 t of albacore tuna (*Thunnus alalunga*), 50.0 t of bigeye tuna (*Thunnus obesus*), 14.1 t of yellowfin tuna (*Thunnus albacares*), 189.9 t of swordfish (*Xiphius gladius*) and 0.7 t of striped marlin (*Tetrapturus audax*). These catches represent less than 10 per cent of the peak catches taken by Australian vessels fishing in the IOTC Area of Competence in 2001, for these five species combined. In addition, Australian vessels using minor line methods took a small amount of catch. The number of active longliners and levels of fishing effort have declined substantially in recent years due to reduced profitability, primarily as a result of lower fish prices and higher operating costs. The catch of southern bluefin tuna (*Thunnus maccoyii*) in the purse seine fishery was 4120 t in 2011. There was no purse seine fishing for skipjack tuna (*Katsuwonus pelamis*) in 2011. The peak skipjack catch taken by Australian vessels fishing in the IOTC Area of Competence was 1039 t in 2001. In 2011, approximately 1 t of shark was landed by the Australian longline fleet operating in the IOTC Area of Competence and approximately 13 000 sharks were discarded/released. In the Western Tuna and Billfish Fishery, 1.7 per cent of hooks set in longline operations were observed over two trips in 2011.

Belize

Long line is the main fishing technique used by Belize flagged vessels to target tuna and tuna like species in the Indian Ocean Tuna Commission (IOTC) Convention area. Belize has no national fleet operating outside its jurisdiction. All our fishing vessels are foreign owned vessels licensed to operate on the high seas or in the EEZ of other States under licensing agreements. In 2011 our fleet consisted of 7 long line tuna fishing vessels which operated mainly between 10°- 40°S and 55° - 75°E. Together, our vessels caught 164 m/t of Albacore tuna, 13.9 m/t of yellowfin tuna, 9.634 m/t of bigeye tuna, 2.536 m/t of swordfish, 5.175 m/t of black marlin, 1.04 m/t of blue marlin, 3.388 of striped marlin, 8.85 m/t of wahoo and 1.833 m/t of blue shark. There have been 83% reductions in our overall catches from 1257 m/t in 2007 to 210 m/t in 2011. Albacore has always been the main target species for our vessels from 2007 to 2011 followed by bigeye tuna, yellowfin and swordfish. The number of active long liners and levels of fishing effort have declined significantly in recent years due to reduced profitability, principally resulting from reduced fish prices and increased operating cost. The average size of our vessels from 2007 to 2011 has fluctuated over the years from a low of 88gt to a high of 628 gt. There has also been a reduction in the number of vessels operating in the area from 10 vessels in 2007, 9 in 2008, 6 in 2009 and 7 in 2010 and 2011.

China

Longline is the only fishing method used by Chinese vessels to catch tuna and tuna-like species in the IOTC waters. The number of longliners operating in the Indian Ocean reduced from 20 in 2010 to 15 in 2011 due to piracy, with the main fishing area shifting to the central and southern Indian Ocean (60 ºE ~ 90ºE , 10ºS ~35ºS). Chinese fishing fleet caught 1845 MT of main tunas (BET, YFT, ALB) in 2011 (72 % lower than the catch of 6643 MT in 2010). The bigeye tuna and yellowfin tuna catches both from deep freezing longliners and ice fresh longliners have been declined dramatically since 2006. The albacore catch from both deep freezing longliners and ice fresh longliners decreased greatly in 2011, compared with in 2010. The logbook and observer programs are going on for the Chinese longline fleets in the Indian Ocean, from which catch and effort data collection of bycatch species are being improved. No scientific observer was sent out for work due to the piracy issue in 2011.

Comoros

Fishing in Comoros is exclusively artisanal, and operated on 3-9 m motorized or non-motorized wooden or fibreglass non-decked vessels. Comorian fishing exploits mainly pelagic species (*Thunnus albacares, Katsuwonus pelamis, Thunnus alalunga, Istiophorus platypterus, Thunnus obesus, Euthynnus affinis*) and contributes entirely to the population's diet, while providing 55% of total jobs in the agricultural sector, i.e. about 8,000 fishermen. Troll line, drop line and few nets targeting small pelagic species are the main fishing techniques used. A trip lasts between one and seven days. Since February 2011, Comoros have implemented a data collection system at unloading sites, thanks to technical and financial support from the IOTC and the OFCF. Data from this collection are being processed by the IOTC. There is no industrial fishing at national level. This fishing activity is operated by a foreign fleet under a Fishing Agreement. None of the catch of this fleet is unloaded or transhipped within the country.

Eritrea

National Report not provided.

European Union

In accordance with IOTC Resolution 10/02, scientific data for fleets flying the flag of Member States of the European Union have been submitted to the IOTC. The EU fleet, composed of fleets of some Member States of the European Union (Spain, France, Portugal and the United Kingdom) has previously submitted its scientific data. All data required for the work of the Scientific Committee, in accordance with the legislation in force, was transmitted to the IOTC. For reasons related to internal adjustments of several research institutions and/or organizations responsible for the management of scientific data, some information has been submitted with some delay; we are pleased to indicate that some data will be validated and available in the near future. In addition, for security reasons related to the development of piracy in the Western Indian Ocean, observer programmes were strongly affected, as piracy has, on the one hand, reduced the frequency of data collection and, on the other hand, led to a decline in data quality. However, European scientists who participated in the various IOTC Working Parties have also transmitted, during the meetings, some of the data necessary to carry out the work of these Working Parties. In addition, the EU experts attending the Scientific Committee may also provide information that complement already transmitted data. The European Union continues its efforts to harmonize the management, collection and reporting of scientific data.

France (OT)

The French Overseas Territories in the Indian Ocean include Mayotte –a Department since 31 March 2011– and the Scattered, islands that are attached to the administration of the French Southern and Antarctic Lands (TAAF). In January 2010, Mayotte has established a nature marine park (NMP) with a Management Board, which maritime boundaries are those of the Mayotte EEZ. A second marine park was established on 22 February 2012 (Decree No. 2012-245 of 22 February 2012): the NMP of the Glorieuses, which is under the responsibility of the Scattered islands, and extends over the entire Glorieuses EEZ. The total catches in the Indian Ocean of the French purse seiners registered in Mayotte amounted in 2011 to 26,610 metric tonnes, a significant increase of 45% compared to 2010 (18,357 Mt) due to an increase in fishing effort. The observer programme introduced in 2005 and discontinued in 2009 for security reasons, following the increase of Somali piracy, resumed in 2011, especially on the larger purse seine fleet, through a collaboration established with the TAAF. The coastal fishing fleet of Mayotte is composed of a large number of canoes and small boats –practicing mainly handline fishing, trolling and net fishing– and of four small longliners (pelagic drifting longline) targeting mainly tuna and swordfish. Catches by this fleet in the waters of Mayotte are estimated at 110 (2010) and 52 (2011) metric tonnes respectively. The French Tuna Research framework (mostly IRD & Ifremer) includes activities such as an observatory, the study of migration patterns of large pelagic species, genetic studies to define stock boundaries, studies on the reproductive biology, the development of bycatch mitigation measures and the study of the dynamics of the tropical ecosystem. Most projects are financed through national, European or international tenders. The report lists the various projects that continued or started in 2010-2012. Overall, France has actively participated in all the Working Parties organized by IOTC, including by presenting 26 scientific contributions in 2012.

Guinea

National Report not provided.

India

India's tuna fishing fleet includes coastal multipurpose boats operating a number of traditional gears, small pole and line boats, small longliners and industrial longliners. The total production of tunas and tuna-like fishes, including neritic and oceanic tunas, billfishes and seerfishes during the year 2011 was 159,924 tonnes, against a total production of 127,616 tonnes during the year 2010. There was a reduction in production by the oceanic fishery and increase in the tuna landings by coastal sector during the year under report. Survey conducted by the Fishery Survey of India in the EEZ revealed that sharks constitute 19.49% by number and 28.39% by weight to the total catch in the longline fishery. There are no reported instances of sea bird interaction in any of the Indian tuna fishery. Sea turtles, marine mammals and whale sharks are protected in India under various national legislations. Data on tuna production is collected by different agencies in India including Fishery Survey of India (FSI), Central Marine Fisheries Research Institute (CMFRI) and Marine Products Export Development Authority (MPEDA). Policy decisions on fishery management are being formulated by the Department of Animal Husbandry, Dairying and Fisheries (DAHD&F), Ministry of Agriculture, Government of India.

Indonesia
Fisheries management Areas (FMA) 572 (Indian Ocean – west Sumatera) and 573 (South of Java – East Nusa Tenggara), are two fisheries management area among eleven FMAs that located within the IOTC area of competence. Long liners is the main fishing gear type operated in those FMAs, increase from 1118 vessels in 2010 to 1256 vessels in 2011. The national catch of four main tuna species in 2011 was estimated 161,454 t while the total catch for all species by all gears type was estimated 429,751 t.. Through Research institute for Tuna fisheries at Benoa both port sampling and scientific observer programs continuing is conducted. Indonesia since 10 October 2010 already has a National Plan of Action of the Shark (NPOA-Shark) and recently through ministerial decree of MMAF no 12 year 2012 under chapter X formally regulate a management and conservation of bycatch and ecological related species on tuna fisheries. Template of Indonesia fishing logbook was developed and regulated, however it is required more effort to introduce and implement for both to fishers as well as port officers as required by the commission.

Iran, Islamic Republic of
Fishery for tuna and tuna-like species is a major component in large pelagic fisheries in Iran and one of the most important activities in the Persian Gulf & Oman Sea. There are 4 coastal provinces in that areas about 12 thousand vessels consist of fishing boat, dhows and vessel which are engaged in fishing in the coastal and offshore waters. Gillnet and purse seine are two main fishing methods used by Iranian vessels to target large pelagic species (especially tuna and tuna-like) in the IOTC area competency and also some of small boats used trolling in coastal fisheries. Iran has taken various actions to implement the Scientific Committee recommendations and IOTC Resolutions. One of them national actions to improve data collection system for Tuna fishery during 2012 .we have implemented for Iranian industrial purse seiners and artisanal gillnets modification of logbook template to meet mandatory minimum statistic requirement, particularly with regards to data recording of vessel position in IOTC area for target species, Bycatch, and discard.

Japan
This Japanese national report describes following 8 issues in recent five years (2007-2011), i.e., (1) tuna fisheries (longline fishery and purse seine fishery) (2) fleet information, (3) catch and effort by species and gear, (4) ecosystem and bycatch, (5) national data collection and processing systems including "logbook data collection and verification", "vessel monitoring system", "scientific observer programme", "port sampling programme" and "unloading/transhipment", (6) national research programs and (7) Implementation of Scientific Committee recommendations & resolutions of the IOTC relevant to the Scientific Committee and (8) literature cited and working documents.

Kenya
During the year 2011, the active fishing fleet for tuna and tuna-like species in Kenya consisted of 1,011 artisanal fishing crafts and 87 recreational fishing boats. The vessel sizes measure below 10 meters and usegillnets and arisanal longline hooks as the main gear. Recreational fishing boats use baited trolling lines for fishing. Tuna catches increased by 67% from 180 tons to 302 tons. Owing to the vessel capacity constraints, almost all the catch landed is from the territorial waters. About 179 tons of fish were landed from recreational fisheries. The recreational fisheries catches consist of mostly billfishes (129 tons), Yellowfin tuna (21 tons) and the rest consists of a number of pelagic species.

Korea, Republic of
In 2011, 7 vessels of Korean tuna longline fishery were operated in 2011, and they caught 1,985 mt, which was 30.4% decreasing of the catch in 2010. Fishing effort was 5,362 thousand hooks and distributed higher in the western and eastern areas around 20-40°S than before. As results, the catch of bigeye tuna and yellowfin tuna significantly decreased, and albacore tuna and southern bluefin tuna became important in catch. With regard to the improvement of data reporting, the Act of Korean Distant water fisheries development was revised. The Act obliges the fishermen to monthly submit the logbook in electronic format, including the biological measurement, and information on ecologically related species and interaction with fisheries as well. Unfortunately, no observer could be placed on board Korean longline vessels in 2011. It was as a consequence of the 2 safe accidents of Korean observers in previous years. So Korean national observer program has been under improvement since 2011. As a result, three observers were deployed on board for a period of 60-70 days for each observer in 2012.

Madagascar

National tuna fishing is practiced mainly by small longliners. An increase of the number of vessels on this fishery has been observed in these recent years. In 2011, they are among 07 who have license to fishing for tuna and like species. They operate in the East side of Madagascar since 2010. Tuna mainly neritic tunas are also observed in the catches of the fleets that have license to target demersal fishes, they are longliners, trollers and pole and liner operating in the Western side, and Eastern side of Madagascar, but the proportion is relatively low. Statements of the fishing Companies have observed an increase in catches from the year 2010 to the national fleets catches. However, these statements cannot see the details on the locations of fishing. A new version of logbook has been operational since 2012 to fill this lack. An increase in the catches have observed according by the statement of the fishing Companies compared to the last year (2010)

Malaysia

Tuna fisheries contribute only 5% of total marine finfish catch in Malaysia. Compared to neritic tuna, oceanic tuna fishery is quite new to Malaysian fishery and its contribution to the annual marine catch is insignificant compared to other marine fish fishery. Malaysian waters that fall under the IOTC area of competence is part of the narrow Malacca Straits, off the west coast of Peninsular Malaysia. In 2003, the number of Malaysian flag vessels registered under Malaysian flag for fishing in the Indian Ocean increased steadily from 15 vessels to 58 vessels in 2010. In 2011, the number of active vessels dropped to only 7 vessels with 9 berthing compared to 30 berthing in 2010. The catch of tropical tuna also decreased to 114 mt in 2011 from 1138 mt in 2010. In mid 2011, some of Malaysian tuna longline shifted their target species from tropical tuna to albacore. The fleet moved their fishing areas toward the southern part of Madagascar below 250S latitude. The catch of neritic tuna from the Malacca Straits (under IOTC areas of Competence) showed a steady increased in landings from 8,978 mt in 2001 to 21,763 mt in 2011. A large portion of catch of neritic tuna were contributed by purse seines and trawlers. A new revised NPOA-sharks is near completed and is expected to be released by early 2013. Steps have been taken to reduce incidental catch of sharks as commitment to conserve shark population. On sea turtle, apart from mitigation taken to reduce incidental catch by traditional fishermen, the turtle conservation centres in Malaysia also have a turtle hatching program as a way to enhance turtle population

Maldives

Maldives has a traditional tuna fishery dating back hundreds of years. The main fishing method is still livebait pole-and-line but handline fishing is become popular. The main target species are skipjack (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*). Small amounts of juvenile bigeye (*T. obesus*) tuna are caught mixed with yellowfin in the pole-andline catch. Limited amount of trolling and longline fishing is also conducted. The former targets coastal species of kawakawa (*Euthynnus affinis*) and frigate tuna (*Auxis thazard*) and the latter deep-swimming yellowfin and bigeye. Tuna catches increased to an all-time record of 167,000 t in 2006 but have been declining since then. The average tuna catch for the last five years was about 100,000 mt; skipjack representing 72% and yellowfin 22% and remaining 6% kawakawa, frigate and bigeye. The national data collection is based on an enumeration system which is currently being replaced by a modern logbook data collection system. A web-enabled database is also being developed to allow entry of logbook data remotely. The website is being used to enter tuna purchases by the exporters. In addition the database when fully functional will help maintain records of active fishing vessel and fishing licenses. The website is expected to be fully functional in mid-2013. A number of the scientific programmes are in place that helps to increase Maldives' compliance with the IOTC Resolutions. This includes strengthening data collection, compilation and its analyses, expanding coverage of collection of size data, implementation of the VMS and improving information of the ETP species among others. Maldives has limited amount of recreational fishing targeting large-bodied reef fish varieties in the so called 'night fishing'. More recently recreational fishing for pelagics is getting popular in the tourism sector. At present there is no formal method of the recording catches.

Mauritius

About 110 000 tonnes of raw tuna are processed annually for export as canned and tuna loins mainly to the EU market. Seafood processing contributes to about 1% to GDP and plays an important role in the socio-economic activity of the country. In 2011, Mauritius issued fishing licences to 98 longliners and 26 purse-seiners of various nationalities to fish in its waters. Moreover, under the fishing agreements between Mauritius and the Seychelles, 7 purse-seiners and 7 longliners were issued with fishing licences. However, under fishing agreement with the Federation of Japan Tuna Fisheries Co-operative Associations no application were received from the Japanese fishing vessels probably due to the piracy threats in the Western Indian Ocean. Tuna fishing longliners regularly call at the

Port Louis harbour with an approximate of over 600 calls yearly for unloading and transhipment of tuna. During the year under report, 40 013 tonnes of tuna were transhipped through the Port Louis harbour and albacore tuna constituted more than 40% of the total catch. An increase in the volume of yellowfin, bigeye and skipjack tuna transhipped was also noted due to transhipment effected by European purse-seiners. Four national fishing vessels, less than 24 meters in length, targeting swordfish landed 89 tonnes of chilled fish. The catch composed of 49.2% swordfish and 18.4 % yellowfin, 12.1% bigeye and 9.4 % albacore tuna. The fishing areas were spread between latitudes 12^0S and 23^0S and longitudes 52^0E and 63^0E. About 350 small-scale fishermen operating around the 27 anchored Fish Aggregating Devices set around the island landed 258 tonnes of tuna and the catch was mainly composed of albacore tuna. The sports/recreational fishery supplied the local market with an additional estimated amount of 350 tonnes and the species comprised marlins, sailfish, tuna, dolphinfish and wahoo. Mauritius has been putting all its effort to comply with the IOTC resolutions and is looking forward to further enhance its contribution for the conservation and management of tuna and tuna-like species and address the ecosystem and by-catch issues within the IOTC area of competence.

Mozambique

Purse seine and long line are the two main fishing techniques used in Mozambique in the tuna fishery. Those activities are undertaken by distant water fishing fleets, which operate in the EEZ as from 12 nautical miles off shore from January to December. Purse seine fishing occurs mainly between the parallels 10º 32’ and 20º south. The purse seine fleet is composed of vessels from France, Spain and Seychelles. Long line fishing occurs between 20º and 26º 52’ south, with particular intensity below parallel 25º south. For the purse seine fleet, the peak period of fishing activities occurs between March and June. The longline fleet operates from January to December in Mozambique waters and the peak period is from December to February. During the last 5 years, the longline fleet was composed of vessels from Belize, Panama, Cambodia, Honduras, Japan, China, Korea, Spain and Taiwan. The fishery employs only foreign labour. The catches are conserved on board and transferred to cargo reefer ships or unloaded at foreign ports, mainly Seychelles, Madagascar, Mauritius and South Africa. The tuna fleet never calls to a Mozambican port for landing catches in Mozambique but call for pre-fishing briefing and inspection (Japan fleet). Over the last 10 years, the total catch in Mozambique waters ranged from 948 to 17.470 tonnes per year (Pátria et al., 2011). For the period 2007/2011, a total of 207 fishing licenses for purse seine vessels and 331 fishing licenses for longline vessels were issued, giving an average of 174 tuna fishing licenses issued per year. The number of longline vessels operating in Mozambique EEZ has declined substantially since 2007.

Oman

The total production of the Omani fishery sector amounted to around 159 000 Tons in 2011, with a slight increase of approximately 4.5% compared to 2007. Tuna species, considered as highly valuable products for Omani consumers, have experienced tremendous fluctuations in their total annual production and decreased from 31,420 T in 2007 to 19,550 T in 2011. This fluctuation of coastal tuna activities finds probably its origin, among others, in the modification of environmental factors, predator-prey relationship, spawning problems (Dr. Al Qumi, 2011) and the actual reduction of the industrial pelagic fleet. This segment went from 64 vessels in 2007 to 11 vessels in 2011. This reduction in the industrial fishing capacity was initiated by the national Authorities for the purpose of restructuring the industrial fishing sector to improve its competitiveness and efficiency. Artisanal and coastal fleets have, however, increased massively in the number of vessels and fishermen. For the monitoring aspects of the Tuna fishery, the Omani Government has introduced the logbook data collection scheme, the Vessel Monitoring System (VMS) and Port Sampling Program (PSP), observer programme (underdevelopment) and a scheme to enhance the quality of data gathered in order to manage and sustain efficiently the Omani fisheries. At the same time, the Government started to run and monitor several other projects for other marine species such as sea birds and marine turtles but are still in their starting stages.

Pakistan

National Report not provided.

Philippines

Fisheries are an important component of the agricultural sector in the Philippines and are an important source of protein, livelihood and export earnings. In 2011, total marine catch by the Philippines commercial fleet was estimated at 1,032,820 million tons which accounted for about 20.76% of the total fisheries production. The increased demand for fish from the rapidly growing population and increasing exports has substantially increased fishing pressure on the marine fishery resources over the past two decades. The major key issues facing the fisheries sector are resource depletion and environmental degradation. Declining catch rates and the leveling off of marine landings also supports these conclusions. The Philippines is still one of the top fish producing countries in the world. Over 1.5 million people depend on the fishing industry for their livelihood. The Philippines is also considered to be a major tuna producer in the Western and Central Pacific Ocean (WCPO). It is also considered a distant water fishing nation as it has fishing vessel operating in other oceans other than the Pacific. The fishing industry's contribution to the country's Gross Domestic Products (GDP) in 2009 was 2% and 2.4% at current and constant prices, respectively. Also in 2010, the foreign trade performance of the fishery industry gave a net surplus of US $ 616 million. With a total export value of US $ 803 million and import value of US $ 187 million. Tuna remained as the top export commodity with a collective volume of 106,449 MT for fresh/chilled/frozen, smoked/dried, and canned tuna products valued at US $337.719 million. Canned tuna, though, constitutes bulk of tuna products being exported. In general, tuna export increased by 2% in terms of volume and 3% in terms of value. Major markets for this commodity include USA, UK and Germany.

Seychelles

The Seychelles national report summarizes activities of the Seychelles registered purse seiners, longliners and semi-industrial vessels for the past 5 years. The total catch for the Seychelles registered Purse Seiners in 2011 was estimated at 63,212 MT, obtained from a fishing effort of 2,347 fishing days. This represents a decrease of 17% over the catches reported for 2010. Skipjack remained the dominant species accounting for 52% of the total catch. For the longline fishery, the total catch for the Seychelles fleet in 2011 was estimated at 7,566 MT obtained from a fishing effort of 16 million hooks, representing an increase of 14% in catch and 7% drop in fishing effort when compared to 2010. The total catch for the local semi industrial vessel targeting tuna and swordfish stands at 238MT representing a decrease of 19% compared to the previous year. The fishing effort decrease by 43% from 506,334 hooks to 289,540 hooks. The Seychelles shark NPOA was developed in April 2007, consisting 11 work programmes and 59 actions. In November 2012, a new steering committee was set to review the shark NPOA. To date, Seychelles does not have an NPOA on seabirds in place. Seychelles has a small semi industrial longline fleet and there have been no reports of interactions with seabirds. The national scientific observer programme is in its final stages of implementation. So far 6 observers have been trained and the programme is expected to start early 2013. Seychelles has taken various actions to implement the Scientific Committee recommendations and IOTC Resolutions. Some of the actions include; modification of logbook format to meet mandatory minimum statistic requirement, particularly with regards to data recording of sharks in longline fishery, steps to implement a National Scientific Observer Programme, collaboration with other institutions on research projects focusing on bycatch mitigation.

Sierra Leone

National Report not provided.

Sri Lanka

Tuna fisheries in Sri Lanka are developing rapidly with the expansion of offshore and deep sea /high seas fishing. Over 4000 boats are being currently engaged in tuna fishing, of which around 700 boats are categorized as single day and being operated in the coastal areas where as about 3300 are operated offshore and high seas adjacent to the EEZ. The multiday boats with modern navigational and communication facilities are being venturing now for high seas fishing. In 2011, the total large pelagic fish production was 112, 507 Mt and skipjack tuna has dominated the catches by contributing 44.7%. Among the different fishing gears used for catching large pelagic fish, large-mesh gillnet (GN) or gillnet cum longline (GN/LL), were the widely used fishing gears in tuna fisheries. Gillnet cum longline combination contributes to more than 75 % of the total tuna fishing effort in the country. Longlines are promoted by the Government of Sri Lanka to ensure quality fish production to cater to the rapidly developing export market. Collection of species wise shark landings was reinitiated in 2011 in accordance with the recommendation made by the 14th Session of the IOTC Scientific Committee. Log book has been introduced and made mandatory for all the multiday vessels (> 32 feet in length) since January 2012 by the Department of Fisheries and Aquatic Resources of Sri Lanka. The existing Fisheries and Aquatic Resources Act No.2 of 1996 has been already amended and going through the process to obtain approval from the Cabinet of Ministers and presenting same in parliament enabling High seas fishing as well as to incorporate the provisions in compliance with the international obligations and conventions.

Sudan

Tuna fishery in Sudanese Red Sea coast sorted to be one type of traditional fishery and industrial fishery. the traditional one usually practicing by local fishermen in whole coast, they used hooks over coral reefs zone and net over depth 50m, while the industrial fishing done by Egyptian trawlers in the southern area, they used trawling and purse seine nets. Seasonally this fishery appears in particular areas of Sudanese red sea, even in winter season (February to April) in huge number in southern area of the sea. Tuna are migratory pelagic fishes and are not very common on the local market. Usually product as by catch in industrial fishery and artisanal fishery, not targeted, so the real production over the present catch in two types of fishery.

Tanzania, United Republic of
National Report not provided.

Thailand
Neritic tuna and king mackerel species in the Andaman Sea Coast, Thailand comprise 7 species (*Thunnus tonggol*, *Euthynnus affinis, Auxis thazard, A. rochie, Katsuwonus pelamis* and *Sarda orientalis, Scomberomorus* spp.). These species were caught from purse seine, king mackerel gill net and trawl, while purse seine was the main fishing gear. The trend of neritic tuna catches have been decreasing from 45,083 tons in 1997 to 13,093 tons in 1999. The production was quite stable around 10,711 and increase to 11,861 in 2009. These neritic tuna species are more or less have its production trend similarity. Thai tuna longliners that composed of 3 tuna longliners in 2007 and 2 tuna longliners during 2002-2011. Their main fishing ground was located in the southern part of the Indian Ocean. Data collection from their logbooks displayed important information of catch, fishing operation and effort during 2007-2011, 2276 days fishing operation were recorded. The highest total catch was in 2010 with 607.69 tones followed by 2007, 2011, 2009 and 2008, respectively (461.75, 370.39, 295.23 and 265.57 tones). The highest CPUE was found in 2010 with 13.62 fish 1000 hooks followed by 2007 and 2011, respectively (10.20 and 9.36 fish/1,000 hooks). Albacore tuna was caught with the highest proportion 32.80 % followed by yellowfin tuna, bigeye tuna, swordfish, other fishes and sharks. In 2011 bigeye tuna was caught with the highest proportion 61.4%.

United Kingdom (OT)
On 1 April 2010 the BIOT Commissioner proclaimed a Marine Protected Area (MPA) in the British Indian Ocean Territory [UK (BIOT)]. No fishing licences have been issued since that date and the last foreign fishing licences expired on 31 October 2010. Diego Garcia and its territorial waters are excluded from the MPA and include a recreational fishery. The United Kingdom National Report summarises fishing in its recreational fishery in 2010 and provides details of research activities undertaken. UK (BIOT) does not operate a flag registry and has no commercial tuna fleet or fishing port. The recreational fishery landed 21.29t of tuna and tuna like species on Diego Garcia in 2011. Length frequency data were recorded for a sample of 748 yellowfin tuna from this fishery. The mean length was 76cm. Sharks caught in the recreational fishery are released alive. IUU fishing remains one of the greatest threats to the BIOT ecosystem. Research was undertaken into the impact of the network of Indian Ocean MPAs. A Science Advisory Group has been formed to define a science strategy for BIOT and future research priorities, including those relevant to the pelagic ecosystem and IOTC fisheries. Recommendations of the Scientific Committee and those translated into Resolutions of the Commission have been implemented as appropriate by the BIOT Authorities and are reported.

Vanuatu
National Report not provided.

Yemen
National Report not provided.

Senegal
In Senegal, there are three types of fisheries exploiting tuna and tuna-like species. Industrial fisheries, composed of six pole-and-line vessels, targeting mainly tropical tunas, yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*) and skipjack (*Katsuwonus pelamis*) tuna and one longliner targeting swordfish, artisanal fisheries (handline and gillnet) targeting small tunas and the sport fishery targeting billfishes (marlin, swordfish and sailfish) and tunas. In 2011, the total catch of Senegalese pole-and-line was estimated at 6118 tons. Catches increased in comparison to 2010 (4606 tons). The effort in 2011 increased slightly from 1220 fishing days in 2010 to 1366 fishing days in 2011. For the longline fishery, the catches in 2011 were estimated at 533 tons (312 tons in 2010). Catches are essentially made of swordfish (264 tons) and sharks (216 tons). For artisanal fisheries, catches of all species are estimated to 9024 in 2011. The trend is still increasing (8719 tons in 2010). For sport fishery, catches were estimated at 81 tons in 2011 (288 tons in 2010) for an effort of 809 trips. Sampling of the catch unloaded in Dakar port is implemented by samplers from CRODT. This includes collecting statistical fisheries and sampling data for the different species of tropical tunas unloaded by pole-and-line and purse seine vessels. This work is completed by other information from different sources (customs, boat owners, Marine Fisheries Directorate, etc.). Regarding artisanal fisheries, the sampling of the catch,

effort and size frequency of the istiophorids is increased in the main landing sites for artisanal vessels thanks to the funds of the Intensive research Program on Istiophorids (EPBR).

South Africa, Republic of

South Africa has two commercial fishing sectors which either target or catch tuna and tuna-like species as by-catch in the Indian Ocean. These sectors are swordfish/tuna longline (the shark longline fishery has been incorporated into this sector), pole and line/ rod and reel. In addition, there is a boat-based recreational/sport fishery.

APPENDIX V
PROGRESS ON THE DEVELOPMENT AND IMPLEMENTATION OF NPOAS FOR SHARKS AND SEABIRDS

CPC	Sharks	Date of Implementation	Seabirds	Date of implementation	Comments
MEMBERS					
Australia		14-Apr-2004		2006	Sharks: 2nd NPOA-Sharks (Shark-plan 2) was released in July 2012, along with an operational strategy for implementation: http://www.daff.gov.au/fisheries/environment/sharks/sharkplan2 Seabirds: Has implemented a Threat Abatement Plan [TAP] for the Incidental Catch (or Bycatch) of Seabirds During Oceanic Longline Fishing Operations since 1998. The present TAP took effect from 2006 and largely fulfills the role of an NPOA in terms of longline fisheries. The 2006 TAP is currently under review. Also currently undertaking an assessment of seabird bycatch in trawl, gillnet and purse seine fisheries, and will develop an NPOA to bring together fisheries plans and actions to reduce the incidental catch of seabirds in longline, trawl and gillnet fisheries.
Belize					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
China		–		–	Sharks: Development has not begun. Seabirds: Development has not begun.
–Taiwan,China		May 2006		May 2006	Sharks: No revision currently planned. Seabirds: No revision currently planned.
Comoros		–		–	Sharks: Development has not begun. Seabirds: Development has not begun.
Eritrea					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
European Union		5 Feb 2009		16-Nov-2012	Sharks: Approved on 05-Feb-2009 and it is currently being implemented. Seabirds: The EU adopted on Friday 16 November an Action Plan to address the problem of incidental catches of seabirds in fishing gears.
France (territories)					Sharks: Approved on 05-Feb-2009 but not yet implemented. Seabirds: No information received by the Secretariat.
Guinea					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
India					Sharks: Currently being drafted with the assistance of BOBP-IGO Seabirds: India has determined that seabird interactions are not a problem for their fleets.
Indonesia		–		–	Sharks: NPOA guidelines developed and released for public comment among stakeholders in 2010 (funded by ACIAR Australia—DGCF). Training to occur in 2011, including data collection for sharks based on forms of statistical data to national standards (by DGCF (supported by ACIAR Australia). Implementation expected late 2011/early 2012. Seabirds: Development has not begun.
Iran, Islamic Republic of		–		–	Sharks: Have communicated to all fishing cooperatives the IOTC resolutions on sharks.

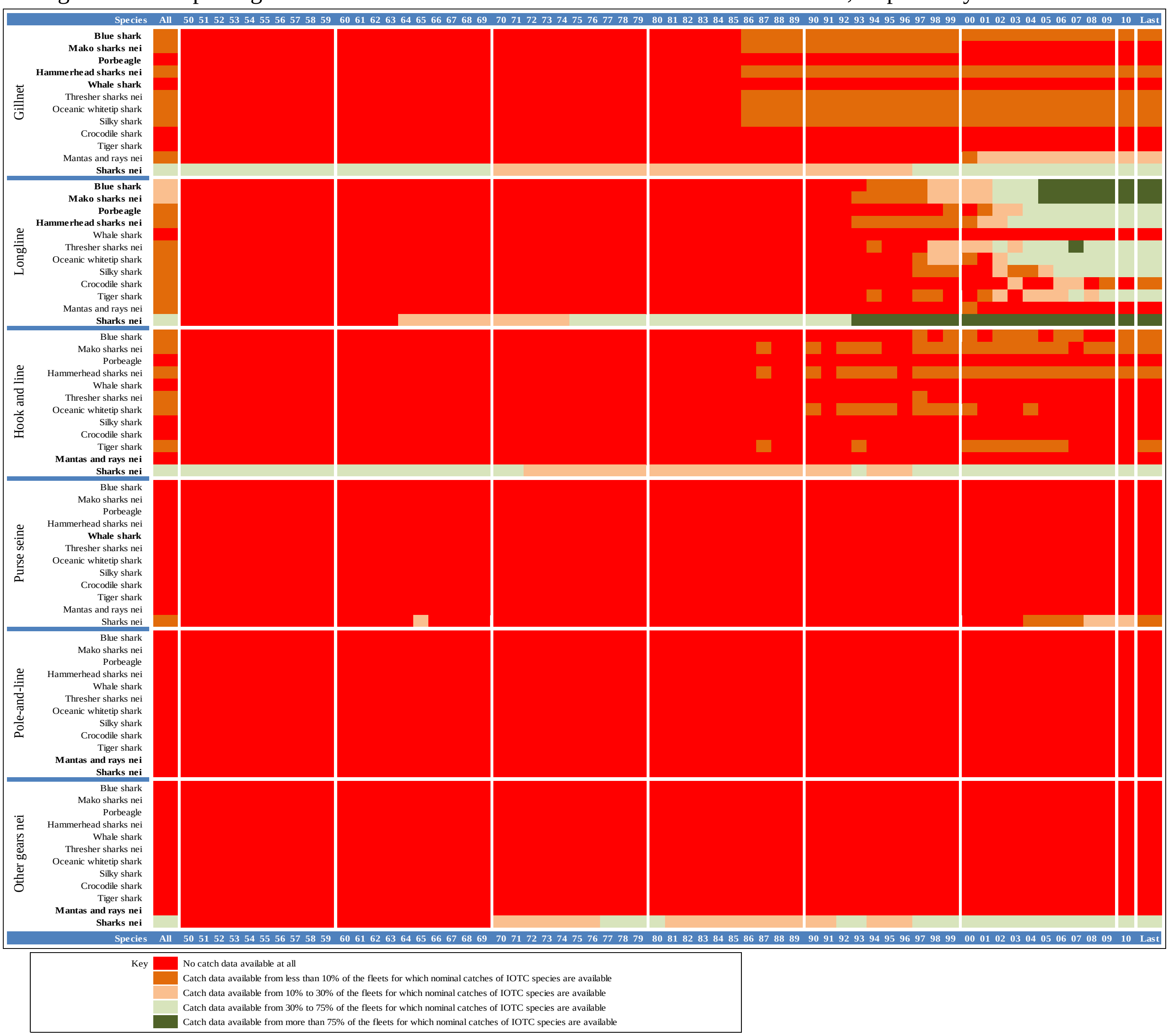
					Have in place a ban on the retention of live sharks. Seabirds: I.R. Iran determined that seabird interactions are not a problem for their fleet as they consist of gillnet vessels only.
Japan		03-Dec-2009		03-Dec-2009	Sharks: NPOA–Shark assessment implementation report submitted to COFI in July 2012 Seabirds: NPOA–Seabird implementation report submitted to COFI in July 2012.
Kenya					Sharks: Development has not begun. Scheduled for development in 2012. Sharks are considered a target species by Kenya. Seabirds: Development has not begun. Scheduled for development in 2012. Kenya has a single longliner targeting swordfish and no seabird interactions have been reported to date.
Korea, Republic of		–		–	Sharks: Approved on 18/08/2011 and is currently being implemented. Seabirds: Early stages of development.
Madagascar		–		–	Sharks: Development has not begun. Seabirds: Development has not begun. Note: A fisheries monitoring system is in place in order to ensure compliance by vessels with the IOTC's shark and seabird conservation and management measures.
Malaysia		2006			Sharks: Revision of second NPOA sharks in progress. Seabirds: No information received by the Secretariat.
Maldives, Republic of		–	n.a.	–	Sharks: An earlier draft of the NOPA is available: Gaps/issues that arose following the total shark ban have been identified through support from the Bay of Bengal Large Marine Ecosystem (BOBLME) Project. Presently Maldives is seeking further support from BOBLME Project to finalize the plan and associated regulation to be published in Government Gazette. Seabirds: Article 12 of IPOA states that if a 'problem exists' CPCs adopt an NPOA. IOTC Resolution 05/09 suggests CPCs to report on seabirds to the IOTC Scientific Committee if the issue is appropriate'. Maldives considers that seabirds are not an issue in Maldives fisheries, both in the pole-and-line fishery and in the longline fishery. The new longline fishing regulations has provision on mitigation measures on seabird bycatch. Maldives will be reporting on seabirds to the appropriate technical Working Party meetings of IOTC.
Mauritius					Sharks: Currently being drafted. Seabirds: Drafting will commence upon completion of NPOA–Sharks. In the meantime fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions.
Mozambique		–		–	Sharks: Development has not begun. Seabirds: Development has not begun.
Oman, Sultinate of					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Pakistan					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Philippines		Sept. 2009		–	Sharks: Under periodic review. Shark catches for 2010 provided to the Secretariat. Seabirds: Development has not begun. No seabird interactions recorded.
Seychelles, Republic of		Apr-2007		–	Sharks: NPOA-sharks to be reviewed in 2012. Seabirds: Development has not begun.
Sierra Leone					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.

Sri Lanka					Sharks: An NPOA-sharks is planned for development in 2012 and an update will be provided at the next SC meeting. Seabirds: Sri Lanka has determined that seabird interactions are not a problem for their fleets.
Sudan					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Tanzania, United Republic of		–		–	Sharks: Initial discussions have commenced. Seabirds: Initial discussions have commenced. Note: Terms and conditions related to protected sharks and seabirds contained within fishing licenses.
Thailand		23-Nov-2005		–	Sharks: Second NPOA-sharks currently being drafted. Seabirds: Development has not begun.
United Kingdom	n.a.	–	n.a.	–	Not applicable: British Indian Ocean Territory (Chagos Archipelago) waters are a Marine Protected Area closed to fishing except recreational fishing around Diego Garcia. For sharks, UK is the 24th signatory to the Convention on Migratory Species 'Memorandum of Understanding on the Conservation of Migratory Sharks' which extends the agreement to UK Overseas Territories including British Indian Ocean Territories; Section 7 (10) (e) of the *Fisheries (Conservation and Management) Ordinance* refers to recreational fishing and requires sharks to be released alive. No seabirds are caught in the recreational fishery.
Vanuatu					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Yemen					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
COOPERATING NON-CONTRACTING PARTIES					
Senegal		25-Sept-2006		–	Sharks: The Sub-Regional Fisheries Commission supported the development of a NPOA-sharks for Senegal in 2005. Other activities conducted include the organization of consultations with industry, the investigation of shark biology and social -economics of shark fisheries). The NPOA is currently being revised. Consideration is being made to the inclusion of minimum mesh size, minimum shark size, and a ban on shark finning. Seabirds: The need for a NPOA-seabirds has not yet been assessed.
South Africa, Republic of		–		2008	Sharks: The gazetting of the draft NPOA-sharks for public comment has been approved by the Minister of the Department of Agriculture, Forestry and Fisheries (6 July 2012). Seabirds: Published in August 2008 and fully implemented. The NPOA-seabirds has been earmarked for review.

APPENDIX VI
AVAILABILITY OF CATCH DATA FOR SHARKS BY GEAR

Availability of catch data for the main shark species expressed as the amount of fleets (%) for which catch data on sharks are available out of the total number of fleets for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2010

Shark species in bold are those identified by the Commission in 2012, for which data shall be recorded in logbooks and reported to the IOTC Secretariat; reporting of catch data for other species can be done in aggregated form (i.e. all species combined as ***sharks nei*** or ***mantas and rays nei***).
Hook and line refers to fisheries using handline and/or trolling and ***Other gears nei*** to other unidentified fisheries operated in coastal waters
Catch rates of sharks on pole-and-line fisheries are thought to be nil or negligible.
Average levels of reporting for 1950–2010 and 2006–10 are shown column ***All*** and ***Last***, respectively.



APPENDIX VII
TERMS OF REFERENCE FOR THE IOTC CPUE STANDARDISATION WORKSHOP

Workshop on standardisation, interpretation and use of CPUE series as indices of abundance for Indian Ocean tuna stocks

A workshop to deal with issues related to standardisation, interpretation and use of CPUE series as indices of population abundance has been requested by most IOTC working parties, given the importance of those data sources.

This workshop should be based around a team of scientists carrying out intersessional work covering a range of issues, as presented in the ToR below. Each item in the ToR should be covered by one or more documents, with work being carried out before the workshop meeting.

Scientists working with data from any fleet for which a CPUE series could be derived would be welcome to join. Ideally, scientists working on purse seine (PS), longline (LL) and Pole and line (PL) fleets, should be able to take part and carry out the necessary work.

- Coordinator: Dr Rishi Sharma, IOTC Secretariat
- Date: TBA
- Venue: TBA

Terms of Reference

The following ToR covers the most important issues that have been higlighted by different working parties. Work should be carried out, for those factors relevant to them, for the following:

- Fleets: EU PS, JAP LL, TWN LL, KOR LL, MAD PL
- Stocks: YFT, SKJ, ALB, BET

1. Development of common guidelines for CPUE standardisation

Despite very similar methods being applied to standardise CPUE series from various fleets, details of implementation and procedure tend to differ, making sometimes difficult to compare results and analyses.

- To develop a set of guidelines, to be applied on different series. The guidelines should draw on best practices employed elsewhere, and cover model building and selection, and the extraction and output of diagnostics.

2. Fishery changes affecting CPUE series

A number of technical and operational issues have been identified over the years as likely to have an important effect on the relationship between CPUE series and biomass. Improvements in technology, widely recognized in some fleets, are likely to affect many others. Changes in targeting, sometimes driven by external factors such as piracy, are also influential but difficult to quantify.

- To discuss and analyse alternative methods for accounting for targeting changes and their effect of selectivity.
- To explore a range of scenarios of technological change and improvements in efficiency affecting various fleets and their effect on estimated population trends, especially in recent years.

3. Spatial structure and statistical issues

Choices on spatial stratification can have a large influence in CPUE standardsation, especially in settings, such as the Indian Ocean, where changes in spatial coverage and intensity of fleet activity have been observed. The change in information contained in the CPUE series at different spatial scales, and possible differences in the signal observed in various areas, are important factors that could be investigated for series covering large areas.

Some statistical questions could also be addressed, such as the method used to deal with zero catches in strata with recorded effort, could also be discussed and evaluated.

- To explore the need and effect of applying different methods of accounting for zero catch values in strata with positive effort in those series where this is applicable.

4. Sources of data

Data forms the basis for all CPUE series, and different problems have been recognised in every data series employed by IOTC working parties.

- To analyse the effect of missing data on CPUE series and evaluate the possible use of data imputation methods to complete time series.
- To evaluate the advantages (e.g. increase in explanatory power) and disadvantages (e.g. increase in variance) of various environmental variables applied to CPUE series standardisation.
- To investigate the availability and uses of additional data (e.g. VMS data) that could increase the ability of the standardisation procedure to deal with different problems.

5. Combining series of abundance and dealing with conflicts in trends

Various stock assessment methods employed by IOTC working parties can only make use of a single index of abundance for estimating population trends. In such cases, indices from different fleets are unduly combined into an unified index. This procedure can be carried out using different methods, and the relative merits of each could be explored in the specific setting of IOTC series.

- To review and test different methods of combining CPUE series.

6. Impact on advice

The interest of CPUE series in a stock assessment exercise lies in their value as indicators of biomass dynamics, leading to the provision of scientific advice on stock status. The effect of various factors affecting CPUE series on final management advice can be investigated via stochastic simulation.

- To carry out initial simulations on the effect of the most important sources of error and bias in CPUE series on management advice as provided with different stock assessment models.

APPENDIX VIII
LIST OF CHAIRS, VICE-CHAIRS AND THEIR RESPECTIVE TERMS FOR ALL IOTC SCIENCE BODIES

Group	Chair/Vice-Chair	Representative	CPC/Affiliation	Term commencement date	Term expiration date (End date is until replacement is elected)	Comments
SC	Chair	Dr. Tsutomu Nishida	Japan	17–Dec–11	End of SC in 2013	1st term
	Vice-Chair	Mr. Jan Robinson	Seychelles	17–Dec–11	End of SC in 2013	1st term
WPB	Chair	Mr. Jerome Bourjea	EU,France	8–Jul–11	End of WPB in 2013	1st term
	Vice-Chair	Mr. Miguel Santos	EU,Portugal	8–Jul–11	End of WPB in 2013	1st term
WPTmT	Chair	Dr. Zang Geun Kim	Korea, Rep. of	22–Sep–11	End of WPTmT in 2013	1st term
	Vice-Chair	Mr. Takayuki Matsumoto	Japan	6–Sep–12	End of WPTmT in 2014	1st term
WPTT	Chair	Dr. Hilario Murua	EU,Spain	25–Oct–10	End of WPTT in 2012	2nd term
	Vice-Chair	Dr. Shiham Adam	Maldives, Rep. of	23–Oct–11	End of WPTT in 2013	1st term
WPEB	Chair	Dr. Charles Anderson	UK/Independent	14–Oct–10	End of WPEB in 2013	2nd term
	Vice-Chair	Dr. Evgeny Romanov	EU,France	27–Oct–11	End of WPEB in 2013	1st term
WPNT	Chair	Dr. Prathibha Rohit	India	27–Nov–11	End of WPNT in 2013	1st term
	Vice-Chair	Mr. Farhad Kaymaram	I.R. Iran	27–Nov–11	End of WPNT in 2013	1st term
WPDCS	Chair	Mr. Miguel Herrera	Secretariat	4–Dec–10	End of WPDCS 2012	2nd term
	Vice-Chair	Dr. Pierre Chavance	European Union	10–Dec–11	End of WPDCS 2013	1st term
WPM	Chair	Dr. Iago Mosqueira	European Union	18–Dec–11	End of WPM 2013	1st term
	Vice-Chair	Dr. Toshihide Kitakado	Japan	18–Dec–11	End of WPM 2013	1st term
WPFC	Chair	Not active	Not active	Not active	Not active	Not active
	Vice-Chair	Not active	Not active	Not active	Not active	Not active

APPENDIX IX
EXECUTIVE SUMMARY: ALBACORE

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

Status of the Indian Ocean albacore (ALB: *Thunnus alalunga*) resource

TABLE 1. Albacore: Status of albacore (*Thunnus alalunga*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Catch 2011: Average catch 2007–2011:	38,946 t 41,609 t	(orange)
	MSY (80% CI)): F_{2010}/F_{MSY} (80% CI): SB_{2010}/SB_{MSY} (80% CI): SB_{2010}/SB_{1950} (80% CI):	33,300 t (31,100–35,600 t) 1.33 (0.9–1.76) 1.05 (0.54–1.56) 0.29 (n.a.)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)	(yellow)	(green)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

There remains considerable uncertainty about the relationship between abundance and the standardised CPUE series, and about the total catches over the past decade.

Stock status. Trends in the Taiwan,China CPUE series suggest that the longline vulnerable biomass has declined to about 29% of the level observed in 1950. There were 20 years of moderate fishing before 1980, and the catch has more than doubled since 1980. Catches have increased substantially since 2007, attributed to the Indonesian fishery although there is substantial uncertainty remaining on the catch estimates. It is considered that recent catches have been well above the MSY level, recent fishing mortality exceeds F_{MSY} (F_{2010}/F_{MSY} = 1.33). Spawning biomass is considered to be at or very near to the SB_{MSY} level (SB_{2010}/SB_{MSY} = 1.05) (Table 1, Fig. 1). Fishing mortality needs to be reduced by at least 20% to ensure that spawning biomass is maintained at MSY levels (Table 2).

Outlook. Maintaining or increasing effort in the core albacore fishing grounds is likely to result in further declines in albacore biomass, productivity and CPUE. The impacts of piracy in the western Indian Ocean has resulted in the displacement of a substantial portion of longline fishing effort into the traditional albacore fishing areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on albacore will decline in the near future unless management action is taken. The following key points should be noted:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- The lack of consistency in the data inputs to the analysis and the impacts of using different areas for each fleet on the CPUE standardisations, makes interpretation of the results difficult.
- The use of fine-scale versus aggregated data in the CPUE standardisations by fleet introduces substantial uncertainty.
- Current catches (average 41,609 t over the last five years, 38,946 t in 2011) exceed the MSY level (33,300 t, range: 31,100–35,600 t). Maintaining or increasing effort will result in further declines in biomass, productivity and CPUE.
- A Kobe 2 Strategy matrix was calculated to quantify the risk of different future catch scenarios, using the projections from the ASPM model (Table 2). The projections indicated that a minimum reduction in fishing

mortality of 20% would be required to ensure that the stock does not move to an overfished state by 2020 (i.e. below SB_{MSY}) (Table 2).

- Provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be well above the provisional target reference point of F_{MSY}, but below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1; Table 3).
  - **Biomass**: Current spawning biomass is considered to be at or very near the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1; Table 3).

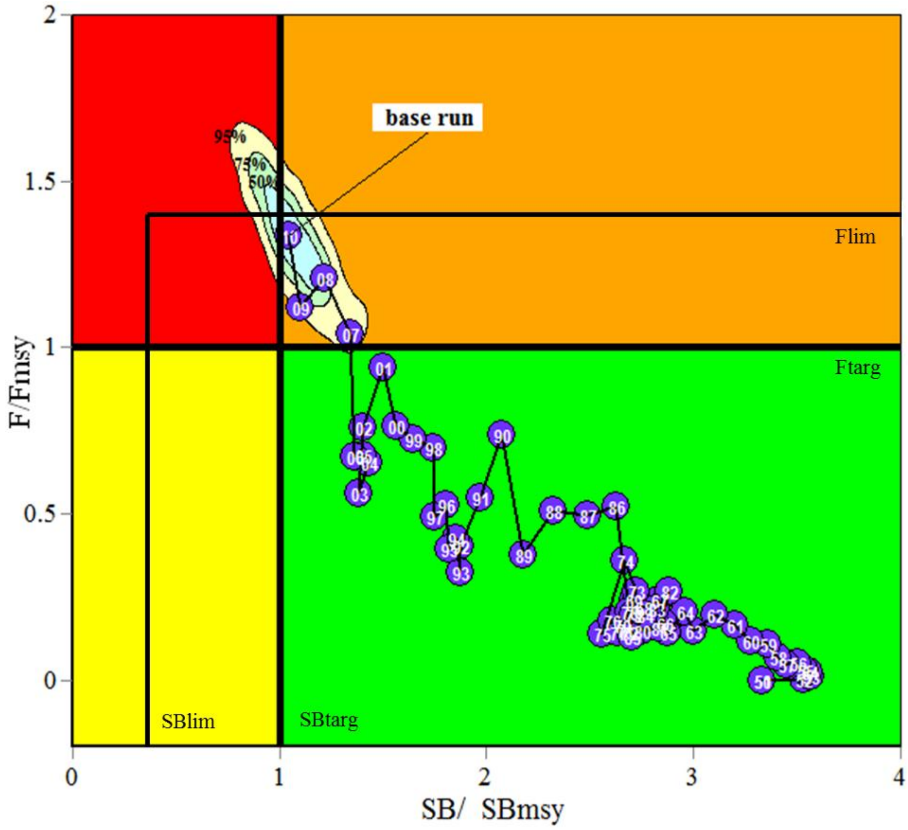


Fig. 1. Albacore: ASPM Aggregated Indian Ocean assessment Kobe plot (95% bootstrap confidence surfaces shown around 2010 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2010. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown.

TABLE 2. Albacore: ASPM Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (2010 catch level, ± 10% ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to 2010) and probability (%) of violating MSY reference points**								
	60% (25,749 t)	**70%** (30,041 t)	**80%** (33,332 t)	**90%** (38,624 t)	**100%** (42,915 t)	**110%** (47,207 t)	**120%** (51,498 t)	**130%** (55,790 t)	**140%** (60,081 t)
$SB_{2013} < SB_{MSY}$	<1	1	8	15	23	35	46	55	65
$F_{2013} > F_{MSY}$	<1	2	18	47	74	91	98	>99	>99
$SB_{2020} < SB_{MSY}$	<1	<1	12	40	69	90	>99	>99	>99
$F_{2020} > F_{MSY}$	<1	<1	20	67	94	>99	>99	>99	>99

TABLE 3. Albacore: ASPM Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based limit reference points for nine constant catch projections (2010 catch level, ± 10% ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to 2010) and probability (%) of violating MSY limit reference points**								
	60% (25,749 t)	**70%** (30,041 t)	**80%** (33,332 t)	**90%** (38,624 t)	**100%** (42,915 t)	**110%** (47,207 t)	**120%** (51,498 t)	**130%** (55,790 t)	**140%** (60,081 t)
$SB_{2013} < SB_{LIM}$	<1	<1	<1	<1	<1	<1	<1	<1	<1
$F_{2013} > F_{LIM}$	<1	<1	<1	7	26	53	75	89	97
$SB_{2020} < SB_{LIM}$	<1	<1	<1	<1	5	28	51	70	83
$F_{2020} > F_{LIM}$	<1	<1	<1	30	69	94	>99	>99	>99

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Temperate Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Albacore (*Thunnus alalunga*) in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

General

Overall, the biology of the albacore stock in the Indian Ocean is not well known and there is relatively little new information on albacore stocks. Albacore (*Thunnus alalunga*) life history characteristics, including a relatively late maturity, long life and sexual dimorphism, make the species vulnerable to over exploitation. Table 4 outlines some of the key life history traits of albacore specific to the Indian Ocean.

TABLE 4. Albacore: Biology of Indian Ocean albacore (*Thunnus alalunga*)

Parameter	**Description**
Range and stock structure	A temperate tuna living mainly in the mid oceanic gyres of the Pacific, Indian and Atlantic oceans. In the Pacific and Atlantic oceans there is a clear separation of southern and northern stocks associated with the oceanic gyres that are typical of these areas. In the Indian Ocean, there is probably only one southern stock, distributed from 5°N to 40°S, because there is no northern gyre. Albacore is a highly migratory species and individuals swim large distances during their lifetime. It can do this because it is capable of thermoregulation, has a high metabolic rate, and advanced cardiovascular and blood/gas exchange systems. Pre-adults (2–5 year old albacore) appear to be more migratory than adults. In the Pacific Ocean, the migration, distribution availability, and vulnerability of albacore are strongly influenced by oceanographic conditions, especially oceanic fronts. It has been observed on all albacore stocks that juveniles concentrate in cold temperate areas (for instance in a range of sea-surface temperatures between 15 and 18°C), and this has been confirmed in the Indian Ocean where albacore tuna are more abundant north of the subtropical convergence (an area where these juvenile were heavily fished by driftnet fisheries during the late 1980's). It appears that juvenile albacore show a continuous geographical distribution in the Atlantic and Indian oceans in the north edge of the subtropical convergence. Albacore may move across the jurisdictional boundary between

	ICCAT and IOTC. It is likely that the adult Indian Ocean albacore tunas do yearly circular counter-clockwise migrations following the surface currents of the south tropical gyre between their tropical spawning and southern feeding zones. In the Atlantic Ocean, large numbers of juvenile albacore are caught by the South African pole-and-line fishery (catching about 10,000 t yearly) and it has been hypothesized that these juveniles may be taken from a mixture of fish born in the Atlantic (north east of Brazil) and from the Indian Ocean. For the purposes of stock assessments, one pan-ocean stock has been assumed.
Longevity	10+ years
Maturity (50%)	**Age**: females 5–6 years; males 5–6 **Size**: females n.a.; males n.a.
Spawning season	Little is known about the reproductive biology of albacore in the Indian Ocean but it appears, based on biological studies and on fishery data, that the main spawning grounds are located east of Madagascar between 15° and 25°S during the 4th and 1st quarters of each year. Like other tunas, adult albacore spawn in warm waters (SST>25°C).
Size (length and weight)	Reported to 128 cm FL in the Indonesian longline fishery $W = aL^b$ with $a = 5.691\times10^{-5}$, $b = 2.7514$.

n.a. = not available. Sources: Lee & Kuo 1988, Lee & Liu 1992, Lee & Yeh 2007, Froese & Pauly 2009, Xu & Tian 2011, Setyadji et al. 2012

Albacore – Catch trends

Albacore are currently caught almost exclusively using drifting longlines (98%) (Figs. 2, 3, 4; Table 5), South of 10°S (Table 6), with remaining catches recorded using purse seines and other gears (Fig. 2). Catches of albacore were relatively stable until the mid-1980s, except for high catches recorded in 1973 and 1974 (Fig. 2). The catches increased markedly during the mid-1980's due to the use of drifting gillnets by Taiwan,China (Fig. 3), with total catches in excess of 30,000 t. The drifting gillnet fleet targeted juvenile albacore in the southern Indian Ocean (30°S to 40°S). In 1992 the United Nations worldwide ban on the use of drifting gillnets effectively closed this gillnet fishery.

Following the removal of the drifting gillnet fleet, catches dropped to less than 20,000 t by 1993 (Figs. 2, 3). However, catches more than doubled over the period from 1993 (less than 20,000 t) to 2001 (44,000 t). Since 2001 catches have been almost exclusively taken by drifting longlines (Figs. 2, 3, 4). Record catches of albacore were reported in 2008 at approximately 44,500 t. Catches for 2010 were estimated to be 42,915 t, while catches for 2011 amount to 38,946 t (Table 5).

Catches of albacore in recent years have come almost exclusively from vessels from Indonesia and Taiwan,China, although the catches of albacore reported for the fresh tuna longline fishery of Indonesia have increased considerably since 2003 to around 17,000 t (Fig. 3), which represents approximately 32% of the total catches of albacore in the Indian Ocean.

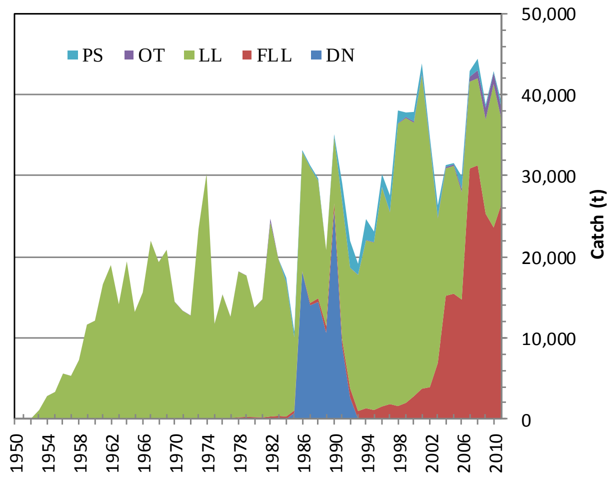


Fig. 2. Albacore: Annual catches of albacore by gear recorded in the IOTC Database (1950–2011) (Data as of October 2012). Freezing-longline (LL); Fresh-tuna longline (FLL); Purse seine (PS); Other gears NEI (OT).

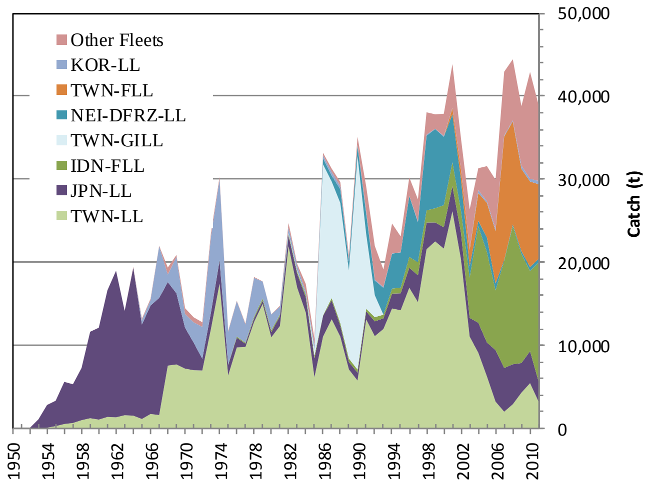


Fig. 3. Albacore: Annual catches of albacore by fleet recorded in the IOTC Database (1950–2011) (Data as of October 2012). Freezing Longlines of Taiwan,China (LL-TWN), Japan (LL-JPN), Rep. of Korea (LL-KOR), and other nei fleets (LL-NEI-DFRZ); Fresh-tuna longlines of Indonesia (FLL-IDN), and Taiwan,China (FLL-TWN); Driftnets of Taiwan,China (DN-TWN); all other fleets combined (Other Fleets).

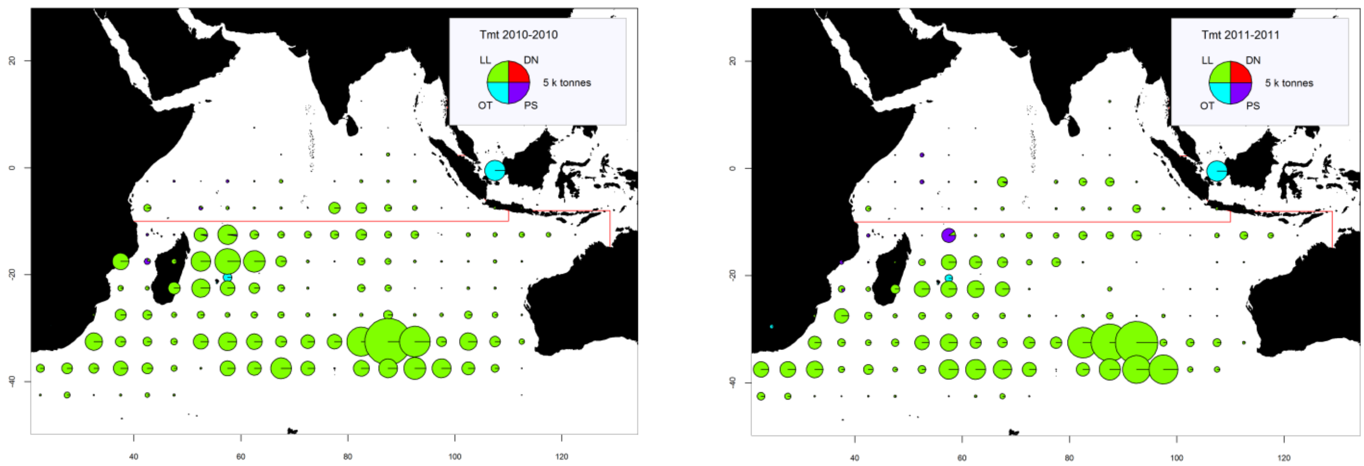


Fig. 4a–b. Albacore: Time-area catches (total combined in tonnes) of albacore estimated for 2010 (left) and 2011 (right) by type of gear: Longline (LL, green), Driftnet (DFRT, red), Purse seine (PS, purple), Other fleets (OT, blue). The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular the coastal fisheries of Indonesia (Data as of October 2012).

Longliners from Japan and Taiwan,China have been operating in the Indian Ocean since the early 1950s (Fig. 3). Although the Japanese albacore catch ranged from 8,000 t to 18,000 t in the period 1959 to 1969, in 1972, catches rapidly decreased to around 1,000 t, due to a change in the target species, mainly to southern bluefin tuna and bigeye tuna. Albacore became a bycatch species for the Japanese fleet with catches between 200 t and 2,500 t. In recent years the Japanese albacore catch has been around 2,000 to 6,000 t (Fig. 3).

In contrast to the Japanese longliners, catches by Taiwan,China longliners increased steadily from the 1950's to average around 10,000 t by the mid-1970s. Between 1998 and 2002 catches ranged between 21,500 t to 26,900 t, equating to just over 60% of the total Indian Ocean albacore catch. Between 2003 and 2010 the albacore catches by Taiwan,China longliners have been between 10,000 and 18,000 t, with catches appearing to be increasing in recent years. There has been a shift in the proportion of catches of albacore by deep-freezing and fresh-tuna longliners in recent years, with increasing catches of fresh-tuna (72% of the total catches for 2008–10) as opposed to deep-freezing longliners (Fig. 2; Table 5).

While most of the catches of albacore have traditionally come from the southwest Indian Ocean, in recent years a larger proportion of the catch has come from the southern and eastern Indian Ocean (Fig. 4; Table 6). The relative increase in catches in the eastern Indian Ocean since the early 2000's is mostly due to increased activity of fresh-tuna longliners from Taiwan,China and Indonesia. In the western Indian Ocean, the catches of albacore mostly result from the activities of deep-freezing longliners and purse seiners. One consequence of Somali maritime piracy in the western tropical Indian Ocean in recent years has been the movement of part of the deep-freezing longline fleets out of this area, where the target species were tropical tunas or swordfish, to operate in southern waters of the Indian Ocean. This led to increased catches of albacore by some longline fleets, in particular vessels from China, Taiwan,China and Japan.

Fleets of oceanic gillnet vessels from Iran and Pakistan and gillnet and longline vessels from Sri Lanka have extended their area of operation in recent years, to operate on the high seas closer to the equator. The lack of catch-and-effort data from these fleets makes it impossible to assess whether they are operating in areas where catches of juvenile albacore are likely to occur.

TABLE 5. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by gear and main fleets [or type of fishery] by decade (1950–2000) and year (2002–2011) in tonnes. Data as of October 2012. Catches by decade represent the average annual catch, noting that some gears were not used for all years (refer to Fig. 3).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
DN				5,823	3,735											
LL			80	314	1,328	15,029	3,925	6,912	15,203	15,454	14,741	30,902	31,291	25,318	23,630	26,584
FLL	3,715	17,233	16,904	15,214	21,876	19,806	29,989	17,808	15,721	15,774	13,264	10,714	10,741	11,635	17,689	10,268
PS	6	9	26	70	64	443	156	149	168	180	385	598	989	1,456	1,388	1,369
OT				203	1,683	920	772	1,496	232	164	1,548	725	1,424	392	207	725
Total	**3,721**	**17,242**	**17,010**	**21,624**	**28,686**	**36,198**	**34,842**	**26,364**	**31,324**	**31,572**	**29,938**	**42,940**	**44,444**	**38,801**	**42,915**	**38,946**

Fisheries: Driftnet (**DN**; Taiwan,China); Freezing-longline (**LL**); Fresh-tuna longline (**FLL**); Purse seine (**PS**); Other gears nei (**OT**).

TABLE 6. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by fishing area for the period 1950–2011 (in metric tons). Data as of October 2012.

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
N	754	1,199	1,171	668	2,238	3,985	2,436	2,671	2,316	3,022	3,826	12,410	6,687	2,993	2,300	2,190
S	2,967	16,043	15,840	20,955	26,448	32,213	32,406	23,693	29,008	28,550	26,112	30,530	37,758	35,808	40,615	36,756
Total	**3,721**	**17,242**	**17,011**	**21,623**	**28,686**	**36,198**	**34,842**	**26,364**	**31,324**	**31,572**	**29,938**	**42,940**	**44,445**	**38,801**	**42,915**	**38,946**

Areas: North of 10ºS (**N**); South of 10ºS (**S**)

Albacore – Uncertainty of catches

While retained catches were fairly well known until the early-1990s (Fig. 5), the quality of catch estimates since that time has been compromised due to poor catch reports from some fleets, in particular:

- Longliners of Indonesia and Malaysia: to date, Indonesia and Malaysia have reported incomplete catches of albacore for their longline fleets, as they do not monitor activities of longliners under their flags based outside of their ports (e.g. Mauritius, Sri Lanka, and Thailand). In addition, in recent years Indonesia has reported catches of albacore for fresh-tuna longliners under its flag that are in contradiction with the amounts of albacore recorded from alternative sources, including data on exports of albacore from Bali, and data from canning factories under the ISSF scheme. The new catches of albacore estimated by the IOTC Secretariat using the above sources are around 14,000 t (average 2006–10), well above those reported by the flag country (8,000 t).
- Fleets using gillnets on the high seas, in particular Iran, Pakistan and Sri Lanka: Catches are likely to be less than 1,000 t.

- Non-reporting industrial longliners (NEI): Refers to catches from longliners operating under flags of non-reporting countries. While the catches were moderately high during the 1990s, they have not exceeded 2,000 t in recent years.

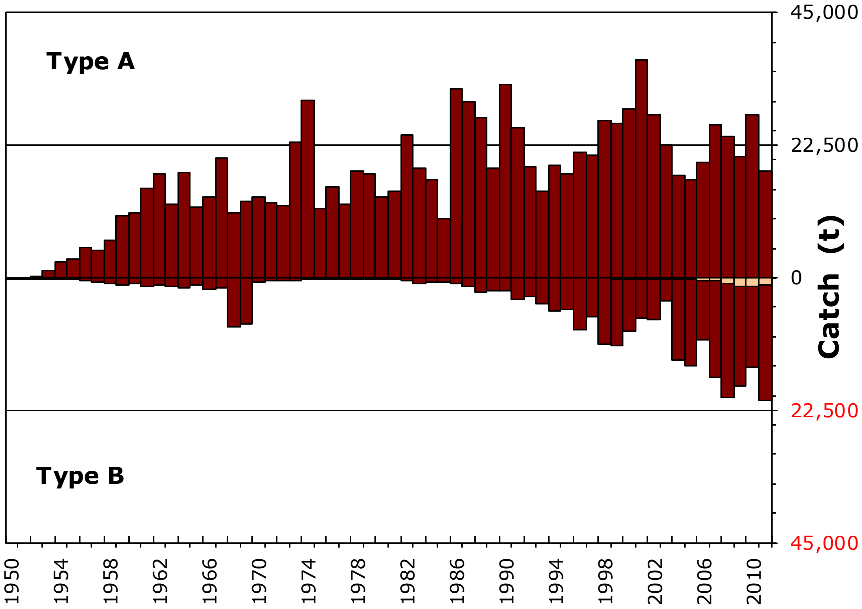


Fig. 5. Albacore: Uncertainty of annual catch estimates for albacore (1950–2011) (Data as of October 2012). Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

- The catch series for albacore has not changed substantially since the WPTmT in 2011.
- Levels of discards are believed to be low although they are unknown for industrial fisheries other than European (EU) purse seiners (2003–07).
- Catch-and-effort series are available from various industrial fisheries. Nevertheless, catch-and-effort are not available from some fisheries or they are considered to be of poor quality, especially during the last decade, for the following reasons:
  - uncertain data from significant fleets of longliners, including India, Indonesia, Malaysia, Oman, and Philippines;
  - no data for fresh-tuna longliners flagged in Taiwan,China during 1990–2006 and poor coverage the following years (2007–10);
  - non-reporting by industrial purse seiners and longliners (NEI).

Albacore – Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2010 and 2011 are provided in Fig. 6, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2010 and 2011 are provided in Fig. 7.

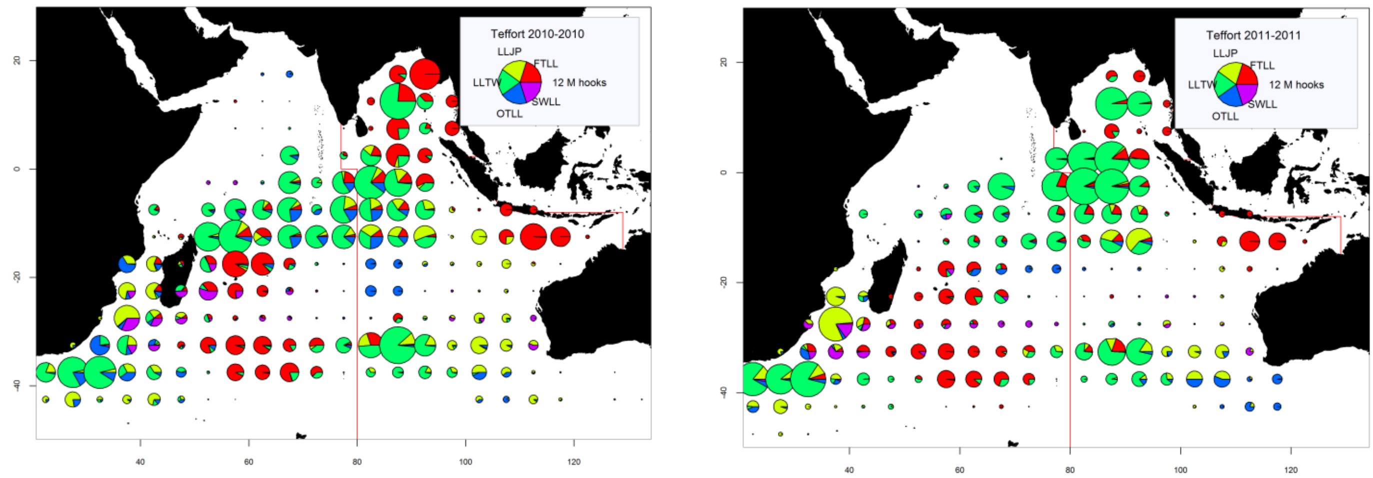


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

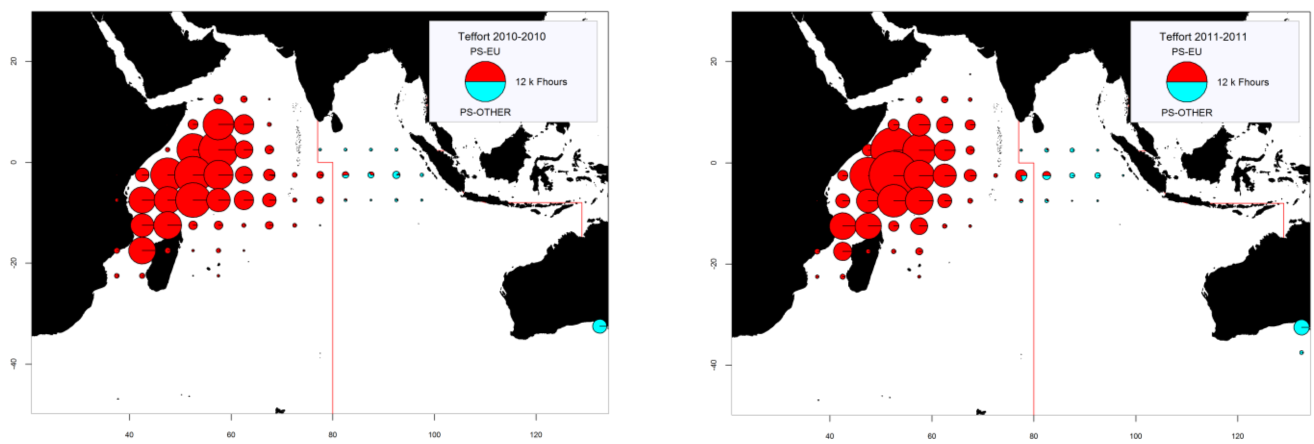


Fig. 7. Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Albacore – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

The size frequency data for the deep-freezing longline fishery from Taiwan,China for the period 1980–2009 is available. In general, the amount of catch for which size data for the species are available before 1980 is still very low. The data for the Japanese longline fleets is available; however, the number of specimens measured per stratum has been decreasing in recent years. Few data are available for the other fleets.

- Trends in average weight can be assessed for several industrial fisheries although they are incomplete or of poor quality for most fisheries before 1980, between 1986 and 1991, and in recent years, due to the lack of length samples for the fleets referred to above (Fig. 8).
- Catch-at-Size/Age tables are available but the estimates are highly uncertain for some periods and fisheries including:
    - all industrial longline fleets before the mid-60s, from the early-1970s up to the early-1980s and most fleets in recent years, in particular fresh-tuna longliners
    - the complete lack of size samples from the driftnet fishery of Taiwan,China over the entire fishing period (1982–92)
    - the paucity of catch by area data available for some industrial fleets (Taiwan,China, NEI, India and Indonesia)

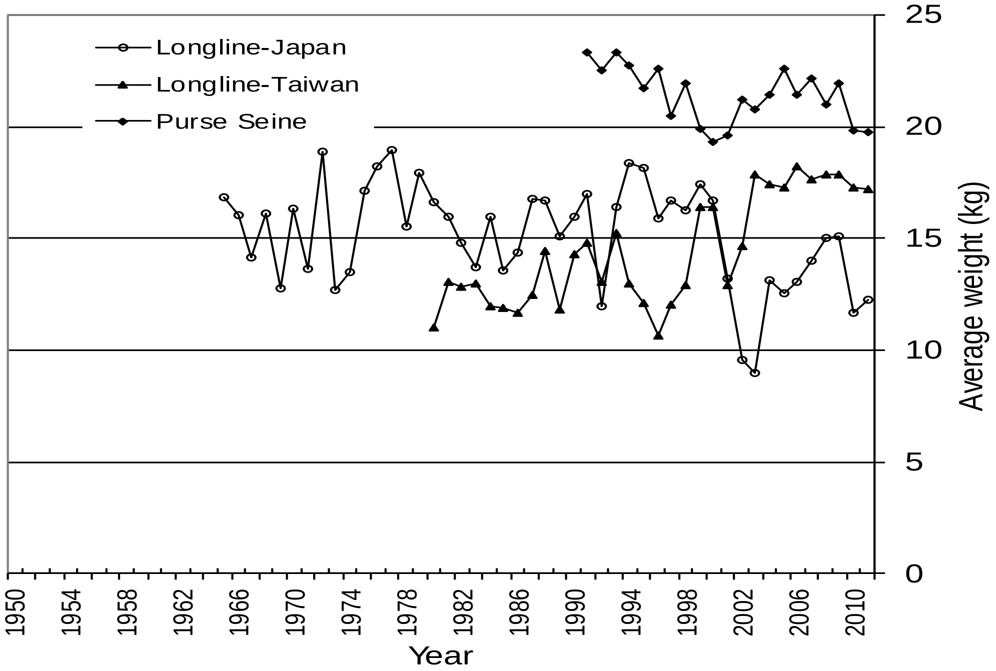


Fig. 8. Albacore: Average weight in kg of the catches of all fleets (blue), gillnet (red), LL-JPN (dark green), LL-TWN (black), Purse seine (green) and other gears (grey) from 1950 to 2011.

Standardised catch–per–unit–effort (CPUE) trends

Catch-and-effort series are available from various industrial fisheries. Nevertheless, catch-and-effort are not available from some fisheries or they are considered to be of poor quality, especially during the last decade, for the following reasons:

- uncertain data from large fleets of longliners, including India, Indonesia, Malaysia, Oman, and the Philippines
- no data for fresh-tuna longliners flagged in Taiwan,China during 1990–2006 and poor coverage the following years (2007–10)
- non-reporting by industrial purse seiners and longliners (NEI)

The CPUE series available for assessment purposes are shown in Fig. 9, although only the Taiwan,China series or a combined CPUE (weighted average of Japan and Taiwan,China) were used in the stock assessment models for 2012 for the reasons discussed in IOTC–2012–WPTmT04–R.

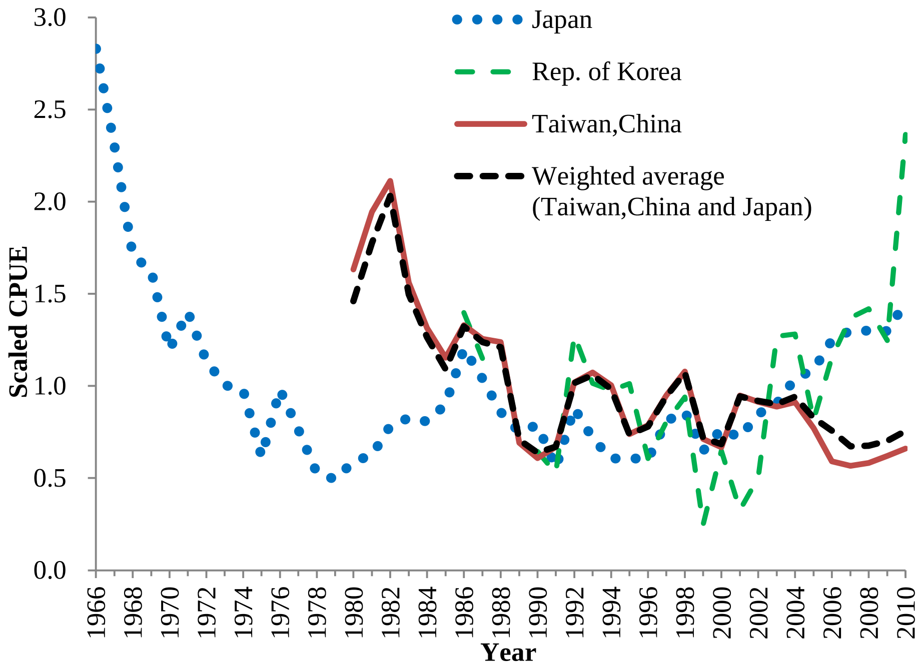


Fig. 9. Albacore: Comparison of the three CPUE series for longline fleets fishing for albacore in the IOTC area of competence, as well as the weight average of the Taiwan,China and Japan series. Series have been rescaled relative to their respective means from 1966–2010.

STOCK ASSESSMENT

A range of quantitative modelling methods (ASPIC, ASPM and SS3) were applied to the albacore assessment in 2012, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis.

The following is worth noting with respect to the various modelling approaches used in 2012:

- There was more confidence in the abundance indices this year due to the additional CPUE analyses from Japan and Taiwan,China, and the exploration of the Rep. of Korea catch and effort data. This has led to improved confidence in the overall assessments.
- The Taiwan,China CPUE is more likely to closely represent albacore abundance at this time, because a substantial part of the Taiwanese fleet has always targeted albacore.
- Conversely, the Japanese CPUE seems to demonstrate very strong targeting shifts away from albacore (1960s) and back towards albacore in recent years (as a consequence of piracy in the western Indian Ocean). Similar trends are seen in the Rep. of Korea CPUE series.
- CPUE series should not be average across series with different trends as this is likely to result in spurious trends. Thus, only series which are considered to be most representative of abundance, in this case the Taiwan,China series, should be used in stock assessments while further work is carried out on the Japanese and Korean longline series.
- Albacore stock status should be determined by qualitatively integrating the results of the various stock assessments undertaken in 2012. All analyses were treated as being equally informative, and focus was given to the features common to all of the results.
- It was recognised that the deterministic production models were only able to explore a limited number of modelling options. The structural rigidity of these simple models causes numerical problems when fit to long time series for some cases.

The stock structure of the Indian Ocean albacore resource is under investigation, but currently uncertain. The south-west region was identified as an area of interest, as it is likely that there is stock connectivity with the southern Atlantic albacore population.

In deciding upon the most appropriate way to present the integrated stock assessment results, the output of the ASPM model were considered to most likely numerically and graphically represent the current status of albacore in the Indian

Ocean (Table 7). However, this does not represent an endorsement of the ASPM model over the other models used in 2012, as there are still substantial problems with the ASPM model, and all of the models should be considered to be equally informative of stock status.

TABLE 7. Albacore (*Thunnus alalunga*) stock status summary.

Management Quantity	**Aggregate Indian Ocean (TWN,CHN CPUE only) (base case)**
2011 catch estimate	38,946 t
Mean catch from 2007–2011	41,609 t
MSY (80% CI)	33,300 (31,100–35,600)
Data period used in assessment	1950–2010
F_{2010}/F_{MSY} (80% CI)	1.33 (0.90–1.76)
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY} (80% CI)	1.05 (0.54–1.56)
B_{2010}/B_{1950} (80% CI)	–
SB_{2010}/SB_{1950}	0.29 (n.a.)
$B_{2010}/B_{1950,\ F=0}$	–
$SB_{2010}/SB_{1950,\ F=0}$	–

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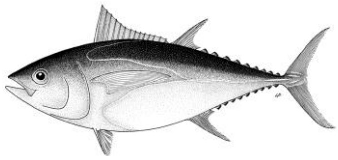
APPENDIX X
EXECUTIVE SUMMARY: BIGEYE TUNA

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



Status of the Indian Ocean bigeye tuna (BET: *Thunnus obesus*) resource

TABLE 1. Bigeye tuna: Status of bigeye tuna (*Thunnus obesus*) in the Indian Ocean

Area[1]	**Indicators**			**2012 stock status determination**
Indian Ocean	Catch in 2011: Average catch 2007–2011:	87,420 t 101,639 t		
		SS3[3]	ASPM[4]	
	MSY (1000 t):	114 t (95–183 t)	103 t (87–119 t)	
	F_{curr}/F_{MSY}:	0.79 (0.50–1.22)	0.67 (0.48–0.86)	
	SB_{curr}/SB_{MSY}:	1.20 (0.88–1.68)	1.00 (0.77–1.24)	
	SB_{curr}/SB_0:	0.34 (0.26–0.40)	0.39	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used in the assessment.
[3]Central point estimate is adopted from the 2010 SS3 model, percentiles are drawn from a cumulative frequency distribution of MPD values with models weighted as in Table 12 of 2010 WPTT report (IOTC–2010–WPTT12–R); the range represents the 5th and 95th percentiles.
[4]Median point estimate is adopted from the 2011 ASPM model using steepness value of 0.5 (values of 0.6, 0.7 and 0.8 are considered to be as pausible as these values but are not presented for simplification); the range represents the 90 percentile Confidence Interval.
Current period (curr) = 2009 for SS3 and 2010 for ASPM.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new stock assessment was carried out in 2012. Revised stock status indicators (e.g. standardised CPUE series) do not show any substantial differences from those carried out in 2011 that would warrant a change in the overall stock status advice. Both of the stock assessments carried out in 2010 and 2011 indicate that the stock is above a biomass level that would produce MSY in the long term and that current fishing mortality is below the MSY-based reference level (i.e. $SB_{current}/SB_{MSY}$ > 1 and $F_{current}/F_{MSY}$ < 1) (Table 1 and Fig. 1). Current spawning stock biomass was estimated to be 34–40 % (Table 1) of the unfished levels. The central tendencies of the stock status results from the WPTT 2011 when using different values of steepness were similar to the central tendencies presented in 2010. Catches in 2011 (87,420 t) remain lower than the estimated MSY values from the 2010 and 2011 stock assessments (Table 1). The average catch over the previous five years (2007–2011; 101,639 t) also remains below the estimated MSY. On the weight of stock status evidence available, the bigeye tuna stock is therefore not overfished, and is not subject to overfishing.

Outlook. The recent declines in longline effort, particularly from the Japanese, Taiwan,China and Republic of Korea longline fleets, as well as purse seine effort have lowered the pressure on the Indian Ocean bigeye tuna stock, indicating that current fishing mortality would not reduce the population to an overfished state in the near future.

The Kobe strategy matrix (Combined SS3 and ASPM) illustrates the levels of risk associated with varying catch levels over time and could be used to inform future management actions (Table 2). Based on the ASPM projections from the 2011 assessment, with steepness 0.5 value for illustration, there is relatively a low risk of exceeding MSY-based reference points by 2020 both when considering current catches of 87,420 t (approximately 11% risk of $SB<SB_{MSY}$) or even if catches increase to around 100,000 t (<41% risk that $B_{2020}<B_{MSY}$ and $F_{2020}>F_{MSY}$).

Moreover, the SS3 projections from the 2010 assessment show that there is a low risk of exceeding MSY-based reference points by 2019 if catches are maintained at the lower range of MSY levels or at the catch level of 102,000 t (< 30% risk that $B_{2019}<B_{MSY}$ and < 25% risk that $F_{2019}>F_{MSY}$) (Table 1). The following key points should be noted:

- The Maximum Sustainable Yield estimate for the Indian Ocean ranges between 102,000 and 114,000 t (range expressed as the median value for 2010 SS3 and steepness value of 0.5 for 2011 ASPM for illustrative purposes (see Table 1 for further description)). Annual catches of bigeye tuna should not exceed the lower range of this estimate which corresponds to the 2009 catches and last year's management advice.
- If the recent declines in effort continue, and catch remains substantially below the estimated MSY of 102,000–114 000 t, then immediate management measures are not required. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
    - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
    - **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).

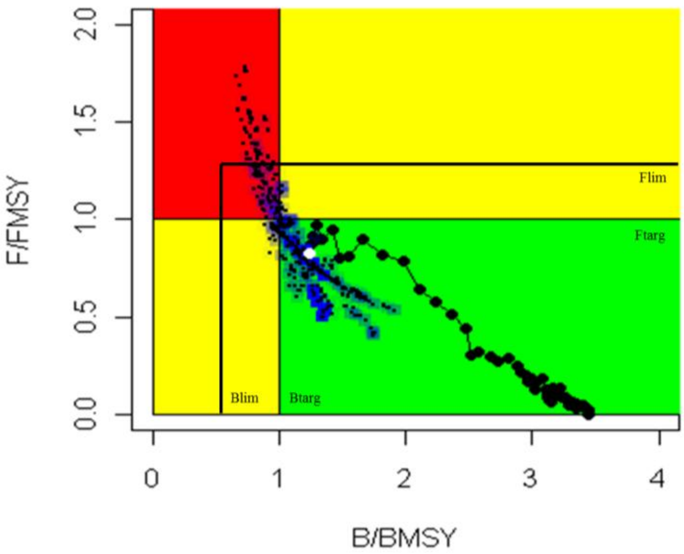


Fig. 1. Bigeye tuna: SS3 Aggregated Indian Ocean assessment Kobe plot. Black circles represent the time series of annual median values from the weighted stock status grid (white circle is 2009). Blue squares indicate the MPD estimates for 2009 corresponding to each individual grid C model, with colour density proportional to the weighting (each model is also indicated by a small black point, as the squares from highly down-weighted models are not otherwise visible)

TABLE 2. Bigeye tuna: Combined 2010 SS3 and 2011 ASPM Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 and 2010 catch levels, ± 20% and ± 40%) projected for 3 and 10 years. K2SM adopted from the 2011 ASPM model using steepness value of 0.5 (values of 0.6, 0.7 and 0.8 are considered to be as pausible as these values but are not presented for simplification). Note that the catch levels for 2009 and 2010 have since been revised, but are not reflected in the projections

Reference point and projection timeframe	Alternative catch projections (relative to 2009) and probability (%) of violating reference point				
	2010 SS3				
	60% (61,200 t)	**80%** (81,600 t)	**100%** (102,000 t)	**120%** (122,400 t)	**140%** (142,800 t)
$SB_{2012} < SB_{MSY}$	19	24	28	40	50
$F_{2012} > F_{MSY}$	<1	<6	22	50	68
$SB_{2019} < SB_{MSY}$	19	24	30	55	73
$F_{2019} > F_{MSY}$	<1	<6	24	58	73

Reference point and projection timeframe	Alternative catch projections (relative to 2010) and probability (%) of violating reference point				
	2011 ASPM				
	60% (42,900t)	**80%** (57,200t)	**100%** (71,500t)	**120%** (85,800t)	**140%** (100,100t)
$SB_{2013} < SB_{MSY}$	4	8	15	24	35
$F_{2013} > F_{MSY}$	<1	<1	1	8	33
$SB_{2020} < SB_{MSY}$	<1	<1	1	11	41
$F_{2020} > F_{MSY}$	<1	<1	<1	5	38

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Tropical Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Bigeye tuna (*Thunnus obesus*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*
- Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.

FISHERIES INDICATORS

Bigeye tuna – General

Bigeye tuna *(Thunnus obesus)* inhabit the tropical and subtropical waters of the Pacific, Atlantic and Indian Oceans in waters down to around 300 m. Table 3 outlines some of the key life history traits of bigeye tuna relevant for management.

TABLE 3. Bigeye tuna: Biology of Indian Ocean bigeye tuna (*Thunnus obesus*)

Parameter	**Description**
Range and stock structure	Inhabits the tropical and subtropical waters of the Pacific, Atlantic and Indian Oceans in waters down to around 300 m. Juveniles frequently school at the surface underneath floating objects with yellowfin and skipjack tunas. Association with floating objects appears less common as bigeye grow older. The tag recoveries from the RTTP-IO provide evidence of rapid and large scale movements of juvenile bigeye tuna in the Indian Ocean, thus supporting the current assumption of a single stock for the Indian Ocean. The average minimum distance between juvenile tag-release-recapture positions is estimated at 657 nautical miles. The range of the stock (as indicated by the distribution of catches) includes tropical areas, where reproduction occurs, and temperate waters which are believed to be feeding grounds.
Longevity	15 years
Maturity (50%)	Age: females and males 3 years. Size: females and males 100 cm.
Spawning season	Spawning season from December to January and also in June in the eastern Indian Ocean.
Size (length	Maximum length: 200 cm FL; Maximum weight: 210 kg.

and weight)	Newly recruited fish are primarily caught by the purse seine fishery on floating objects. The sizes exploited in the Indian Ocean range from 30 cm to 180 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack tuna and juvenile yellowfin tuna and are mainly limited to surface tropical waters, while larger fish are found in sub-surface waters.

Sources: Nootmorn 2004, Froese & Pauly 2009

Bigeye tuna – Fisheries and catch trends

Bigeye tuna is mainly caught by industrial longline (59% in 2011) and purse seine (26% in 2011) fisheries, with the remaining 15% of the catch is taken by other fisheries (Table 4; Fig. 2). However, in recent years the catches of bigeye tuna by gillnet fisheries are likely to be higher, due to the major changes experienced in some of these fleets, notably changes in boat size, fishing techniques and fishing grounds, with vessels using deeper gillnets on the high seas, in areas where catches of bigeye tuna are high.

Total annual catches have increased steadily since the start of the fishery, reaching the 100,000 t level in 1993 and peaking at 150,000 t in 1999 (Fig. 2). Catches dropped since then to values between 120,000–140,000 t (2000–07), further dropping in recent years, to values under 90,000 t in recent years (2010–11). The SC believes that the recent drop in catches could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean, which has led to a marked drop in the levels of longline effort in the core fishing area of these species.

Table 4. Bigeye tuna: Best scientific estimates of the catches of bigeye tuna (*Thunnus obesus*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (2002–2011), in tonnes. Data as of September 2012. Catches by decade represent the average annual catch, noting that some gears were not used for all years (refer to Fig. 2)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LL	6,488	21,970	30,462	45,940	88,106	93,721	109,895	104,613	113,940	94,094	90,668	93,493	69,947	66,761	46,371	51,587
FS	0	0	0	2,067	4,808	6,042	4,099	7,172	3,658	8,501	6,406	5,670	9,648	5,317	3,827	6,172
LS	0	0	0	4,234	18,224	20,147	24,944	15,662	18,749	17,568	18,249	18,066	19,831	24,773	18,440	16,636
OT	146	262	567	1,449	2,086	4,560	2,236	2,306	2,257	2,618	5,467	5,912	8,620	11,868	12,228	13,024
Total	6,634	22,231	31,030	53,690	113,225	124,470	141,174	129,753	138,604	122,782	120,791	123,141	108,047	108,719	80,866	87,420

Longline (LL); Purse seine free-school (FS); Purse seine associated school (LS); Other gears nei (OT)

Bigeye tuna have been caught by industrial longline fleets since the early 1950's, but before 1970 they only represented an incidental catch (Fig. 3). After 1970, the introduction of fishing practices that improved catchability of the bigeye tuna resource, combined with the emergence of a sashimi market, resulted in bigeye tuna becomes a primary target species for the main industrial longline fleets. Total catch of bigeye tuna by longliners in the Indian Ocean increased steadily from the 1970's attaining values over 90,000 t between 1996 and 2007, and dropping markedly thereafter (Fig. 2). Bigeye tuna catches in recent years have been low representing less than half the catches of bigeye tuna recorded before the onset of piracy in the Indian Ocean. Since the late 1980’s Taiwan,China has been the major longline fleet fishing for bigeye tuna in the Indian Ocean, taking as much as 40% of the total longline catch in the Indian Ocean (Fig. 3). However, the catches of longliners from Taiwan,China have decreased in recent years, with current catches of bigeye tuna (≈20,000 t) three times lower than those in 2003. Large bigeye tuna (averaging just above 40 kg) are primarily caught by longlines, in particular deep longlines.

Since the late 1970’s, bigeye tuna has been caught by purse seine vessels fishing on tunas aggregated on floating objects and, to a lesser extent, associated to free swimming schools (Fig. 2) of yellowfin tuna or skipjack tuna. The highest catch of bigeye tuna by purse seiners in the Indian Ocean was recorded in 1999 (≈40,000 t). Catches since 2000 have been between 20,000 and 30,000 t. Purse seiners under flags of EU countries and Seychelles take the majority of purse seine caught bigeye tuna in the Indian Ocean (Fig. 3). Purse seiners mainly take small juvenile bigeye (averaging around 5 kg) whereas longliners catch much larger and heavier fish; and while purse seiners take lower tonnages of bigeye tuna compared to longliners, they take larger numbers of individual fish. Even though the activities of purse seiners have been affected by piracy in the Indian Ocean, the impacts have not been as marked as for longline fleets. The main reason for this is the presence of security personnel onboard purse seine vessels of the EU and Seychelles, which has made it possible for purse seiners under these flags to continue operating in the northwest Indian Ocean (Fig. 4).

By contrast with yellowfin tuna and skipjack tuna, for which the major catches are taken in the western Indian Ocean, bigeye tuna is also exploited in the eastern Indian Ocean (Fig. 3). The relative increase in catches in the eastern Indian Ocean in the late 1990’s was mostly due to increased activity of small longliners fishing tuna to be marketed fresh.

This fleet started its operation in the mid 1970’s (Fig. 3, Indonesia). However, the catches of bigeye tuna in the eastern Indian Ocean have shown a decreasing trend in recent years, as some of the vessels moved south to target albacore.

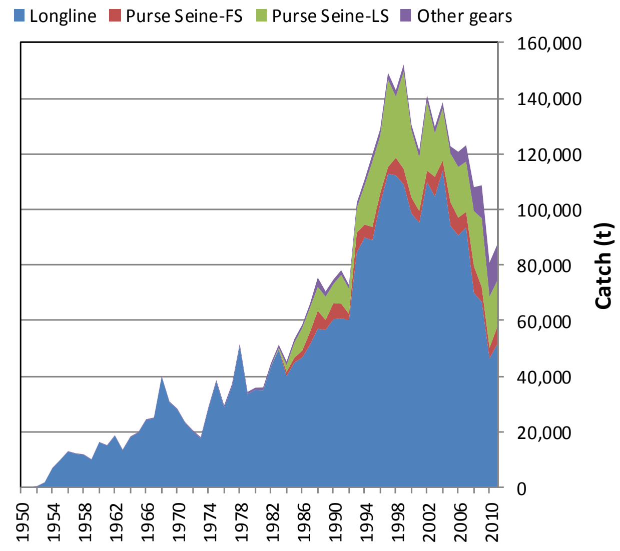


Fig. 2. Bigeye tuna: Annual catches of bigeye tuna by gear (1950–2011) (Data as of September 2012)

Fig. 3. Bigeye tuna: Annual catches of bigeye tuna by fleet (1950–2011) (Data as of September 2012)

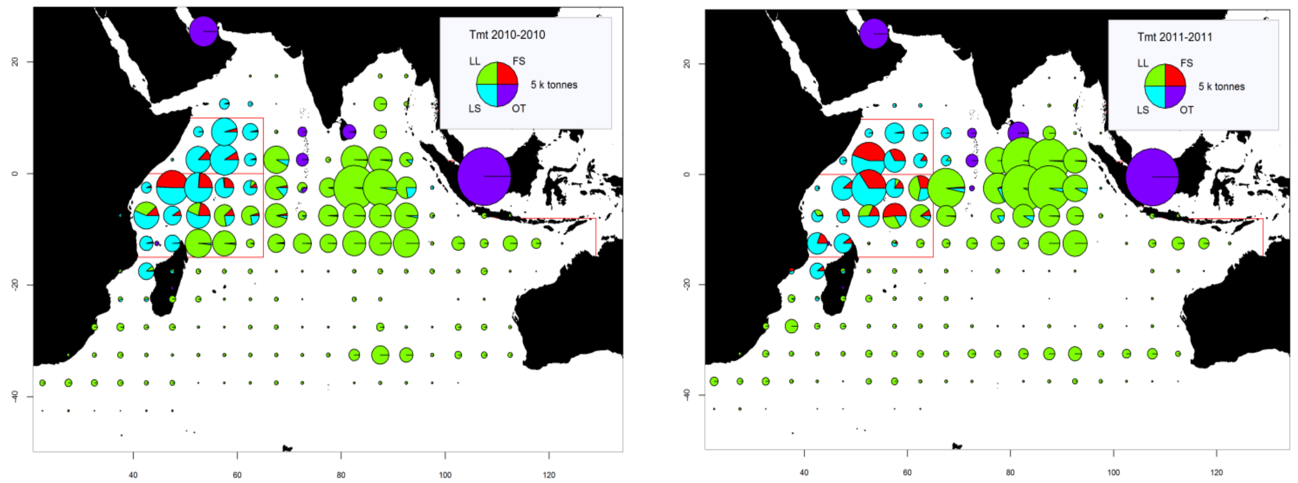


Fig. 4. Bigeye tuna: Time-area catches (total combined in tonnes) of bigeye tuna estimated for 2010 (left) and 2011 (right) by gear. Longline (LL), Purse seine free-schools (FS), Purse seine associated-schools (LS), and other fleets (OT), including pole-and-line, drifting gillnets, and various coastal fisheries (Data as of September 2012). The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from Iran, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Indonesia

Bigeye tuna – uncertainty of catches

Retained catches: Thought to be well known for the major fleets (Fig. 5) but are less certain for non-reporting industrial purse seiners and longliners (NEI) and for other industrial fisheries (longliners of India and Philippines). Catches are also uncertain for some artisanal fisheries including the pole-and-line fishery in the Maldives, the gillnet fisheries of Iran and Pakistan, the gillnet and longline combination fishery in Sri Lanka and the artisanal fisheries in Indonesia, Comoros and Madagascar.

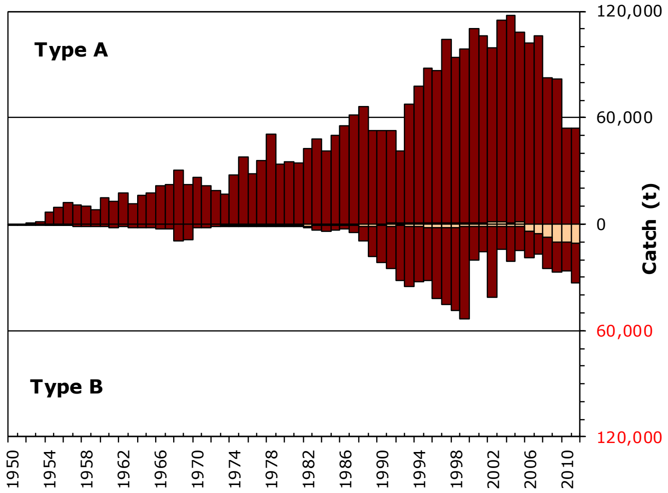


Fig. 5. Bigeye tuna: Uncertainty of annual catch estimates for bigeye tuna (Data as of September 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Discard levels: Believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–07.

Changes to the catch series: There have not been significant changes to the catches of bigeye tuna since the WPTT in 2011.

CPUE Series: Catch-and-effort data are generally available from the major industrial fisheries. However, these data are not available from some fisheries or they are considered to be of poor quality, especially throughout the 1990s and in recent years, for the following reasons:

- non-reporting by industrial purse seiners and longliners (NEI)
- no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006
- uncertain data from significant fleets of industrial purse seiners from Iran and longliners from India, Indonesia, Malaysia, Oman, and Philippines.
- No data available for the driftnet fisheries of Iran and Pakistan and the gillnet/longline fishery of Sri Lanka, especially in recent years.

Bigeye tuna – Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2010 and 2011 are provided in Fig. 6, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2010 and 2011 are provided in Fig. 7. The total number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 and 2010 are provided in Fig. 8.

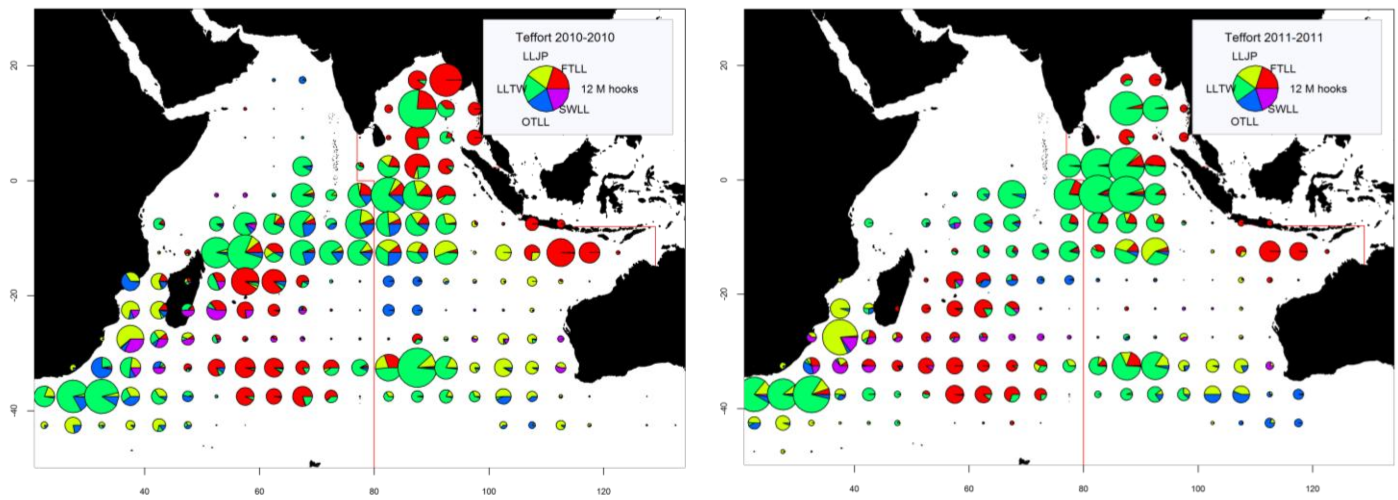


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

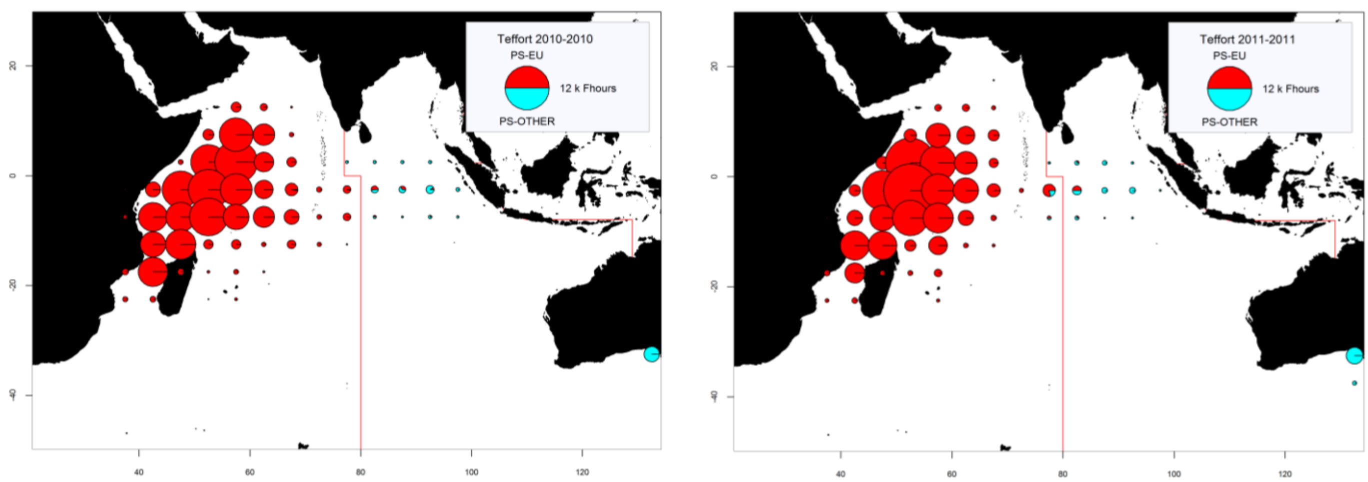


Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

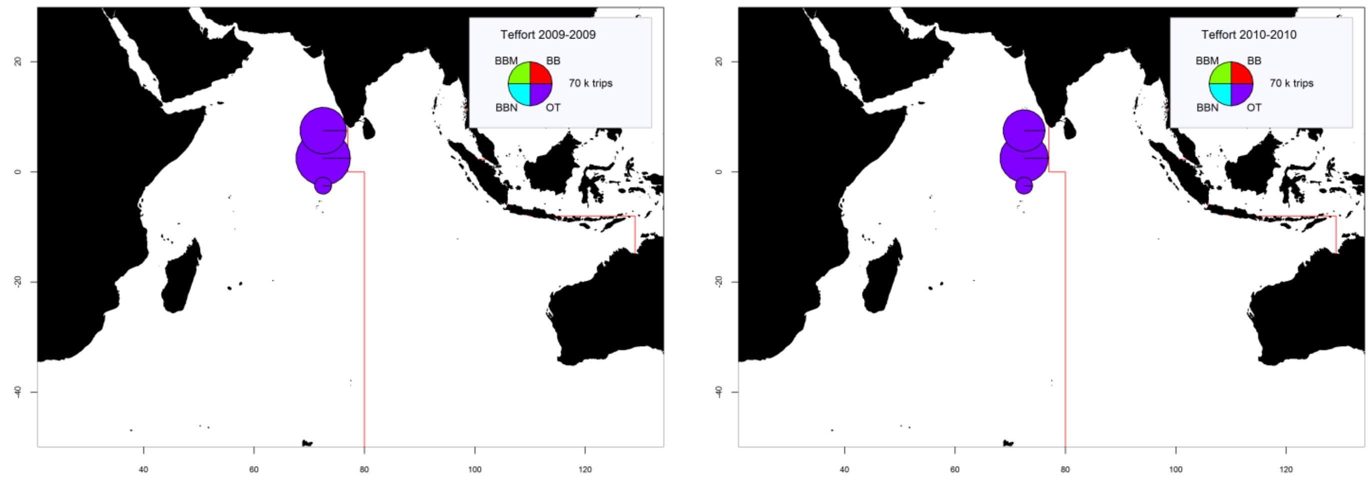


Fig. 8. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of September 2012)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): Unclassified gears
Note that the above maps were derived using the available catch-and-effort data in the IOTC database, which is limited to the number of baitboat calls (trips) by atoll by month for Maldivian baitboats for the period concerned. Note that some trips may be fully devoted to handlining, trolling, or other activities (data by gear type are not available since 2002). No data are available for the pole-and-line fisheries of India (Lakshadweep) and Indonesia.

Bigeye tuna: Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Trends in average weight: Can be assessed for several industrial fisheries although they are incomplete or of poor quality for most fisheries before the mid-1980s and for some fleets in recent years (e.g. Japan longline) (Fig. 9).

Catch-at-Size table: This is available but the estimates are more uncertain for some years and some fisheries due to:

- the paucity of size data available from industrial longliners before the mid-60s, from the early-1970s up to the mid-1980s and in recent years (Japan and Taiwan,China)
- the paucity of catch by area data available for some industrial fleets (NEI, India, Indonesia, Iran, Sri Lanka).

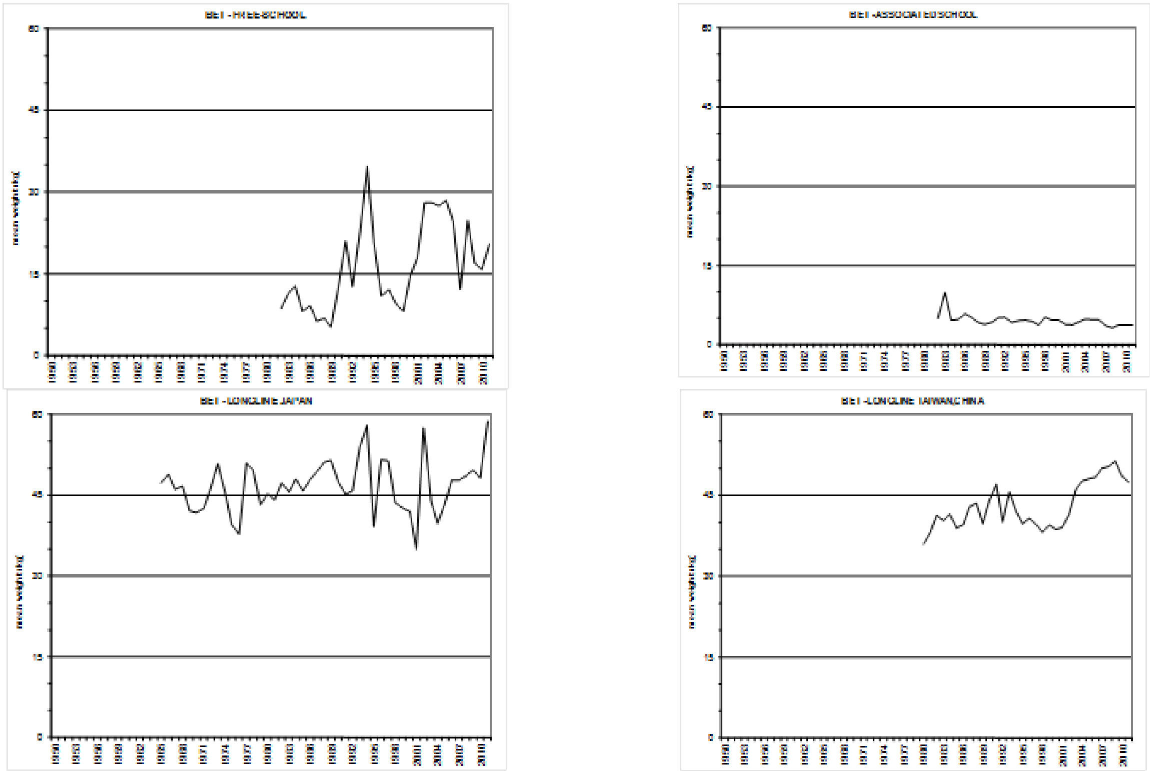


Fig. 9. Bigeye tuna: Changes in average weight (kg) of bigeye tuna from 1950 to 2010 – all fisheries combined (top) and by main fleet (Data as of September 2012)

Bigeye tuna: Standardised catch–per–unit–effort (CPUE) trends

The CPUE series presented at the WPTT14 meeting in 2012 are listed below and shown in Fig. 10, noting that the Japanese series from the tropical areas and the Indian Ocean as a whole, showed very similar trends and are therefore not shown separately:

- Japan data (1960–2011): Series 2 from document IOTC–2012–WPTT14–26. Whole Indian Ocean (Fig. 10).
- Taiwan,China data (1979–2011): Series from document IOTC–2012–WPTT14–27 (Fig. 10).
- Rep. of Korea data (1978–2011): Series from document IOTC–2012–WPTT14–25 (Fig. 10).
- Japan data (1960–2011): Series 1 from document IOTC–2012–WPTT14–26. Tropical area of Indian Ocean.

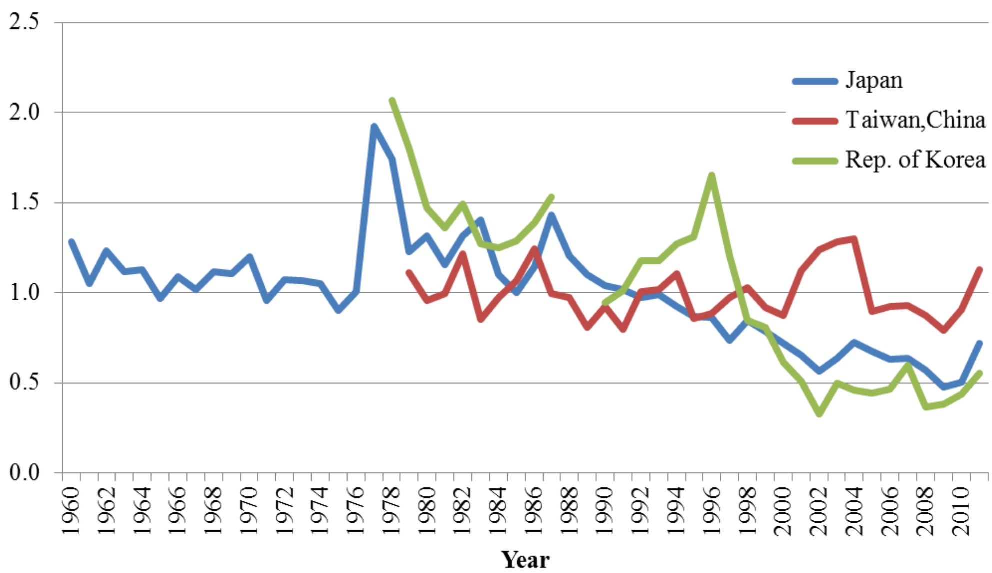


Fig. 10. Comparison of the three standardised CPUE series for Indian Ocean bigeye tuna. Series have been rescaled relative to their respective means from 1960–2011

The CPUE series for the Taiwan,China longline fleet conflicts with the declining trends of the Japanese and Rep. of Korea series, except for the most recent years. The recent decline in the Taiwan,China CPUE series and the divergence between nominal and standardised series was thought to be due to changes in targeting and in the spatial distribution of effort, likely related to piracy activities in the northwest Indian Ocean.

Bigeye tuna – tagging data

A total of 35,997 bigeye tuna (17.9%) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of them (96.0%) were tagged during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and released off the coast of Tanzania in the western Indian Ocean, between May 2005 and September 2007 (Fig. 11). The remaining were tagged during small-scale projects, and by other institutions with the support of the IOTC Secretariat, in the Maldives, Indian, and in the south west and the eastern Indian Ocean. To date, 5,740, (15.9%), have been recovered and reported to the IOTC Secretariat. These tags were mainly reported from the purse seine fleets operating in the Indian Ocean (91.5%), while 4.9% were recovered from longline vessels.

Although bigeye tuna was not subject to a stock assessment analysis by the WPTT in 2012, additional analysis of bigeye tuna was presented during the tagging symposium held immediately following the WPTT14. The new results are not yet included in this executive summary as they have yet to be considered by the WPTT. The SC noted that the new analysis and other information should be considered by the WPTT in 2013, including but not limited to the latitudinal movement of adult bigeye tuna, the possible verification of a two-stanza growth curve, the different maximum size of males and females (larger males) and the low natural mortality now estimated for bigeye tuna. The results arising from the tagging research will likely be of major importance in the future stock assessment analysis of the bigeye tuna stock. Any new information on bigeye tuna biology verified by the WPTT should be incorporated in the next executive summaries.

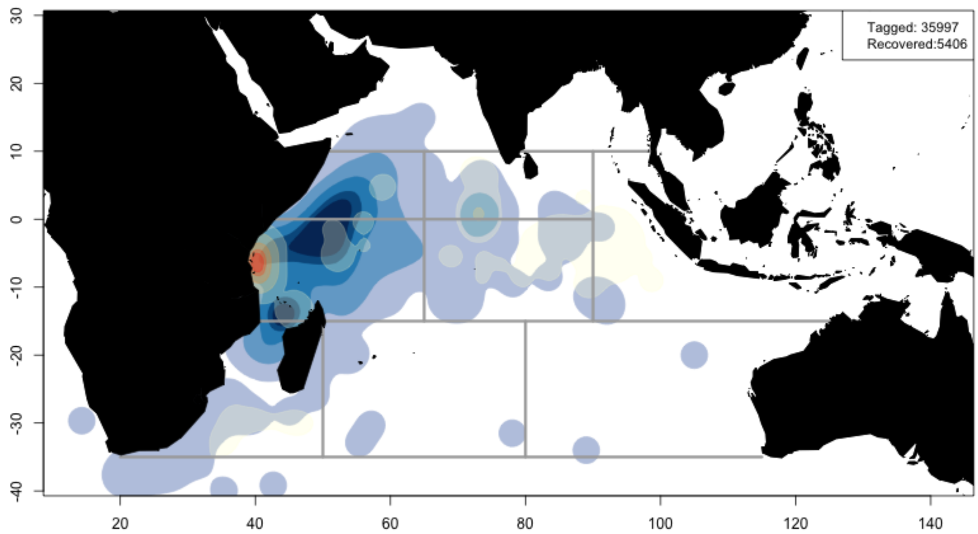


Fig. 11. Bigeye tuna: Densities of releases (in red) and recoveries (in blue). Data as of September 2012

STOCK ASSESSMENT

No stock assessment was carried out in 2012. The most up to date CPUE trends do not give a pessimistic view of the stock which would require a more thorough stock assessment in 2012. Management advice for bigeye tuna is based on the 2010 SS3 stock assessment and various steepness scenarios of the current 2011 ASPM stock assessment results. For last year's SS3 assessment, the data did not seem to be sufficiently informative to justify the selection of any individual model and the results were combined on the basis of a model weighting scheme that was proposed to, and agreed by, the WPTT in 2010.

A single quantitative modelling method (ASPM) was applied to the bigeye tuna assessment in 2011, using data from 1950–2010. The following is worth noting with respect to the modelling approach used:

- The steepness value (h=0.5) was selected on the basis of the likelihood and was near the lower boundary of what would be considered plausible for bigeye tuna. Selection of steepness on the basis of the likelihood was not considered reliable because i) steepness is difficult to estimate in general, and ii) substantial autocorrelation in the recruitment deviates was ignored in the likelihood term.

- Cohort-slicing to estimate ages from lengths introduces substantial errors, for long-living species such as bigeye tuna, except for the youngest ages.
- Uncertainty in natural mortality was not considered.

It is essential to include uncertainty in the steepness parameter as a minimum requirement for the provision of management advice. The general population trends and MSY parameters estimated by the ASPM model appeared to be plausibly consistent with the general perception of the fishery and the data. However, these results are considered to be uncertain because of i) uncertainty in the catch rate standardization, and ii) uncertainty in recent catches.

Management advice for bigeye tuna was based on the 2010 SS3 stock assessment and various steepness scenarios of the current 2011 ASPM stock assessment results (Tables 1, 5). For last year's SS3 assessment, the data did not seem to be sufficiently informative to justify the selection of any individual model and the results were combined on the basis of a model weighting scheme that was proposed to, and agreed by, the WPTT in 2010.

Key assessment results for the 2010 SS3 and 2011 ASPM stock assessments are shown in Tables 1, 2 and 5; Fig. 1.

Table 5. Bigeye tuna: Key management quantities from the 2010 SS3 and 2011 ASPM assessments for bigeye tuna in the Indian Ocean

Management Quantity	**2010 SS3**	**2011 ASPM**
2009 (SS3) and 2010 (ASPM) catch estimate	102,000 t	71,500 t
Mean catch from 2006–2010	104,700 t	104,700 t
MSY	114,000 t (95,000–183,000)	102,900 t (86,600–119,300) [2]
Data period used in assessment	1952–2009	1950–2010
F_{curr}/F_{MSY} [3]	0.79 [1] (0.50 – 1.22) [1]	0.67 (0.48–0.86) [2]
B_{curr}/B_{MSY} [3]	–	–
SB_{curr}/SB_{MSY} [3]	1.20 [1] (0.88 – 1.68)	1.00 (0.77–1.24) [2]
B_{curr}/B_0 [3]	–	0.43 (n.a.)
SB_{curr}/SB_0 [3]	0.34[1] (0.26 – 0.40)	0.39[2]
$B_{curr}/B_{0,\ F=0}$ [3]	–	–
$SB_{curr}/SB_{0,\ F=0}$ [3]	–	–

[1] Central point estimate is adopted from the 2010 SS3 model, percentiles are drawn from a cumulative frequency distribution of MPD values with models weighted as in Table 12 of 2010 WPTT report (IOTC–2010–WPTT12–R); the range represents the 5th and 95th percentiles.
[2] Median point estimate is adopted from the 2011 ASPM model using steepness value of 0.5 (values of 0.6, 0.7 and 0.8 are considered to be as pausible as these values but are not presented for simplification); the range represents the 90 percentile Confidence Interval.
[3] Current period ($_{curr}$) = 2009 for SS3 and 2010 for ASPM.

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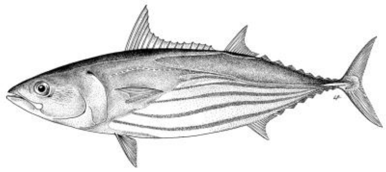
Nootmorn, P (2004) Reproductive biology of bigeye tuna in the eastern Indian Ocean. IOTC–2004–WPTT04–05

APPENDIX XI
EXECUTIVE SUMMARY: SKIPJACK TUNA

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



Status of the Indian Ocean skipjack tuna (SKJ: *Katsuwonus pelamis*) resource

TABLE 1. Status of skipjack tuna (*Katsuwonus pelamis*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Catch 2011: Average catch 2007–2011:	398,240 t 435,527 t	(green)
	MSY (1000 t): F_{2011}/F_{MSY}: SB_{2011}/SB_{MSY}: SB_{2011}/SB_0:	478 t (359–598 t) 0.80 (0.68–0.92) 1.20 (1.01–1.40) 0.45 (0.25–0.65)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(C_{year}/MSY> 1)	(red)	(orange)
Stock not subject to overfishing (C_{year}/MSY≤ 1)	(yellow)	(green)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The results suggest that the stock is not overfished ($B>B_{MSY}$) and that overfishing is not occurring (C<MSY and $F<F_{MSY}$) (Table 1 and Fig. 1). Spawning stock biomass was estimated to have declined by approximately 45 % in 2011 from unfished levels (Table 1).

Outlook. The recent declines in catches are thought to be caused by a recent decrease in purse seine effort as well as due to a decline in CPUE of large skipjack tuna in the surface fisheries. There remains considerable uncertainty in the assessment, and the range of runs analysed illustrate a range of stock status to be between 0.73–4.31 of SB_{2011}/SB_{MSY} based on all runs examined. The WPTT does not fully understand the recent declines of pole-and-line catch and CPUE, which may be due to the combined effects of the fishery and environmental factors affecting recruitment or catchability. Catches in 2010 (428,000 t) and 2011 (398,240 t) as well as the average level of catches of 2007–2011 (435,527 t) are below MSY targets though may have exceeded them in 2005 and 2006.

The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions. Based on the SS3 assessment conducted in 2011, there is a low risk of exceeding MSY-based reference points by 2020 if catches are maintained at the current levels (< 20 % risk that $B_{2019} < B_{MSY}$ and 30 % risk that C_{2019}>MSY as proxy of $F > F_{MSY}$) and even if catches are maintained below the 2005–2010 average (500,000 t) based on the analysis done in 2011 (the 2012 reference point indicates that 500,000 t levels maybe too high for the Indian Ocean skipjack tuna stock). The following key points should be noted:

- The mean estimates of the Maximum Sustainable Yield for the skipjack tuna Indian Ocean stock is 478,190 t (Table 1) and considering the average catch level from 2007–2011 was 435,527 t, the stock appears to be in no immediate threat of breaching target and limit reference points.
- If the recent declines in effort continue, and catch remains substantially below the estimated MSY, then urgent management measures are not required. However, recent trends in some fisheries, such as Maldivian pole-and-line, suggest that the situation of the stock should be closely monitored.
- The Kobe strategy matrix (Table 2: from the 2011 assessment) illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of $1.5*F_{MSY}$

(Fig. 1). Based on the current assessment there is a very low probability that the limit reference points of 1.5*F_{MSY} at the current catch levels will be exceeded in 3 or 10 years.

- **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of 0.4*SB_{MSY} (Fig. 1). Based on the current assessment, there is a low probability that the spawing stock biomass, at the current catch levels, will be below the limit reference point of 0.4*SB_{MSY} in 3 or 10 years.

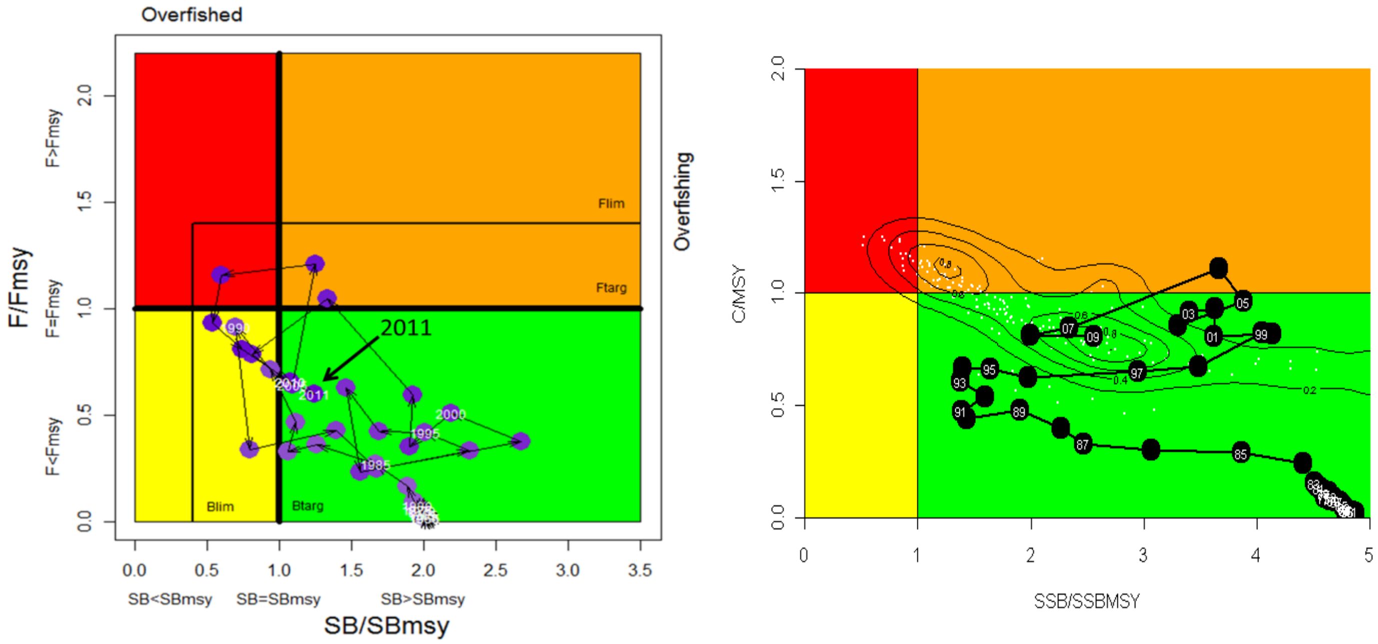


Fig. 1. Skipjack tuna: 2012 SS3 Indian Ocean assessment Kobe plot (left; mean values of the weighted models used in the analysis in 2012). Circles indicate the trajectory of the point estimates for the SB ratio and F/FMSY ratio for each year 1950–2011. 2011 SS3 Aggregated Indian Ocean assessment Kobe plot (right). Black circles indicate the trajectory of the weighted median of point estimates for the SB ratio and C/MSY ratio for each year 1950–2009. Probability distribution contours are provided only as a rough visual guide of the uncertainty (e.g. the multiple modes are an artifact of the coarse grid of assumption options). Due to numerical problems in the F_{MSY} calculations for this population, the proxy reference point C/MSY is reported instead of F/F_{MSY}, which should be interpreted with caution for the reasons given under Table 1 above

TABLE 2. Skipjack tuna: 2011 SS3 Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Weighted probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years. Note: from the 2011 stock assessment using catch estimates at that time

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and weighted probability (%) scenarios that violate reference point**				
	60% (274,000 t)	**80%** (365,000 t)	**100%** (456,000 t)	**120%** (547,000 t)	**140%** (638,000 t)
$SB_{2013} < SB_{MSY}$	<1	5	5	10	18
$C_{2013} > MSY$ (proxy for F_{2009}/F_{MSY})	<1	<1	31	45	72
$SB_{2020} < SB_{MSY}$	<1	5	19	31	56
$C_{2020} > MSY$ (proxy for F_{2009}/F_{MSY})	<1	<1	31	45	72

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Tropical Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Skipjack tuna (*Katsuwonus pelamis*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*
- Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.

FISHERIES INDICATORS

Skipjack tuna – General

Skipjack tuna (*Katsuwonus pelamis*) life history characteristics, including a low size and age at maturity, short life and high productivity/fecundity, make it resilient and not easily prone to overfishing. Table 3 outlines some of the key life history traits of skipjack tuna.

TABLE 3. Skipjack tuna: Biology of Indian Ocean skipjack tuna (*Katsuwonus pelamis*)

Parameter	**Description**
Range and stock structure	Cosmopolitan species found in the tropical and subtropical waters of the Indian, Pacific and Atlantic Oceans. It generally forms large schools, often in association with other tunas of similar size such as juveniles of yellowfin tuna and bigeye tuna. The tag recoveries from the RTTP-IO provide evidence of rapid, large scale movements of skipjack tuna in the Indian Ocean, thus supporting the current assumption of a single stock for the Indian Ocean. Skipjack recoveries indicate that the species is highly mobile, and covers large distances. The average distance between skipjack tagging and recovery positions is estimated at 640 nautical miles. Skipjack tuna in the Indian Ocean are considered a single stock for assessment purposes.
Longevity	7 years
Maturity (50%)	Age: females and males <2 years. Size: females and males 41–43 cm. Unlike in *Thunnus* species, sex ratio does not appear to vary with size. Most of skipjack tuna taken by fisheries in the Indian Ocean have already reproduced.
Spawning season	High fecundity. Spawns opportunistically throughout the year in the whole inter-equatorial Indian Ocean (north of 20°S, with surface temperature greater than 24°C) when conditions are favourable.
Size (length and weight)	Maximum length: 110 cm FL; Maximum weight: 35.5 kg. The average weight of skipjack tuna caught in the Indian Ocean is around 3.0 kg for purse seine, 2.8 kg for the Maldivian baitboats and 4–5 kg for the gillnet. For all fisheries combined, it fluctuates between 3.0–3.5 kg; this is larger than in the Atlantic, but smaller than in the Pacific. It was noted that the mean weight for purse seine catch exhibited a strong decrease since 2006 (3.1 kg) until 2009 (2.4 kg), for both free (3.8 kg to 2.4 kg) and log schools (3.0 kg to 2.4 kg).

Sources: Collette & Nauen 1983, Froese & Pauly 2009, Grande et al. 2010, Dortel et al. 2012, Eveson et al. 2012
NOAA http://www.nmfs.noaa.gov/fishwatch/species/atl_skipjack.htm 14/12/2011

Skipjack tuna: Fisheries and catch trends

Catches of skipjack increased slowly from the 1950s, reaching around 50,000 t during the mid-1970s, mainly due to the activities of fleets using pole-and-lines and gillnets (Table 4; Fig. 2). The catches increased rapidly with the arrival of the purse seiners in the early 1980s, and skipjack became one of the most important commercial tuna species in the Indian Ocean. Annual catches peaked at over 600,000 t in 2006 (Fig. 2). Though preliminary, the catch levels estimated for 2011, at around 400,000 t, represent the lowest catches recorded since 1998.

The increase in skipjack tuna catches by purse seiners (Table 4; Fig. 3) is due to the development of a fishery in association with Fish Aggregating Devices (FADs). In recent years, 85% of the skipjack tuna caught by purse seine vessels is taken from around FADs (Table 4; Fig. 2). Catches by purse seiners increased steadily since 1984 with the highest catches recorded in 2002 and 2006 (>240,000 t). The catches dropped in the years 2003 and 2004, probably as a consequence of high purse seine catch rates on free schools of yellowfin tuna during those years. In 2007 purse seine catches declined by around 100,000 t, from those taken in 2006. The constant increase in catches and catch rates of purse seiners until 2006 are believed to be associated with increases in fishing power and in the number of FADs (and the technology associated with them) used in the fishery. The sharp decline in purse seine catches since 2007coincided with a similar decline in the catches by Maldivian baitboats.

Table 4. Skipjack tuna: Best scientific estimates of the catches of skipjack tuna (*Katsuwonus pelamis*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (2002–2011), in tonnes (Data as of September 2012). Catches by decade represent the average annual catch, noting that some gears were not used for all years (refer to Fig. 2)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BB	9,497	13,368	22,797	40,538	77,729	111,118	124,300	116,672	114,567	140,346	147,391	106,509	98,819	77,555	69,032	69,032
FS				1,626	1,602	897	22,801	30,992	18,565	43,123	34,954	24,198	16,277	10,458	8,853	8,906
LS				3,776	8,147	13,385	215,781	180,556	137,882	168,012	211,940	120,925	128,596	148,717	144,139	123,012
OT	6,596	16,809	30,752	52,490	101,765	185,519	137,693	172,988	204,444	195,670	223,817	211,689	205,587	208,144	199,899	197,291
Total	**16,093**	**30,177**	**53,549**	**98,430**	**189,244**	**310,918**	**500,575**	**501,209**	**475,457**	**547,151**	**618,102**	**463,321**	**449,278**	**444,874**	**421,923**	**398,240**

Pole-and-Line (BB); Purse seine free-school (FS); Purse seine associated school (LS); Other gears nei (OT)

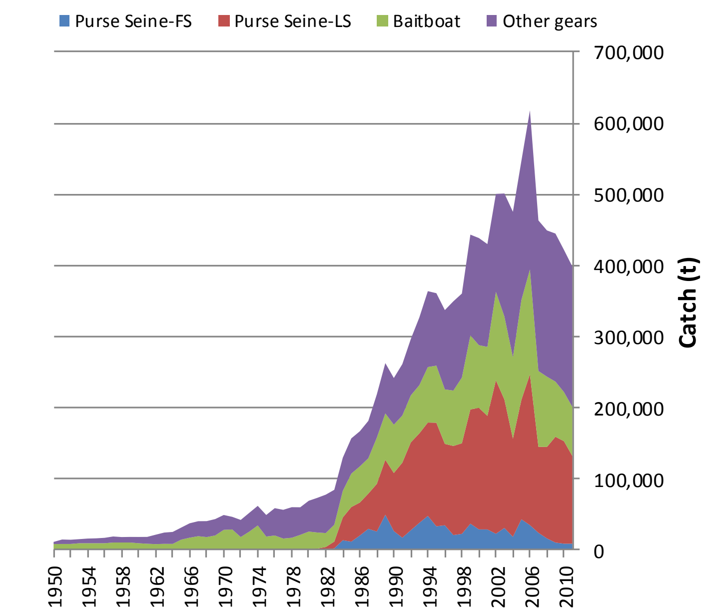


Fig. 2. Skipjack tuna: Annual catches of skipjack tuna by gear (1950–2011) (Data as of September 2012)

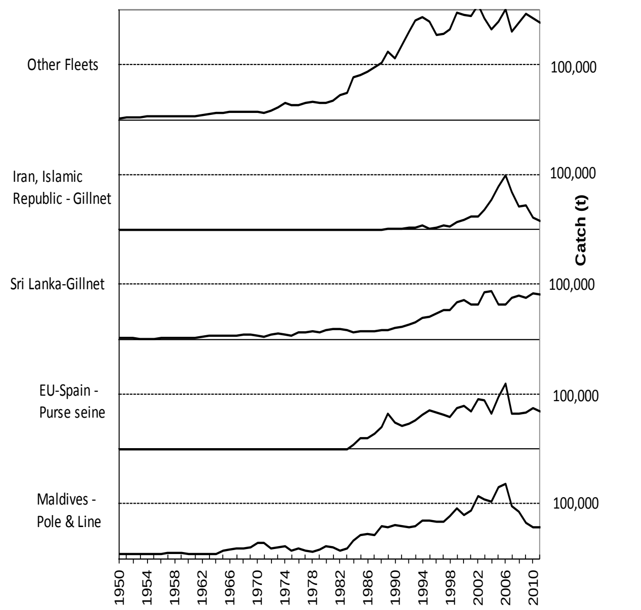


Fig. 3. Skipjack tuna: Catches of skipjack tuna by fleet by year (1950–2011) (Data as of September 2012)

The Maldivian fishery (Fig. 3) has effectively increased its fishing effort with the mechanisation of its pole-and-line fleet since 1974, including an increase in boat size and power and the use of anchored FADs since 1981. Skipjack tuna represents some 75% of its total catch, and catch rates regularly increased between 1980 and 2006, the year in which the maximum catch was recorded for this fishery (≈135,000 t). The catches of skipjack tuna have declined since, with catches in recent years estimated to be at around 55,000 t, representing less than half the catches taken in 2006.

Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean (Fig. 2), including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of Iran and Pakistan, and gillnet fisheries of India and Indonesia. In recent years gillnet catches have represented as much as 20 to 30 % of the total catches of skipjack tuna in the Indian Ocean. Although it is known that vessels from Iran and Sri Lanka (Fig. 3) have been using gillnets on the high seas in recent years, reaching as far as the Mozambique Channel, the activities of these fleets are poorly understood, as no time-area catch-and-effort series have been made available for those fleets to date.

The majority of the catches of skipjack tuna originate from the western Indian Ocean (Fig. 4). Since 2007 the catches of skipjack tuna in the western Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya, Tanzania and around the Maldives. The drop in catches are considered by the SC to be partially explained by the drop in catch rates and fishing effort by some fisheries due to the effects of piracy in the western Indian Ocean region, including all industrial purse seiners and fleets using driftnets from Iran (Fig. 3) and Pakistan; and the drop in the catches of skipjack tuna by Maldives baitboats (Fig. 3) following the introduction of handlines to target large specimens of yellowfin tuna.

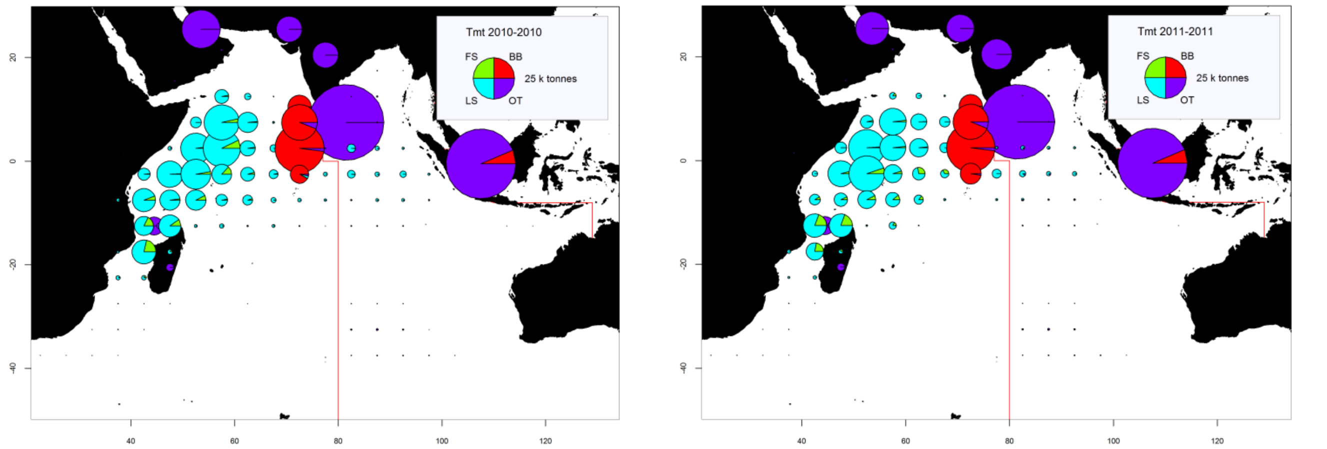


Fig. 4. Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for 2010 (left) ad 2011 (right) by gear. Purse seine free-schools (FS), Purse seine associated-schools (LS), pole-and-line (BB), and other fleets (OT), including longline, drifting gillnets, and various coastal fisheries. Data as of September 2012. The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from Iran and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Comoros, Indonesia and India.

Skipjack tuna – uncertainty of catches

Retained catches: Generally well known for the industrial fisheries but are less certain for many artisanal fisheries (Fig. 5), notably because:

- catches are not being reported by species
- there is uncertainty about the catches from some significant fleets including the coastal fisheries of Sri Lanka, Comoros and Madagascar.
- There has been a decline in the quality of skipjack tuna data in recent years (2010 and 2011) and that this decline is likely to have a detrimental impact on any stock assessment.

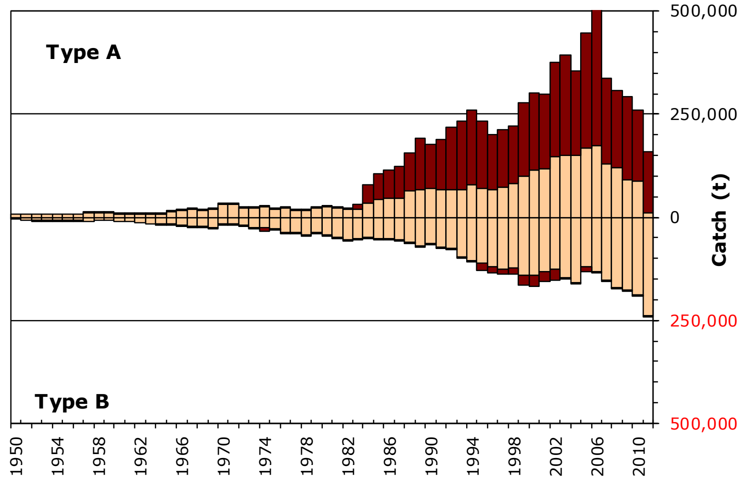


Fig. 5. Skipjack tuna: Uncertainty of annual catch estimates for skipjack tuna (Data as of September 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC

Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets

Discard levels: Believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–07.

Changes to the catch series: There have been no major changes to the catches of skipjack tuna, as a whole, since the WPTT in 2011. However, the IOTC Secretariat used new information compiled during 2011-12 to rebuild the catch series for the coastal fisheries operated in some countries, in particular Madagascar, Sri Lanka, and India. In general, the new catches of skipjack tuna estimated by the IOTC Secretariat are lower than those used in the past by the WPTT.

CPUE Series: Catch and effort data are available from various industrial and artisanal fisheries. However, these data are not available from some important fisheries or they are considered to be of poor quality for the following reasons:

- no data are available for the gillnet fisheries of Iran and Pakistan
- the poor quality effort data for the gillnet/longline fishery of Sri Lanka
- no data are available from important coastal fisheries using hand and/or troll lines, in particular Indonesia, India, Madagascar and Comoros.

Skipjack tuna – Effort trends

Total effort from purse seine vessles flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2010 and 2011 are provided in Fig. 6. The total number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2010 and 2011 are provided in Fig. 7.

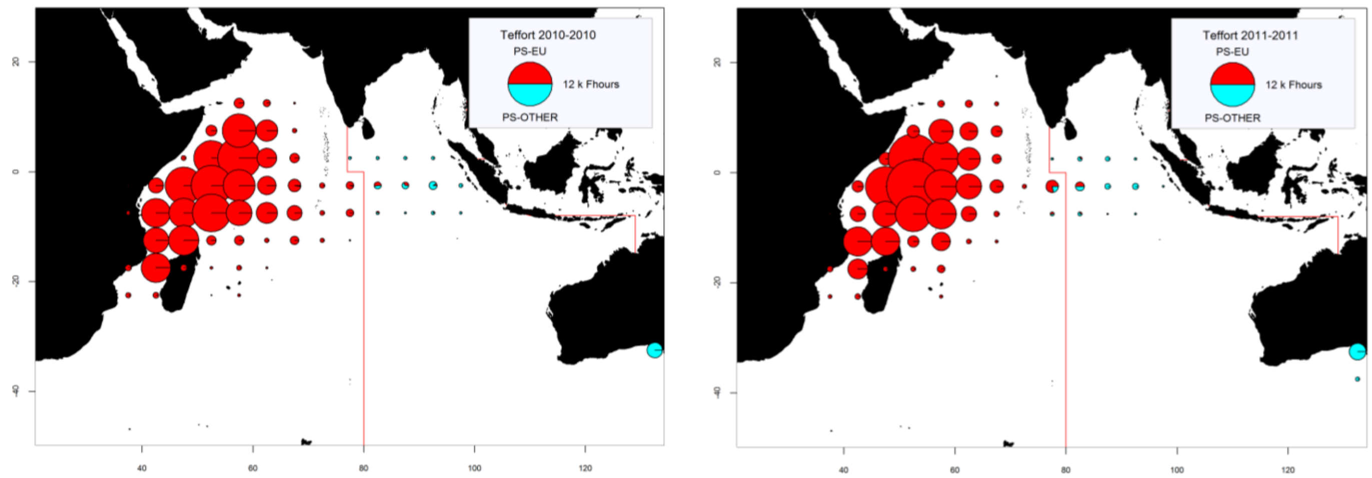


Fig. 6. Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

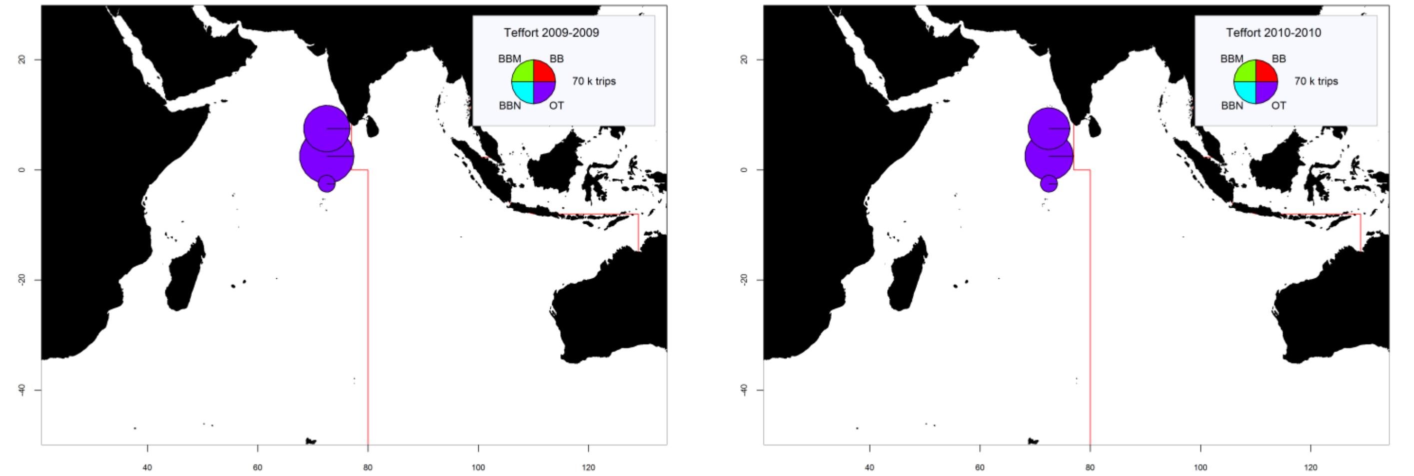


Fig. 7. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of September 2012)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): Unclassified gears
Note that the above maps were derived using the available catch-and-effort data in the IOTC database, which is limited to the number of baitboat calls (trips) by atoll by month for Maldivian baitboats for the period concerned. Note that some trips may be fully devoted to handlining, trolling, or other activities (data by gear type are not available since 2002). No data are available for the pole-and-line fisheries of India (Lakshadweep) and Indonesia.

Skipjack tuna – Standardised catch–per–unit–effort (CPUE) trends

The CPUE series available for assessment purposes are listed below, although only the standardised pole-and-line series from 2004 to 2009 was used in the stock assessment model for 2012. The other two series were explored (shown in Fig. 8).

- Maldives nominal pole and line: 1970–2003 from document IOTC–2012–WPTT14–29 Rev_1.
- Maldives standardised pole-and-line: (2004–2009): Series1 (PL – preferred) from document IOTC–2011–WPTT13–29 and 31 and IOTC–2012–WPTT14–29 Rev_1.
- EU,France purse seine free school data (1991–2010): Series from document IOTC–2011–WPTT13–20 and IOTC–2012–WPTT14–29 Rev_1. This series was not used in the assessment because it was not standardised and likely subject to problems as noted in the sections above.

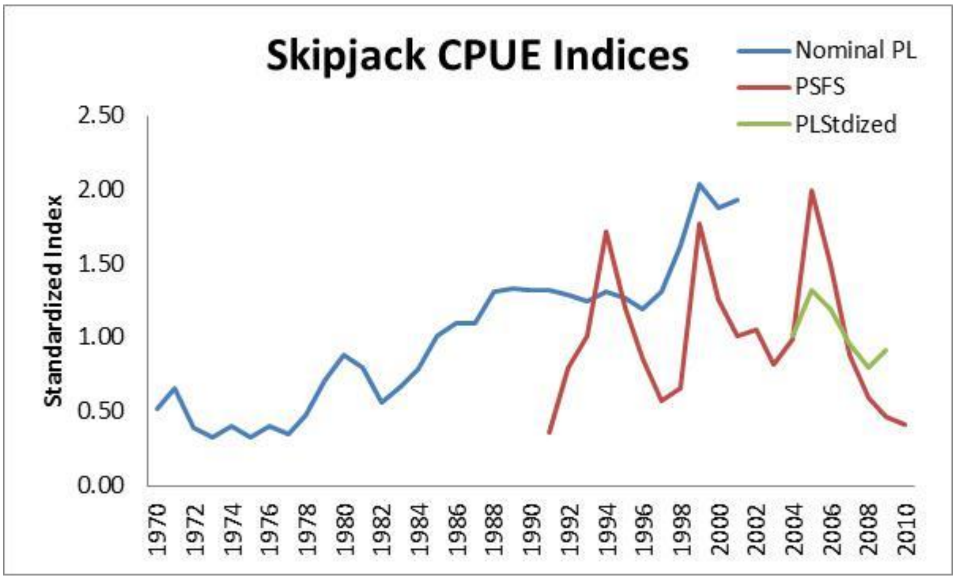


Fig. 8. Skipjack tuna: CPUE Indices based on different fisheries, and methods examined

The EU purse seine free-school CPUE is not a good indicator of the skipjack tuna population abundance as this fishery is seasonal and mainly located in the Mozambique Channel. As such, it would not be as representative as the

Maldivian pole-and-line CPUE series of the overall population abundance. The FAD-associated school purse seine fishery should be used in future assessments which may better represent the abundance index trends of the population.

Skipjack tuna: Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Trends in average weight cannot be assessed before the mid-1980s and are incomplete for most artisanal fisheries thereinafter, namely hand lines, troll lines and many gillnet fisheries (Indonesia) (Fig. 9).

Catch-at-Size table: CAS are available but the estimates are uncertain for some years and fisheries due to:

- the lack of size data before the mid-1980s
- the paucity of size data available for some artisanal fisheries, notably most hand lines and troll lines (Madagascar, Comoros) and many gillnet fisheries (Indonesia, Sri Lanka).

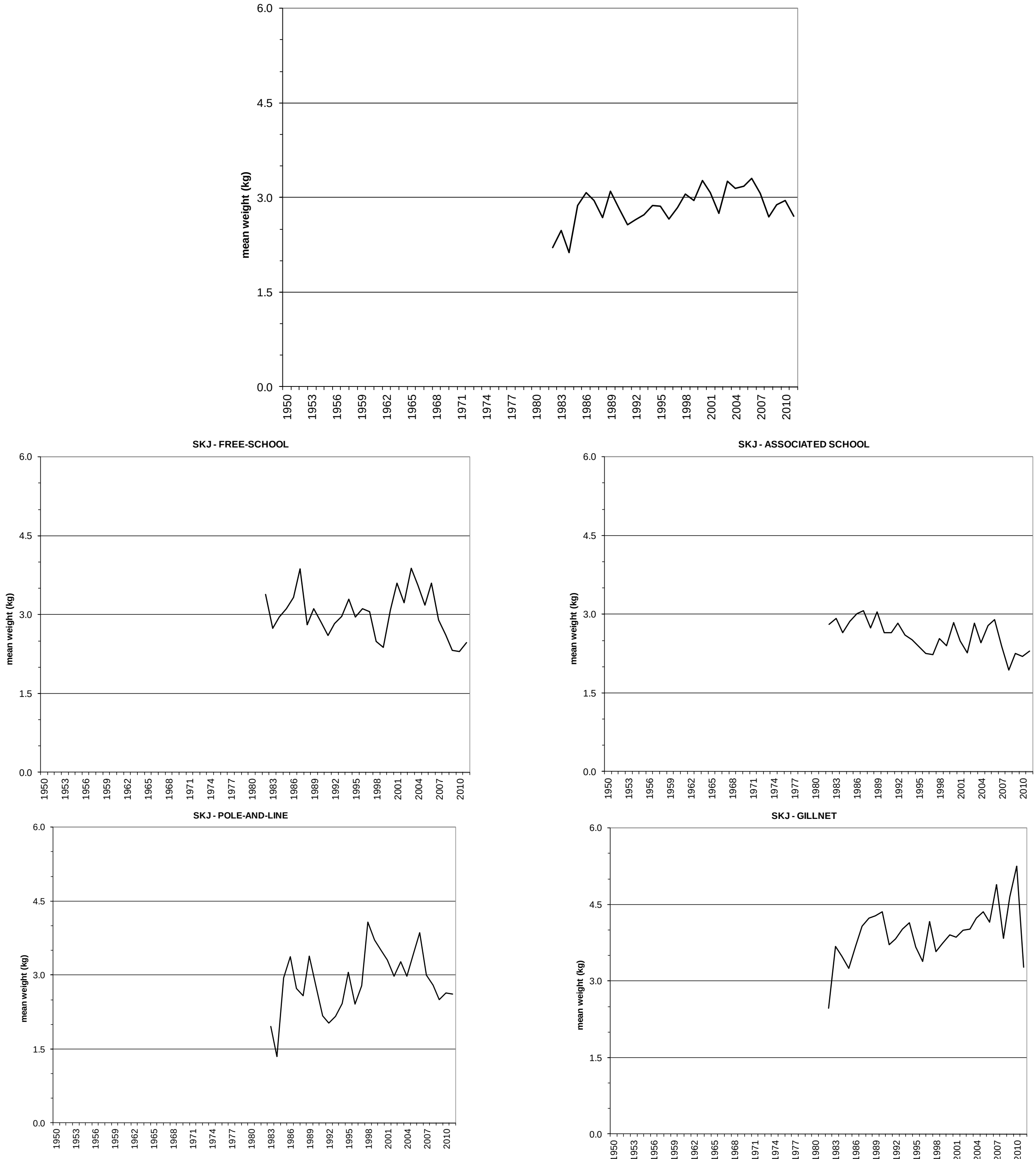


Fig. 9. Skipjack tuna: Changes in average weight (kg) of skipjack tuna from 1950 to 2011 – all fisheries combined (top) and by main fleet (Data as of September 2012)

Skipjack tuna – Tagging data

A total of 101,212 skipjack (representing 50.2% of the total number of fish tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of them, 77.4%, were released during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were released around Seychelles, in the Mozambique Channel and off the coast of Tanzania, between May 2005 and September 2007 (Fig. 10). The remaining were tagged during small-scale tagging projects, and by other institutions with the support of IOTC, around the Maldives, India, and in the south west and the eastern Indian Ocean. To date, 15,729 (15.5%), have been recovered and reported to the IOTC Secretariat. Around 78% of the recoveries were from the purse seine fleets operating from the Seychelles, and around 20% by the pole-and-line vessels mainly operating from the Maldives. The addition of the data from the past projects in the Maldives (in 1990s) added 14,506 tagged skipjack tuna to the databases, or which 1,960 were recovered mainly in the Maldives.

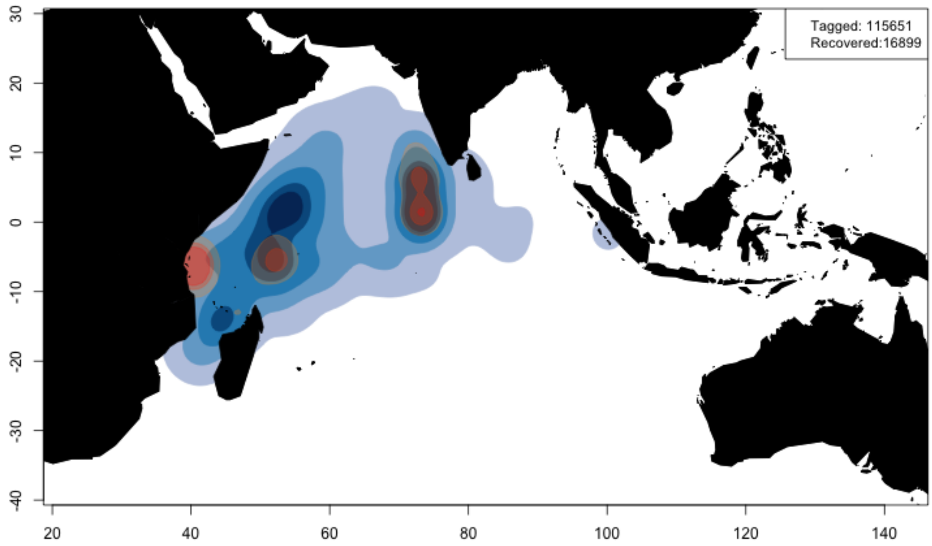


Fig. 10. Skipjack tuna: Densities of releases (in red) and recoveries (in blue) (Data as of September 2012)

STOCK ASSESSMENT

Despite the difficulties facing the assessment of skipjack tuna in the Indian Ocean, the comparison of various fishery indicators with their historical levels may provide a basis to infer the status of the stock in the absence of traditional reference points. However, the interpretation of the fishery indicator trends should take into account several caveats and incorporate expert knowledge.

In general the indicators obtained for skipjack tuna in this study are partially conflicting and highly variable. The average size indicators from the purse seine fleets have dropped for both free and associated schools in recent years. In the long term, however, there does not appear to be an overall major change in mean weight. For the pole-and-line fishery, the average weight indices have also been decreasing over the last three years. However, the gillnet fishery showed an increasing trend during recent years.

The catch rates on associated schools are increasing for both the EU,Spain and EU,France fleets. It is difficult to interpret these results, however, it seems that the increase in catch rate is associated with a decrease in effort which could be interpreted as a positive signal. It is possible that the high catch rates for associated schools may be caused by hyperstability (i.e. the aggregating effect of the FADs is masking decreasing population numbers), which is not relevant for free schools of tuna.

The advice on the status of skipjack tuna in 2012 was derived from models using an integrated statistical assessment method from 2011 and 2012. Model formulations were explored to ensure that various plausible sources of uncertainty were explored and represented in the final result. In general, the data did not seem to be sufficiently informative to justify the selection of any individual model, and the results of different model runs were presented.

Table 5. Skipjack tuna: Key management quantities from the 2012 SS3 assessment, for the aggregate Indian Ocean

Management Quantity	**Aggregate Indian Ocean**
2011 catch estimate	398,240 t
Mean catch from 2007–2011	435,527 t
MSY (95% CI)	478,190 t (358,900–597,500 t)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (95% CI)	0.80 (0.68–0.92)
B_{2011}/B_{MSY}	–
SB_{2011}/SB_{MSY} (95% CI)	1.2 (1.01–1.43)
B_{2011}/B_0	–
SB_{2011}/SB_0 (95% CI)	0.45 (0.25–0.65)
$B_{2011}/B_{1950,\ F=0}$	–
$SB_{2011}/SB_{1950,\ F=0}$	0.45 (0.25–0.65)

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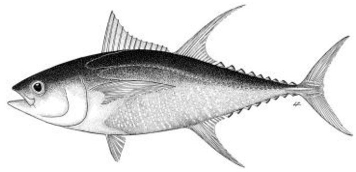
APPENDIX XII
EXECUTIVE SUMMARY: YELLOWFIN TUNA

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



Status of the Indian Ocean yellowfin tuna (YFT: *Thunnus albacares*) resource

TABLE 1. Yellowfin tuna: Status of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean

Area[1]	**Indicators**			**2012 stock status determination**
Indian Ocean	Catch 2011: Average catch 2007–2011:	302,939 t 302,064 t		
		Multifan	ASPM	
	MSY (1000 t):	344 t (290–453 t)	320 (283–358 t)	
	$F_{current}/F_{MSY}$:	0.69 (0.59–0.90)	0.61 (0.31–0.91)	
	$SB_{current}/SB_{MSY}$:	1.24 (0.91–1.40)	1.35 (0.96–1.74)	
	$SB_{current}/SB_0$:	0.38 (0.28–0.38)	-	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
* These values are obtained from the MFCL base case assessment.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The stock assessment model results for 2012 do not differ substantively from the previous (2011) assessment; however, the final overall estimates of stock status differ somewhat due to the refinement in the selection of the range of model options due to increased understanding of key biological parameters (primarily natural mortality). The stock assessment model used in 2012 suggests that the stock is currently not overfished (SB_{2010}>SB_{MSY}) and overfishing is not occurring (F_{2010}<F_{MSY}) (Table 1 and Fig. 1). Two trajectories are presented that compare the Kobe plots obtained from the MFCL and ASPM assessments. While the MFCL assessment indicates that fishing mortality is below the limit and target reference points during the whole time series, the ASPM model run indicates that the target reference points may have been exceeded during the period of high catches in the mid 2000's (2003–2006). However, estimates of total and spawning stock biomass show a marked decrease from 2004 to 2009 in both cases, corresponding to the very high catches of 2003–2006. Recent reductions in effort and, hence, catches resulted in a slight improvement in stock status in 2010. Spawning stock biomass in 2010 was estimated to be 38% (31–38%) (from Table 1) of the unfished levels.

The following key points should be noted:

- The Maximum Sustainable Yield estimate for the whole Indian Ocean is 344,000 t with a range between 290,000–453,000 t for MFCL; 320,000 t with a range between 283,000 and 358,000 t for ASPM (Table 1), and annual catches of yellowfin tuna should not exceed the lower range of MSY (300,000 t) in order to ensure that stock biomass levels could sustain catches at the MSY level in the long term.
- Recent recruitment estimated by MFCL is estimated to be considerably lower than the whole time series average. If recruitment continues to be lower than average, catches below MSY would be needed to maintain stock levels. However, although recent recruitment estimated by ASPM are similar to MFCL estimates, the ASPM recruitment trend are estimated to be at a lower level without any declining trend.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:

- **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
- **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).

Outlook (Based on MultifanCL). Estimates of stock status using 2011 data are not considered reliable in Multifan. The potential yields from the fishery have also declined over the last five years as an increased proportion of the catch is comprised of smaller fish, primarily from the purse seine FAD fishery. The main mechanism that appears to be behind the very high catches in the 2003–2006 period is an increase in catchability by surface and longline fleets due to a high level of concentration across a reduced area and depth range. This was likely linked to the oceanographic conditions at the time generating high concentrations of suitable prey items that yellowfin tuna exploited. A possible increase in recruitment in previous years, and thus in abundance, cannot be completely ruled out, but no signal of it is apparent in either data or model results. This means that those catches probably resulted in considerable stock depletion.

In an attempt to provide management advice independent of the MSY construct, the recent levels of absolute fishing mortality estimated from region 2 were compared to the natural mortality level. It is considered that the tagging data provides a reasonable estimate to fishing mortality for the main tag recovery period (2007–09). The estimates of fishing mortality for the main age classes harvested by the purse-seine fishery are considerably lower than the corresponding levels of natural mortality and on that basis, recent fishing mortality levels are not considered to be excessive.

The decrease in longline and purse seiner effort in recent years has substantially lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality has not exceeded the MSY-related levels in recent years. If the security situation in the western Indian Ocean were to improve, a rapid reversal in fleet activity in this region may lead to an increase in effort which the stock might not be able to sustain, as catches would then be likely to exceed MSY levels. Catches in 2010 (299,000 t) are within the lower range of MSY values The current assessment indicates that catches of about the 2010 level are sustainable, at least in the short term. However, the stock is unlikely to support substantively higher yields based on the estimated levels of recruitment from over the last 15 years.

In 2011, the WPTT undertook projections of yellowfin tuna stock status under a range of management scenarios for the first time, following the recommendation of both the Kobe process and the Commission, to harmonise technical advice to managers across RFMOs by producing Kobe II management strategy matrices. The purpose of the table is to quantify the future outcomes from a range of management options (Table 2). The table describes the presently estimated probability of the population being outside biological reference points at some point in the future, where "outside" was assigned the default definitions of $F>F_{MSY}$ or $SB<SB_{MSY}$. The timeframes represent 3 and 10 year projections (from the last data in the model), which corresponds to predictions for 2013 and 2020. The management options represent three different levels of constant catch projection: catches 20% less than 2010, equal to 2010 and 20% greater than 2010.

The projections were carried out using 12 different scenarios based on similar scenarios used in the assessment for the combination of those different MFCL runs: LL selectivity flat top vs. dome shape; steepness values of 0.7, 0.8 and 0.9; and computing the recruitment as an average of the whole time series vs. 15 recent years (12 scenarios). The probabilities in the matrices were computed as the percentage of the 12 scenarios being $SB>SB_{MSY}$ and $F<F_{MSY}$ in each year. In that sense, there are not producing the uncertainty related to any specific scenario but the uncertainty associated to different scenarios.

There was considerable discussion on the ability of the WPTT to carry out the projections with MFCL for yellowfin tuna. For example, it was not clear how the projection redistributed the recruitment among regions as recent distribution of recruitment differs from historic; which was assumed in the projections. The WPTT agreed that the true uncertainty is unknown and that the current characterization is not complete; however, the WPTT feels that the projections may provide a relative ranking of different scenarios outcomes. The WPTT recognised at this time that the matrices do not represent the full range of uncertainty from the assessments. Therefore, the inclusion of the K2SM at this time is primarily intended to familiarise the Commission with the format and method of presenting management advice.

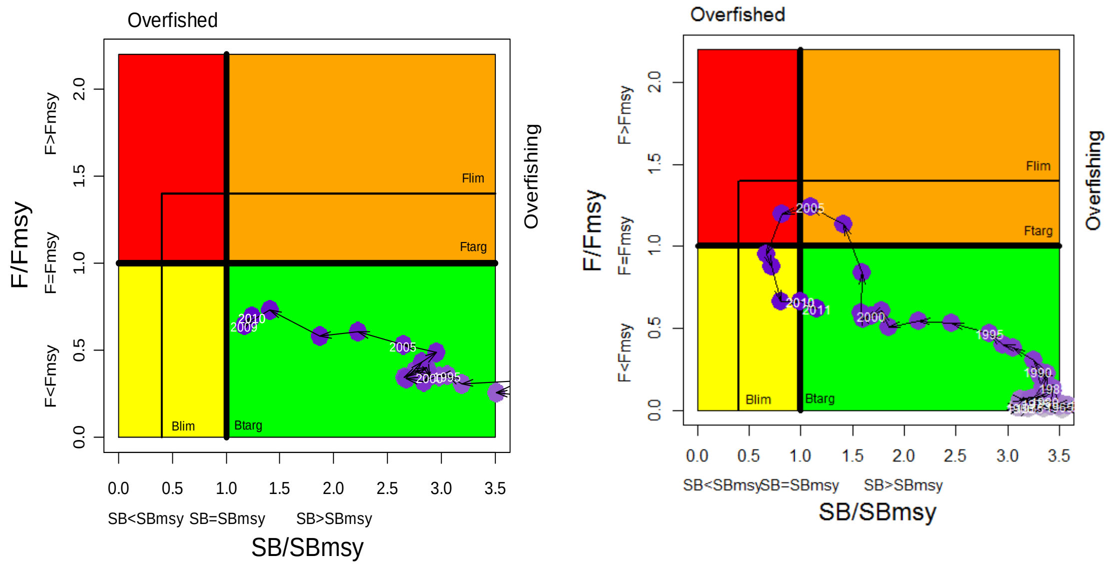


Fig. 1. Yellowfin tuna: MULTIFAN-CL Indian Ocean yellowfin tuna stock assessment Kobe plot. Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1972–2010 for a steepness value of 0.8. The left panel is output obtained from the base case run in MFCL. The right panel is obtained from the ASPM base case model run with steepness value of 0.9.

TABLE 2. Yellowfin tuna: 2011 MULTIFAN-CL Indian Ocean yellowfin tuna stock assessment Kobe II Strategy Matrix. Percentage probability of violating the MSY-based reference points for five constant catch projections (2010 catch level, ± 20% and ± 40%) projected for 3 and 10 years. In the projection, however, 12 scenarios were investigated: the six scenarios investigated above as well as the same scenarios but with a lower mean recruitment assumed for the projected period. Note: from the 2011 stock assessment using catch estimates at that time.

Reference point and projection timeframe	**Alternative catch projections (relative to 2010) and probability (%) of violating reference point**				
	60% (165,600 t)	**80%** (220,800 t)	**100%** (276,000 t)	**120%** (331,200 t)	**140%** (386,400 t)
$SB_{2013} < SB_{MSY}$	<1	<1	<1	<1	<1
$F_{2013} > F_{MSY}$	<1	<1	58.3	83.3	100
$SB_{2020} < SB_{MSY}$	<1	<1	8.3	41.7	91.7
$F_{2020} > F_{MSY}$	<1	41.7	83.3	100	100

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Tropical Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Yellowfin tuna (*Thunnus albacares*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and*

Cooperating Non-Contracting Parties

- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*
- Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.

FISHERIES INDICATORS

General

Yellowfin tuna *(Thunnusalbacares)* is a cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three major oceans, where it forms large schools. Table 3 outlines some of the key life history traits of yellowfin tuna relevant for management.

TABLE 3. Yellowfin tuna: Biology of Indian Ocean yellowfin tuna (*Thunnus albacares*)

Parameter	Description
Range and stock structure	A cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three major oceans, where it forms large schools. Feeding behaviour has been extensively studied and it is largely opportunistic, with a variety of prey species being consumed, including large concentrations of crustaceans that have occurred recently in the tropical areas and small mesopelagic fishes which are abundant in the Arabian Sea. It has also been observed that large individuals can feed on very small prey, thus increasing the availability of food for this species. Archival tagging of yellowfin tuna has shown that this species can dive very deep (over 1000 m) probably to feed on meso-pelagic prey. Longline catch data indicates that yellowfin tuna are distributed throughout the entire tropical Indian Ocean. The tag recoveries of the RTTP-IO provide evidence of large movements of yellowfin tuna, thus supporting the assumption of a single stock for the Indian Ocean. The average distance travelled by yellowfin between being tagging and recovered is 710 nautical miles, and showing increasing distances as a function of time at sea.
Longevity	9 years
Maturity (50%)	Age: females and males 3–5 years. Size: females and males 100 cm.
Spawning season	Spawning occurs mainly from December to March in the equatorial area (0-10°S), with the main spawning grounds west of 75°E. Secondary spawning grounds exist off Sri Lanka and the Mozambique Channel and in the eastern Indian Ocean off Australia.
Size (length and weight)	Maximum length: 240 cm FL; Maximum weight: 200 kg. Newly recruited fish are primarily caught by the purse seine fishery on floating objects. Males are predominant in the catches of larger fish at sizes than 140 cm (this is also the case in other oceans). The sizes exploited in the Indian Ocean range from 30 cm to 180 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack tuna and juvenile bigeye tuna and are mainly limited to surface tropical waters, while larger fish are found in surface and sub-surface waters. Intermediate age yellowfin tuna are seldom taken in the industrial fisheries, but are abundant in some artisanal fisheries, mainly in the Arabian Sea.

Sources: Froese & Pauly 2009

Yellowfin tuna – Fisheries and catch trends

Catches by gear, area, country and year from 1950 to 2011 are shown in Figs. 2, 3 and 4. Contrary to the situation in other oceans, the artisanal fishery component in the Indian Ocean is substantial, taking 20–30% of the total catch. Catches of yellowfin tuna remained more or less stable between the mid-1950s and the early-1980s, ranging between 30,000 and 70,000 t, owing to the activities of longliners and, to a lesser extent, gillnetters. The catches increased rapidly with the arrival of the purse seiners in the early 1980s and increased activity of longliners and other fleets, reaching over 400,000 t in 1993 (Table 4; Fig. 2). Catches of yellowfin tuna between 1994 and 2002 remained stable, between 330,000 and 350,000 t. Yellowfin tuna catches during 2003, 2004, 2005 and 2006 were much higher than in previous years with the highest catches ever recorded in 2004 (over 520,000 t) and average annual catch for the period at around 470,000 t. Yellowfin tuna catches dropped markedly after 2006, with the lowest catches recorded in 2009. Catch levels in 2011 are estimated to be at around 300,000 t, although they represent preliminary figures.

Table 4. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (2002–2011), in tonnes (Data as of September 2012). Catches by decade represent the average annual catch, noting that some gears were not used for all years

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
FS			18	32590	64942	89761	77,058	137,492	168,799	124,024	85,021	53,529	74,990	36,263	32,022	36,591
LS			17	18090	56304	61909	61,934	86,585	59,597	69,873	74,454	43,843	41,453	51,565	73,387	76,460
LL	21990	41257	29513	33889	66689	57032	53,125	55,727	86,597	117,324	70,388	51,240	25,973	20,014	18,139	19,027
LF			615	4286	47570	32955	34,425	31,290	31,303	34,083	30,741	30,642	29,675	22,776	24,390	26,152
BB	1795	1490	4693	6830	11005	15675	17,291	17,150	15,686	16,235	17,302	15,569	17,975	16,719	12,755	12,755
GI	2376	6838	11395	18560	54805	74081	57,363	82,354	101,902	85,053	88,414	68,543	73,437	70,918	91,722	85,754
HD	681	1170	2660	6823	18854	31346	33,857	31,379	39,337	36,824	30,126	30,438	30,036	24,914	20,600	20,612
TR	630	1066	3185	5489	10366	17929	13,828	13,272	19,824	14,545	17,299	22,238	28,225	24,271	24,545	24,909
OT	118	130	497	686	851	1165	670	1,170	1,581	1,286	1,546	1,228	1,564	1,036	747	679
Total	**27,589**	**51,951**	**52,593**	**127,242**	**331,386**	**381,854**	**349,551**	**456,419**	**524,626**	**499,247**	**415,291**	**317,270**	**323,328**	**268,476**	**298,307**	**302,939**

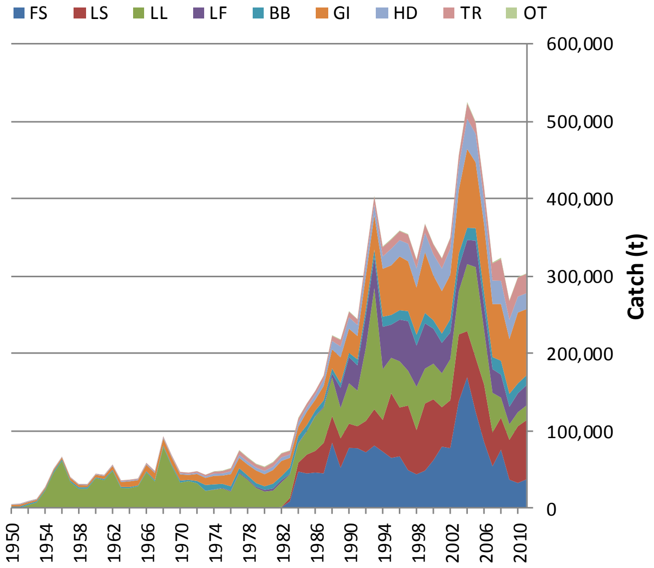
Purse seine free-school (FS); Purse seine associated school (LS); Deep-freezing longline (LL); Fresh-tuna longline (LF); Pole-and-Line (BB); Gillnet (GI); Hand line (HD); Trolling (TR); Other gears nei (OT)

Although some Japanese purse seiners have fished in the Indian Ocean since 1977, the purse seine (Figs. 2 and 3) fishery developed rapidly with the arrival of European vessels between 1982 and 1984. Since then, there has been an increasing number of yellowfin tuna caught, with a larger proportion of the catches made of adult fish, as opposed to bigeye tuna catches, of which the majority refers to juvenile fish. Purse seine vessels typically take fish ranging from 40 to 140 cm fork length (FL) and smaller fish are more common in the catches taken north of the equator. Catches of yellowfin tuna increased rapidly to around 130,000 t in 1993, and subsequently they fluctuated around that level, until 2003–05 when they were substantially higher (over or close to 200,000 t). The amount of effort exerted by the EU purse seine vessels (fishing for yellowfin tuna and other tunas) varies seasonally and from year to year.

The purse seine fishery is characterised by the use of two different fishing modes (Table 4; Fig. 2). The fishery on floating objects (FADs), which catches large numbers of small yellowfin tuna in association with skipjack tuna and juvenile bigeye tuna, and a fishery on free swimming schools, which catches larger yellowfin tuna on multi-specific or mono-specific sets. Between 1995 and 2003, the FAD component of the purse seine fishery represented 48–66% of the sets undertaken (60–80% of the positive sets) and accounted for 36–63% of the yellowfin tuna catch by weight (59–76% of the total catch). The proportion of yellowfin tuna caught (in weight) on free-schools during 2003–06 (64%) was much higher than in previous or following years (at around 50%).

The longline fishery (Table 4; Figs. 2 and 3) started in the early 1950's and expanded rapidly over throughout the Indian Ocean. Longline gear mainly catches large fish, from 80 to 160 cm FL, although smaller fish in the size range 60 – 100 cm (FL) have been taken by longliners from Taiwan,China since 1989 in the Arabian Sea. The longline fishery targets several tuna species in different parts of the Indian Ocean, with yellowfin tuna and bigeye tuna being the main target species in tropical waters. The longline fishery can be subdivided into a deep-freezing longline component (large scale deep-freezing longliners operating on the high seas from Japan, Korea and Taiwan,China) and a fresh-tuna longline component (small to medium scale fresh tuna longliners from Indonesia and Taiwan,China). The total longline catch of yellowfin tuna reached a maximum in 1993 (≈200,000 t). Catches between 1994 and 2004 fluctuated between 85,000 t and 120,000 t. The second highest catches of yellowfin tuna by longliners were recorded in 2005 (≈150,000 t). As was the case for the purse seine fleets, since 2005 longline catches have declined with current catches estimated to be at around 45,000 t, representing a three-fold decrease from the catches taken in 2005. The SC believes that the recent drop in longline catches could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean, which has led to a marked drop in the levels of longline effort in one of the core fishing areas of the species (Fig. 5).

Catches by other gears, namely pole-and-line, gillnet, troll, hand line and other minor gears, have increased steadily since the 1980s (Table 4; Figs. 2 and 3). In recent years the total artisanal yellowfin tuna catch has been around 140,000–160,000 t, with the catch by gillnets (the dominant artisanal gear) at around 80,000 t. During the year 2004 the catches by artisanal gears attained its maximum over the time series, peaking at 180,000 t.



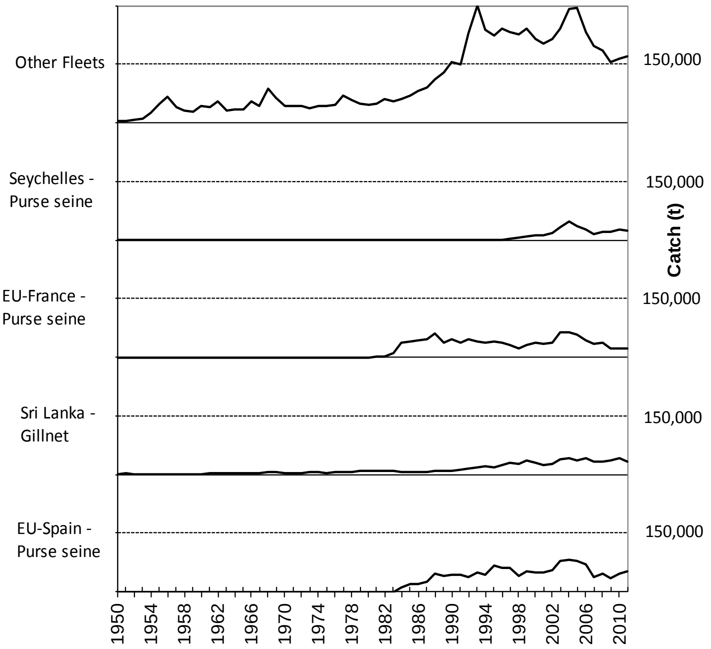


Fig. 2. Yellowfin tuna: Catches of yellowfin tuna by gear by year estimated for the WPTT (1950–2011). Data as of September 2012. Purse seine free-school (FS); Purse seine associated school (LS); Deep-freezing longline (LL); Fresh-tuna longline (LF); Pole-and-Line (BB); Gillnet (GI); Hand line (HD); Trolling (TR); Other gears nei (OT)

Fig. 3. Yellowfin tuna: Catches of yellowfin tuna by fleet by year estimated for the WPTT (1950–2011) (Data as of September 2012)

Yellowfin tuna catches in the Indian Ocean during 2003, 2004, 2005 and 2006 were much higher than in previous years (Fig. 2), while bigeye tuna catches remained at their average levels. Purse seiners currently take the bulk of the yellowfin tuna catch, mostly from the western Indian Ocean (Table 5) around Seychelles and off Somalia (R2) and Mozambique Channel (R3); Fig. 5). In 2003 and 2004, total catches by purse seine vessels in this area were around 225,000 t — about 50% more than the previous largest purse seine catch, which was recorded in 1995. Similarly, artisanal yellowfin tuna catches have been near their highest levels and longliners have reported higher than normal catches in the tropical western Indian Ocean during this period.

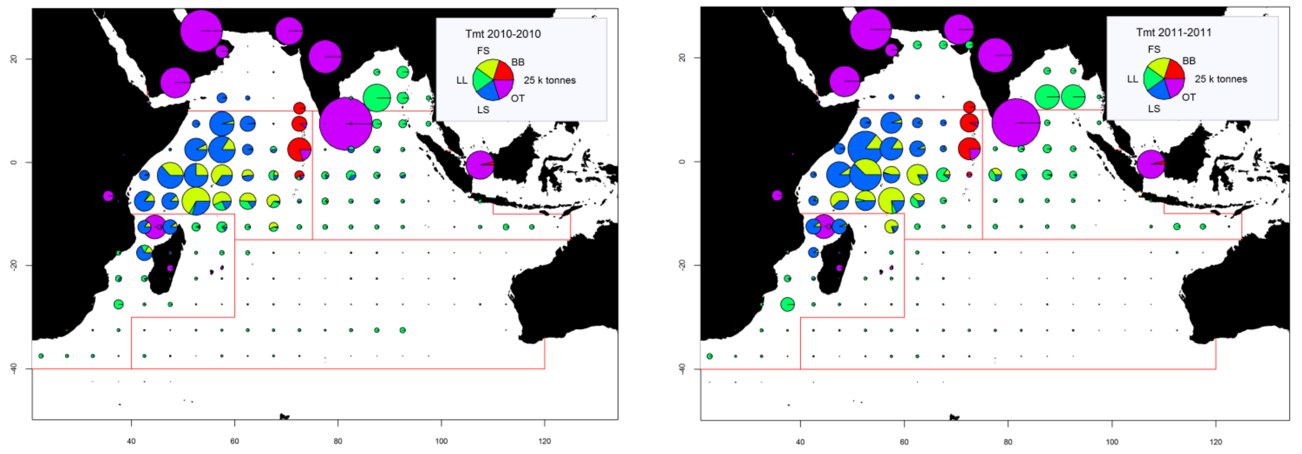


Fig. 4. Time-area catches (total combined in tonnes) of yellowfin tuna estimated for 2010 (left) and 2011 (right) by gear. Longline (LL), Purse seine free-schools (FS), Purse seine associated-schools (LS), pole-and-line (BB), and other fleets (OT), including drifting gillnets, and various coastal fisheries. Data as of September 2012. The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from Iran and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Yemen, Oman, Comoros, Indonesia and India

Table 5. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by area by decade (1950–2009) and year (2002–2011), in tonnes. Data as of September 2012. Catches by decade represent the average annual catch. The areas are presented in Fig. 5

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
R1	1,912	4,502	7,506	18,021	79,714	90,252	81,265	90,744	134,533	136,556	106,021	80,660	75,150	60,035	68,998	71,660
R2	11,869	23,064	21,137	73,042	135,201	175,180	154,305	254,089	261,289	240,184	189,622	122,182	132,649	100,288	110,034	116,774
R3	643	7,299	4,169	7,470	24,425	27,828	28,634	25,251	29,579	28,471	28,019	28,909	27,011	25,864	25,407	25,817
R4	997	1,919	1,639	1,321	3,555	3,503	4,618	4,255	5,878	4,780	3,218	1,349	1,449	1,501	1,866	1,707
R5	12,169	15,168	18,142	27,389	88,491	85,092	80,728	82,082	93,348	89,252	88,409	84,166	87,076	80,792	92,002	86,977
Total	**27,590**	**51,953**	**52,592**	**127,243**	**331,386**	**381,855**	**349,550**	**456,420**	**524,627**	**499,242**	**415,289**	**317,267**	**323,336**	**268,479**	**298,307**	**302,935**

Areas: Arabian Sea (R1); Off Somalia (R2); Mozambique Channel (R3); South Indian Ocean (R4); East Indian Ocean (R5). See Fig. 22 for areas. Totals from Table 3 and 4 may differ, due to rounding

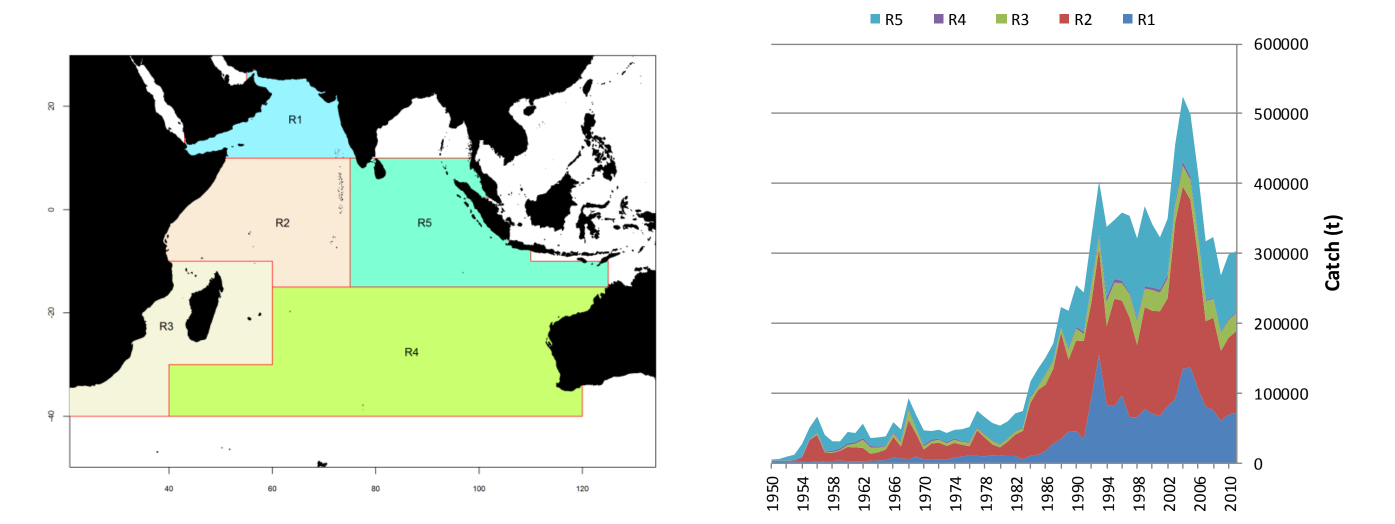


Fig. 5. Yellowfin tuna: Catches of yellowfin tuna by area (left) by year (right) estimated for the WPTT (1950–2011) (Data as of September 2012). Catches outside the areas presented in the Map were assigned to the closest neighbouring area. Arabian Sea (**R1**); Off Somalia (**R2**); Mozambique Channel (**R3**); South Indian Ocean (**R4**); East Indian Ocean (**R5**)

In recent years the catches of yellowfin tuna in the western Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya and Tanzania and in particular between 2007 and 2011 (Fig. 6). The drop in catches is the consequence of a drop in fishing effort due to the effect of piracy in the western Indian Ocean region. Even though the activities of purse seiners have been affected by piracy in the Indian Ocean, the effects have not been as marked as with longliners, for which current levels of effort are close to nil in the area impacted by piracy. The main reason for this is the presence of security personnel onboard purse seine vessels of the EU and Seychelles, which has made it possible for purse seiners under these flags to continue operating in the northwest Indian Ocean.

Yellowfin tuna – uncertainty of catches

Retained catches: Generally well known (Fig. 6); however, catches are less certain for:

- many coastal fisheries, notably those from Indonesia, Sri Lanka, Yemen, Madagascar, and Comoros
- the gillnet fishery of Pakistan
- non-reporting industrial purse seiners and longliners (NEI), and longliners of India.

Discard levels: Believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–07.

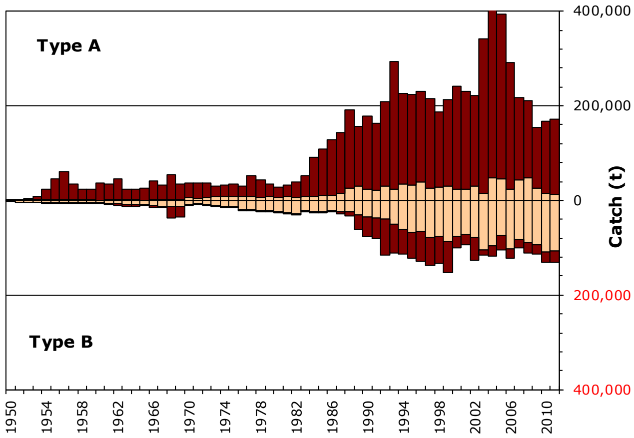


Fig. 6. Yellowfin tuna: Uncertainty of annual catch estimates for yellowfin tuna (Data as of September 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets

Changes to the catch series: There have not been significant changes to the total catches of yellowfin tuna since the WPTT in 2011.

However, the IOTC Secretariat used new information compiled during 2011–12 to rebuild the catch series for the coastal fisheries operated in some countries, in particular Madagascar, Sri Lanka, and India. In general, the new catches of yellowfin tuna estimated by the IOTC Secretariat are lower than those used in the past by the WPTT.

CPUE Series: Catch-and-effort data are available from the major industrial and artisanal fisheries. However, these data are not available for some important fisheries or they are considered to be of poor quality for the following reasons:

- no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006
- no data are available for the gillnet fisheries of Iran and Pakistan
- the poor quality effort data for the significant gillnet/longline fishery of Sri Lanka
- no data are available from important coastal fisheries using hand and/or troll lines, in particular Yemen, Indonesia, Madagascar and Comoros.

Yellowfin tuna – Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2010 and 2011 are provided in Fig. 7, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2010 and 2011 are provided in Fig. 8. The total number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 and 2010 are provided in Fig. 9.

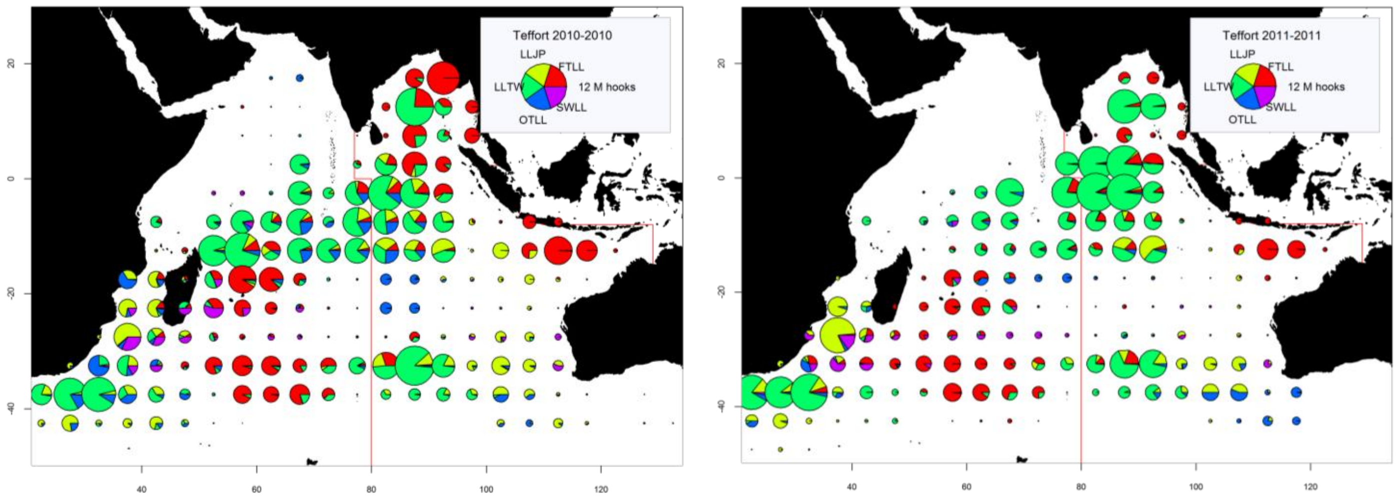


Fig. 7. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

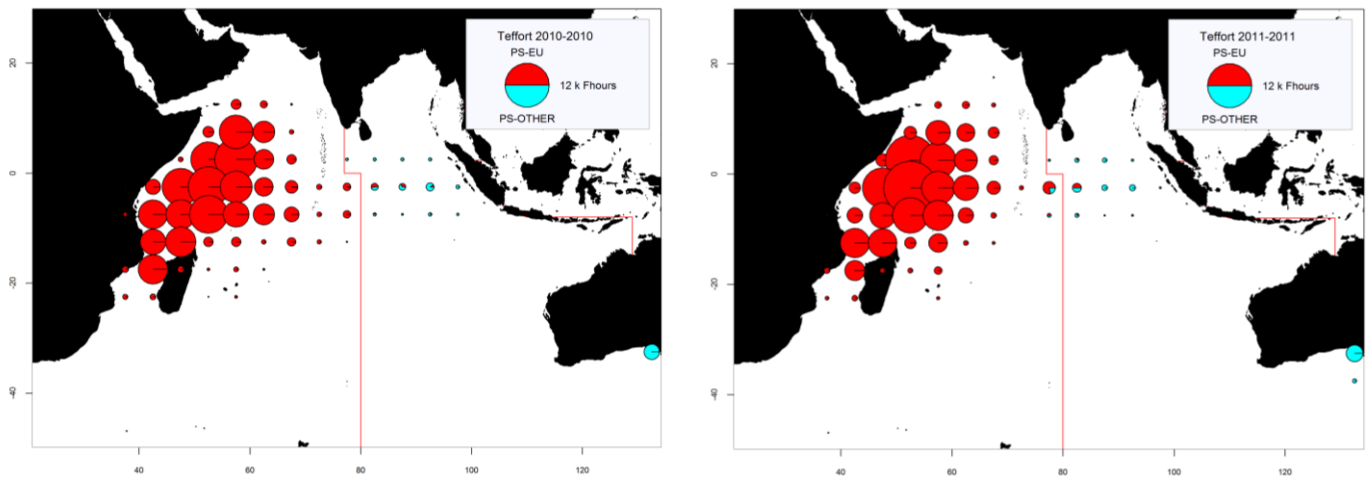


Fig. 8. Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

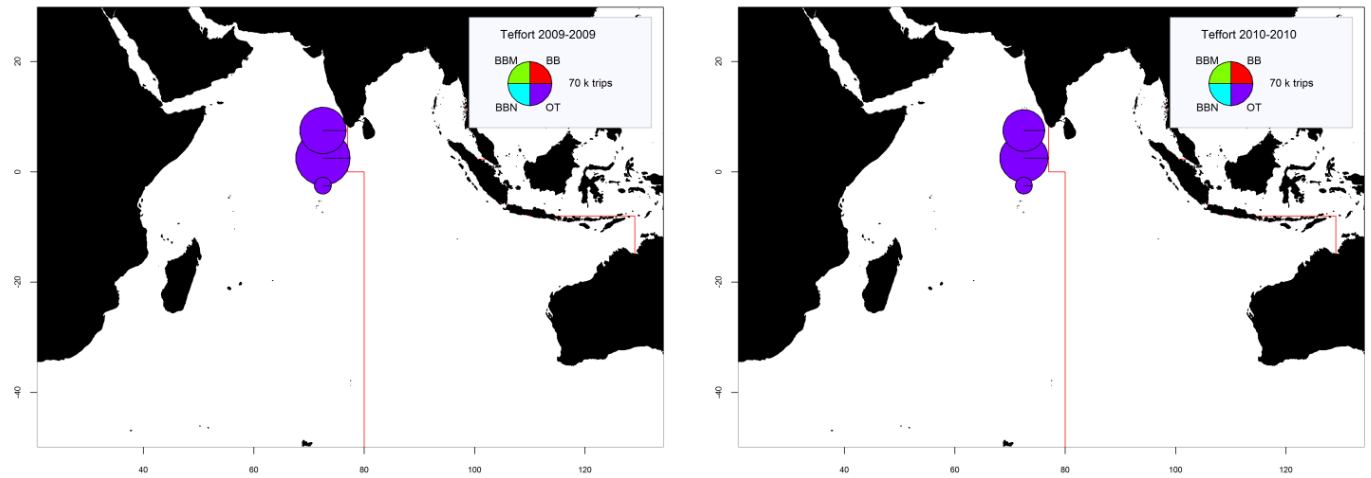


Fig. 9. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of September 2012)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): Unclassified gears
Note that the above maps were derived using the available catch-and-effort data in the IOTC database, which is limited to the number of baitboat calls (trips) by atoll by month for Maldivian baitboats for the period concerned. Note that some trips may be fully devoted to handlining, trolling, or other activities (data by gear type are not available since 2002). No data are available for the pole-and-line fisheries of India (Lakshadweep) and Indonesia

Yellowfin tuna – Standardised catch–per–unit–effort (CPUE) trends

For the longline fisheries (LL fisheries in regions 1–5; Fig. 10), CPUE indices were derived using generalised linear models (GLM) from the Japanese longline fleet (LL regions 2–5) and for the Taiwanese longline fleet (LL region 1) to be used in the stock assessment. Standardised longline CPUE indices for the Taiwanese fleet were available for 1979–2008. The GLM analysis used to standardise the Japanese longline CPUE indices was refined for the 2011 and 2012 assessments to include a spatial (latitude*longitude) variable. The resulting CPUE indices were generally comparable to the indices derived from the previous model and were adopted as the principal CPUE indices for the 2012 assessment (Fig. 11). There is considerable uncertainty associated with the Japanese CPUE indices for region 2 in the most recent year (2010) and no CPUE indices are available for region 1 for 2009–10.

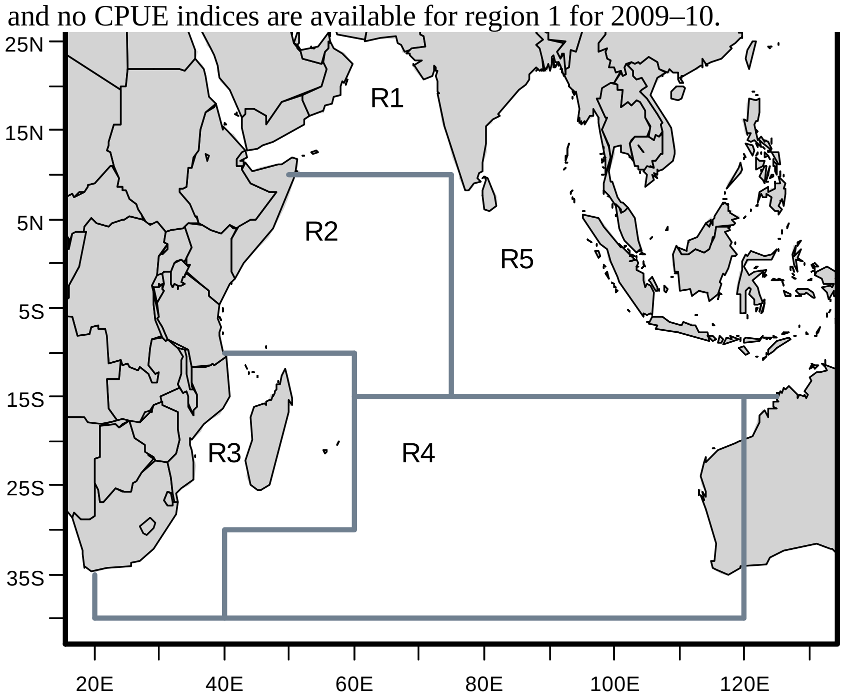


Fig. 10. Spatial stratification of the Indian Ocean for the MFCL assessment model

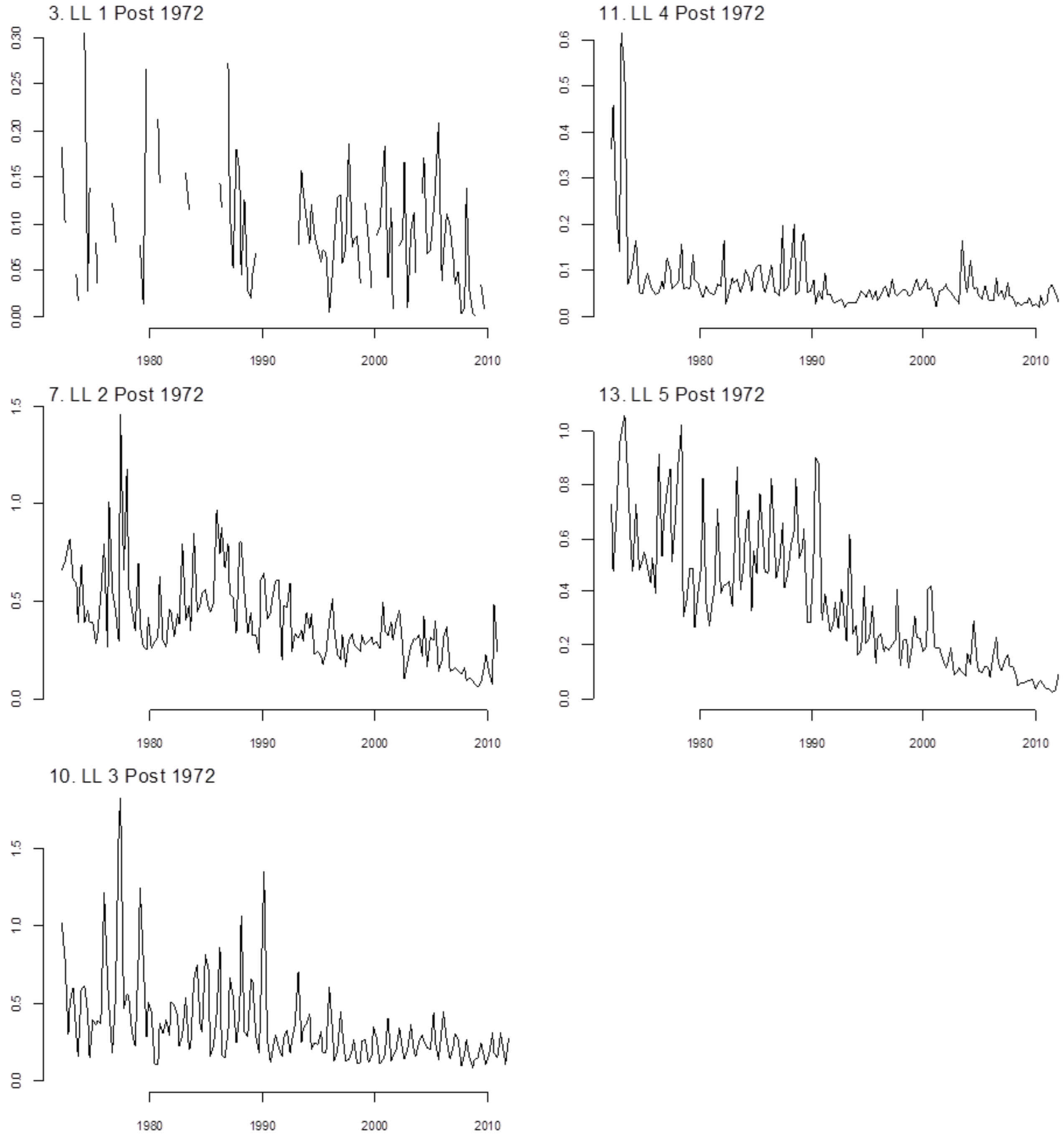


Fig. 11. Yellowfin tuna: Quarterly GLM standardised catch-per-unit-effort (CPUE) for the principal longline fisheries (LL 1 to 5) scaled by the respective region scalars.

Yellowfin tuna – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Trends in average weight: Can be assessed for several industrial fisheries but they are very incomplete or of poor quality for some fisheries, namely hand lines (Yemen, Comoros, Madagascar), troll lines (Indonesia) and many gillnet fisheries (Fig. 12).

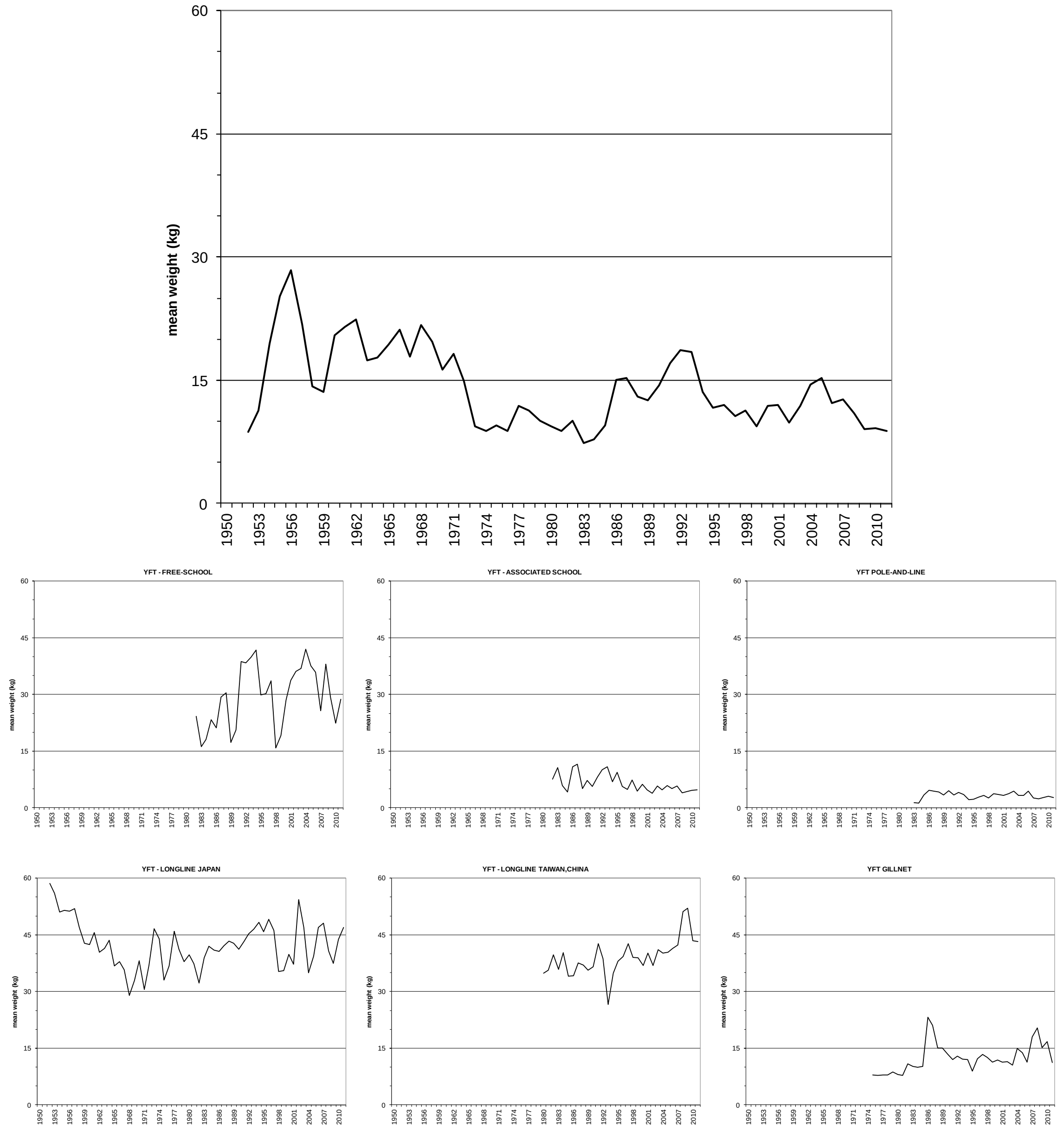


Fig. 12. Yellowfin tuna: Changes in average weight (kg) of yellowfin tuna from 1950 to 2011 – all fisheries combined (top) and by main fleet (Data as of September 2012)

Catch-at-Size table: This is available although the estimates are more uncertain in some years and some fisheries due to:

- size data not being available from important fisheries, notably Yemen, Pakistan, Sri Lanka and Indonesia (lines and gillnets) and Comoros and Madagascar (lines)
- the paucity of size data available from industrial longliners from the late-1960s up to the mid-1980s, and in recent years (Japan and Taiwan,China)
- the paucity of catch by area data available for some industrial fleets (NEI, Iran, India, Indonesia, Malaysia).

Yellowfin tuna – tagging data

A total of 63,328 yellowfin tuna (representing 31.4% of the total number of specimens tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of them (86.4%) were released during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were released around Seychelles, in the Mozambique Channel, along the coast of Oman and off the coast of Tanzania, between May 2005 and September 2007 (Fig. 13). The remaining were tagged during small-scale tagging projects, and by other institutions with the support of IOTC Secretariat, in Maldives, India, and in the south west and the eastern Indian Ocean. To date, 10,662 (16.8%), have been recovered and reported to the IOTC Secretariat. More than 87% of these recoveries we made by the purse seine fleets operating in the Indian Ocean, while around 8.5% were made by pole-and-line and less than 1% by longline vessels. The addition of the data from the past projects in the Maldives (in 1990s) added 3,211 tagged skipjack to the databases, or which 151 were recovered, mainly from the Maldives.

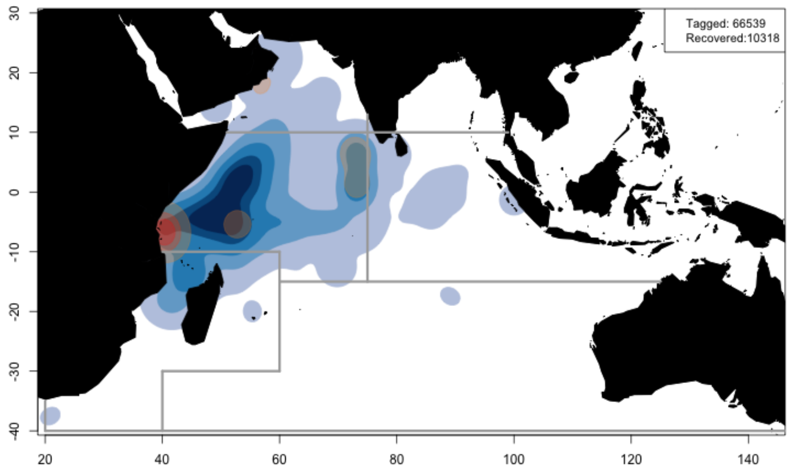


Fig. 13. Yellowfin tuna: Densities of releases (in red) and recoveries (in blue). The red line represents the stock assessment areas (Data as of September 2012)

STOCK ASSESSMENT

A range of quantitative modelling methods were applied to the yellowfin tuna assessment in 2012, ranging from the non-spatial, age-structured production model (ASPM) to the age and spatially-structured MULTIFAN-CL and SS3 analysis. The different assessments were presented to the WPTT in documents IOTC–2012–WPTT14–38, 39 and 40 Rev_2.

Management advice for yellowfin tuna is based on the 2012 MFCL stock assessment based upon the base case analysis with short term recruitment with alternative steepness of the stock-recruitment relationship of 0.7, 0.8 and 0.9 (Table 6) and the ASPM based case using steepness of 0.9. A major limitation of the ASPM model is that it is not spatially structured and thus does not allow the internal incorporation of tagging data, although it does externally by using the improved catch-at-age table and natural mortality estimates based on tagging data.

The following is worth noting with respect to the MFCL (MULTIFAN-CL) modelling and estimation approach used in 2012:

- The main features of the model in the 2012 assessment included a fixed growth curve (with variance) with an inflection, an age-specific natural mortality rate profile (M), the modelling of 25 fisheries including the separation of two purse seine fisheries into three time blocks, using logistic and cubic spline functions to estimate longline selectivities, separation of the analysis into five regions of the Indian Ocean as well as the three steepness parameters for the stock recruitment relationship (h=0.7, 0.8 and 0.9).
- In addition to another year of data, the 2012 assessment included several changes to the previous assessment: the longline CPUE indices were modified (Japanese updated with latest year which included information about latitude and longitude in the standardisation process for Regions 2–5 was supplied except for Region 2 in 2011; no update was available for the Taiwan,China index for Region 1; All of the analyses were conducted using a new version of MFCL provided by the Secretariat of the Pacific Community.

The problems identified in the catch data from some fisheries, and especially on the length frequencies in the catches of various fleets, a very important source of information for stock assessments. Length frequency data is almost unavailable for some fleets, while in other cases sample sizes are too low to reliably document changes in abundance and selectivity by age. Moreover, in general, catch data from some coastal fisheries is considered as poor.

The results of the MFCL model were studied in detail to improve the understanding of the estimated population dynamics and address specific properties of the model that were inconsistent with the general understanding of the yellowfin tuna stock and fisheries. The main issues identified are as follows:

- The model estimates a strong temporal decline in recruitment and in biomass within the eastern equatorial region (Region 5). This declining trend in recruitment is driven by the decline in the Japanese longline CPUE indices over the model period. There are limited data to reliably estimate recruitment in the region as the size data included in the model are considered uninformative. Consequently, the resulting recruitment and biomass trends may be unreliable. A participant noted that during this period the Taiwan,China longline fleet, a fleet more active than the Japanese longline fleet in this area, showed a stable nominal CPUE trend and high stable catches.

- The model estimates limited movement between the two equatorial regions. This is consistent with the low number of tag recoveries from the eastern equatorial region, an area from where recovery rates are difficult to estimate but probably low. Nonetheless, the low movement rate is consistent with the oceanographic conditions that prevailed during the main tag recovery period (see papers IOTC–2012–WPTT14–9 and 31). The model assumes a constant movement pattern throughout the model period and estimated movement pattern may not persist under different oceanographic conditions.
- Similarly, movement rates between the western equatorial region and the Arabian Sea (Region 1) were estimated to be very low. Although various recoveries crossing the border limit of 10°N line in both directions may suggest a higher mixing rate, the observation is consistent with the tag release/recovery observations (few tag releases from Region 2 were recovered in Region 1 and vice versa). However, reporting rates of most fisheries operating in Region 1 are estimated to be low and this may underestimate the low mixing rate observed by the model.
- The model estimated that fishing mortality rates within the western equatorial region did not increase during 2002–2006 period to the extent that would be anticipated given the large increase in catch from the purse seine fishery during that period (on average 470,000 t: well above all estimated MSY values). The large increase of catch, previously described due mainly to a catchability increased, will suggest an expected corresponding increase in fishing mortality well above the level of F_{MSY}. The explanation for this is that the longline standardised CPUE remained relatively constant during the period of high purse seine catch and in the subsequent years. To fit to the longline CPUE indices during this period the model increases the level of recruitment in the period that precedes the high purse seine catches which may be considered unreliable. This recruitment pattern was evident in all model options. However, further examination of the size frequency data is warranted to confirm that this recruitment trend is consistent with the other fisheries data. The status of the yellowfin tuna stock assessed by the model during the period of very high catches (2003–2006), estimated to be in the middle of the green area of the Kobe plot, was questioned by some participants.

The final base model option for the 2012 assessment incorporated the 5–region spatial structure, full selectivity of the older age classes by the longline fishery and estimated (average) natural mortality within the MFCL model, and a period of 4 quarter for tag mixing. For sensitivity analysis, a tag mixing period of 2 quarters was also analysed. In both cases three values of steepness (0.7, 0.8 and 0.9) were considered plausible. The estimated level of natural mortality was considerably higher than the level of natural mortality assumed in previous assessments. However, the estimated level of natural mortality was generally consistent with an external analysis of the tag release/recovery data (IOTC–2012–WPTT14–32), especially for younger ages, and with levels of natural mortality assumed for the assessment of yellowfin tuna by other RFMOs.

Biomass was estimated to have declined to about the B_{MSY} level, while fishing mortality rates had remained well below the F_{MSY} level. The base model estimated recent (1997–2011) recruitment levels that were considerably lower (approximately 25%) than the long term level of recruitment. This resulted in an apparent inconsistency between the annual trend in MSY based fishing mortality and biomass reference points and the observed catch trajectory. Biomass was estimated to have declined to about the B_{MSY} level, while fishing mortality rates had remained well below the F_{MSY} level. This pattern was evident for the range of steepness values considered for the stock-recruitment relationship. The recruitment trend may be an artefact of the model as there are limited data to reliably estimate the time series of recruitment and, hence, the model has considerable freedom to estimate recruitments to account for the observed decline in the longline CPUE abundance trend. The resulting estimates of MSY (380,000–450,000 t) are considerably higher than levels of catch sustained from the fishery and are considered to be overly optimistic. Similarly, the corresponding estimates of stock status are considered to be highly uncertain or unreliable.

It is considered more appropriate to formulate stock status advice based on the more recent period of recruitment on the basis that the level of recruitment from the early period is highly uncertain and that, at least in the short-term, recruitment would be more likely to be in line with recent levels. Estimating the stock status based on the recent (average 1997–2011) recruitment level resulted in lower MSY values, levels of fishing mortality that were comparable to the base model, and a more optimistic level of biomass relative to B_{MSY}.

The potential yield from the stock from different harvesting patterns was investigated by comparing alternative age specific patterns of fishing mortality that corresponded to the estimated selectivity of the main fisheries. A shift in the strategy to exclusively harvest the stock by longline or free-school purse seine would result in a substantial increase (50%) in the overall yield from the fishery relative to current yields. Conversely, a harvest pattern consistent with the purse seine FAD based fishery would result in a large (42%) reduction in overall yields. A shift to a gillnet based harvest pattern had a neutral effect relative to current yield. This analysis simply illustrates the relative yield per recruit of the individual fisheries, however, the results are theoretical and do not consider the complex nature of the operation of this multi-gear/multi-species fishery or the practicalities of substantially changing the harvest pattern.

Table 6. Key management quantities from the MFCL assessment, for the agreed scenarios of yellowfin tuna in the Indian Ocean. The range values represent the point estimates of different scenarios analysis (6 scenarios showing long term and short term recruitment with three values of steepness as well as the sensitivity analysis with 2 quarter for tag mixing, long- and short term recruitment and 0.8 value of steepness). The range is described by the range values between those scenarios.

Management Quantity	**Indian Ocean**
2011 catch estimate	302,939 t
Mean catch from 2007–2011	302,064 t
MSY	344,000 t (290,000–453,000 t)
Data period used in assessment	1972–2011
F_{2010}/F_{MSY}	0.69 (0.59–0.90)
B_{2010}/B_{MSY}	1.28 (0.97–0.1.38)
SB_{2010}/SB_{MSY}	1.24 (0.91–1.40)
B_{2010}/B_0	n.a.
SB_{2010}/SB_0	0.38 (0.28–0.38)
$B_{2010}/B_{0,\ F=0}$	n.a.
$SB_{2010}/SB_{0,\ F=0}$	n.a.

LITERATURE CITED

Froese R, Pauly DE (2009) *FishBase*, version 02/2009, FishBaseConsortium, <www.fishbase.org>

APPENDIX XIII
EXECUTIVE SUMMARY: SWORDFISH

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

Status of the Indian Ocean swordfish (SWO: *Xiphias gladius*) resource

TABLE 1. Swordfish: Status of swordfish (*Xiphias gladius*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Catch 2011: Average catch 2007–2011:	19,631 t 21,870 t	
	MSY (4 models): F_{2009}/F_{MSY} (4 models): SB_{2009}/SB_{MSY} (4 models): SB_{2009}/SB_0 (4 models):	29,900–34,200 t 0.50–0.63 1.07–1.59 0.30–0.53	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. All models suggest that the stock is above, but close to a biomass level that would produce MSY and current catches are below the MSY level. MSY-based reference points were not exceeded for the Indian Ocean population as a whole ($F_{2009}/F_{MSY} < 1$; $SB_{2009}/SB_{MSY} > 1$). Spawning stock biomass in 2009 was estimated to be 30–53% (from Table 1; Fig. 1) of the unfished levels.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality would not reduce the population to an overfished state. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current levels until 2019 (<11% risk that $B_{2019} < B_{MSY}$, and <9% risk that $F_{2019} > F_{MSY}$) (Table 2). The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is 29,900–34,200 t (range of best point estimates from Table 2) and annual catches of swordfish should not exceed this estimate.
- if the recent declines in effort continue, and catch remains substantially below the estimated MSY of 30,000–34,000 t, then management measures are not required which would pre-empt current resolutions and planned management strategy evaluation. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.
- the Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- advice specific to the southwest region is provided below, as requested by the Commission.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
    a. **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, but below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
    b. **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).

TABLE 2. Swordfish: Aggregated Indian Ocean assessment - Kobe 2 Strategy Matrix, indicating a range of probabilities across four assessment approaches. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to 2009) and probability (%) of violating reference point				
	60% (12,502 t)	**80%** (16,670 t)	**100%** (20,837 t)	**120%** (25,004 t)	**140%** (29,172 t)
$B_{2012} < B_{MSY}$	0–4	0–8	0–11	2–12	4–16
$F_{2012} > F_{MSY}$	0–1	0–2	0–9	0–16	6–27
$B_{2019} < B_{MSY}$	0–4	0–8	0–11	0–13	6–26
$F_{2019} > F_{MSY}$	0–1	0–2	0–9	0–23	7–31

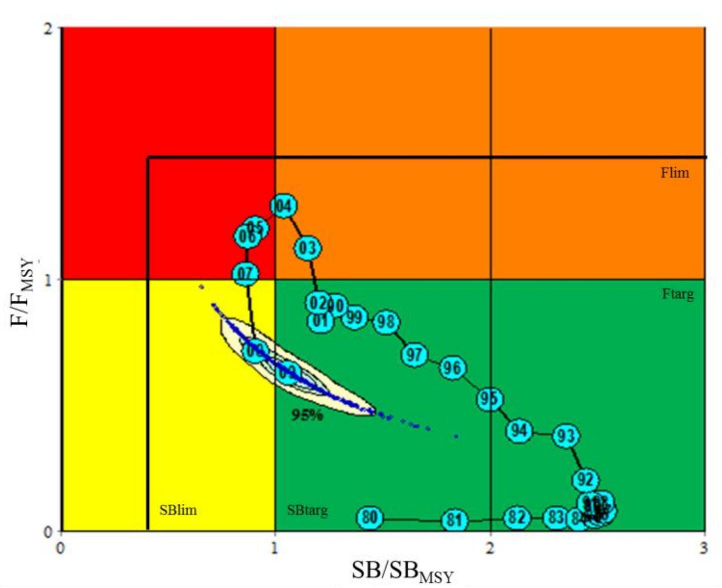


Fig. 1. Swordfish: ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2010. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown.

Indian Ocean Tuna Commission
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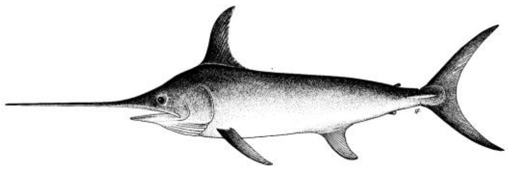


Status of the southwest Indian Ocean swordfish (SWO: *Xiphias gladius*) resource

TABLE 3. Swordfish: Status of swordfish (*Xiphias gladius*) in the southwest Indian Ocean

Area[1]	Indicators		2012 stock status determination
Southwest Indian Ocean	Catch 2011: Average catch 2007–2011:	6,559 t 6,939 t	
	MSY (3 models): F_{2009}/F_{MSY} (3 models): SB_{2009}/SB_{MSY} (3 models): SB_{2009}/SB_0 (3 models):	7,100 t–9,400 t 0.64–1.19 0.73–1.44 0.16–0.58	

[1]Boundaries for southwest Indian Ocean stock assessment are defined in IOTC–2011–WPB09–R.

Colour key	Stock overfished ($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing ($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

SOUTHWEST INDIAN OCEAN – MANAGEMENT ADVICE

Stock status. Most of the evidence provided to the WPB indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and biomass remains below the level that would produce MSY (B_{MSY}). Recent declines in catch and effort have brought fishing mortality rates to levels below F_{MSY} (Table 3). The catches of swordfish in the southwest Indian Ocean increased in 2010 to 8,046 t, which equals 120.5% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011. If catches are maintained at 2010 levels, the probabilities of violating target reference points in 2012 are less than 18% for F_{MSY} and less than 30% for B_{MSY} (Table 4), which is considered low.

Outlook. The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. However, in 2010, catches exceeded the maximum recommended by the WPB09 and SC14 in 2011 (6,678 t), with 8,046 t caught in this region. The WPB09 estimated that there is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at 2009 levels (<25% risk that $B_{2019} < B_{MSY}$, and <8% risk that F2019 > F_{MSY}). There is a risk of reversing the rebuilding trend if there is any increase in catch in this region (Table 4). The following key points should be noted:

- the Maximum Sustainable Yield estimate for the southwest Indian Ocean is 7,100–9,400 t (range of best point estimates from Table 3).
- catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,678t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.
- in 2010, catches have exceeded the maximum recommended by the WPB09 and SC14 (6,678 t), with 8,112 t caught in this region.
- the Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
    a. **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and thus, below the provisional limit reference point of $1.4*F_{MSY}$.
    b. **Biomass**: Current spawning biomass is considered to be below the target reference point of SB_{MSY}, and therefore, below the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).

TABLE 4. Swordfish: Southwest Indian Ocean assessment - Kobe 2 Strategy Matrix, indicating a range of probabilities across three assessment approaches. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and probability (%) of violating reference point**				
	60% (12,502 t)	**80%** (16,670 t)	**100%** (20,837 t)	**120%** (25,004 t)	**140%** (29,172 t)
$B_{2012} < B_{MSY}$	0–15	0–20	0–25	0–30	12–32
$F_{2012} > F_{MSY}$	0–1	0–5	0–8	0–18	13–34
$B_{2019} < B_{MSY}$	0–15	0–20	0–25	0–32	18–34
$F_{2019} > F_{MSY}$	0–1	0–5	0–8	0–18	19–42

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Swordfish in the Indian Ocean is currently subject to a single direct conservation and management measure adopted by the Commission: Resolution 12/11 *On The implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties.* This Resolution applies a freezing of fishing capacity for fleets targeting swordfish in the Indian Ocean to levels applied in 2007. The Resolution limits vessels access to those that were active (*effective presence*) or under construction during 2007, and were over 24 metres overall length, or under 24 meters if they fished outside the EEZs. At the same time the measure permits CPCs to vary the number of vessels targeting swordfish, as long as any variation is consistent with the national fleet development plan submitted to the IOTC, and does not increase effective fishing effort. This Resolution is effective for 2012 and 2013.

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/08 *Concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*.
- Resolution 11/04 *On a regional observer scheme*
- Resolution 12/03 *On the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *Concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *On The implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

General

Swordfish (*Xiphias gladius*) is a large oceanic apex predator that inhabits all the world's oceans (Fig. 2). Throughout the Indian Ocean, swordfish are primarily taken by longline fisheries, and commercial harvest was first recorded by the Japanese in the early 1950's as a bycatch/byproduct of their tuna longline fisheries. Swordfish life history characteristics, including a relatively late maturity, long life and sexual dimorphism, make the species vulnerable to over exploitation. Table 5 outlines some of the key life history traits of swordfish specific to the Indian Ocean.

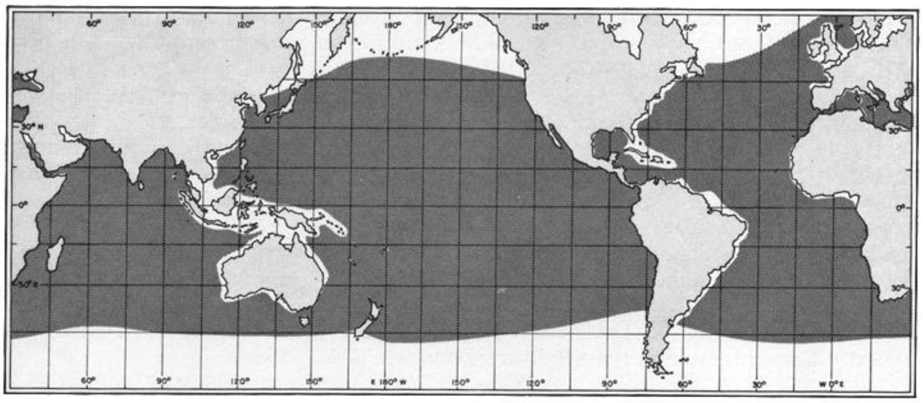


Fig. 2. Swordfish: The worldwide distribution of swordfish (Source: Nakamura 1984)

TABLE 5. Swordfish: Biology of Indian Ocean swordfish (*Xiphias gladius*)

Parameter	**Description**
Range and stock structure	Entire Indian Ocean down to 50˚S. Juvenile swordfish are commonly found in tropical and subtropical waters and migrate to higher latitudes as they mature. Large, solitary adult swordfish are most abundant at 15–35˚S. Males are more common in tropical and subtropical waters. By contrast with tunas, swordfish is not a gregarious species, although densities increase in areas of oceanic fronts and seamounts. Extensive diel vertical migrations, from surface waters during the night to depths of 1000 m during the day, in association with movements of the deep scattering layer and cephalopods, their preferred prey. A recent genetic study did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches. Results obtained from the markers used may simply be a matter of the resolving power of the markers used, which may simply have been insufficient for detecting population subdivision. Spatial heterogeneity in stock indicators (catch–per–unit–effort trends) indicates the potential for localised depletion of swordfish in the Indian Ocean.
Longevity	30+ years
Maturity (50%)	**Age**: females 6–7 years; males 1–3 years **Size**: females ~170 cm LJFL; males ~120 cm LJFL
Spawning season	Highly fecund batch spawner. May spawn as frequently as once every three days over a period of several months in spring. Known spawning ground and season are: tropical waters of Southern hemisphere from October to April, including in the vicinity of Reunion Island.
Size (length and weight)	Maximum: 455 cm lower-jaw FL; 550+ kg total weight in the Indian Ocean. Sexual dimorphism in size, growth rates and size and age at maturity - females reach larger sizes, grow faster and mature later than males. Most swordfish larger than 200 kg are female. Recruitment into the fishery: varies by fishing method; ~50 cm LJFL for longline fisheries. By one year of age, a swordfish may reach 90 cm lower-jaw FL (~15 kg). The average size of swordfish taken in Indian Ocean longline fisheries is between 40 kg and 80 kg (depending on latitude). L-W relationships for the Indian Ocean are: females TW=0.00002409*LJFL^2.86630, males TW=0.00006289*LJFL**2.66196, both sexes mixed TW=0.00001443*LJFL^2.96267. TW in kg, LJFL in cm

Sources: Froese & Pauly 2009, Muths et al. 2009, Poisson & Fauvel 2009, Bach et al. 2011, Romanov, Romanova, 2012

Swordfish: Catch trends

Swordfish are caught mainly using longlines (95%) and drifting gillnets (4%) (Table 6, Fig. 3). Between 1950 and 1980, catches of swordfish in the Indian Ocean slowly increased in tandem with the level of coastal state and distant water fishing nation longline effort targeting tunas and sharks (Figs. 3, 4). Swordfish were not targeted by industrial longline fisheries before the early 1990's, however with the introduction of night fishing using longlines baited with squid and light sticks, catches increased post 1990.

Since 2004, annual catches have declined steadily (Fig. 4), largely due to the continued decline in the number of active Taiwan,China longliners in the Indian Ocean (Fig. 5). Annual catches since 2004 have been dominated by the Taiwan,China and EU fleets (Spain, UK, France and Portugal), with the fishery extending eastward due to the effects of piracy actions (Fig. 5, Table 7).

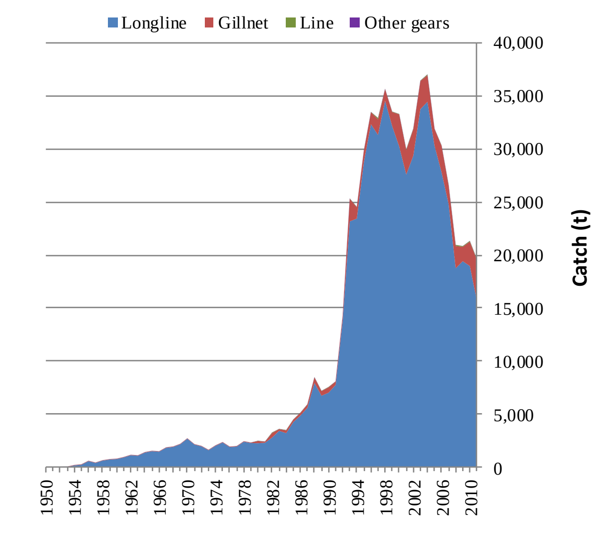


Fig. 3 Swordfish: Catches of swordfish per gear and year recorded in the IOTC database (1960–2011)

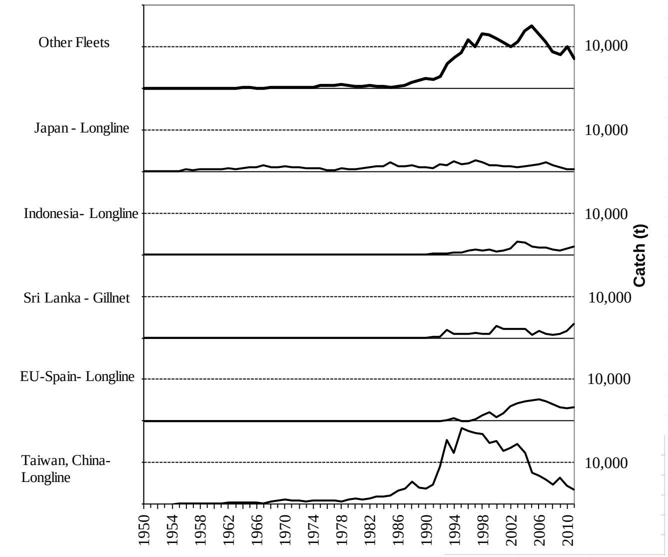


Fig. 4. Swordfish: Catches of swordfish by fleet recorded in the IOTC database (1960–2011)

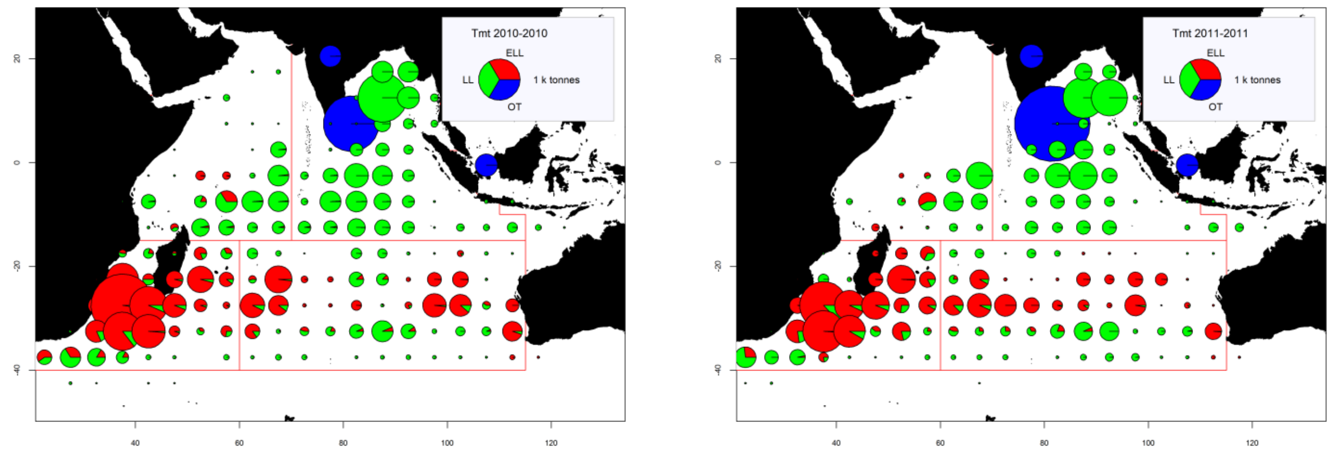


Fig. 5a–b. Swordfish: Time-area catches (total combined in tonnes) of swordfish as reported for the longline fleets of Japan (JPN), Taiwan,China (TWN), and EU-Spain (ESP), the latter directed at swordfish, for 2010 and 2011 by type of gear. Red lines represent the boundaries of the areas used for the assessments of swordfish (Data as of October 2012)

TABLE 6. Swordfish: Best scientific estimates of the catches of swordfish by type of fishery for the period 1950–2011 (in metric tons) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
ELL	-	-	-	9	1,846	9,998	8,903	9,470	12,740	14,966	12,998	11,534	8,196	8,155	9,518	7,790
LL	283	1,426	2,134	4,337	21,576	17,632	20,450	24,262	21,686	15,318	14,775	13,255	10,546	11,257	9,440	7,909
OT	41	42	47	319	1,097	2,288	2,560	2,693	2,578	1,615	2,546	1,823	2,203	1,425	2,369	3,932
Total	**323**	**1,468**	**2,181**	**4,665**	**24,519**	**29,918**	**31,913**	**36,424**	**37,004**	**31,900**	**30,319**	**26,612**	**20,945**	**20,837**	**21,327**	**19,631**

Fisheries: Swordfish longline (**ELL**); Other longline (**LL**); Other fisheries (**OT**)

TABLE 7. Swordfish: Best scientific estimates of the catches of swordfish by fishing area for the period 1950–2011 (in metric tons) (Data as of October 2012)

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
NW	85	534	637	1,444	7,195	9,362	12,066	14,622	11,928	10,694	10,001	8,080	5,916	3,649	2,025	1,260
SW	14	258	468	753	8,685	7,621	7,466	4,092	6,305	9,779	8,826	7,376	6,185	6,531	8,046	6,559
NE	187	467	750	2,098	5,653	6,787	5,988	8,278	8,401	5,176	6,919	5,913	5,269	7,551	7,446	8,472
SE	37	209	326	371	2,986	6,149	6,393	9,431	10,370	6,250	4,572	5,242	3,575	3,106	3,810	3,339
Total	**323**	**1,468**	**2,181**	**4,666**	**24,519**	**29,919**	**31,913**	**36,423**	**37,004**	**31,899**	**30,318**	**26,611**	**20,945**	**20,837**	**21,327**	**19,630**

Areas: Northwest Indian Ocean (NW); Southwest Indian Ocean (SW); Northeast Indian Ocean (NE); Southeast Indian Ocean (SE); Southern Indian Ocean (OT)

Swordfish: Uncertainty of time–area catches

Retained catches are fairly well known (Fig. 6); however catches are uncertain for:

- Drifting gillnet fisheries of Iran and Pakistan: To date, Iran has not reported catches of swordfish for its gillnet fishery. Although Pakistan has reported catches of swordfish they are considered to be too low for a driftnet fishery (catches of swordfish in recent years represent less than 2% of the total catches of swordfish in the Indian Ocean).
- Longline fishery of Indonesia: The catches of swordfish for the fresh tuna longline fishery of Indonesia may have been underestimated in recent years due to insufficient sampling coverage. Although the new catches estimated by the Secretariat are thought to be more accurate, swordfish catches remain uncertain, especially in recent years (where they represent around 6% of the total catches of swordfish in the Indian Ocean).
- Longline fishery of India: India has reported very incomplete catches and catch-and-effort data for its longline fishery. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of swordfish remain uncertain (catches of swordfish in recent years represent less than 3% of the total catches of swordfish in the Indian Ocean).
- Longline fleets from non-reporting countries (NEI): The Secretariat had to estimate catches of swordfish for a fleet of longliners targeting tunas or swordfish and operating under flags of various non-reporting countries. The catches estimated since 2006 are, however, low (they represent around 6% of the total catches of swordfish in the Indian Ocean).
- There have not been significant changes to the catch series of swordfish since the WPB in 2010. Changes since the last WPB refer to revisions of historic data series for the artisanal fisheries of Indonesia and India. These changes, however, did not lead to significant changes in the total catch estimates.
- Discards are believed to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of swordfish may also occur in the driftnet fishery of Iran, as this species has no commercial value in this country.

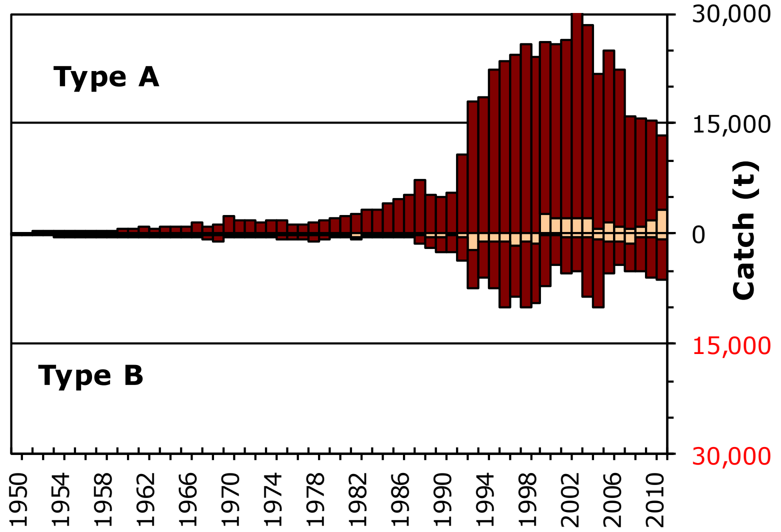


Fig. 6. Swordfish: Uncertainty of annual catch estimates for swordfish (Data as of October 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat),

do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets

Swordfish: Fish size or age trends (e.g. by length, weight, sex and/or maturity)

In general, the amount of catch for which size data for the species are available before 2005 is still very low and the number of specimens measured per stratum has been decreasing in recent years.

- Average fish weight (Fig. 7) can be assessed for several industrial fisheries although they are incomplete or poor quality for most fisheries before the early-80s and in recent years (low sampling coverage and time-area coverage of longliners from Japan). The average weights of swordfish are variable but show no clear trend. It is considered encouraging that there are no clear signals of declines in the size-based indices, but these indices should be carefully monitored, as females mature at a relatively large size, therefore, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.
- Catch-at-Size(Age) data are available but the estimates are thought to have been compromised for some years and fisheries due to:
  - the uncertainty in the catches of swordfish for the drifting gillnet fisheries of Iran and the fresh-tuna longline fishery of Indonesia.
  - the total lack of size data before the early-70s and poor coverage before the early-80s and for most artisanal fisheries (Pakistan, India, Indonesia).
  - the paucity of size data available from industrial longliners since the early-1990s (Japan, Philippines, India and China).
  - the lack of time-area catches for some industrial fleets (Indonesia, India, NEI).
  - the paucity of biological data available, notably sex-ratio and sex-length-age keys.

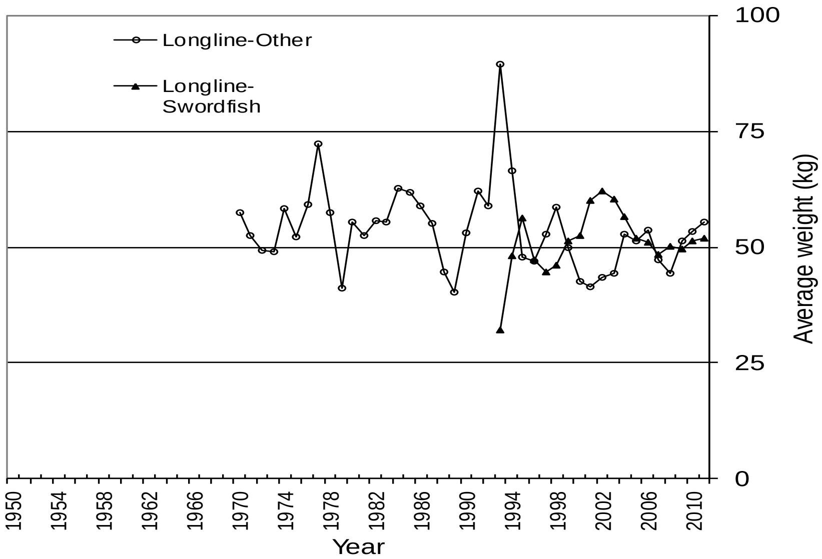


Fig. 7. Swordfish: Average weight of swordfish (kg) estimated from the size samples available for longliners targeting swordfish (1993–2011) and other longliners (1970–2011). NOTE: Average weights are shown only for years in which 300 or more specimens were sampled for length

Swordfish: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid for 2010 to 2011 are provided in Fig. 8, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2010 and 2011 are provided in Fig. 9.

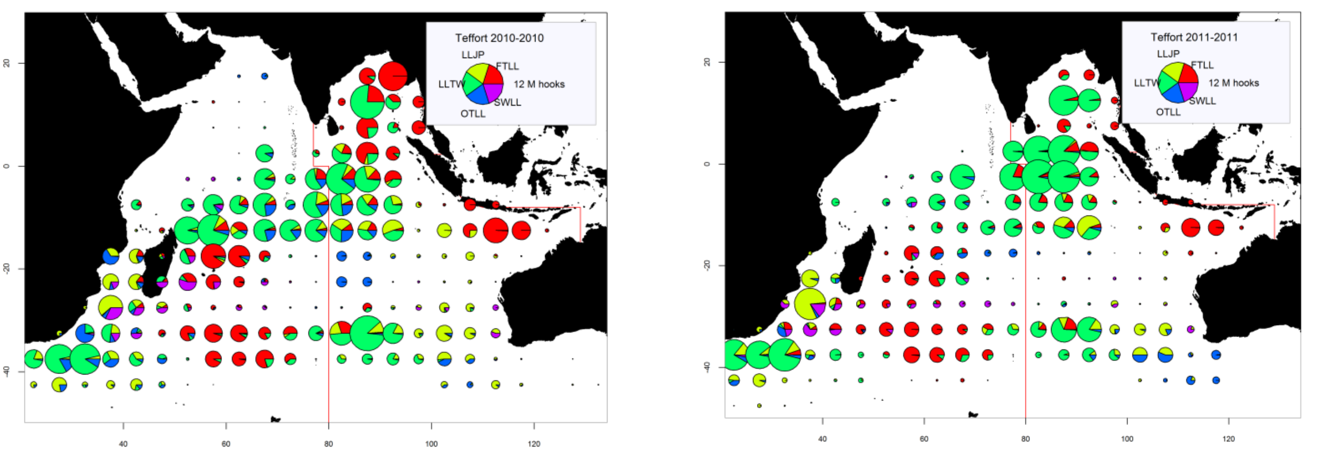


Fig. 8. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

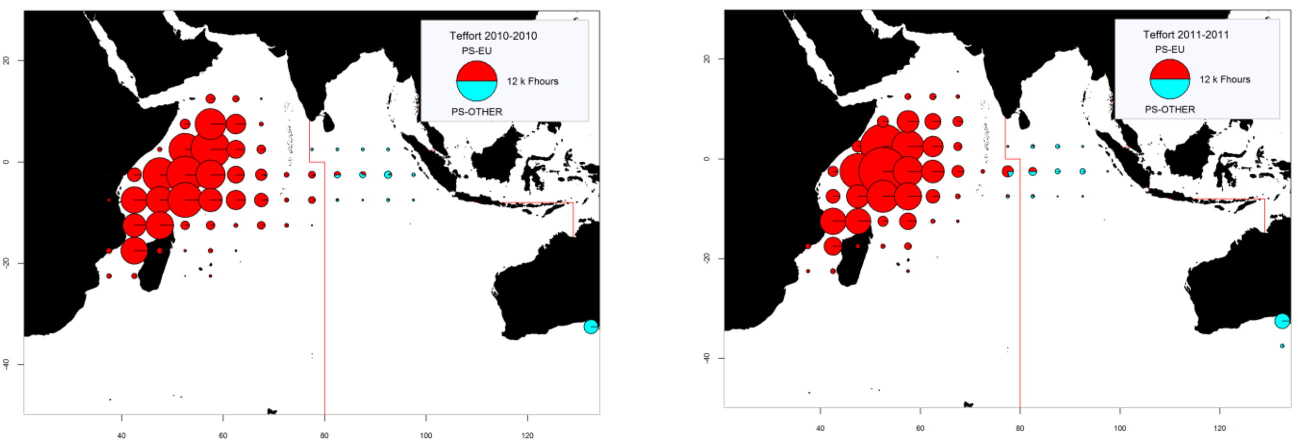


Fig. 9. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Swordfish: Catch–per–unit–effort (CPUE) trends

The following CPUE series were used in the stock assessment models for 2011 (Figs. 10 and 11), while the relative weighting of the different CPUE series were left to the individual analyst to determine and justify.

- Japan data (1980–2009): Series 3.2 from document IOTC–2011–WPB09–14, which includes fixed latitude and longitude effects, plus environmental effects.
- Taiwan,China data (1995–2009): Model 10 from document IOTC–2011–WPB09–23, which includes fixed latitude and longitude effects, plus environmental effects.

- EU,Spain data (2001–2009): Series 5 from document IOTC–2011–WPB09–23, calculated for the southwest area only (includes sub-region factors and species ratio factors) area and run 1 for the assessment of whole Indian Ocean.
- EU,La Reunion data (1994–2000): Same series as last year (IOTC–2010–WPB–03).

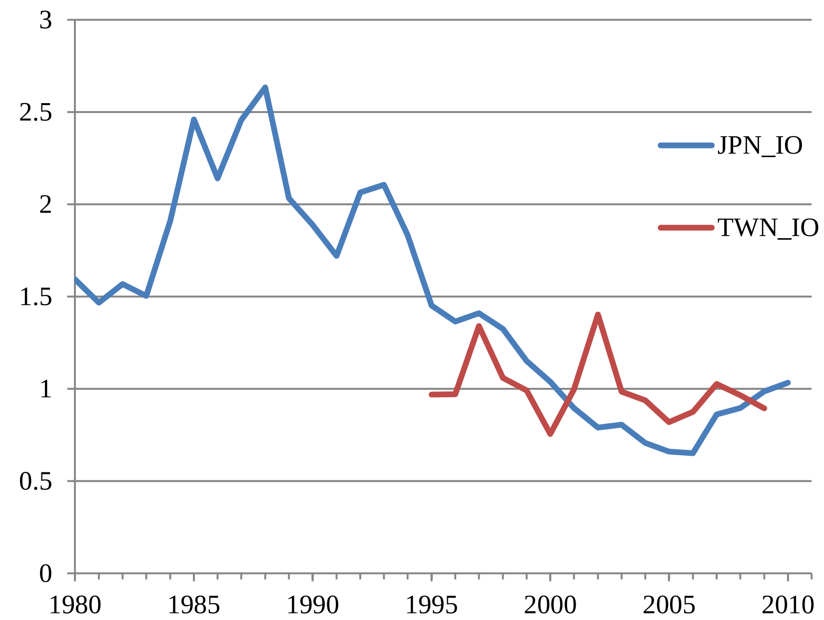
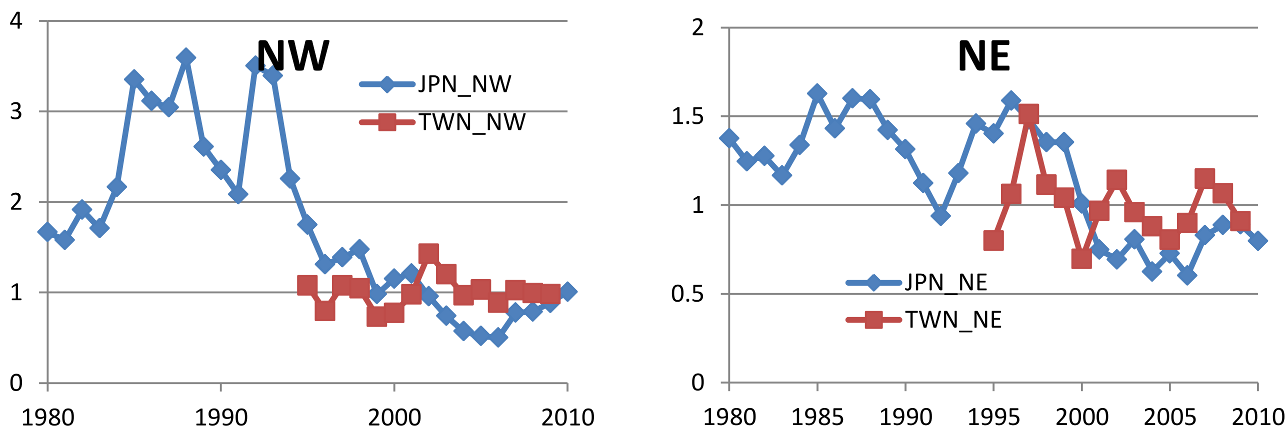


Fig. 10. Swordfish: Aggregate Indian Ocean CPUE series for swordfish. Series have been rescaled relative to their respective means from 1995–2010



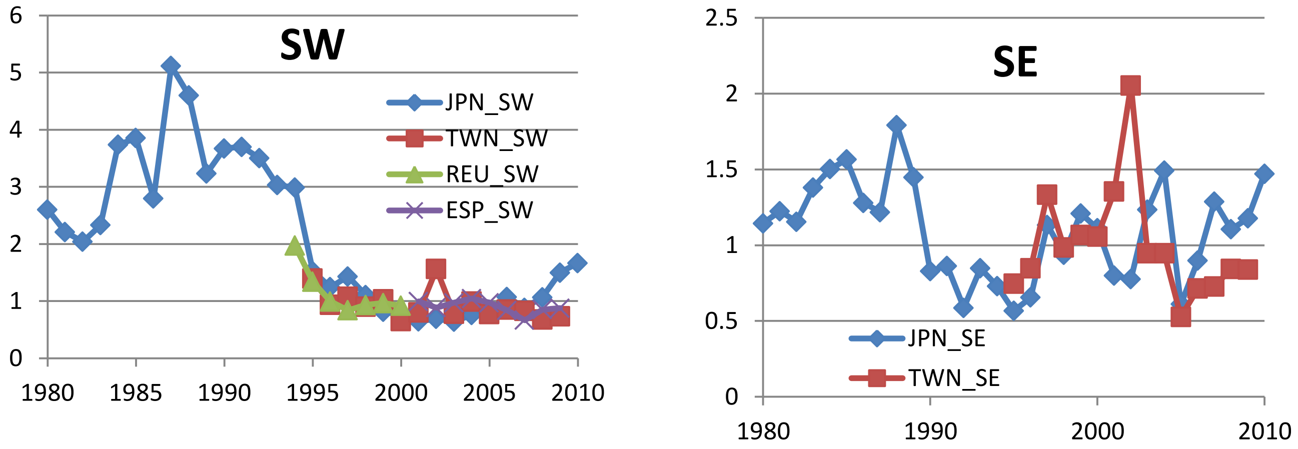


Fig. 11. Swordfish: CPUE series for Indian Ocean swordfish assessments by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods). NW – north-west; SW – south-west; NE – north-east; SE – south-east Indian Ocean.

STOCK ASSESSMENT

The stock structure of the Indian Ocean swordfish resource remains under investigation, but currently uncertain. The southwest region was identified as a management unit of particular concern, because it seems to be more depleted than other regions in the Indian Ocean, and may have limited mixing with other regions.

The range of quantitative modelling methods were applied to the swordfish assessment in 2011, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis. The different assessments were presented to the WPB in documents IOTC–2011–WPB09–17, 18, 19 and 20. Each model is summarised in the report of the Ninth Session of the WPB (IOTC–2011–WPB09–R).

There is value of comparing different modelling approaches. The structured models are capable of a more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simple production models. However, there are a lot of uncertainties in basic swordfish biology (e.g. growth rates, M, stock recruitment relationship), and it is difficult to represent all of these uncertainties. In contrast, the production models often provide robust estimates regardless of uncertainties in basic biological characteristics. However, sometimes the ASPIC model can have difficulty fitting long time series, and production models in general cannot represent some important dynamics (e.g. arising from complicated recruitment variability).

The swordfish stock status was determined by qualitatively integrating the results of the various stock assessments undertaken in 2011. The WPB treated all analyses as equally informative, and focussed on the features common to all of the results, as well as the latest catch and effort trends (Tables 1 and 8).

TABLE 8. Swordfish: Key management quantities from the 2011 Stock Synthesis 3 assessments, for the aggregate and southwest Indian Ocean. Values represent the 50th (5th–95th) percentiles of the (plausibility-weighted) distribution of maximum posterior density estimates from the full range of the models examined

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2011catch estimate	19,631 t	6,559 t
Mean catch from 2007–2011	21,870 t	6,939 t
MSY	29,900– 34,200	7,100 t–9,400 t
Data period used in assessment	1951–2009	1951–2009
F_{2009}/F_{MSY}	0.50 (0.23–1.08)	0.64 (0.27–1.27)
B_{2009}/B_{MSY}	–	–
SB_{2009}/SB_{MSY}	1.59 (0.94–3.77)	1.44 (0.61–3.71)
B_{2009}/B_0	–	–
SB_{2009}/SB_0	0.35 (0.22–0.42)	0.29 (0.15–0.43)

$B_{2009}/B_{0,\ F=0}$	–	–
$SB_{2009}/SB_{0,\ F=0}$	–	–

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APPENDIX XIV
EXECUTIVE SUMMARY: BLACK MARLIN

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

Status of the Indian Ocean black marlin (BLM: *Makaira indica*) resource

TABLE 1. Black marlin: Status of black marlin (*Makaira indica*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Catch 2011: Average catch 2007–2011:	6,890 t 6,292 t	Uncertain
	MSY (range): F_{2011}/F_{MSY} (range): SB_{2011}/SB_{MSY} (range): SB_{2011}/SB_0 (range):	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	(yellow)	(green)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for black marlin in the Indian Ocean; due to a lack of fishery data and poor quality of available data for several gears, only preliminary stock indicators can be used. Therefore stock status remains uncertain (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a more formal assessment are a cause for considerable concern. Research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

Outlook. Longline catch and effort for black marlin in recent years has continued to increase to a total of 7,021 tonnes in 2010. Although a lower catch of 6,890 tonnes was caught in 2011, the pressure on the Indian Ocean stock as a whole remains highly uncertain. Thus, there remains insufficient information to evaluate the effect this will have on the resource. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of black marlin are highly uncertain and need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.
- research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Black marlin (*Makaira indica*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.

- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Resolution 11/04 *on a regional observer scheme*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

Black marlin: General

Black marlin (*Makaira indica*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans. Table 2 outlines some key life history parameters relevant for management. There is limited reliable information on the catches of black marlin and no information on the stock structure or growth and mortality in the Indian Ocean.

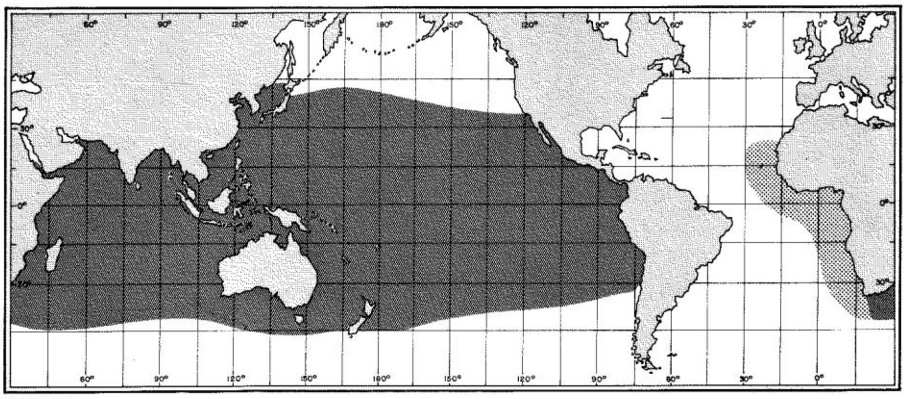

Fig. 1. Black marlin: The worldwide distribution of black marlin (Source: Nakamura 1984)

TABLE 2. Black marlin: Biology of Indian Ocean black marlin (*Makaira indica*)

Parameter	**Description**
Range and stock structure	Little is known on the biology of the black marlin in the Indian Ocean. Black marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. Some rare individuals have been reported in the Atlantic Ocean but there is no information to indicate the presence of a breeding stock in this area. Black marlin inhabits oceanic surface waters above the thermocline and typically near land masses, islands and coral reefs; however rare excursions to mesopelagic waters down to depths of 800 m are known. Thought to associate with schools of small tuna, which is one of its primary food sources (also reported to feed on other fishes, squids and other cephalopods, and large decapod crustaceans). No information on stock structure is currently available in the Indian Ocean; thus for the purposes of assessment, one pan-ocean stock is assumed. Long distance migrations at least in the eastern Indian Ocean (two black marlins tagged in Australia were caugh off east Indian coast and Sri Lanka) support a single stock hypothesis. It is known that black marlin forms dense nearshore spawning aggregations, making this species vulnerable to exploitation even by small-scale fisheries. Spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	No data available for the Indian Ocean. In the Pacific (Australia) 11–12 years.
Maturity (50%)	**Age**: unknown **Size**: females around 100 kg; males 50 to 80 kg total weight
Spawning season	No spawning grounds have been identified in the Indian ocean. Spawning hotspot off eastern Australia apparently has no links with Indian Ocean stock. Spawning individuals apparently prefer water temperatures above 26–27°C. Highly fecund batch spawner. Females may produce up to 40 million eggs.
Size (length and weight)	Maximum: In other oceans can grow to more than 460 cm FL and weigh 800 kg total weight. In the Indian Ocean it reach at least 360 cm LJFL. Young fish grow very quickly in length then put on weight later in life. In eastern Australian waters black marlin grows from 13 mm long at 13 days old to 180 cm and around 30 kg after 13 months. Sexual dimorphism in size, growth rates and size and age at maturity - females reach larger sizes, grow faster and mature later than males. In the Indian Ocean documented maximum size for females: 306 cm LJFL, 307 kg total weight; males: 280 cm LJFL, 147 kg total weight. Most black marlin larger than 200 kg are female.

	Recruitment into the fishery: varies by fishing method; ~60 cm LJFL for artisanal fleets and methods. The average size of black marlin taken in Indian Ocean longline fisheries is not available. L-W relationships for the Indian Ocean are: females TW=0.00000010*LJFL**3.7578, males TW=0.00002661*LJFL**3.7578, both sexes mixed TW=0.00000096*LJFL**3.35727, TW in kg, LJFL in cm. However these relationships were obtained from small sample sizes (n=75), therefore it should be treated with caution.

Sources: Nakamura 1985, Cyr et al. 1990, Gunn et al. 2003, Speare 2003; Sun et al. 2007, Froese & Pauly 2009, Romanov & Romanova 2012, Domeier & Speare 2012

Black marlin: Catch trends

Black marlin are caught mainly by drifting longlines (44%) and gillnets (49%) with remaining catches taken by troll and hand lines (Table 3, Fig. 2). Black marlin are not targeted by industrial fisheries, but are targeted by some artisanal and sport/recreational fisheries. Black marlin are also known to be taken in purse seine fisheries, but are not currently being reported. In recent years, the fleets of Taiwan,China (longline), Sri Lanka (gillnet), Indonesia (gillnets) and India (gillnets) are attributed with the highest catches of black marlin (Fig. 3). The minimum average annual catch estimated for the period 2007 to 2011 is 6,292 t (Table 3), although this figure is considered to be a gross underestimate due to under reporting and misidentification.

Between the early-1950s and the late-1980s part of the Japanese fleet was licensed to operate within the EEZ of Australia, and reported very high catches of black marlin in that area, in particular in waters off northwest Australia. In recent years, deep-freezing longliners from Japan and Taiwan,China have reported lower catches of black marlin, mostly in waters off the western coast of India and, to a lesser extent, the Mozambique Channel (Fig. 4).

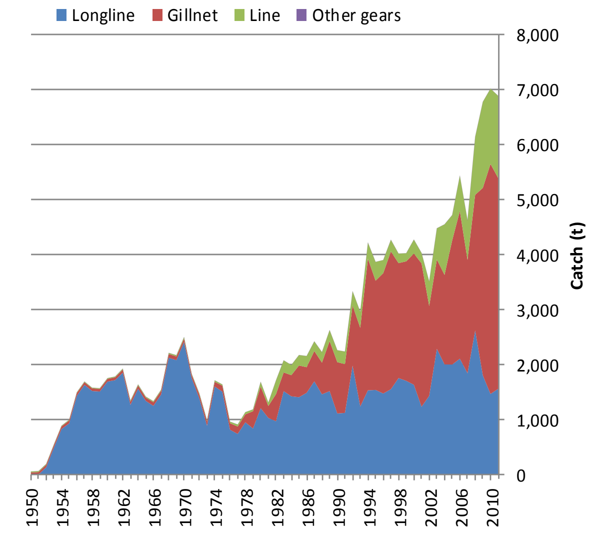

Fig. 2. Black marlin: Catches of black marlin per gear and year recorded in the IOTC Database (1960–2011)

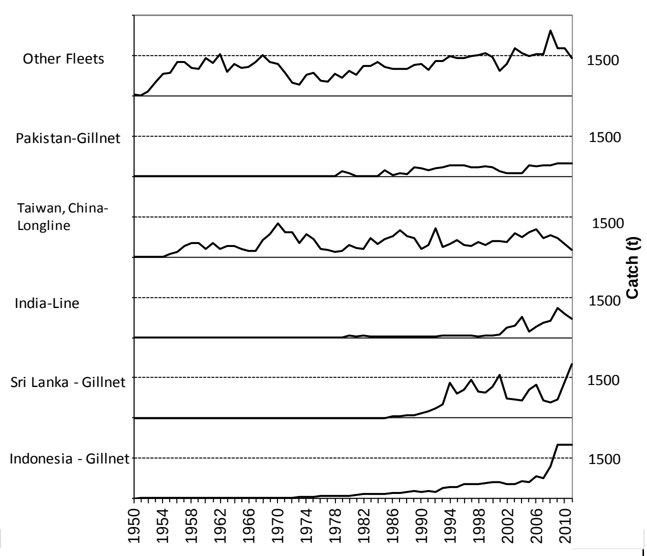

Fig. 3. Black marlin: Catches of black marlin by fleet recorded in the IOTC Database (1960–2011)

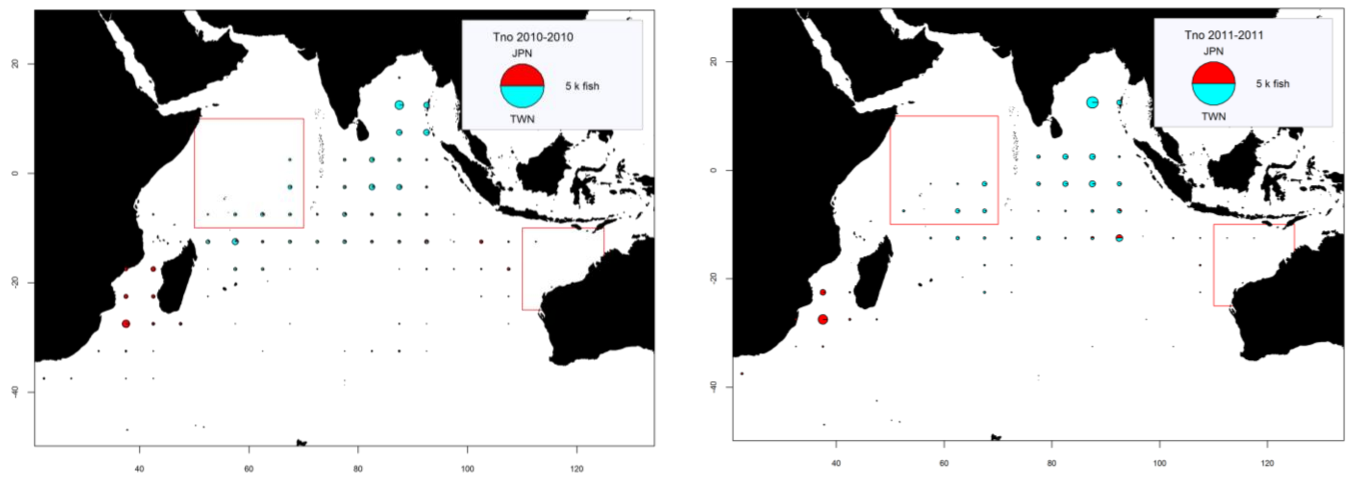

Fig. 4a–b. Black marlin: Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2010 and 2011 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB (Data as of October 2012)

TABLE 3. Best scientific estimates of the catches of black marlin by type of fishery for the period 1950–2011 (in metric tonnes) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LL	846	1,633	1,288	1,371	1,500	1,896	1,431	2,286	2,003	2,000	2,106	1,842	2,620	1,802	1,465	1,559
GN	47	60	118	491	1,769	2,278	1,634	1,626	1,629	2,259	2,687	2,062	2,469	3,412	4,185	3,835
HL	15	19	25	176	240	683	446	568	920	461	643	721	1,055	1,566	1,371	1,496
OT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**908**	**1,712**	**1,431**	**2,038**	**3,510**	**4,856**	**3,512**	**4,480**	**4,552**	**4,721**	**5,437**	**4,625**	**6,143**	**6,780**	**7,021**	**6,890**

Fisheries: Gillnet (GN); Longline (LL); Hook-and-Line (HL), including handline, trolling, baitboat, and sport fisheries; Other gears (OT)

Black marlin: Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the Secretariat.

Retained catches are uncertain for some fisheries (Fig. 5), due to the fact that:

- catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries.
- catches of non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries for which the black marlin is not a target species.
- conflicting catch reports: Longline catches from the Republic of Korea are reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of black marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of black marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- the catch series used by the WPB in 2011 and that to be used for the WPB in 2012 are slightly different, following an increase in the catches estimated in recent years for the fleets of India (longline and trolling), and Indonesia (gillnet).
- Discards are unknown, but considered to be low for most industrial fisheries, mainly longliners. This species is usually kept for crew consumption if not marketed. Discards of black marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.

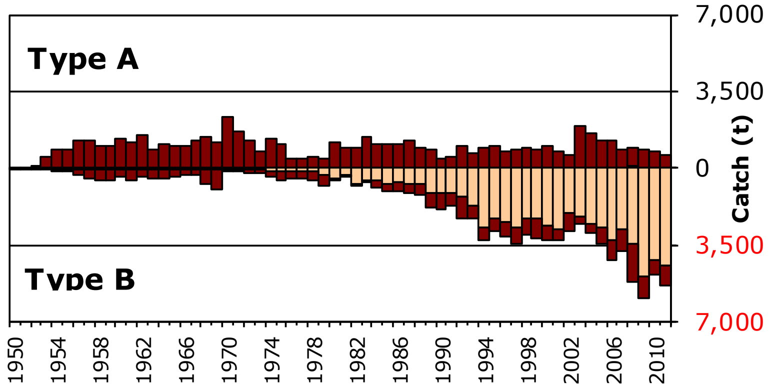

Fig. 5. Black marlin: Uncertainty of annual catch estimates for black marlin (Data as of October 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets

Black marlin: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2010 and 2011 are provided in Fig. 6, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2010 and 2011are provided in Fig. 7.

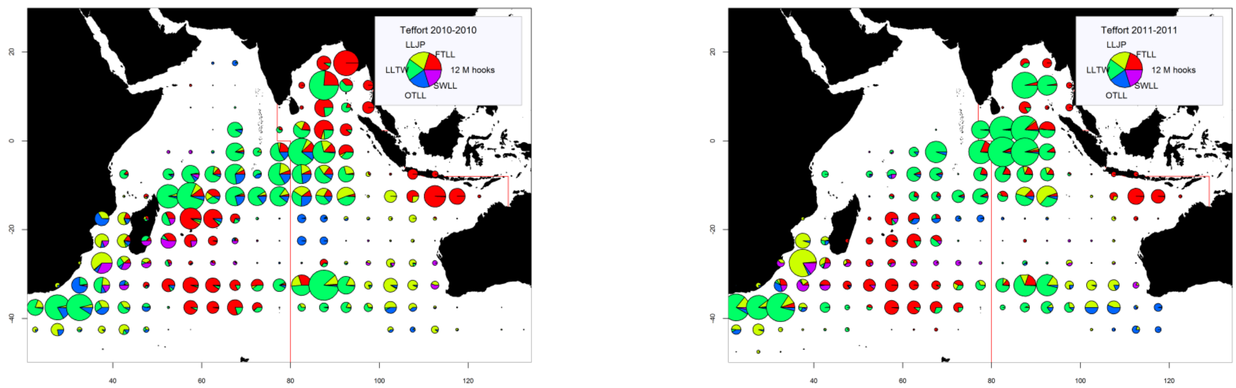

Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of November 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
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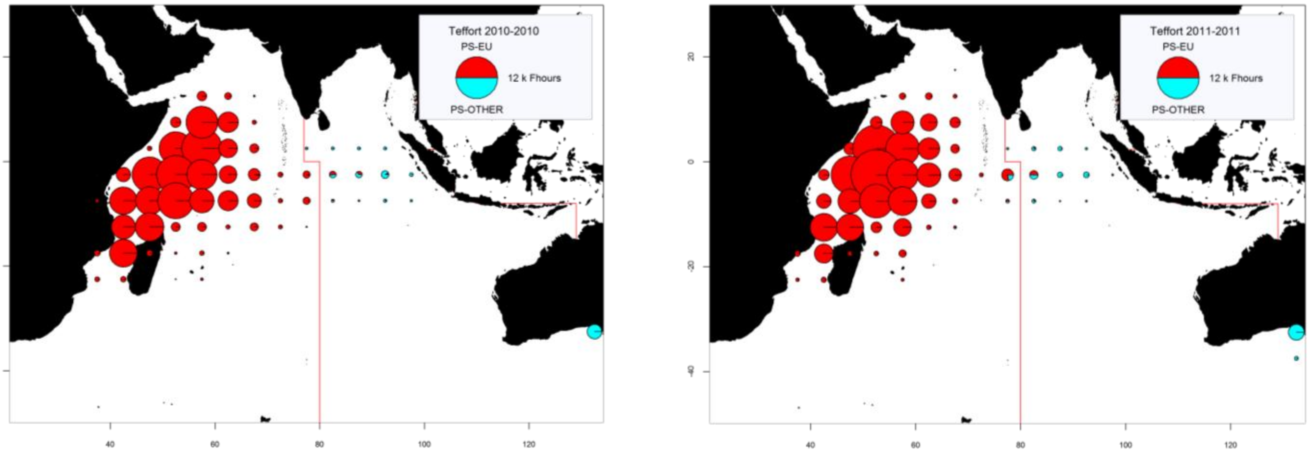

Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Black marlin: Catch–per–unit–effort (CPUE) trends

Catch rate time series for the longline fleets of Japan and Taiwan,China (Fig. 8) show a similar decreasing trend from 1960's until the end of 2000's. There is no available data for the longline fleet of Taiwan,China for the 1950's and part of the 1960's. Catch rates as calculated based on Japanese dataset show a strong decreasing trend in the early 1950's, in the very beginning of the commercial fisheries. Nevertheless it is important to highlight the doubts on the reliability of the results based on aggregated data sets not fully reviewed by experts on Japanese longline fisheries. The sharp decline between 1952 and 1958 in the Japanese black marlin CPUE series does not reflect the trend in abundance.

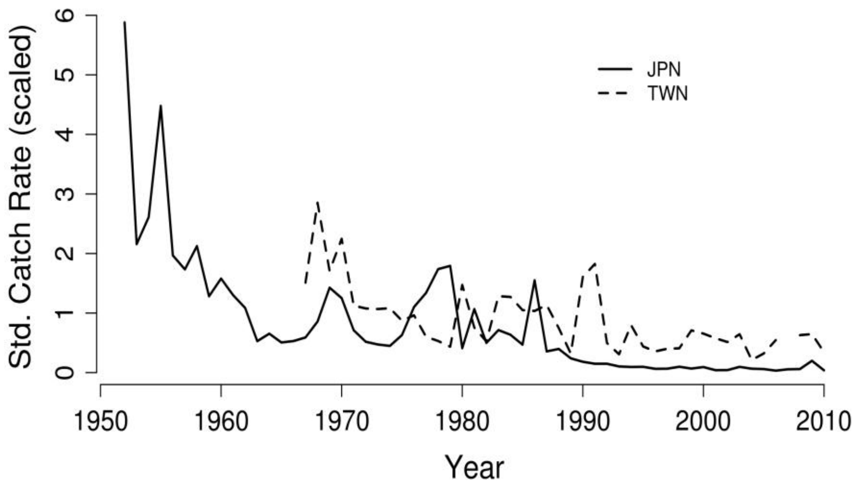

Fig. 8. Black marlin: Standardised catch rates of black marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period

No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Black marlin: Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low (Fig. 9).

Catch-at-Size(Age) tables have not been built for black marlin due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

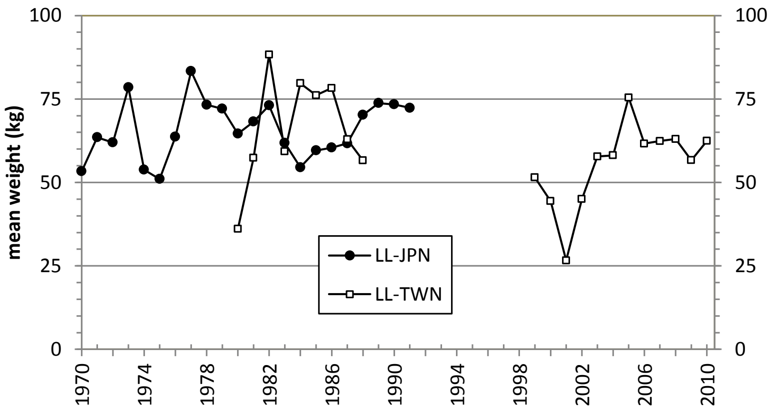

Fig. 9. Black marlin: Average weight of black marlin (kg) estimated from the size samples available for longliners of Japan (1970–2009) and Taiwan,China (1980–2010). Note: Average weights are shown only for years in which 300 or more specimens were sampled for length

STOCK ASSESSMENT

No quantitative stock assessment for black marlin in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. However, a preliminary estimation of stock indicators was attempted on the longline catch and effort datasets from Japan and Taiwan,China that represent the best available information. Standardised CPUE exhibited dramatic declines since the beginning of the Japanese longline fishery (Fig. 7) and catches in the initial core areas have also decreased substantially. However, there is considerable uncertainty about the degree to which these indicators, prior to 1958, represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trend. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Black marlin (*Makaira indica*) stock status summary

Management Quantity	**Aggregate Indian Ocean**
2011 catch estimate	6,890 t
Mean catch from 2007–2011	6,292 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1958} (80% CI)	–
SB_{2011}/SB_{1958}	–
$B_{2011}/B_{1958, F=0}$	–
$SB_{2011}/SB_{1958, F=0}$	–

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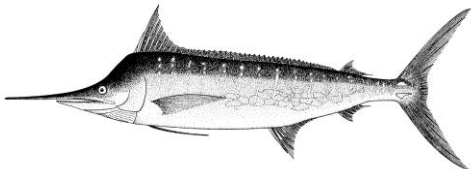
APPENDIX XV
EXECUTIVE SUMMARY: BLUE MARLIN

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



Status of the Indian Ocean blue marlin (BUM: *Makaira nigricans*) resource

TABLE 1. Blue marlin: Status of blue marlin (*Makaira nigricans*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Catch 2011: Average catch 2007–2011:	12,115 t 9,443 t	Uncertain
	MSY (range): F_{2011}/F_{MSY} (range): SB_{2011}/SB_{MSY} (range): SB_{2011}/SB_0 (range):	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for blue marlin in the Indian Ocean which is considered developed enough for the provision of management advice. Due to a lack of reliable fishery data and poor quality of available data for several gears, only very preliminary stock indicators can be used. The standardised longline CPUE series suggest that there was a decline in the early 1980s, followed by a constant or slightly increasing abundance over the last 20 years. This contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s. Therefore the stock status is determined as being uncertain (Table 1). However, aspects of species biology, productivity and fisheries combined with the data on which to base a quantitative assessment is a cause for concern.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, although 2011 catches increased substantially to 12,115 t. There is insufficient information to evaluate the effect this will have on the resource at this point in time. Given the concerning results obtained from the preliminary stock assessments carried out in 2012 for blue marlin, the data and other inputs for stock assessment urgently needs to be revised so that a new assessment may be carried out in 2013. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of blue marlin are highly uncertain and need to be reviewed as problems in the catch series from the main fleets catching blue marlin were identified in 2012.
- improvement in data collection and reporting is required to further improve the assessment of the stock.
- research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Blue marlin in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Resolution 11/04 *on a regional observer scheme*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

General

Blue marlin (*Makaira nigricans*) is a large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. Table 2 outlines some key life history parameters relevant for management.

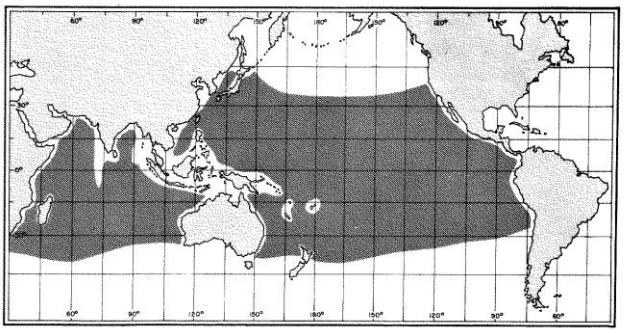


Fig. 1. Blue marlin: The worldwide distribution of blue marlin (Source: Nakamura 1984).

TABLE 2. Blue marlin: Biology of Indian Ocean blue marlin (*Makaira nigricans*).

Parameter	**Description**
Range and stock structure	Little is known on the biology of the blue marlin in the Indian Ocean. Blue marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. It is capable for long-distance migrations: in the Pacific Ocean a tagged blue marlin is reported to have travelled 3000 nm in 90 days. In the Indian Ocean a blue marlin tagged in South Africa was recaptured after 90 days at liberty off the southern tip of Madagascar crossing Mozambique Channel and travelling 1398 km with average speed 15.5 km/day. Other tagging off western Australia revealed potential intermixing of Indian Ocean and Pacific stocks: one individual was caught in the Pacific Indonesian waters. Blue marlin is a solitary species and prefers the warm offshore surface waters (>24°C); it is scarce in waters less than 100 m in depth or close to land. The blue marlin's prey includes octopuses, squid and pelagic fishes such as tuna and frigate mackerel. Feeding takes place during the daytime, and the fish rarely gather in schools, preferring to hunt alone. No information on stock structure is currently available in the Indian Ocean; thus for the purposes of assessment, one pan-ocean stock is assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	~28 years; Females n.a.; Males n.a.
Maturity (50%)	**Age**: 2–4 years; females n.a. males n.a. **Size:** females ~50 cm LJFL (55 kgs whole weight); males ~80 cm LJFL (40 kgs total weight).
Spawning season	No spawning grounds have been identified in the Indian ocean. Females may produce up to 10 million eggs. In the Pacific ocean, blue marlin are thought to spawn between May and September off the coast of Japan.
Size (length and weight)	Maximum: Females 430 cm FL; 910 kgs whole weight; males 300 cm FL; 200 kgs whole weight. Young fish grow very quickly in length then put on weight later in life. Sexual dimorphism in size, growth rates and size and age at maturity - females reach larger sizes, grow faster and mature later than males. L-W relationships for the Indian Ocean are: females TW=0.00000026*LJFL^3.59846 males TW=0.00001303*LJFL^2.89258, both sexes mixed TW=0.00000084*LJFL^3.39404. TW in kg, LJFL in cm

n.a. = not available. Sources: Nakamura 1985, Cry et al. 1990, Shimose et al. 2008, Froese & Pauly 2009, Romanov & Romanova 2012

Blue marlin: Catch trends

Blue marlin are caught mainly by drifting longlines (60%) and gillnets (30%) with remaining catches recorded under troll and hand lines (Table 3, Fig. 2). Blue marlin is an important target for several artisanal and sport/recreational fleets. Blue marlin are also known to be taken in purse seine fisheries, but are not currently being reported. The reported catches of blue marlin are higher than those of black marlin and striped marlin combined, although this is highly uncertain due to under reporting and misidentification. In recent years, the fleets of Taiwan,China (longline), Indonesia (longline and gillnet), Sri Lanka (gillnet) and India (gillnet) are attributed with the highest catches of blue marlin (Fig. 3). The distribution of blue marlin catches has changed since the 1980's with most of the reported catch now taken in the western areas of the Indian Ocean. However, non-reporting of catches by gillnet fleets in the northern Indian Ocean masks the true level of harvest in the Indian Ocean.

Catch trends for blue marlin are variable; this may reflect the variability of targeting by longline fleets and the level of reporting for other gears. The catches of blue marlin by drifting longline fisheries were more or less stable until the mid-80's, at around 3,000 t, steadily increasing since then. The largest catches were recorded in 1997 (~11,000 t). Longline catches have been recorded by Taiwan,China and Japan fleets and, recently, Indonesia and several NEI fleets (Fig. 3). In recent years, deep-freezing longliners from Japan and Taiwan,China have reported most of the catches of blue marlin in waters of the western and central tropical Indian Ocean and, to a lesser extent, the Mozambique Channel and the Arabian Sea (Fig. 4).

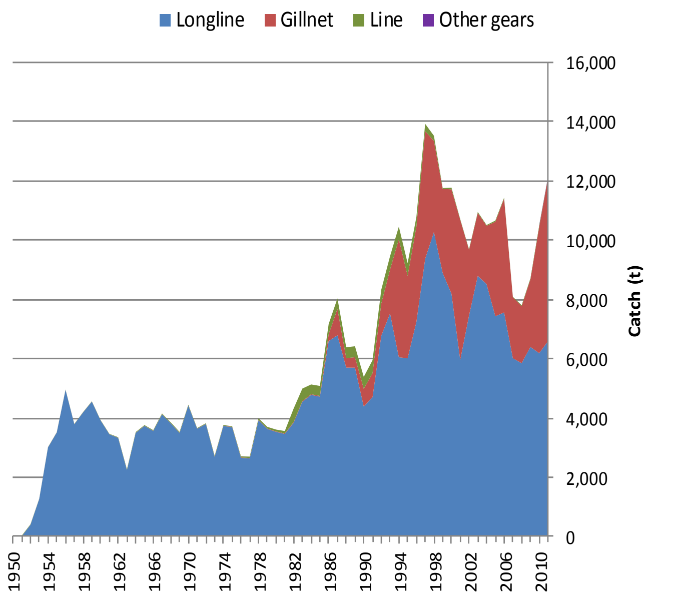


Fig. 2. Blue marlin: Catches of blue marlin per gear and year recorded in the IOTC database (1950–2011)

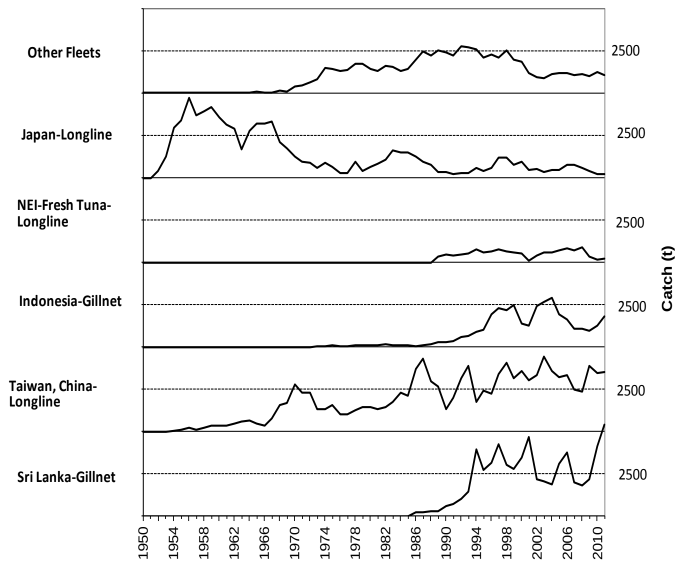


Fig. 3. Blue marlin: Catches of blue marlin by fleet recorded in the IOTC database (1950–2011)

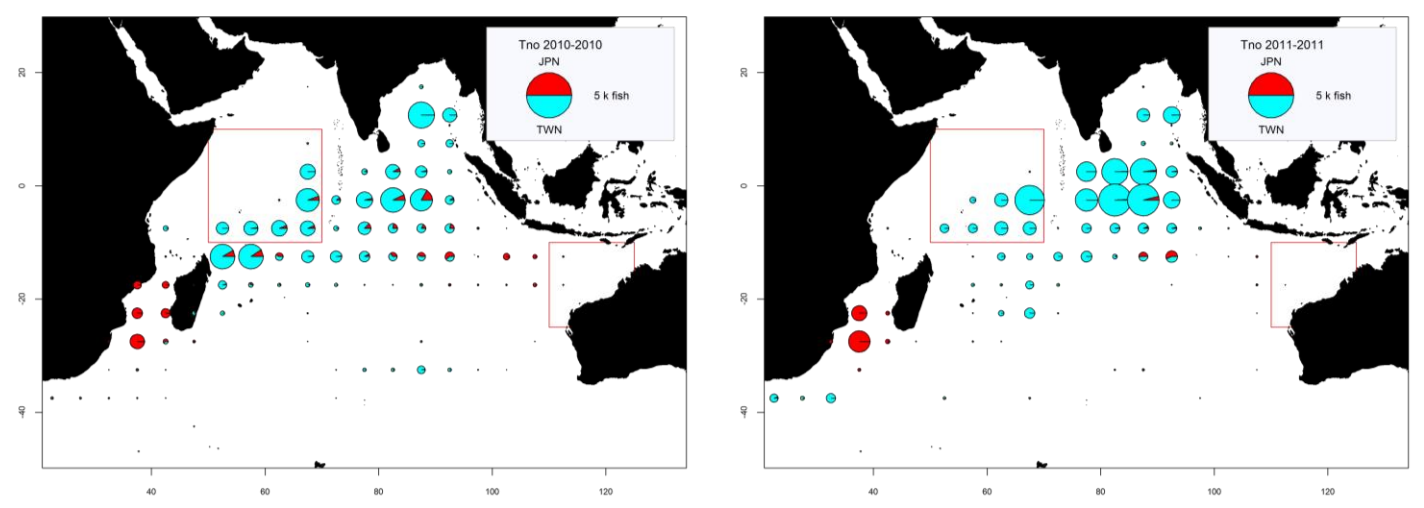


Fig. 4a–b. Blue marlin: Time-area catches (in number of fish) of blue marlin as reported for the longline (LL) fisheries of Japan (JPN) and Taiwan,China (TWN) for 2010 and 2011 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB

TABLE 3. Blue marlin: Best scientific estimates of the catches of blue marlin by type of fishery for the period 1950–2011 (in metric tonnes) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LL	2,563	3,513	3,477	4,964	7,122	7,216	7,455	8,796	8,516	7,432	7,559	6,014	5,848	6,395	6,186	6,586
GN	3	4	10	192	2,419	2,787	2,219	2,124	1,972	3,188	3,843	2,061	1,922	2,281	4,261	5,512
HL	11	23	33	312	340	32	23	33	26	42	33	15	34	35	47	16
OT	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**2,576**	**3,540**	**3,521**	**5,468**	**9,881**	**10,036**	**9,698**	**10,953**	**10,513**	**10,662**	**11,436**	**8,090**	**7,805**	**8,711**	**10,494**	**12,115**

Fisheries: Gillnet (GN); Longline (LL); Hook-and-Line (HL), including handline, trolling, baitboat, and sport fisheries; Other gears (OT)

Blue marlin: Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the Secretariat.

Retained catches are poorly known for most fisheries (Fig. 5) due to:

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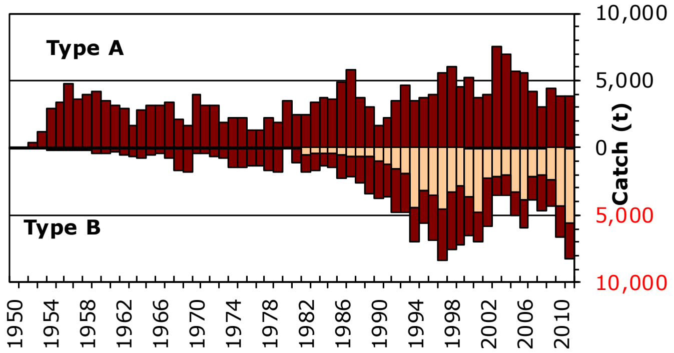
- catches of non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries for which the blue marlin is not a target species.
- conflicting catch reports: Longline catches from the Republic of Korea are reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of blue marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of blue marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- There have not been significant changes to the catches of blue marlin since the WPB in 2011.
- Discards are unknown for most industrial fisheries, mainly longliners. Discards of blue marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.



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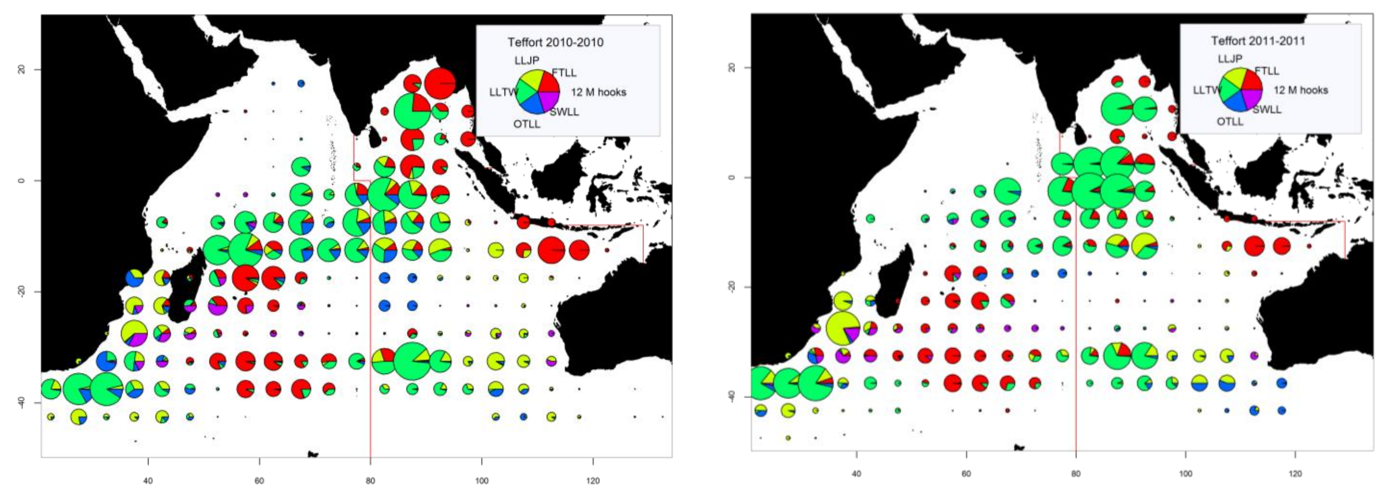

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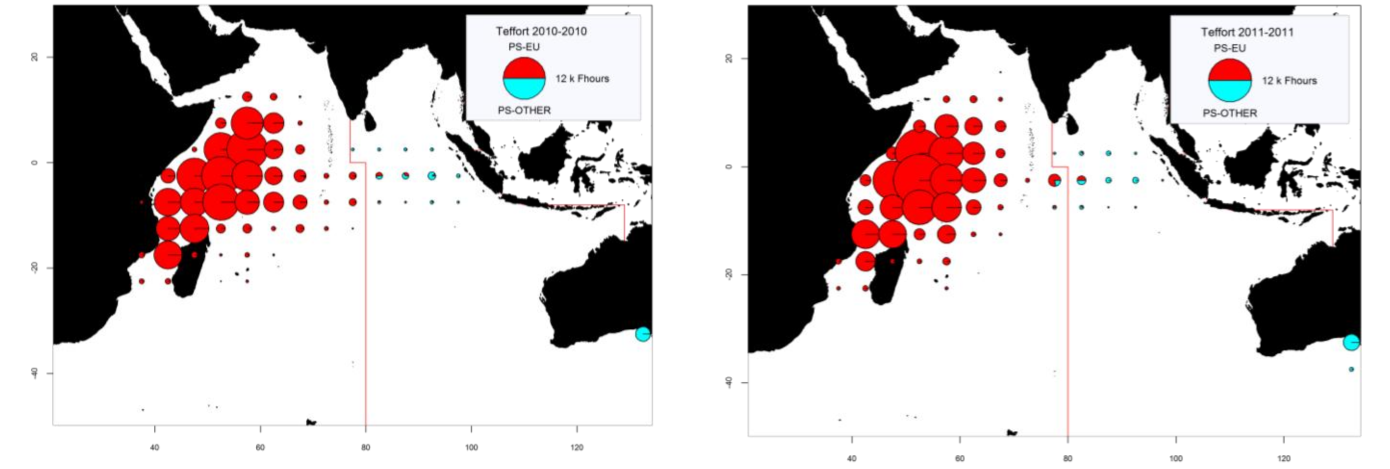

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Blue marlin: Catch–per–unit–effort (CPUE) trends

Catch rate time series for the longline fleet of Japan (Fig. 8) show a decreasing trend from the mid-1950's until the early 1960s. There is no available data for the longline fleet of Taiwan,China for the 1950's and part of the 1960's. Catch rates as calculated based on Japanese dataset show a strong decreasing trend in the early 1950's, in the very beginning of the commercial fisheries. Nevertheless it is important to highlight the doubts on the reliability of the results based on aggregated data sets not fully reviewed by experts on Japanese longline fisheries. The sharp decline between 1952 and 1956 in the Japanese blue marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1970 until 2011 is more likely to represent actual declines in stock abundance (Fig. 8). The catches and CPUE series estimated for blue marlin were very different between the longline fleets of Japan and Tawain,China. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

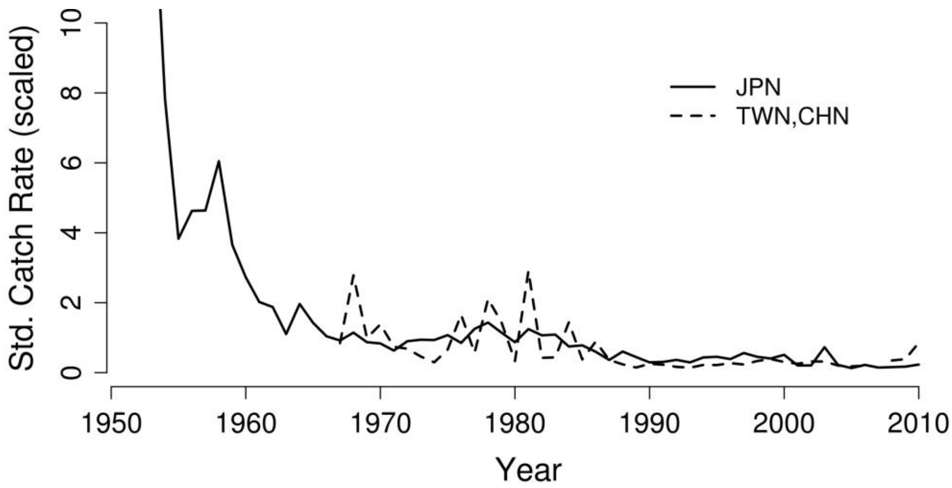

Fig. 8. Blue marlin: Standardised catch rates of blue marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period

Of the blue marlin CPUE series available for assessment purposes, the Japanese NCEP series should be used in the stock assessment model (Fig. 9).

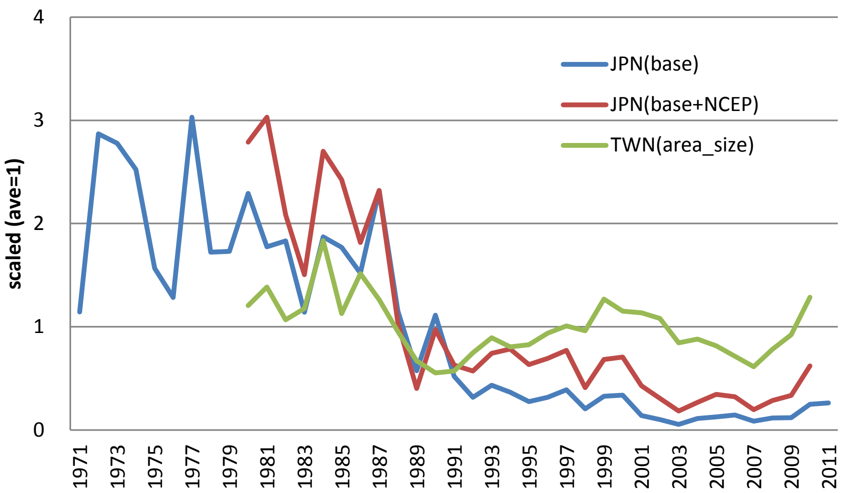

Fig. 9. Blue marlin: Comparison of the multiple CPUE series for longline fleets of Japan and Taiwan,China

The recent data for the longline fleet of Taiwan,China, in particular for 2010, should be examined in detail to determine if the increased catches are a function of relocated effort into areas where blue marlin were not previously targeted, or an alternative reason.

Blue marlin: Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped and blue marlin may be occurring in the Taiwanese longline fishery; the length frequency distributions derived from samples collected on longliners from Taiwan,China differ greatly from those collected on longliners flagged in Japan (Fig. 6).

Catch-at-Size(Age) tables have not been built for blue marlin due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

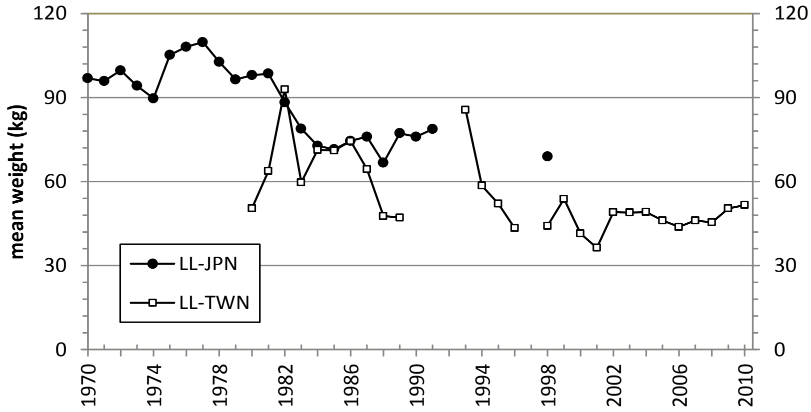

Fig. 6. Blue marlin: Average weight of blue marlin (kg) estimated from the size samples available for longliners of Japan (1970–2009) and Taiwan,China (1980–2010). Note: Average weights are shown only for years in which 300 or more specimens were sampled for length

Stock Assessment

In 2012, a range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Surplus Production with catchability changes over decades) were applied to the blue marlin. The assessments carried out in 2012 were preliminary and the results were developed for exploratory and discussion purposes only.

Alternative approaches should be explored using the following in 2013:

- More effort should be made in examining the standardised CPUE data for use in the assessments as these are the basis for assessments without any age/length data available.
- Age/Length data over time should be collected so that alternative approaches could be examined.
- Examining whether a constant or variable catchability (q) is dependent on how well the CPUE is standardised. If the standardisation does not account for the changes, then using variable catchabilities should occur in the assessment.
- Finer spatial resolution and fisheries structure should probably be taken into account in the assessment.

The preliminary estimation of stock indicators attempted on the longline catch and effort datasets from Japan and Taiwan,China represent the best available information (described above). However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Blue marlin: Blue marlin (*Makaira nigricans*) stock status summary

Management Quantity	Aggregate Indian Ocean
2011 catch estimate	12,115 t
Mean catch from 2007–2011	9,443 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1971} (80% CI)	–
SB_{2011}/SB_{1971}	–
$B_{2011}/B_{1971, F=0}$	–
$SB_{2011}/SB_{1971, F=0}$	–

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Romanov EV (2002) Bycatch in the tuna purse-seine fisheries of the western Indian Ocean. Fish Bull 100(1): 90–105

Romanov E, Romanova N (2012) Size distribution and length-weight relationships of some billfish (marlins, spearfish and swordfish) in the Indian Ocean. IOTC–2012–WPB10–19, 12 p

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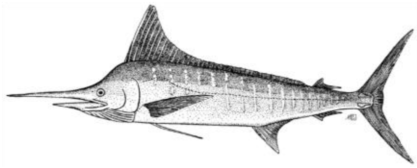
APPENDIX XVI
EXECUTIVE SUMMARY: STRIPED MARLIN

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



Status of the Indian Ocean striped marlin (MLS: *Tetrapturus audax*) resource

TABLE 1. Striped marlin: Status of striped marlin (*Tetrapturus audax*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Catch 2011:	1,885 t	Uncertain
	Average catch 2007–2011:	2,245 t	
	MSY (range):	unknown	
	F_{2011}/F_{MSY} (range):	unknown	
	SB_{2011}/SB_{MSY} (range):	unknown	
	SB_{2011}/SB_0 (range):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)	(yellow)	(green)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for striped marlin in the Indian Ocean which is considered developed enough for the provision of management advice. Due to a lack of reliable fishery data and poor quality of available data for several gears, only very preliminary stock indicators can be used. The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. This contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s. Therefore stock status remains uncertain (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a quantitative assessment are a cause for considerable concern.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is insufficient information to evaluate the effect this will have on the resource. Given the concerning results obtained from the preliminary stock assessments carried out in 2012 for striped marlin, the data and other inputs for stock assessment urgently needs to be revised so that a new assessment may be carried out in 2013. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of striped marlin are highly uncertain and need to be reviewed as problems in the catch series from the main fleets catching striped marlin were identified in 2012.
- improvement in data collection and reporting is required to further improve the assessment of the stock.
- research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Striped marlin (*Tetrapturus audax*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*

- Resolution 11/04 *on a regional observer scheme*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

Striped marlin: General

Striped marlin (*Tetrapturus audax*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans (Fig. 1). Table 2 outlines some key life history parameters relevant for management. There is limited reliable information on the catches of this species and no information on the stock structure or growth and mortality in the Indian Ocean.

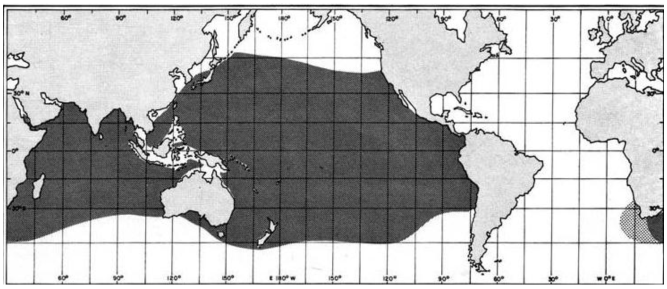


Fig. 1. Striped marlin: The worldwide distribution of striped marlin (Source: Nakamura, 1984)

TABLE 2. Striped marlin: Biology of Indian Ocean striped marlin (*Tetrapturus audax*)

Parameter	Description
Range and stock structure	A large oceanic apex predator that inhabits tropical and sub-tropical waters of the Indian and Pacific oceans. Some rare individuals have been reported in the Atlantic Ocean but there is no information to indicate the presence of a breeding stock in this area. Its distribution is different from other marlins in that it prefers more temperate or cooler waters however in the Indian Ocean it is common in tropical zone: off the east African coast (0-10ºS), the south and western Arabian Sea, the Bay of Bengal, and north-western Australian waters. Several transoceanic migrations were reported in the Indian Ocean (the longest is from Kenya to Australia). Therefore a single stock hypothesis apparently is most appropriate for stock assessement and management.
Longevity	~10 years. Females and males n.a.
Maturity (50%)	Age: 2–3 years. Females and males n.a.
Spawning season	Highly fecund batch spawner. Females may produce up to 20 million eggs. Usually spawn in the vicinity of oceanic islands, seamounts or coastal areas, associated with local increases in primary productivity. In the Indian Ocean larvae of this species was recorded off the Somalian coast, around Reunion and Mauritius and off north-western Australia.
Size (length and weight)	In the Indian Ocean documented maximum size for females 314 cm LJFL and 330 kg TW, for males 292 cm LJFL, 185 kg TW. However males longer than 260 cm LJFL are rare. Young fish grow very quickly in length then put on weight later in life. Striped marlin is the smallest of the marlin species; but unlike the other marlin species, striped marlin males and females grow to a similar size. L-W relationships for the Indian Ocean are: females TW=0.00000009*LJFL**3.76598 males TW=0.00005174*LJFL**2.59633, both sexes mixed TW=0.00000039*LJFL**3.50024, TW in kg, LJFL in cm.

n.a. = not available. Sources: Nakamura 1985, Gonzalez-Armas et al. 1999, Hyde et al. 2006, Froese & Pauly 2009, Kadagi et al. 2011, Romanov & Romanova 2012

Striped marlin: Catch trends

Striped marlin are caught almost exclusively by drifting longlines (98%) with remaining catches recorded by gillnets and troll lines (Table 3, Fig. 2). Striped marlin are also known to be taken in purse seine fisheries, but are not currently being reported. Catch trends for striped marlin are variable; however, this may reflect the level of targeting by longline fleets and the level. The catches of striped marlin by drifting longlines have been changing over time, between 2,000 t and 7,000 t (Fig. 2), although this is highly uncertain due to under reporting and misidentification.

Longline catches have been recorded by Taiwan,China, Japan, Republic of Korea fleets and, recently, Indonesia and several NEI fleets (Fig. 3). Taiwan,China and Japan have reported large drops in the catches of striped marlin for its longline fleets since the mid-1980’s and mid-1990’s, respectively. The reason for such decreases in catches is not fully understood. Between the early 1950s and the late 1980s part of the Japanese fleet was licensed to operate within the EEZ of Australia, reporting relatively high catches of striped marlin in the area, in particular in waters off northwest Australia. High catches of the species were also reported in the Bay of Bengal during this period, by both Taiwan,China and Japanese longliners. The distribution of reported striped marlin catches has changed since the 1980's with most of the catch now taken in the western areas of the Indian Ocean (Fig. 4). However, non-reporting of catches by the gillnet and troll line fisheries masks the true level of harvest in the Indian Ocean.

These changes of fishing area and catches over the years are thought to be related to changes in the type of access agreements to EEZs of coastal countries in the Indian Ocean, rather than changes in the distribution of the species over time. However, since 2007, catches in the northwest Indian Ocean have dropped markedly, in tandem with a reduction of longline effort in the area as a consequence of maritime piracy off Somalia (Fig. 4).

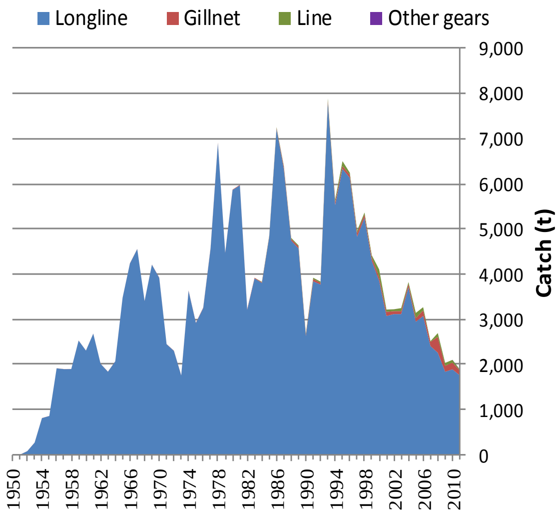


Fig. 2. Striped marlin: Catches of striped marlin per gear and year recorded in the IOTC database (1960–2011)

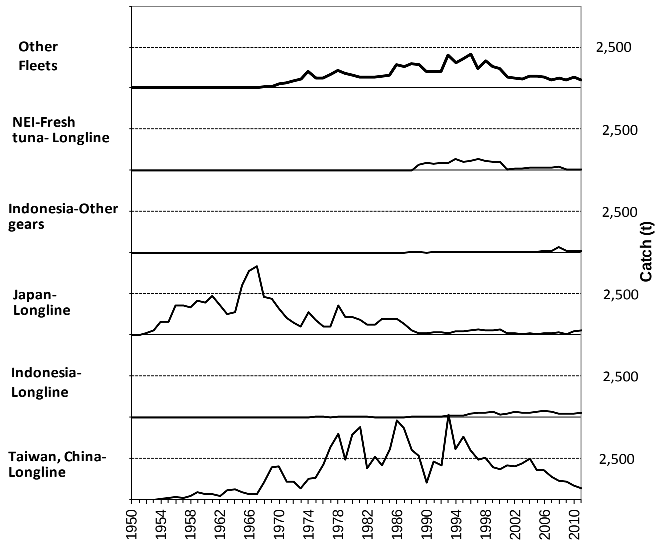


Fig. 3. Striped marlin: Catches of striped marlin by fleet recorded in the IOTC database (1960–2011)

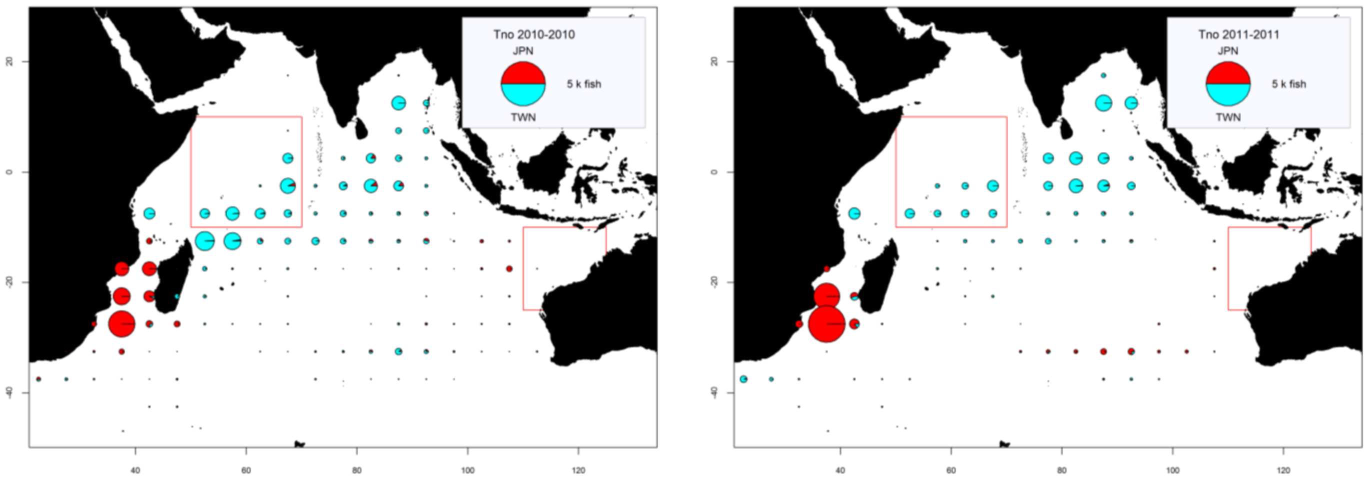


Fig. 4a–b. Striped marlin: Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2010 and 2011 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB (Data as of October 2012)

TABLE 3. Striped marlin: Best scientific estimates of the catches of striped marlin by type of fishery for the period 1950–2011(in metric tonnes) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LL	1,024	3,077	3,612	5,039	5,038	2,936	3,113	3,113	3,708	2,943	3,071	2,403	2,258	1,837	1,889	1,756
GN	2	3	6	24	59	117	65	66	74	81	125	96	351	132	149	115
HL	-	-	1	11	47	71	41	66	39	115	69	15	83	63	62	15
OT	-	-	2	-	-	0	0	-	0	-	-	-	-	-	-	-
Total	**1,026**	**3,080**	**3,622**	**5,074**	**5,145**	**3,124**	**3,220**	**3,245**	**3,822**	**3,139**	**3,266**	**2,514**	**2,692**	**2,032**	**2,100**	**1,885**

Fisheries: Gillnet (GN); Longline (LL); Hook-and-Line (HL), including handline, trolling, baitboat, and sport fisheries; Other gears (OT)

Striped marlin: Uncertainty of time–area catches

Retained catches are reasonably well known for the main industrial fleets (Fig. 5) although they remain uncertain for many smaller fleets:

- Catch reports refer to total catches of all three marlin species; catches by species have to be estimated by the IOTC Secretariat for some industrial fisheries (longliners of Indonesia and Philippines).
- Catches of non-reporting industrial longliners (India, NEI) estimated by the IOTC Secretariat using alternative information. As they are not reported by the countries concerned, catches are likely to be incomplete for some industrial fisheries for which the striped marlin is seldom the target species.
- Conflicting catch reports: The catches for longliners flagged to the Republic of Korea, reported as nominal catches and catches and effort, are conflicting with higher catches recorded in the catch and effort table. For this reason, the IOTC Secretariat revised the catches of striped marlin over the time-series using both datasets. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of striped marlin remain uncertain for this fleet.
- There have not been significant changes to the catches of striped marlin since the WPB in 2011.
- Discards are thought to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of striped marlin may also occur in the driftnet fishery of Iran, as this species has no commercial value in this country.

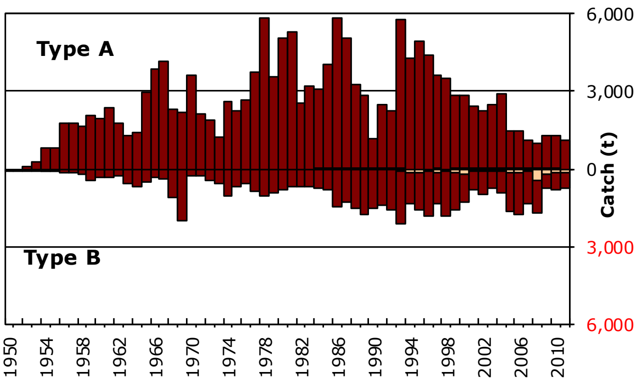


Fig. 5. Striped marlin: Uncertainty of annual catch estimates for striped marlin (Data as of October 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets

Striped marlin: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid for 2010 and 2011 are provided in Fig. 6, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2010 and 2011 are provided in Fig. 7.

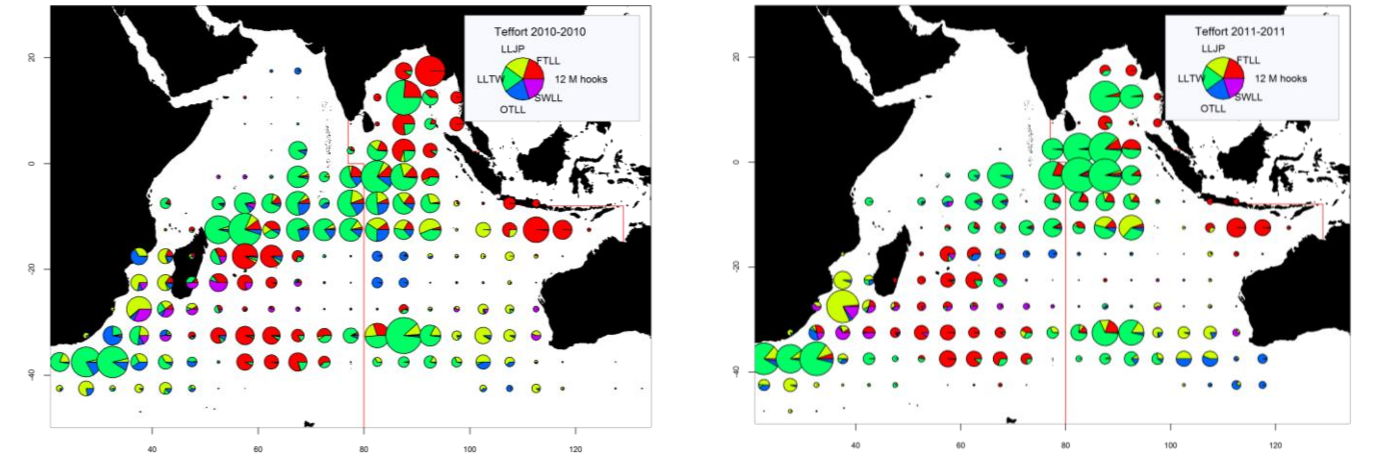


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

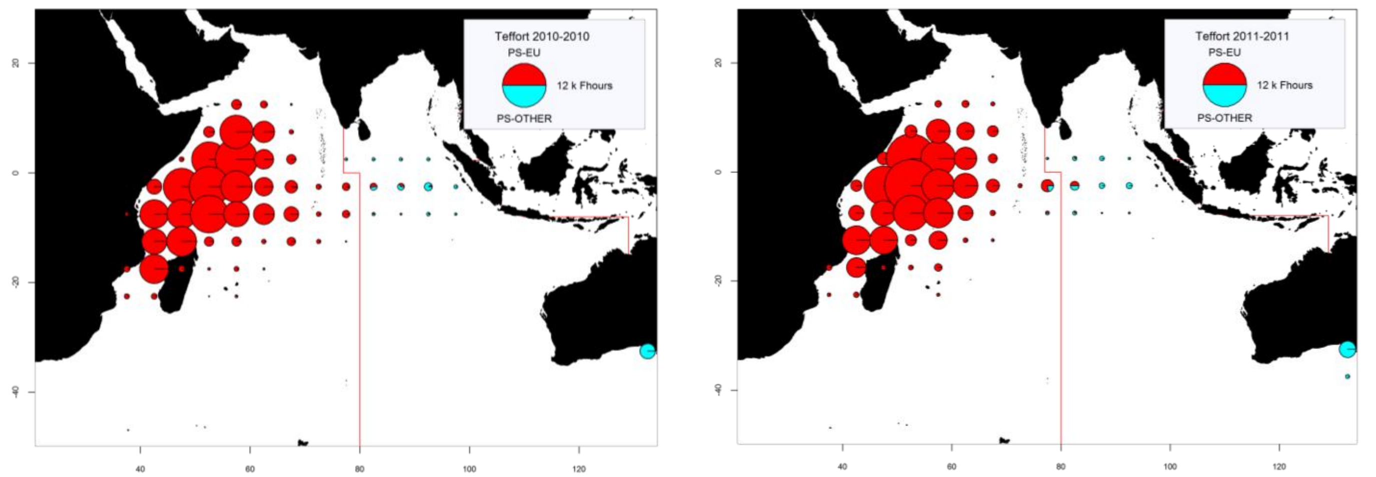


Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Striped marlin: Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet; Figs. 7 and 8) although catches are thought to be incomplete (catches of non-target species are not always recorded in logbooks). No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of I.R. Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Catch rate time series for the longline fleet of Japan (Fig. 8) show a variable but decreasing trend from the mid-1950's until the early 1990s. Catch rates as calculated based on Japanese dataset show a strong decreasing trend in the late-1950's, in the very beginning of the commercial fisheries. Nevertheless it is important to highlight the doubts on the reliability of the results based on aggregated data sets not fully reviewed by experts on Japanese longline fisheries. The sharp decline between 1952 and 1960 in the Japanese striped marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1960 until 2011 is more likely to represent actual declines in stock abundance (Fig. 8).

The catches and CPUE series estimated for striped marlin were very different between the longline fleets of Japan and Taiwan,China. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation. There is no available data for the longline fleet of Taiwan,China for the 1950's and part of the 1960's.

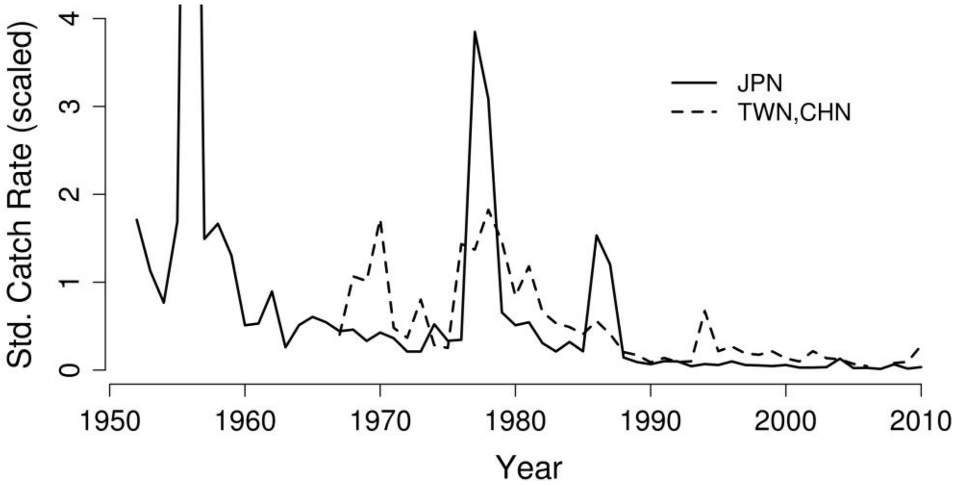


Fig. 8. Striped marlin: Standardised catch rates of striped marlin for Japan (JPN) and Taiwan,China (TWN,CHN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period

Of the striped marlin CPUE series available for assessment purposes, the Taiwan,China series should be used in stock assessment models (Fig. 9).

The recent data for the longline fleet of Taiwan,China, in particular for 2010, should be examined in detail to determine if the increased catches are a function of relocated effort into areas where striped marlin were not previously targeted, or an alternative reason.

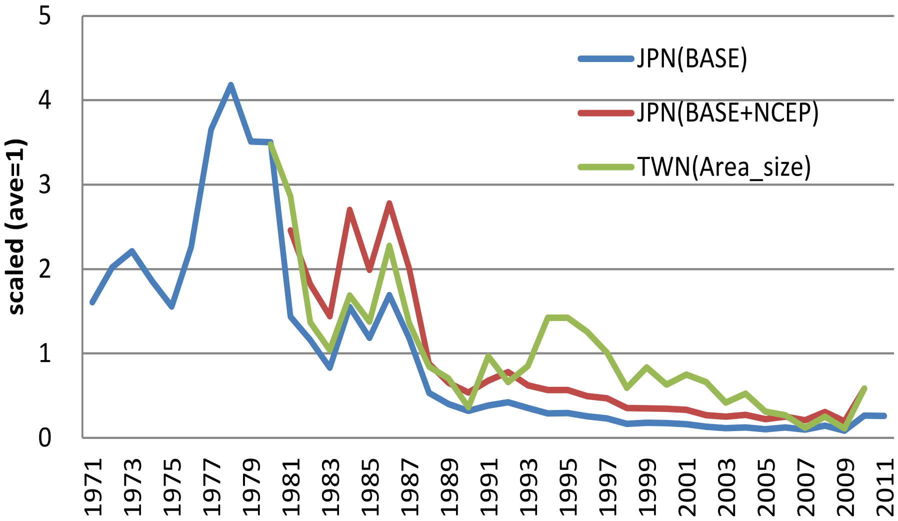


Fig. 9. Striped marlin: Comparison of the multiple CPUE series for longline fleets of Japan and Taiwan,China

Striped marlin: Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped and blue marlin may be occurring in the Taiwanese longline fishery; the length frequency distributions derived from samples collected on Taiwanese longliners differ greatly from those collected on longliners flagged in Japan (Fig. 10).

Catch-at-Size(Age) tables have not been built for this species due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

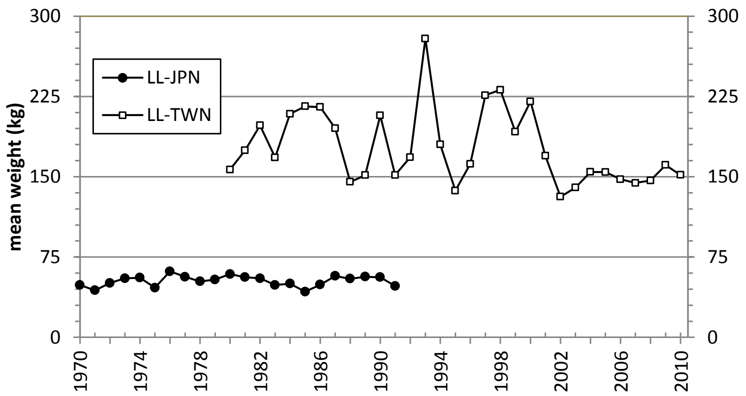


Fig. 10. Striped marlin: Average weight of striped marlin (kg) estimated from the size samples available for longliners of Japan (1970–2009) and Taiwan,China (1980–2010). Note: Average weights are shown only for years in which 300 or more specimens were sampled for length

STOCK ASSESSMENT

In 2012, a range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Surplus Production with catchability changes over decades) were applied to the striped marlin. The assessments carried out in 2012 were preliminary and the results were developed for exploratory and discussion purposes only.

Alternative approaches should be explored using the following in 2013:

- More effort should be made in examining the standardised CPUE data for use in the assessments as these are the basis for assessments without any age/length data available.
- Age/Length data over time should be collected so that alternative approaches could be examined.
- Examining whether a constant or variable catchability (q) is dependent on how well the CPUE is standardised. If the standardisation does not account for the changes, then using variable catchabilities should occur in the assessment.
- Finer spatial resolution and fisheries structure should probably be taken into account in the assessment.

The preliminary estimation of stock indicators attempted on the longline catch and effort datasets from Japan and Taiwan,China represent the best available information (described above). However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Striped marlin (*Tetrapturus audax*) stock status summary

Management Quantity	Aggregate Indian Ocean
2011 catch estimate	1,885 t
Mean catch from 2007–2011	2,245 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1971} (80% CI)	–
SB_{2011}/SB_{1971}	–
$B_{2011}/B_{1971, F=0}$	–
$SB_{2011}/SB_{1971, F=0}$	–

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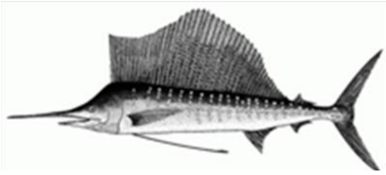
APPENDIX XVII
EXECUTIVE SUMMARY: INDO-PACIFIC SAILFISH

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



Status of the Indian Ocean Indo-Pacific sailfish (SFA: *Istiophorus platypterus*) resource

TABLE 1. Indo-Pacific sailfish: Status of Indo-Pacific sailfish (*Istiophorus platypterus*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Catch 2011: Average catch 2007–2011:	32,503 t 27,103 t	Uncertain
	MSY (range): F_{2011}/F_{MSY} (range): SB_{2011}/SB_{MSY} (range): SB_{2011}/SB_0 (range):	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for Indo-Pacific sailfish in the Indian Ocean; due to a lack of fishery data and poor quality of available data for several gears, only preliminary stock indicators can be used. Therefore stock status remains uncertain (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a more formal assessment are a cause for considerable concern. Research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

Outlook. The increase in longline catch and effort in recent years is a substantial cause for concern for the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of Indo-Pacific sailfish are highly uncertain and need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.
- research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Indo-Pacific sailfish (*Istiophorus platypterus*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Resolution 11/04 *on a regional observer scheme*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of*

competence and access agreement information

- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

Indo-Pacific sailfish: General

Indo-Pacific sailfish (*Istiophorus platypterus*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans. Table 2 outlines some key life history parameters relevant for management. There is limited reliable information on the catches of this species and no information on the stock structure or growth and mortality in the Indian Ocean.

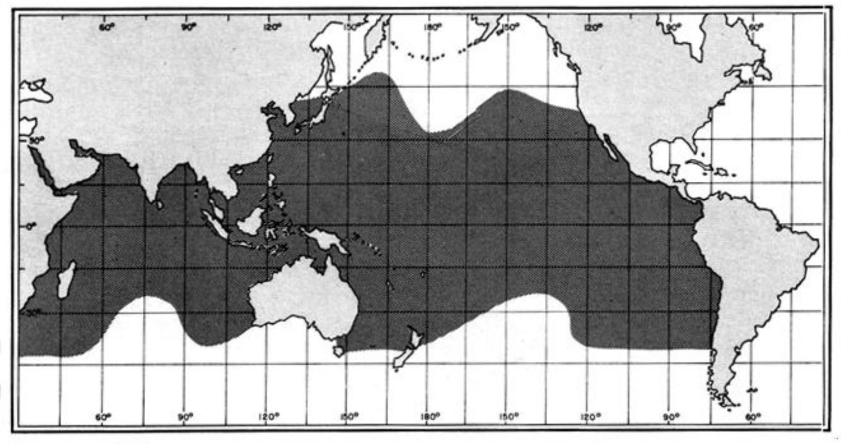


Fig. 1. Indo-Pacific sailfish: The worldwide distribution of Indo-Pacific sailfish (Source: Nakamura, 1984)

TABLE 2. Indo-Pacific sailfish: Biology of Indian Ocean Indo-Pacific sailfish (*Istiophorus platypterus*)

Parameter	**Description**
Range and stock structure	Found throughout the tropical and subtropical regions of the Pacific and the Indian Oceans. It is mainly found in surface waters above the thermocline, close to coasts and islands in depths from 0 to 200 m. Indo–Pacific sailfish is a highly migratory species and renowned for its speed and (by recreational fishers) for its jumping behaviour — one individual has been reported burst swimming at speeds in excess of 110 km/h. The stock structure of Indo-Pacific sailfish in the Indian Oceans is uncertain: apparently there are local reproductively isolated stocks. At least one stock was reported in the Persian Gulf with no or very little intermixing with open Indian Ocean stocks. However outside of the Gulf no stock differentiation has been determined; thus for the purposes of assessment, one pan-ocean stock is assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	Females: 11–13 years; Males: 7–8 years
Maturity (50%)	**Age**: females n.a.; males n.a. **Size**: females n.a.; males n.a.
Spawning season	Spawning in Indian waters occurs between December to June with a peak in February and June. In subtropical waters of the southern hemisphere spawning is associated with warmer months: in Mozambique Channel and around Reunion Island high percentage of ripe females occurs in December.
Size (length and weight)	Maximum: 350 cm FL and weight 100 kg total weight. The Indo-Pacific sailfish is one of the smallest-sized billfish species, but is relatively fast growing. Individuals may grow to over 3 m and up to 100kg, and live to around 7 years. Young fish grow very quickly in length then put on weight later in life. Sexual dimorphism in size, growth rates and size and age at maturity - females reach larger sizes, grow faster and mature later than males. Females: 300 cm LJFL, 50+ kg total weight; Males: 200 cm LJFL, 40+ kg total weight in the Indian Ocean. Recruitment into the fishery: varies by fishing method, apparently at age 0+ and size less than 100 cm LJFL for artisanal fleets. The average weight of fish caught in the Kenyan sports fishery is ~25 kgs whole weight.

n.a. = not available.

Sources: Nakamura 1985, Hoolihan 2003, 2004, 2006, Speare 2003, Hoolihan & Luo 2007, Sun et al. 2007, Froese & Pauly 2009, Ndegwa & Herrera 2011

Indo-Pacific sailfish: Catch trends

Indo-Pacific sailfish is targeted by artisanal fisheries in the Maldives, Yemen and Sri Lanka and by sport/recreational fisheries including in Kenya, Mauritius and Seychelles. Indo-Pacific sailfish is caught mainly by gillnets (78%) with remaining catches reported from troll and hand lines (15%), longlines (7%) or other gears (Table 3, Fig. 2). I.P. sailfish are also known to be taken in purse seine fisheries, but are not currently being reported. The minimum average annual catch estimated for the period 2007 to 2011 is 27,103 t, however this figure is highly uncertain due to under reporting and misidentification. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea (India, Iran, Pakistan and Sri Lanka). Smaller catches are reported for line fishers in Comoros and Mauritius and by Indonesia longliners.

Catches of Indo-Pacific sailfish greatly increased since the mid-1990’s in response to the development of a gillnet/longline fishery in Sri Lanka (Fig. 3) and, especially, the extension in the area of operation of Iranian gillnet vessels to areas beyond the EEZ of I.R. Iran. The catches of Iranian gillnets (Fig. 3) increased dramatically, more than six-fold, after the late 1990’s.

Catches of Indo-Pacific sailfish by drifting longlines (Table 3) and other gears do not show any specific trends in recent years. However, it is likely that longline fleets under report catches of this species due to its little commercial value. In recent years, deep-freezing longliners from Japan have reported catches of Indo-Pacific sailfish in the central western Indian Ocean, between Sri Lanka and the Maldives and the Mozambique Channel (Fig. 4).

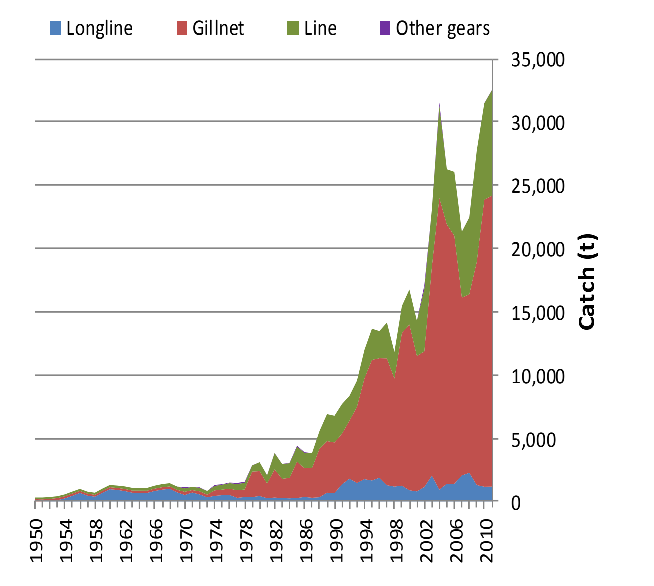


Fig. 2. Indo-Pacific sailfish: Catches of Indo-Pacific sailfish per gear and year recorded in the IOTC Database (1960–2011)

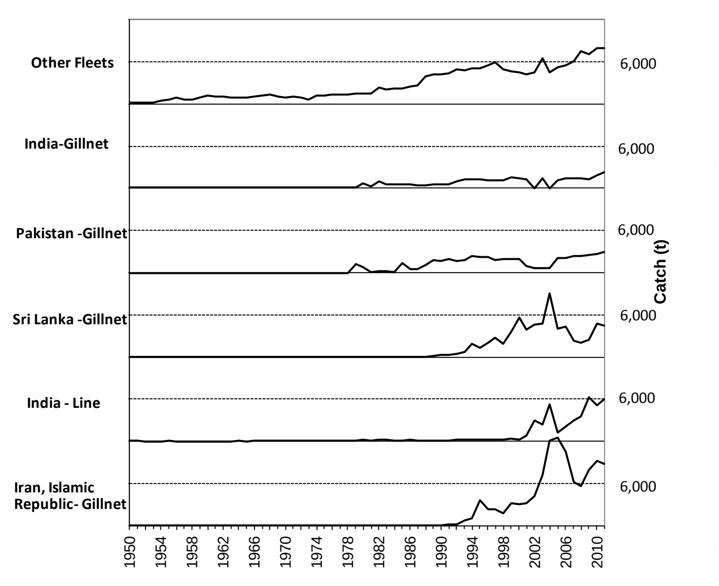


Fig. 3. Indo-Pacific sailfish: Catches of Indo-Pacific sailfish by fleet recorded in the IOTC Database (1960–2011)

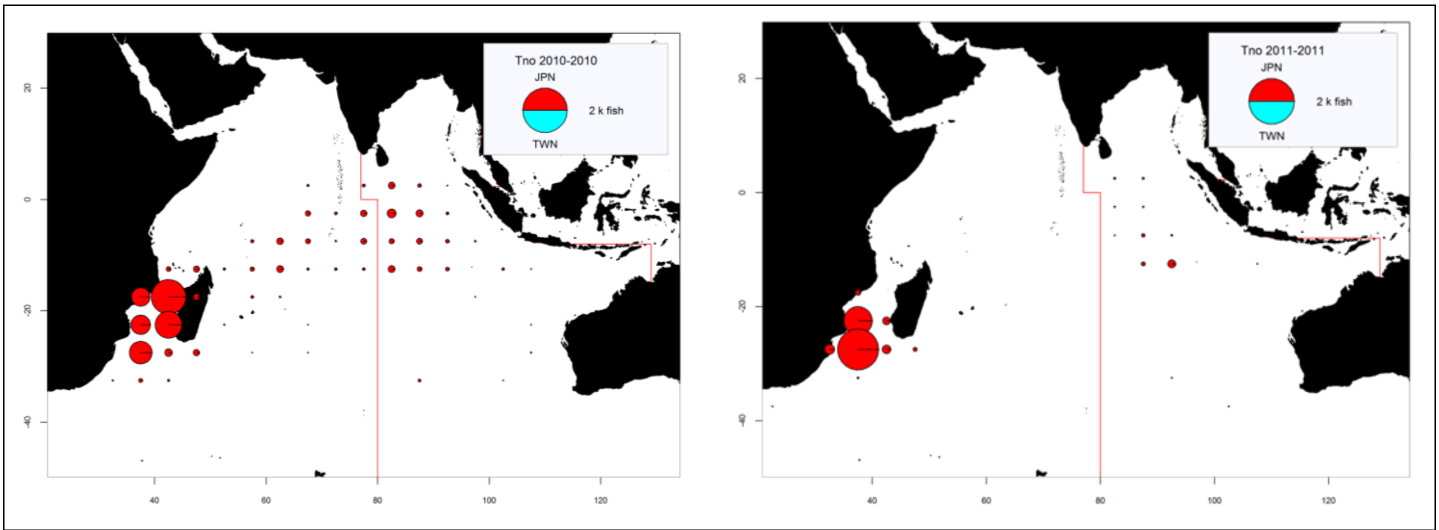


Fig. 4a–b. Indo-Pacific sailfish: Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2010 and 2011 by fleet. Data as of October 2012

TABLE 3. Indo-Pacific sailfish: Best scientific estimates of the catches of Indo-Pacific sailfish by type of fishery for the period 1950–2011 (in metric tonnes). Data as of October 2012

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LL	299	773	449	342	1,425	1,418	1,144	2,035	933	1,395	1,396	2,055	2,263	1,291	1,163	1,172
GN	165	186	549	2,390	7,620	16,001	10,722	16,486	23,053	20,505	19,612	14,064	14,111	17,646	22,685	23,003
HL	155	233	378	1,211	2,244	5,188	4,940	4,558	7,310	4,367	5,052	5,206	6,075	8,814	7,629	8,329
OT	-	9	48	19	1	55	297	-	240	-	-	-	12	-	-	-
Total	**618**	**1,202**	**1,424**	**3,963**	**11,290**	**22,662**	**17,102**	**23,080**	**31,535**	**26,267**	**26,059**	**21,325**	**22,461**	**27,752**	**31,476**	**32,503**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

Indo-Pacific sailfish: Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Unlike the other billfish, Indo-Pacific sailfish are probably more reliably identified because of the large and distinctive first dorsal fin that runs most of the length of the body.

Retained catches are poorly known for most fisheries (Fig. 5) due to:

- Catch reports often refer to total catches of all billfish species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries.
- Catches of IP sailfish reported for some fisheries may refer to the combined catches of more than one species of billfish, in particular marlins and shortbill spearfish (gillnet fishery of Iran and many coastal fisheries).
- Catches likely to be incomplete for some artisanal fisheries (gillnets of Pakistan, pole and lines of Maldives) due to under-reporting.
- Catches are likely to be incomplete for industrial fisheries for which the Indo-Pacific sailfish is not a target species.
- A lack of catch data for most sport fisheries.
- There have not been significant changes to the catches of Indo-Pacific sailfish since 2011.
- Discards are unknown for most industrial fisheries, mainly longliners (for which they are presumed to be moderate-high).

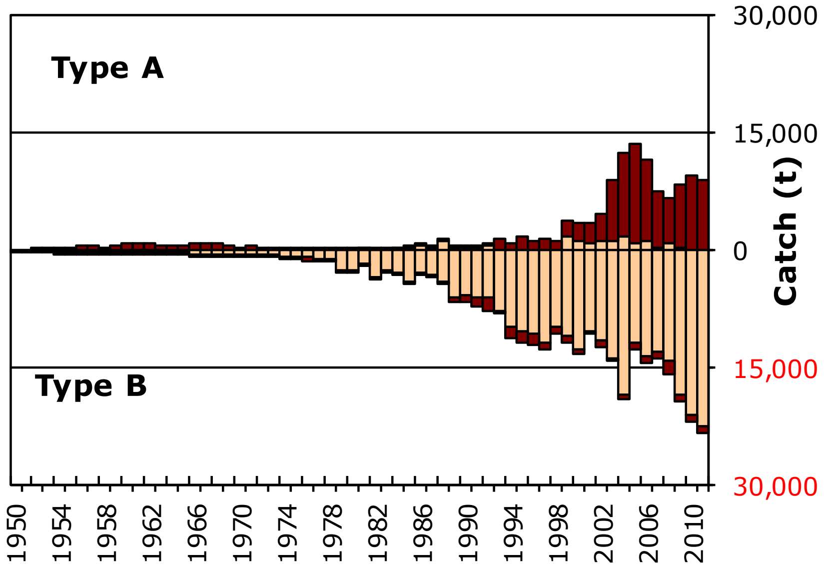


Fig. 5. Indo-Pacific sailfish: Uncertainty of annual catch estimates for Indo-Pacific sailfish. (Data as of October 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets

Indo-Pacific sailfish: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2011 are provided in Fig. 6, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 7.

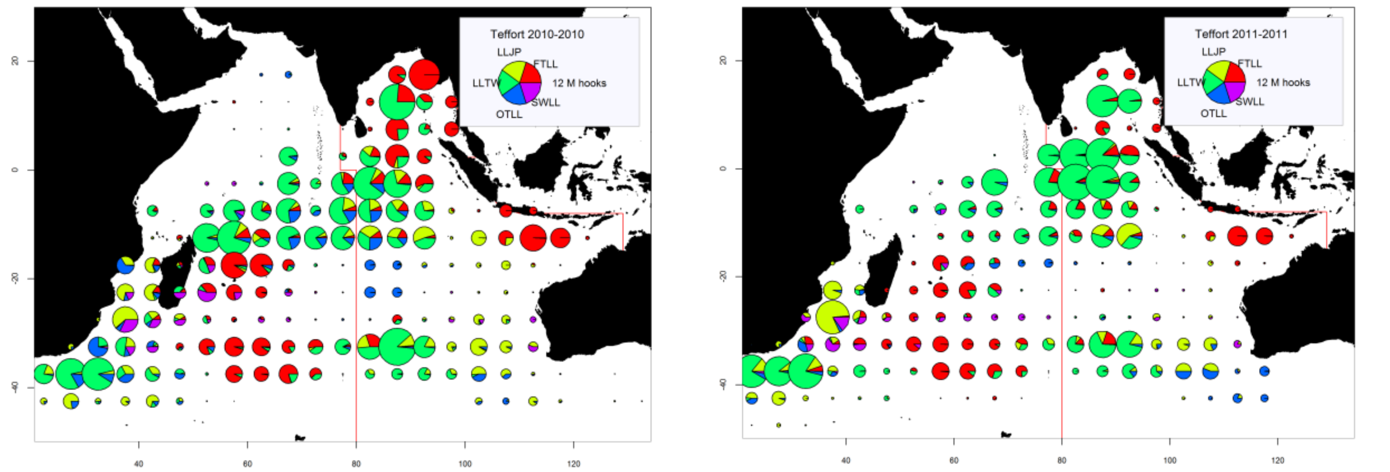


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

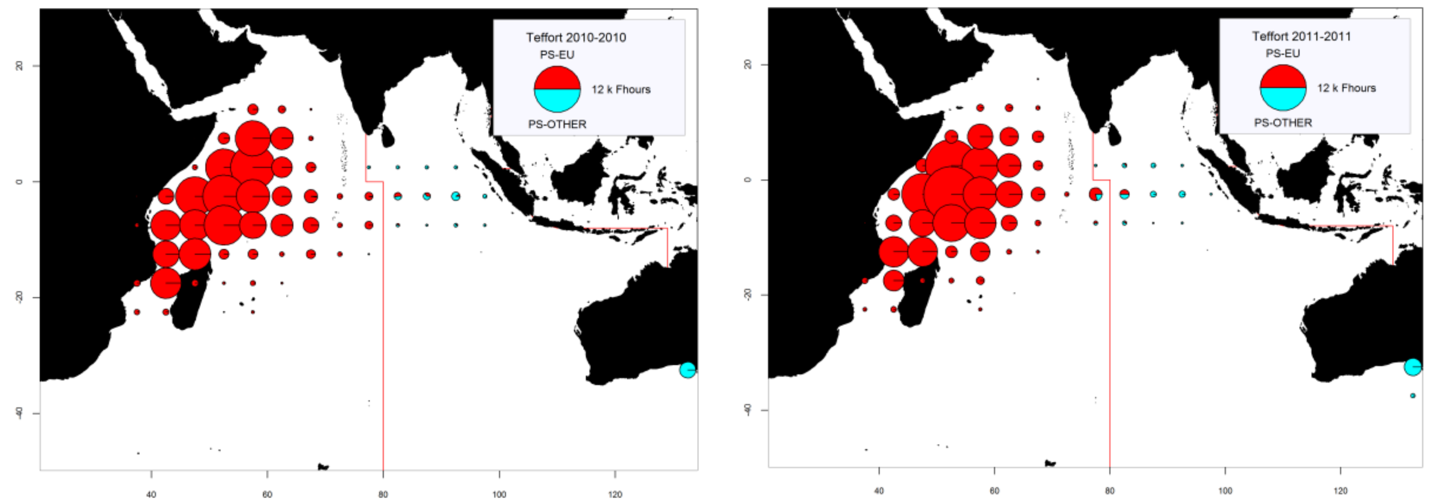


Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Indo-Pacific sailfish: Catch–per–unit–effort (CPUE) trends

Standardised and nominal CPUE series have not yet been developed. No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of I.R. Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Indo-Pacific sailfish: Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and the gillnet/longline fishery of Sri Lanka since the late 1980s (Fig. 8). The number of specimens measured on Japanese longliners in recent years is, however, very low. Furthermore, the specimens discarded might be not accounted for in industrial fisheries, where they are presumed to be of lower size (possible bias of existing samples).

Catch-at-Size(Age) tables have not been built for this species due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

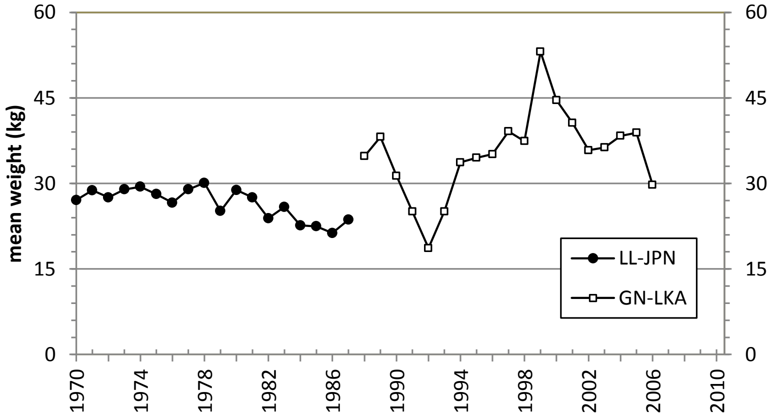


Fig. 8. Indo-Pacific sailfish: Average weight of Indo-Pacific sailfish (kg) estimated from the size samples available for longliners of Japan (1970–2009) and gillnets of Sri Lanka (1980–2010). Note: Average weights are shown only for years in which 300 or more specimens were sampled for length

STOCK ASSESSMENT

No quantitative stock assessment for Indo-Pacific sailfish in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. Further work must be undertaken to derive stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Indo-Pacific sailfish (*Istiophorus platypterus*) stock status summary

Management Quantity	**Aggregate Indian Ocean**
2011 catch estimate	32,503 t
Mean catch from 2007–2011	27,103 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_0 (80% CI)	–
SB_{2011}/SB_0	–
$B_{2011}/B_{0,\ F=0}$	–
$SB_{2011}/SB_{0,\ F=0}$	–

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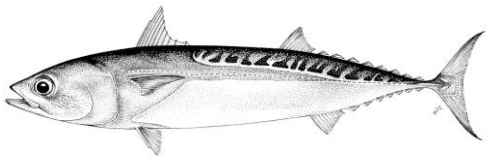
APPENDIX XVIII
EXECUTIVE SUMMARY: BULLET TUNA

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



Status of the Indian Ocean bullet tuna (BLT: *Auxis rochei*) resource

TABLE 1. Bullet tuna: Status of bullet tuna (*Auxis rochei*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Catch[2] 2011: Average catch[2] 2007–2011:	4,949 t 2,961 t	
	MSY: F_{2011}/F_{MSY}: SB_{2011}/SB_{MSY}: SB_{2011}/SB_0:	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about stock structure and about the total catches. No quantitative stock assessment is currently available for bullet tuna in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains uncertain (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for bullet tuna is likely to have further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted. The following should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Bullet tuna in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of*

competence and access agreement information
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

Bullet tuna: General

Bullet tuna (*Auxis rochei*) is an oceanic species found in the equatorial areas of the major oceans. It is a highly migratory species with a strong schooling behaviour. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Bullet tuna: Biology of Indian Ocean bullet tuna (*Auxis rochei*)

Parameter	Description
Range and stock structure	Little is known on the biology of bullet tuna in the Indian Ocean. An oceanic species found in the equatorial areas of the major oceans. It is a highly migratory species with a strong schooling behaviour. Adults are principally caught in coastal waters and around islands that have oceanic salinities. No information is available on the stock structure in Indian Ocean. Bullet tuna feed on small fishes, particularly anchovies, crustaceans (commonly crab and stomatopod larvae) and squids. Cannibalism is common. Because of their high abundance, bullet tunas are considered to be an important prey for a range of species, especially the commercial tunas.
Longevity	Females n.a; Males n.a.
Maturity (50%)	**Age**: 2 years; females n.a. males n.a. **Size:** females and males ~35 cm FL.
Spawning season	It is a multiple spawner with fecundity ranging between 31,000 and 103,000 eggs per spawning (according to the size of the fish). Larval studies indicate that bullet tuna spawn throughout its range.
Size (length and weight)	Maximum: Females and males 50 cm FL; weight n.a.

n.a. = not available. Sources: Froese & Pauly 2009, Kahraman 2010, Widodo et al. 2012

Bullet tuna – Fisheries and catch trends

Bullet tuna is caught mainly by gillnet, handline, and trolling, across the broader Indian Ocean area (Table 3; Fig. 1). This species is also an important catch for artisanal purse seiners. The catch estimates for bullet tuna were derived from very small amounts of information and are therefore highly uncertain[1].

TABLE 3. Bullet tuna: Best scientific estimates of the catches of bullet tuna by type of fishery for the period 1950–2011 (in metric tonnes) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Purse seine	-	3	10	81	164	200	210	209	169	169	208	213	214	199	171	226
Gillnet	5	9	35	92	694	908	1,186	469	922	545	1,127	1,453	1,089	1,356	2,322	3,970
Line	12	16	72	187	495	595	553	541	473	478	596	808	729	686	617	754
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**17**	**28**	**117**	**360**	**1,353**	**1,704**	**1,948**	**1,219**	**1,565**	**1,192**	**1,932**	**2,474**	**2,032**	**2,241**	**3,110**	**4,949**

Estimated catches of bullet tuna reached around 1,000 t in the early 1990's, increasing markedly in the following years to reach a peak in 1998 at around 2,800 t. The catches decreased sharply in the following years and remained around 2,000 t until the mid-2000's. The highest reported catches of bullet tuna were taken in 2011 with 4,950 t estimated as being landed. The high catches of bullet tuna recorded since 2006, compared to previous years, are thought to be highly uncertain. The difference in catches may come from improved identification of specimens of frigate tuna and bullet tuna in recent years, leading to higher catches of bullet tuna reported to the IOTC Secretariat.

[1] The uncertainty in the catch estimates has been assessed by the IOTC Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of unreporting fisheries for which catches had to be estimated.

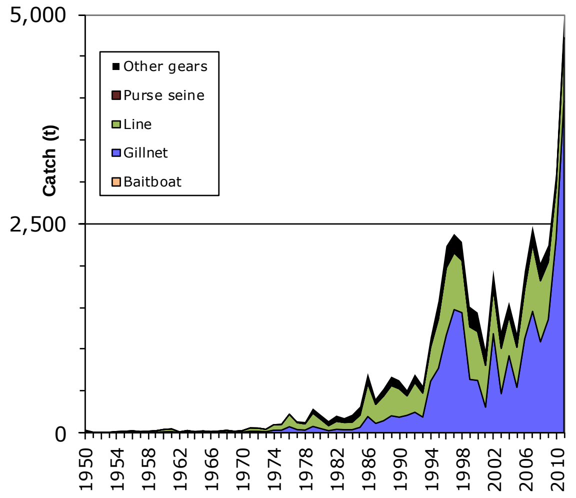


Fig. 1. Bullet tuna: Annual catches of bullet tuna by gear recorded in the IOTC Database (1950–2011)

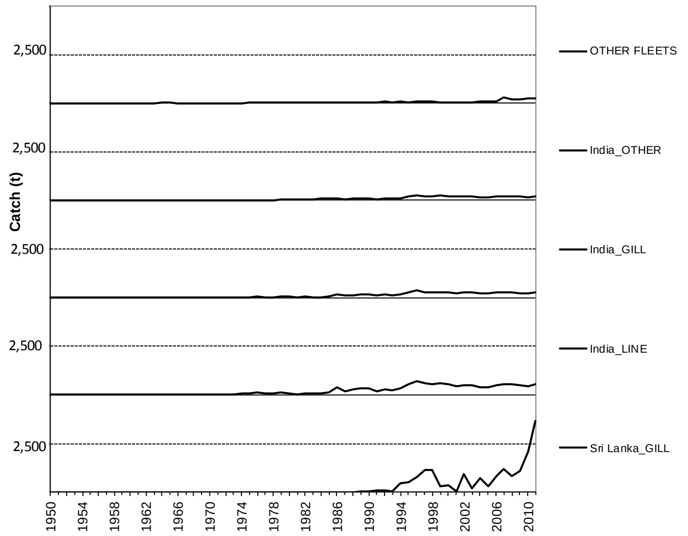


Fig. 2. Bullet tuna: Catches of bullet tuna recorded in the IOTC database for main fishing fleets (1950–2011)

In recent years, the countries attributed with the highest catches of bullet tuna are Sri Lanka and India (Fig. 2). Length frequency data for bullet tuna is only available for some Sri Lanka fisheries and periods.

Bullet tuna – Uncertainty of catches

Retained catches are highly uncertain for all fisheries (Fig. 3) due to:

- Aggregation: Bullet tuna are usually not reported by species being aggregated with frigate tunas or, less frequently, other small tuna species.
- Mislabelling: Bullet tuna are usually mislabelled as frigate tuna, their catches reported under the latter species.
- Underreporting: the catches of bullet tuna by industrial purse seiners are rarely, if ever, reported.

It is for the above reasons that the catches of bullet tunas in the IOTC database are thought to represent only a small fraction of the total catches of this species in the Indian Ocean. In particular, catches reported by India in recent years are unreliable and need to be verified.

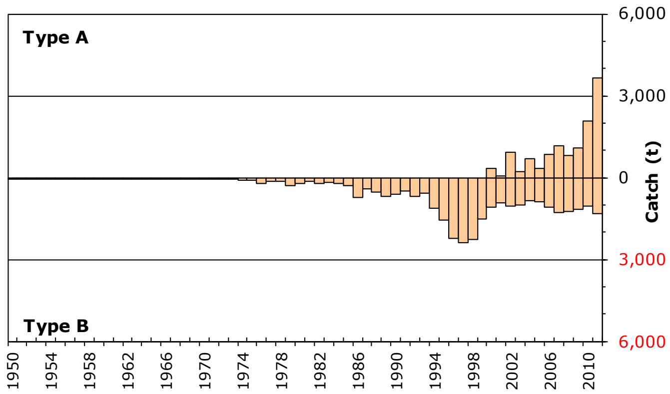


Fig. 3. Bullet tuna: Uncertainty of annual catch estimates for bullet tuna (1950–2011). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets (Data as of October 2012)

- Discard levels are moderate for industrial purse seine fisheries. The EU recently reported discard levels of bullet tuna for its purse seine fleet, for 2003–07, estimated using observer data.
- Changes to the catch series: The catch series of bullet tuna has changed substantially since the WPNT meeting in 2011, following reviews of catches of frigate tuna and bullet tuna for the coastal fisheries in India, with an

increased proportion of frigate tuna to the previously reported total catches of both frigate tuna and bullet tuna.

Bullet tuna – Effort trends

Effort trends are unknown for bullet tuna in the Indian Ocean.

Bullet tuna – Catch–per–unit–effort (CPUE) trends

Catch-and-effort series are not available for most fisheries (Table. 4) and, when available, they are usually considered to be of poor quality for the fisheries having reasonably long catch-and-effort data series, as it is the case with the gillnet fisheries of Sri Lanka (Fig. 5).

TABLE. 4. Bullet tuna: Availability of catches and effort series, by fishery and year (1970–2011)[2]. Note that no catch and effort data are available for the period 1950–78

Gear-Fleet	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	00	02	04	06	08	10
PSS-Indonesia								■■	■■												
PSS-Sri Lanka											·■										
GILL-India					·■																
GILL-Indonesia								■■													
GILL-Sri Lanka								·■	■■	■■	■■		■■	■■	■■	■■	■■	■·			
LINE-India					·■																
LINE-Indonesia								·■													
LINE-Sri Lanka									■·												
LINE-Yemen																	·■	■■	■·		
OTHR-Sri Lanka													■■	■■	■■	■■	■■	■·			

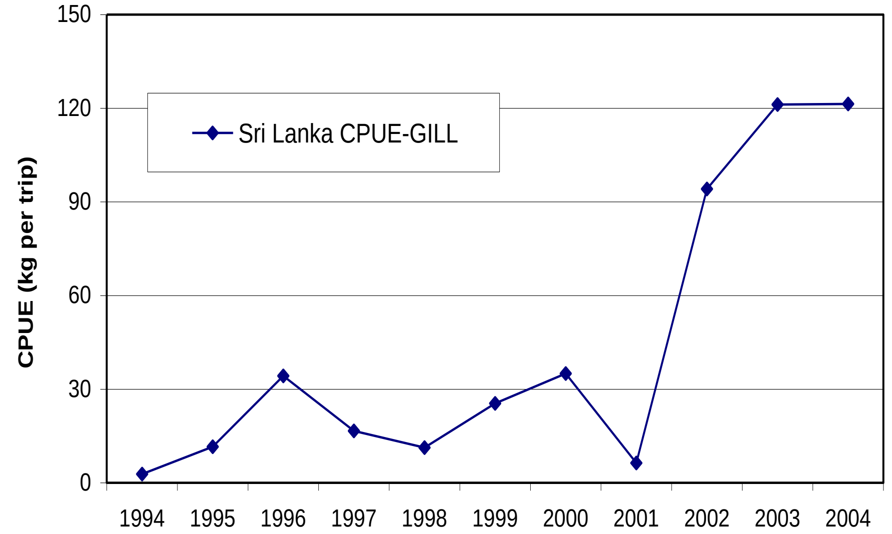


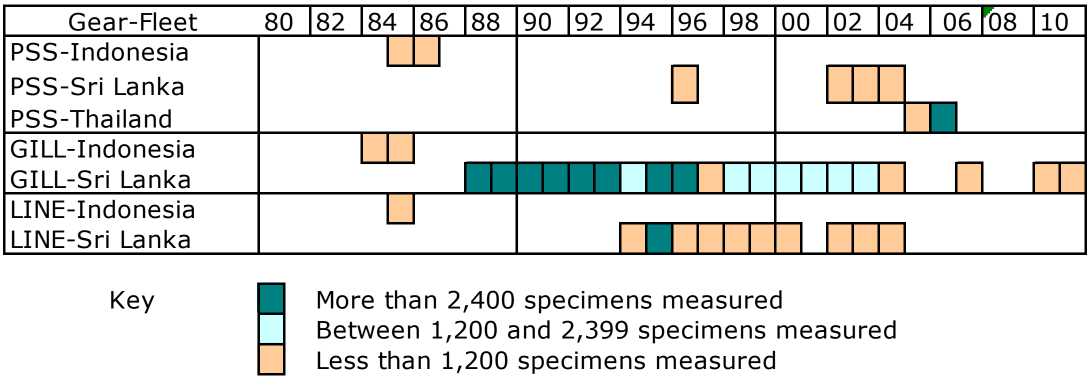
Fig. 5. Bullet tuna: Nominal CPUE series for the gillnet fishery of Sri Lanka derived from the available catches and effort data (1994–2004)

Bullet tuna – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- The size of bullet tuna taken by the Indian Ocean fisheries typically ranges between 13–48 cm depending on the type of gear used, season and location.
- Trends in average weight cannot be assessed for most fisheries. Reasonable long series of length frequency data are only available for Sri Lankan gillnets and lines but the amount of specimens measured has been very low in recent years (Table 5).
- Catch-at-Size(age) data are not available for bullet tuna due to the paucity of size data available from most fleets and the uncertain status of the catches for this species. Length distributions derived from the data available for some selected fisheries are shown in Fig. 6
- Sex ratio data have not been provided to the Secretariat by CPCs.

[2] Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, when available catches and effort may not be available throughout the year existing only for short periods

TABLE. 5. Bullet tuna: Availability of length frequency data, by fishery and year (1980–2011)[3]. Note that no length frequency data are available for the period 1950–83



Stock Assessment

No quantitative stock assessment for bullet tuna in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. However, a preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Sri Lankan gillnet fleet (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Bullet tuna (*Auxis rochei*) stock status summary

Management Quantity	Aggregate Indian Ocean
2011 catch estimate	4,949 t
Mean catch from 2007–2011	2,961 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_0 (80% CI)	–
SB_{2011}/SB_0	–
$B_{2011}/B_{0,\ F=0}$	–
$SB_{2011}/SB_{0,\ F=0}$	–

[3] Note that the above list is not exhaustive, showing only the fisheries for which size data are available in the IOTC database. Furthermore, when available size data may not be available throughout the year existing only for short periods

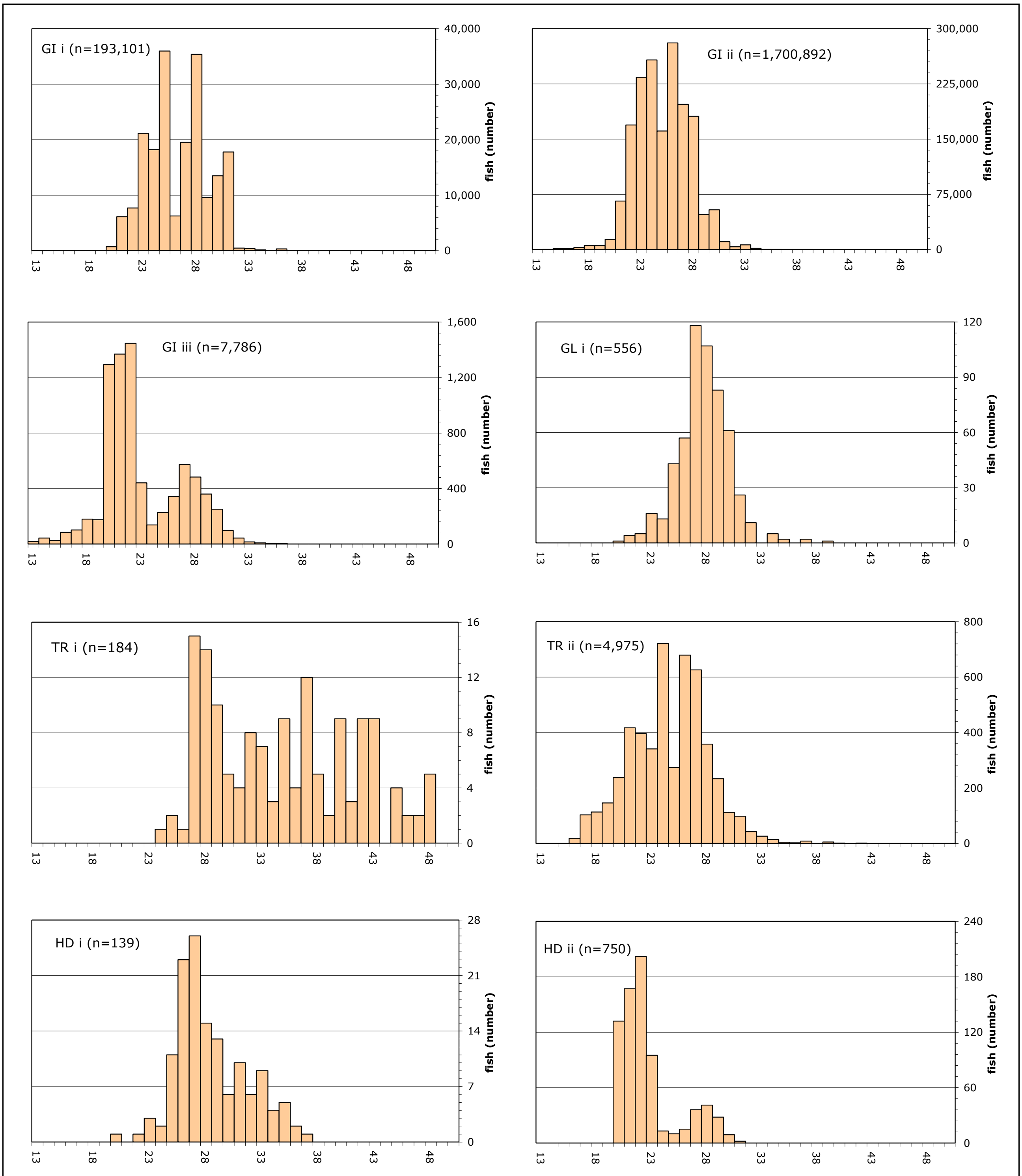


Fig. 6. Bullet tuna: Length frequency distributions (total amount of fish measured by 1cm length class by decade) derived from the data available at the IOTC Secretariat for selected fisheries and periods. GI: Gillnet fisheries: i. Sri Lanka 1980–89, ii. Sri Lanka 1990-99, iii. Sri Lanka 2000–06. GL: Gillnet and longline combination: i. Sri Lanka 2000–06. TR: Troll line fisheries: i. Sri Lanka 1980–89, ii. Sri Lanka 1990–99. HD: Hand line fisheries: i. Sri Lanka 1990–99, ii. Sri Lanka 2000–06

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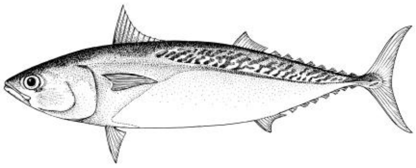
Widodo AA, Satria F, Barata A (2012) Catch and size distribution of bullet and frigate tuna caught by drifting gillnet in Indian Ocean based at Cilacap fishing port-Indonesia. IOTC–2012–WPNT02–12

APPENDIX XIX
EXECUTIVE SUMMARY: FRIGATE TUNA

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



Status of the Indian Ocean frigate tuna (FRI: *Auxis thazard*) resource

TABLE 1. Frigate tuna: Status of frigate tuna (*Auxis thazard*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Catch[2] 2011: Average catch[2] 2007–2011:	83,210 t 75,777 t	
	MSY: F_{2011}/F_{MSY}: SB_{2011}/SB_{MSY}: SB_{2011}/SB_0:	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about stock structure and about the total catches. No quantitative stock assessment is currently available for frigate tuna in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains uncertain (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for frigate tuna is likely to have further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted. The following should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Frigate tuna in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of*

competence and access agreement information

- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

Frigate tuna: General

Frigate tuna (*Auxis thazard*) is a highly migratory species found in both coastal and oceanic waters. It is highly gregarious and often schools with other Scombrids. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Frigate tuna: Biology of Indian Ocean frigate tuna (*Auxis thazard*)

Parameter	**Description**
Range and stock structure	Little is known on the biology of frigate tuna in the Indian Ocean. Highly migratory species found in both coastal and oceanic waters. It is highly gregarious and often schools with other Scombrids. Frigate tuna feeds on small fish, squids and planktonic crustaceans (e.g. decapods and stomatopods). Because of their high abundance, frigate tuna are considered to be an important prey for a range of species, especially the commercial tunas. No information is available on the stock structure of frigate tuna in Indian Ocean.
Longevity	Females n.a; Males n.a.
Maturity (50%)	**Age**: n.a.; females n.a. males n.a. **Size:** females and males ~29–35 cm FL.
Spawning season	In the southern Indian Ocean, the spawning season extends from August to April whereas north of the equator it is from January to April. Fecundity ranges between 200,000 and 1.06 million eggs per spawning (depending on size).
Size (length and weight)	Maximum: Females and males 60 cm FL; weight n.a.

n.a. = not available. Sources: Froese & Pauly 2009

Frigate tuna – Fisheries and catch trends

Frigate tuna is taken from across the Indian Ocean area using gillnets, pole-and-lines, handlines and trolling gear (Table 3; Fig. 1). This species is also an important incidental catch for industrial purse seine vessels and is the target of some ring net fleets. The catch estimates for frigate tuna were derived from very small amounts of information and are therefore highly uncertain[4].

The catches provided in Table 3 are based on the information available at the IOTC Secretariat and the following observations on the catches cannot currently be verified. Estimated catches have increased steadily since the late 1970’s reaching around 15,000 t in the early 1980’s and over 45,000 t by the mid-1990’s, and remaining at the same level over the following ten years. Catches increased substantially 2005, with current catches at around 80,000 t (Table 3; Fig. 2). The catches of frigate tuna have been higher in the east since the late 1990’s, with ¾ of the catches of frigate tuna taken in the eastern Indian Ocean in recent years.

In recent years, the countries attributed with the highest catches are Indonesia (65%), India (14%), Iran (7%), and Sri Lanka (5%) (Table 3; Fig. 2).

[4] The uncertainty in the catch estimates has been assessed by the IOTC Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of non-reporting fleets for which catches had to be estimated.

TABLE 3. Frigate tuna: Best scientific estimates of the catches of frigate tuna by type of fishery for the period 1950–2011 (in metric tonnes) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Purse seine	-	12	891	6,433	16,228	30,473	24,052	25,214	29,826	27,602	31,262	33,701	41,257	39,637	39,674	40,097
Gillnet	265	407	1,252	3,689	10,456	14,926	12,025	11,971	11,023	10,509	14,399	20,880	22,401	24,651	28,525	32,121
Line	447	666	1,197	2,916	5,658	5,265	5,374	5,038	4,745	4,600	5,298	5,584	5,486	5,810	5,015	6,149
Other	1,782	2,580	3,304	3,957	6,852	6,078	6,175	6,266	5,542	6,345	4,818	5,285	6,050	6,878	4,842	4,843
Total	**2,494**	**3,666**	**6,644**	**16,995**	**39,194**	**56,742**	**47,626**	**48,489**	**51,134**	**49,055**	**55,778**	**65,449**	**75,194**	**76,976**	**78,056**	**83,210**

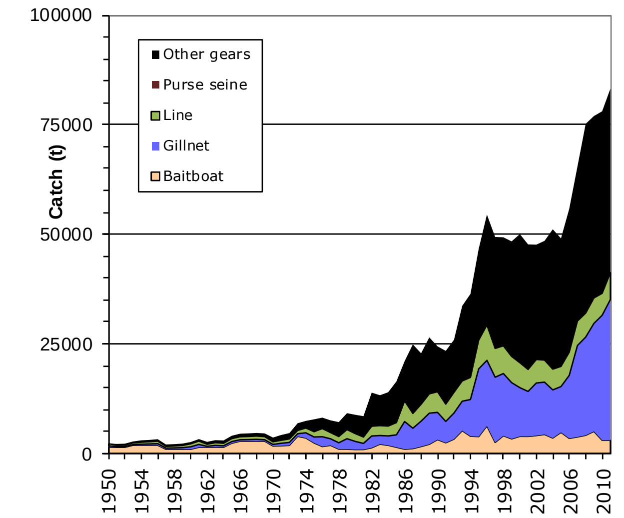


Fig. 1. Frigate tuna: Annual catches of frigate tuna by gear recorded in the IOTC Database (1950–2011)

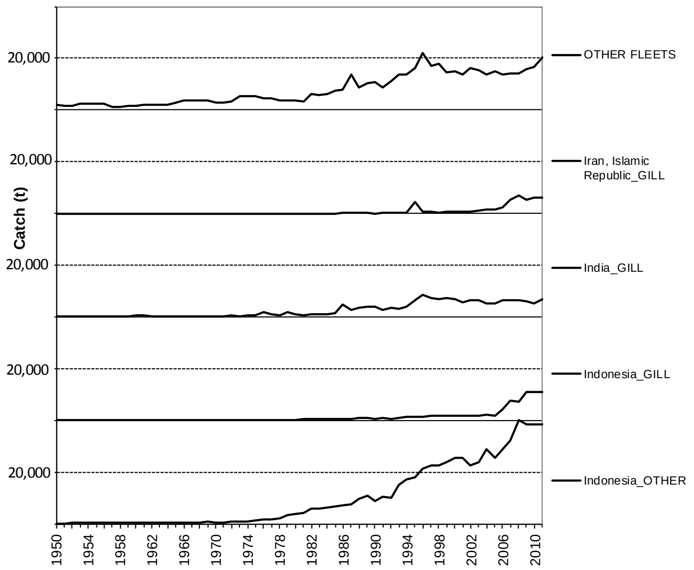


Fig. 2. Frigate tuna: Catches of frigate tuna recorded in the IOTC Database for main fishing fleets (1950–2011)

Frigate tuna – uncertainty of catches

Retained catches are highly uncertain (Fig. 3) notably for the following fisheries:

- Artisanal fisheries of Indonesia: Indonesia did not report catches of frigate tuna by species or by gear for 1950–2004; catches of frigate tuna, bullet tuna and other species were reported aggregated for this period. The Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004 by gear and species. The catches estimated for the frigate tuna represent around 65% of the total catches of this species in the Indian Ocean in recent years.
- Artisanal fisheries of India: Although India reports catches of frigate tuna they are not always reported by gear. The IOTC Secretariat has allocated the catches of frigate tuna by gear for years in which this information was not available. In recent years, the catches of frigate tuna in India have represented 14% of the total catches of this species in the Indian Ocean.
- Artisanal fisheries of Myanmar (and Somalia): None of these countries have ever reported catches of frigate tuna to the IOTC Secretariat. Catch levels are unknown.
- Other artisanal fisheries: The catches of frigate tuna and bullet tuna are seldom reported by species and, when reported by species, they usually refer to both species (due to mislabelling, with all catches assigned to the frigate tuna).
- Industrial fisheries: The catches of frigate tuna recorded for industrial purse seiners are thought to be a fraction of those retained on board. Due to this species being a bycatch, its catches are seldom recorded in the logbooks, nor can they be monitored in port. The EU recently reported catch levels of frigate tuna for its purse seine fleet, for 2003–07, estimated using observer data.

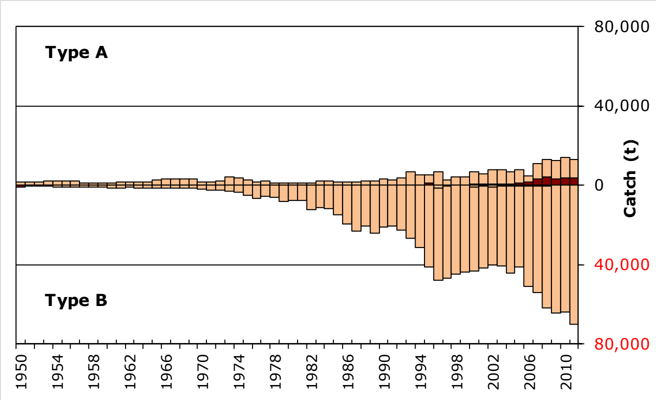


Fig. 3. Frigate tuna: Uncertainty of annual catch estimates for frigate tuna (1950–2011). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets (Data as of October 2012)

- Discard levels are moderate for industrial purse seine fisheries. The EU recently reported discard levels of frigate tuna for its purse seine fleet, for 2003–07, estimated using observer data.
- Changes to the catch series: The catch series of frigate tuna has not changed substantially since the WPNT meeting in 2011.

Frigate tuna – Effort trends

Effort trends are unknown for frigate tuna in the Indian Ocean.

Frigate tuna – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Catch-and-effort series are available from some fisheries but they are considered highly incomplete (Fig. 4). In most cases catch-and-effort data are only available for short periods. Reasonably long catch-and-effort series (extending for more than 10 years) are only available for Maldives baitboats and hand and troll lines (Table 4) and Sri Lanka gillnets. The catches and effort recorded for Sri Lankan gillnets are, however, thought to be inaccurate due to the dramatic changes in CPUE recorded between consecutive years.

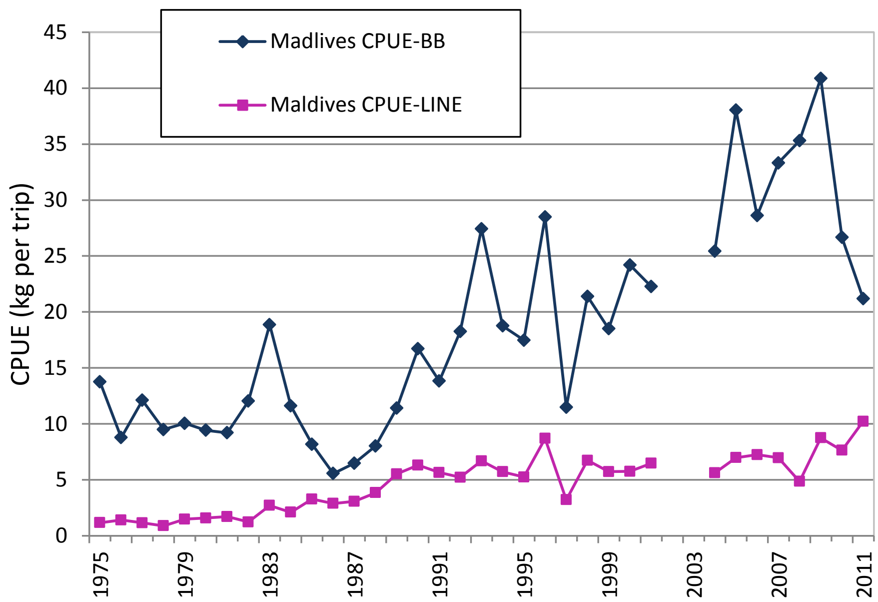
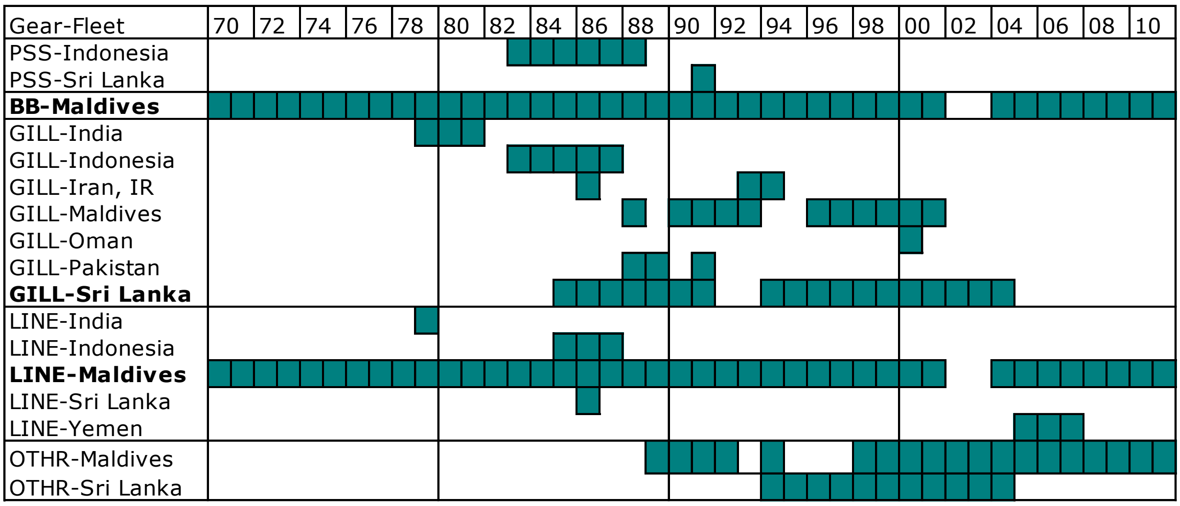


Fig. 4. Frigate tuna: Nominal CPUE series for the baitboat (BB using mechanized boats) and line (LINE, including handlines and trolling using mechanized boats) fisheries of Maldives derived from the available catches and effort data (1975–2011)

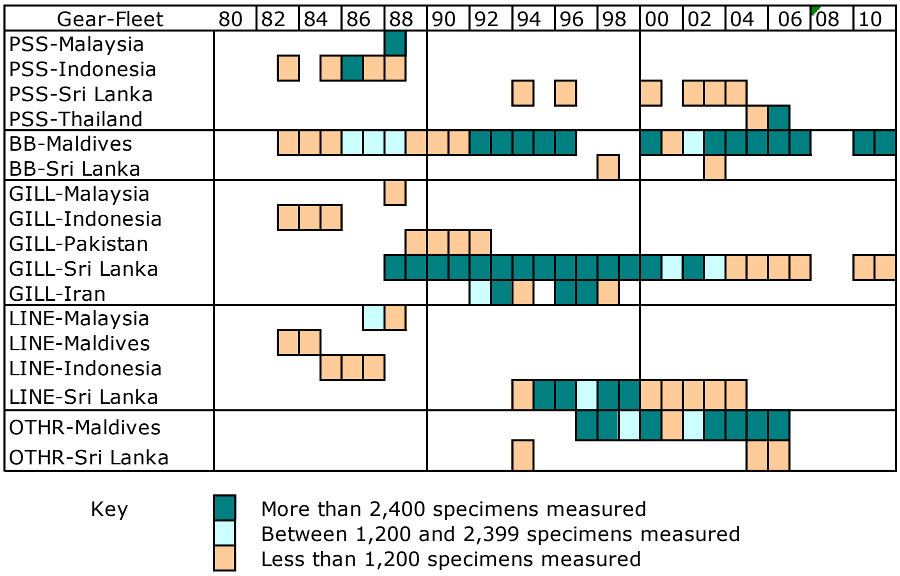
TABLE 4. Frigate tuna: Availability of catches and effort series, by fishery and year (1970–2011)[5]. Note that no catches and effort are available for the period 1950–69 in the IOTC Secretariat databases



Frigate tuna – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- Trends in average weight can only be assessed for Sri Lankan gillnets and Maldivian pole-and-lines but the amount of specimens measured has been very low in recent years (Table 5). The length frequency data available from the mid-eighties to the early nineties was obtained with the support of the IPTP (Indo-Pacific Tuna Programme). Unfortunately, data collection did not continue in most countries after the end of the IPTP activities.

TABLE 5. Frigate tuna: Availability of length frequency data, by fishery and year (1980–2011)[6]. Note that no length frequency data are available for the period 1950–82



- The size of frigate tunas taken by the Indian Ocean fisheries typically ranges between 20 and 50 cm depending on the type of gear used, season and location (Fig. 5). The fisheries operating in the Andaman Sea (coastal purse seines and troll lines) tend to catch frigate tuna of small to medium size (15–40 cm) while the gillnet, baitboat and other fisheries operating in the Indian Ocean catch usually larger specimens (25–50 cm).

[5] Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, when available catches and effort may not be available throughout the year existing only for short periods

[6] Note that the above list is not exhaustive, showing only the fisheries for which size data are available in the IOTC database. Furthermore, when available size data may not be available throughout the year existing only for short periods

- Catch-at-Size(Age) data are not available for the frigate tuna due to the paucity of size data available from most fleets (Table 3) and the uncertain status of the catches for this species (Fig. 3). Length distributions derived from the data available for some selected fisheries are shown in Fig. 5.
- Sex ratio data have not been provided to the Secretariat by CPCs.

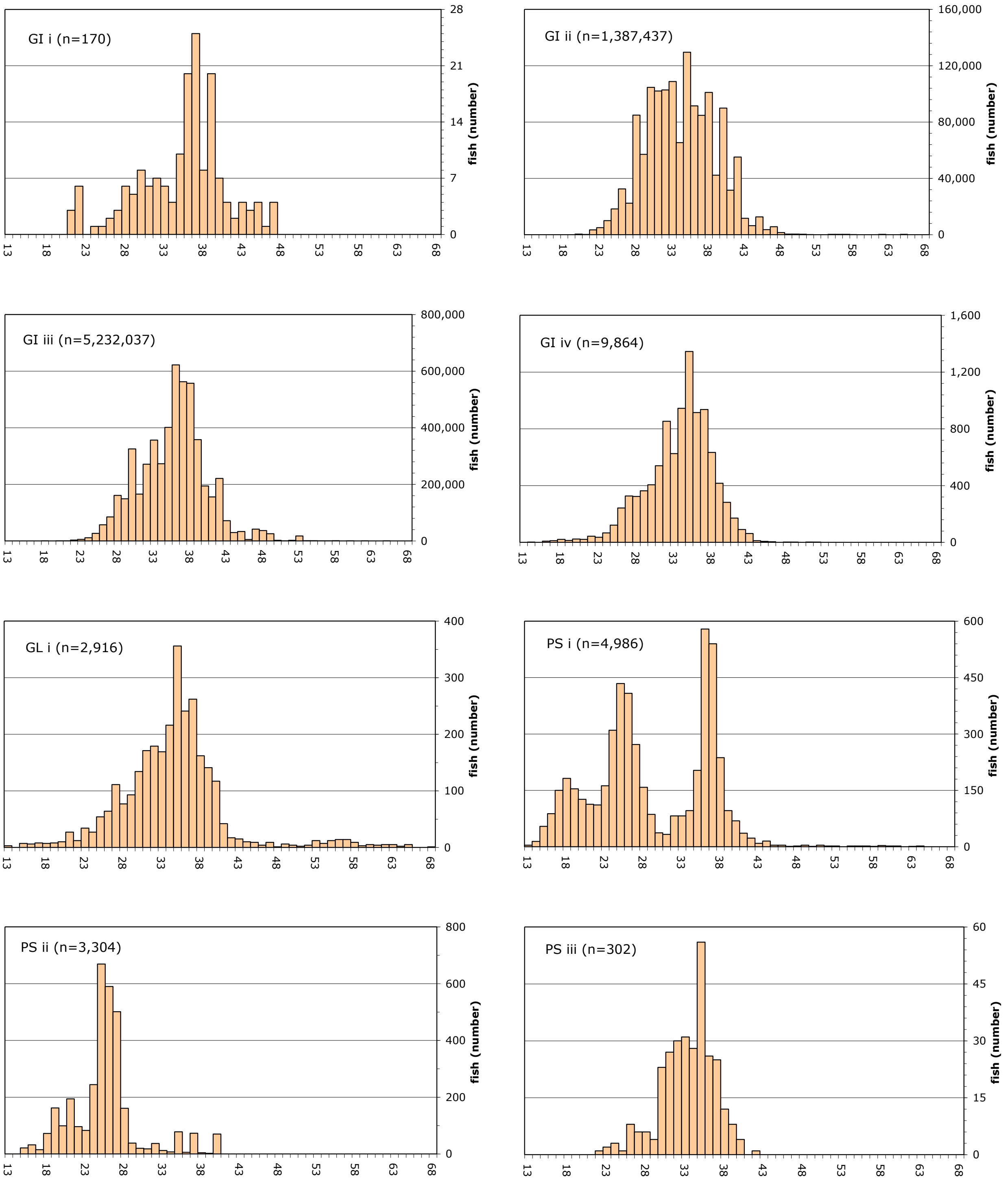


Fig. 5. Frigate tuna: Length frequency distributions (total amount of fish measured by 1 cm length class by decade) derived from the data available at the IOTC Secretariat for selected fisheries and periods. GI: Gillnet fisheries: i. Indonesia 1980–89, ii. Sri Lanka 1980–89, iii. Sri Lanka 2000–06, iv. Sri Lanka 2000–06. GL: Gillnet and longline combination: i. Sri Lanka 2000–06. PS: Coastal purse seine fisheries: i. Indonesia 1980–89, ii. Malaysia 1980–89, iii. Sri Lanka 2000–06 (ring net)

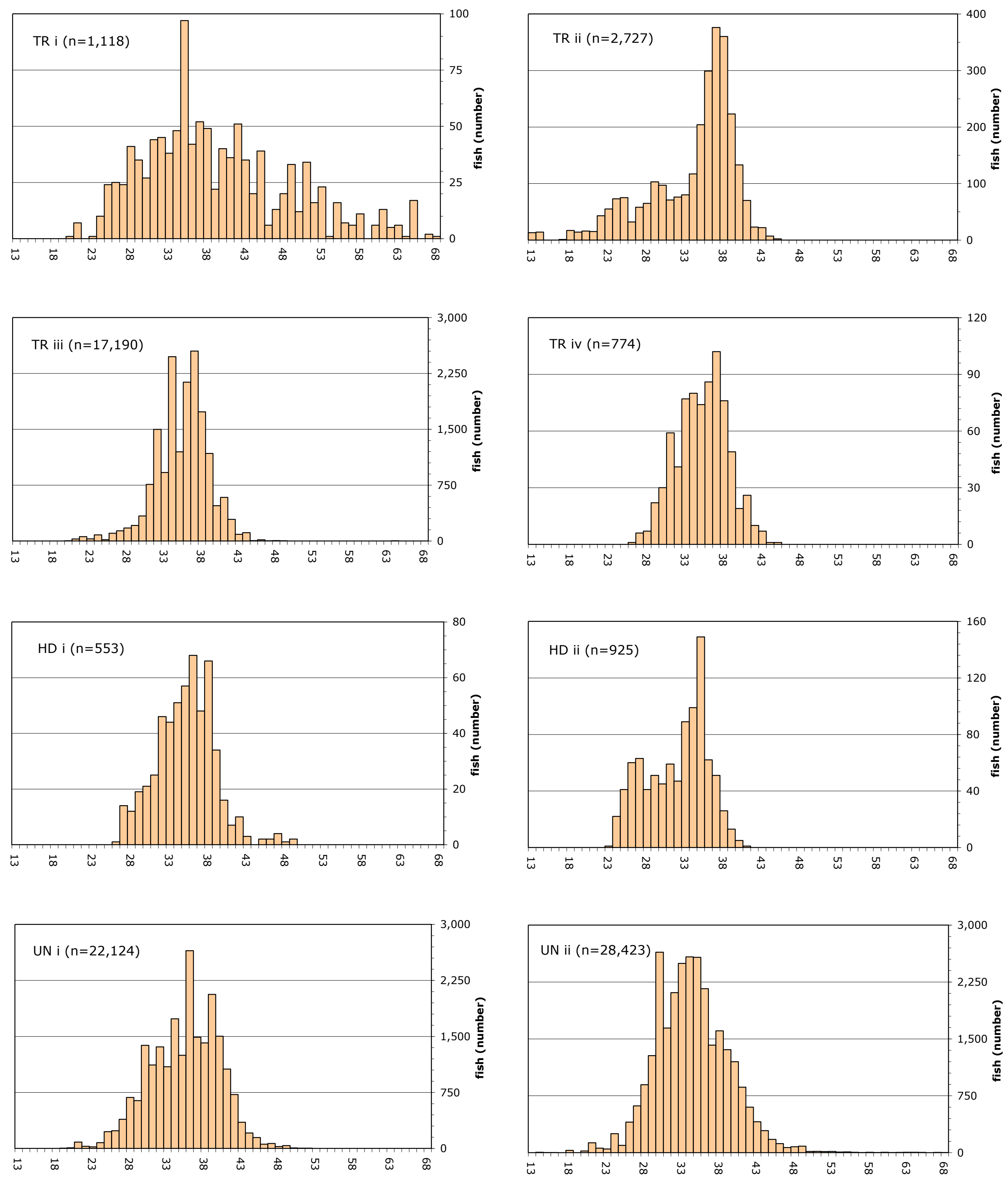


Fig. 5 (cont). Frigate tuna: Length frequency distributions (total amount of fish measured by 1cm length class by decade) derived from the data available at the IOTC Secretariat for selected fisheries and periods. TR: Troll line fisheries: i. Indonesia 1980–89, ii. Malaysia 1980–89, iii. Sri Lanka 1990–99, iv. Sri Lanka 2000–06. HD: Hand line fisheries: i. Sri Lanka 1990–99, ii. Sri Lanka 2000–06. UN: Unclassified fisheries (mainly pole and line): i. Maldives 1990-99, ii. Maldives 2000–06

STOCK ASSESSMENT

No quantitative stock assessment for frigate tuna in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. However, a preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Maldives baitboat and line fisheries (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 6. Frigate tuna (*Auxis thazard*) stock status summary

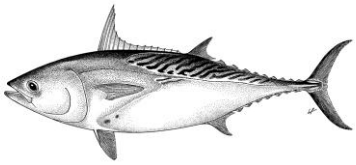
Management Quantity	Aggregate Indian Ocean
2010 catch estimate	83,210 t
Mean catch from 2006–2010	75,777 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_0 (80% CI)	–
SB_{2011}/SB_0	–
$B_{2011}/B_{0,\ F=0}$	–
$SB_{2011}/SB_{0,\ F=0}$	–

LITERATURE CITED

Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, <www.fishbase.org>.

APPENDIX XX
EXECUTIVE SUMMARY: KAWAKAWA

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



Status of the Indian Ocean kawakawa (KAW: *Euthynnus affinis*) resource

TABLE 1. Kawakawa: Status of kawakawa (*Euthynnus affinis*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Catch[2] 2011: Average catch[2] 2007–2011:	143,393 t 134,314 t	
	MSY: F_{2011}/F_{MSY}: SB_{2011}/SB_{MSY}: SB_{2011}/SB_0:	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about stock structure and about the total catches. A preliminary surplus production assessment undertaken in 2012 indicates that the Indian Ocean stock may be fully exploited/over exploited and the current spawning stock size levels may be at optimal spawning stock size. However, further exploratory analysis of the data available should be undertaken in preparation for the next WPNT meeting before the assessment results are used for stock status determination. Due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains uncertain (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for kawakawa is likely to have further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted. The following should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Kawakawa in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

Kawakawa: General

Kawakawa (*Euthynnusaffinis*) lives in open waters close to the shoreline and prefers waters temperatures ranging from 18° to 29°C. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Kawakawa: Biology of Indian Ocean kawakawa (*Euthynnus affinis*)

Parameter	Description
Range and stock structure	Lives in open waters close to the shoreline and prefers waters temperatures ranging from 18° to 29°C.Kawakawa form schools by size with other species sometimes containing over 5,000 individuals. Kawakawa are often found with yellowfin, skipjack and frigate tunas. Kawakawa are typically found in surface waters, however, they may range to depths of over 400 m (they have been reported under a fish-aggregating device employed in 400 m), possibly to feed.Kawakawa larvae are patchy but widely distributed and can generally be found close to land masses. Large changes in apparent abundance are linked to changes in ocean conditions. This species is a highly opportunistic predator feeding on small fishes, especially on clupeoids and atherinids; also squid, crustaceans and zooplankton. Fish form the dominant prey item (76.7%). *Sardinella longiceps, Encrasicholina devisi, Decapterus* spp. and *Nemipterus* spp. are the major food items. No information is available on stock structure of kawakawa in Indian Ocean.
Longevity	9 years
Maturity (50%)	**Age**: n.a; females n.a. males n.a. **Size:** females and males ~38–50 cm FL.
Spawning season	Spawning occurs mostly during summer. A 1.4 kg female (48 cm FL) may spawn approximately 0.21 million eggs per batch (corresponding to about 0.79 million eggs per season). Spawning is prolonged with peaks during June and October.
Size (length and weight)	Maximum: Females and males 100 cm FL; weight 14 kgs. Juveniles grow rapidly reaching lengths between 50–65 cm by 3 years of age.

n.a. = not available. Sources: Froese & Pauly 2009, Taghavi et al. 2010, Abdussamad et al. 2012, Kaymaram & Darvishi 2012

Kawakawa – Fisheries and catch trends

Kawakawa is caught mainly by coastal purse seines, gillnets and, to a lesser extent, handlines and trolling (Table 3; Fig. 1); and may be also an important by-catch of the industrial purse seiners. The catch estimates for kawakawa were derived from very small amounts of information and are therefore highly uncertain[7] (Fig. 2).

TABLE 3. Best scientific estimates of the catches of kawakawa by type of fishery for the period 1950–2011 (in metric tonnes) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Purse seine	100	385	1,809	9,487	32,303	56,275	46,863	49,163	53,563	52,262	60,772	63,524	70,433	71,567	71,494	69,207
Gillnet	1,908	3,411	8,055	16,754	27,630	37,542	35,484	35,359	30,302	31,340	37,589	41,616	50,676	46,533	46,107	56,601
Line	1,423	2,007	4,414	8,449	11,590	11,054	10,018	8,882	9,757	9,893	10,453	11,462	15,357	15,041	13,749	15,093
Other	0	60	277	737	1,576	2,002	1,852	2,006	1,897	2,188	1,546	2,539	2,286	2,483	3,310	2,492
Total	**3,431**	**5,863**	**14,555**	**35,427**	**73,098**	**106,873**	**94,216**	**95,410**	**95,520**	**95,683**	**110,360**	**119,141**	**138,752**	**135,625**	**134,660**	**143,393**

The catches provided in Table 3 are based on the information available at the IOTC Secretariat and the following observations on the catches cannot currently be verified. Annual estimates of catches for the kawakawa increased

[7] The uncertainty in the catch estimates has been assessed by the IOTC Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of unreporting fisheries for which catches had to be estimated.

markedly from around 10,000 t in the mid-1970's to reach the 50,000 t mark in the mid-1980's and 143,000 t in 2011, the highest catches ever recorded for this species. In recent years the majority of the catches of kawakawa have been taken in the East Indian Ocean.

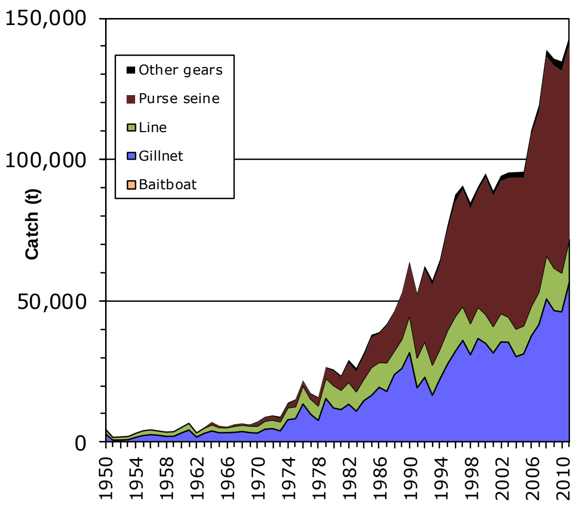


Fig. 1. Kawakawa: Annual catches of kawakawa by gear recorded in the IOTC database (1950–2011)

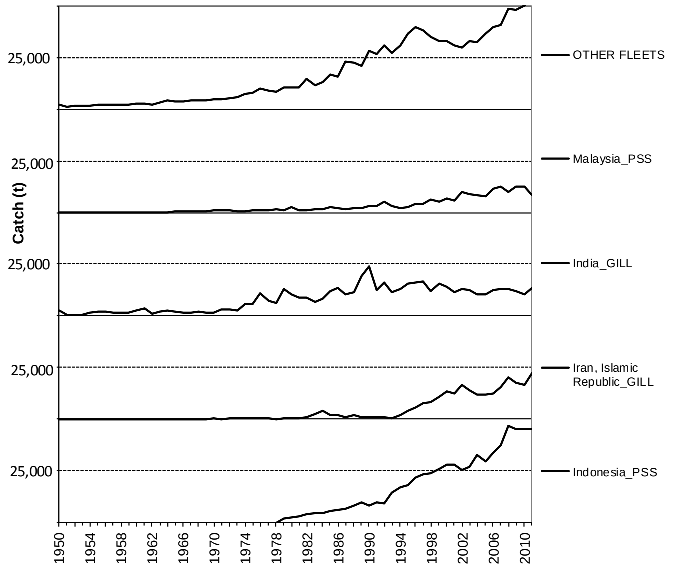


Fig. 2. Kawakawa: Catches of kawakawa recorded in the IOTC Database for main fishing fleets (1950–2011).

In recent years, the countries attributed with the highest catches are Indonesia (38%), India (17%), Iran (14%), Malaysia (8%) and Thailand (6%) (Fig. 2).

Kawakawa – Uncertainty of catches

Retained catches are uncertain (Fig. 3), notably for the following fisheries:

- Artisanal fisheries of Indonesia: Indonesia did not report catches of kawakawa by species or by gear for 1950–2004; catches of kawakawa, longtail tuna and, to a lesser extent, other species were reported aggregated for this period. The IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004 by gear and species. The catches of kawakawa estimated for this component represent around 38% of the total catches of this species in recent years.
- Artisanal fisheries of India: Although India reports catches of kawakawa they are not always reported by gear. The IOTC Secretariat has allocated the catches of kawakawa by gear for years in which this information was not available. The catches of kawakawa have represented 17% of the total catches of this species in the Indian Ocean in recent years.
- Artisanal fisheries of Myanmar (and Somalia): None of these countries have ever reported catches to the IOTC Secretariat. Catch levels are unknown.
- Other artisanal fisheries: The catches of kawakawa are usually not reported by species, being combined with catches of other small tuna species like skipjack tuna and frigate tuna (e.g. coastal purse seiners of Malaysia and Thailand).
- Industrial fisheries: The catches of kawakawa recorded for industrial purse seiners are thought to be a fraction of those retained on board. Due to this species being a bycatch, its catches are seldom recorded in the logbooks, nor are they monitored in port. The EU recently reported catch levels of frigate tuna for its purse seine fleet, for 2003–07, estimated using observer data.
- Discard levels are moderate for industrial purse seine fisheries. The EU recently reported discard levels of kawakawa for its purse seine fleet, for 2003–07, estimated using observer data.
- The catch series of kawakawa has not changed substantially since the WPNT meeting in 2011.

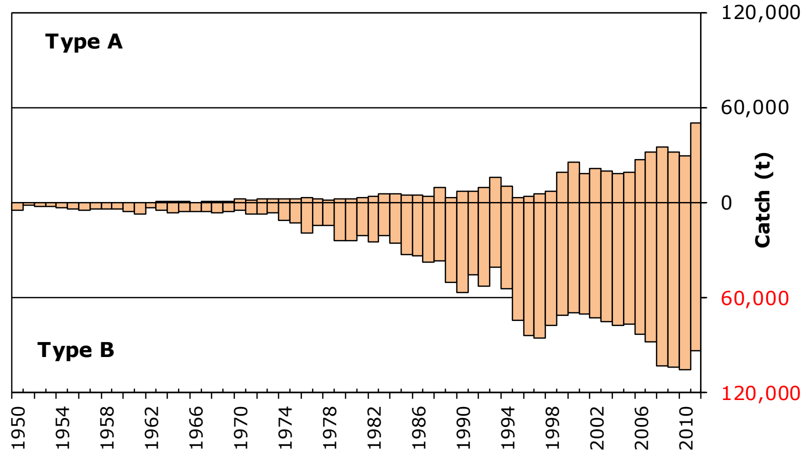


Fig. 3. Kawakawa: Uncertainty of annual catch estimates for kawakawa (1950–2011). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets (Data as of October 2012)

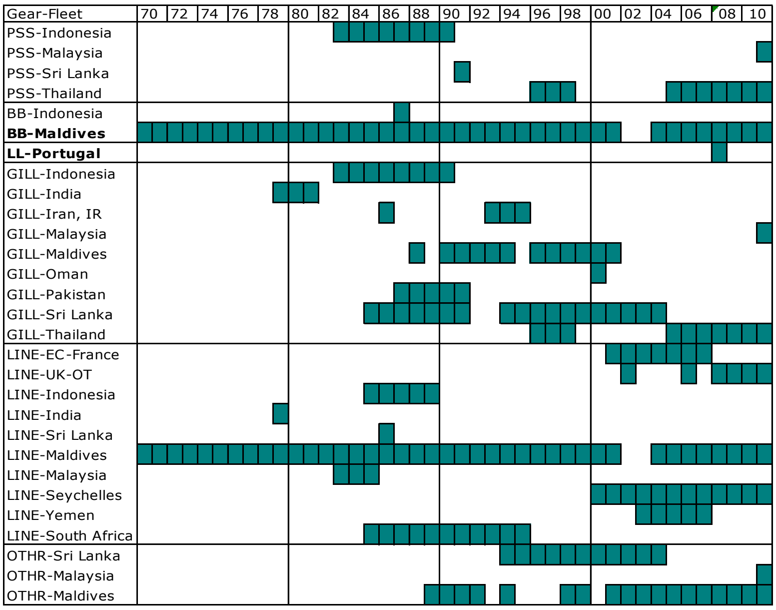
Kawakawa – Effort trends

Effort trends are unknown for kawakawa in the Indian Ocean.

Kawakawa – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Catch-and-effort series are available from some fisheries but they are considered highly incomplete. In most cases catch-and-effort data are only available for short periods (Table 4). Reasonably long catch-and-effort data series (extending for more than 10 years) are only available for Maldives baitboats and troll lines and Sri Lanka gillnets (Fig. 4). The catch-and-effort data recorded for Sri Lankan gillnets are, however, thought to be inaccurate due to the dramatic changes in CPUE recorded between consecutive years.

TABLE 4. Kawakawa: Availability of catches and effort series, by fishery and year (1970–2011)[8]. Note that no catch and effort data are available for the period 1950–69 in the IOTC Secretariat databases



[8] Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, when available catches and effort may not be available throughout the year existing only for short periods

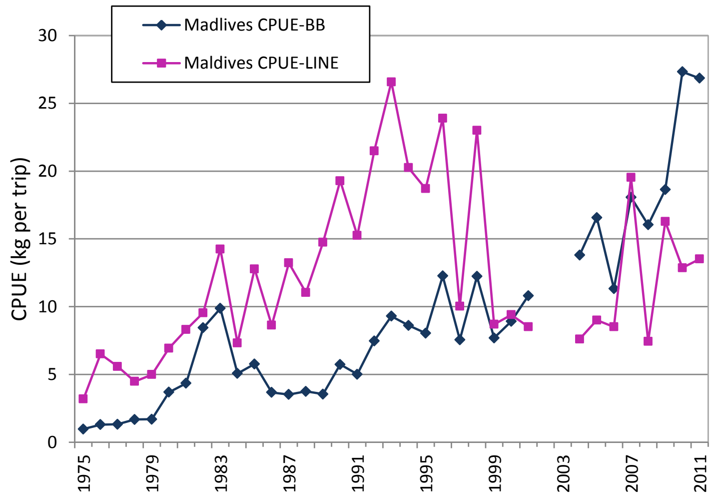
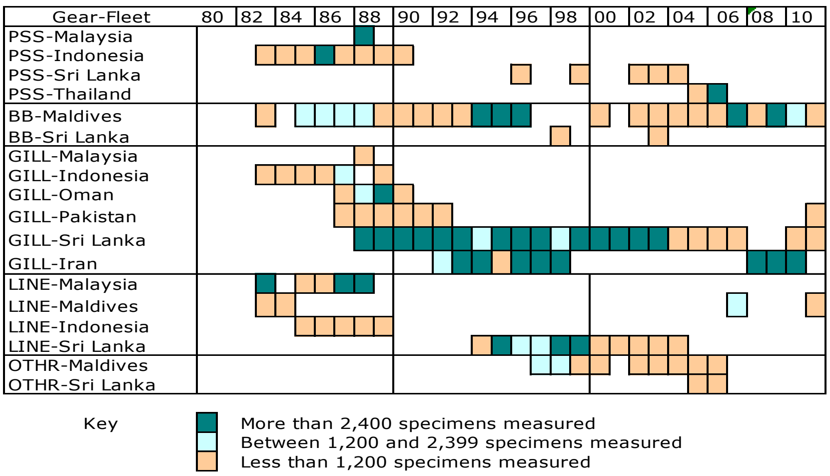


Fig. 4. Kawakawa: Nominal CPUE series for the baitboat (BB) and troll line (TROL) fisheries of Maldives (1975–2011) derived from the available catches and effort data

Kawakawa – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- The size of kawakawa taken by the Indian Ocean fisheries typically ranges between 20 and 60 cm depending on the type of gear used, season and location (Fig. 5). The coastal purse seine fisheries operating in the Andaman Sea tend to catch kawakawa of small size (15–30 cm) while the gillnet, baitboat and other fisheries operating in the Indian Ocean catch usually larger specimens (25–55 cm).
- Trends in average weight can only be assessed for Sri Lankan gillnets but the amount of specimens measured has been very low in recent years (Table 5). The length frequency data available from the mid-eighties to the early nineties was obtained with the support of the IPTP (Indo-Pacific Tuna Programme). Unfortunately, data collection did not continue after the end of the IPTP activities.
- Catch-at-Sizeage) data are not available for the kawakawa due to the paucity of size data available from most fleets (Table 5) and the uncertain status of the catches for this species. Length distributions derived from the data available for some selected fisheries are shown in Fig. 56.
- Sex ratio data have not been provided to the IOTC Secretariat by CPCs.

TABLE 5. Kawakawa: Availability of length frequency data, by fishery and year (1980-2011)[9]. Note that no length frequency data are available for the period 1950–82



[9] Note that the above list is not exhaustive, showing only the fisheries for which size data are available in the IOTC database. Furthermore, when available size data may not be available throughout the year existing only for short periods

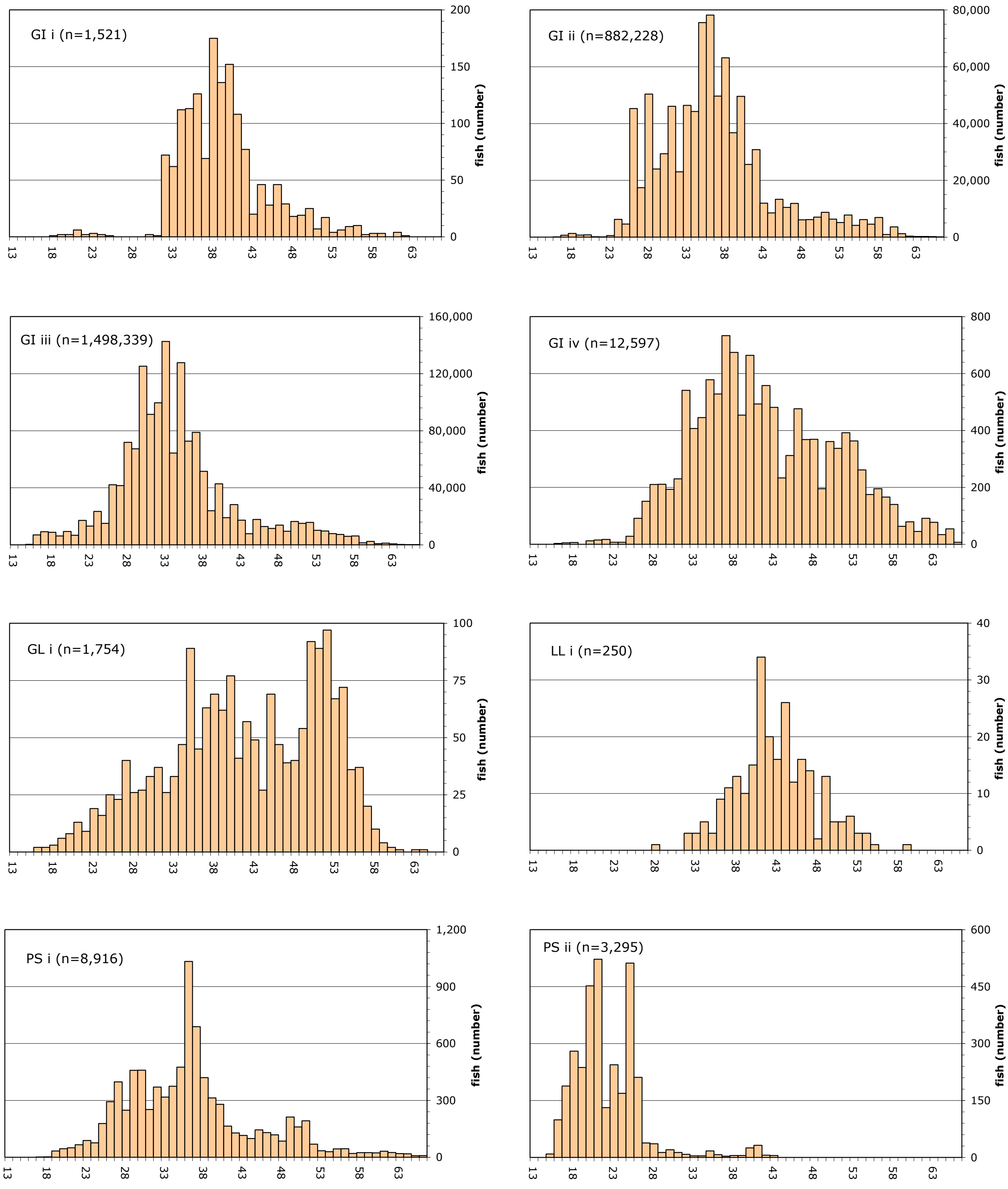


Fig. 5. Kawakawa: Length frequency distributions (total amount of fish measured by 1cm length class by decade) derived from the data available at the IOTC Secretariat for selected fisheries and periods. GI: Gillnet fisheries: i. Indonesia 1980–89, ii. Sri Lanka 1980–89, iii. Sri Lanka 1990–99, iv. Sri Lanka 2000–06. GL: Gillnet and longline combination: i. Sri Lanka 2000–06. LL: Coastal longline fisheries: i. Sri Lanka 1990–99. PS: Coastal purse seine fisheries: i. Indonesia 1980–89, ii. Malaysia 1980–89

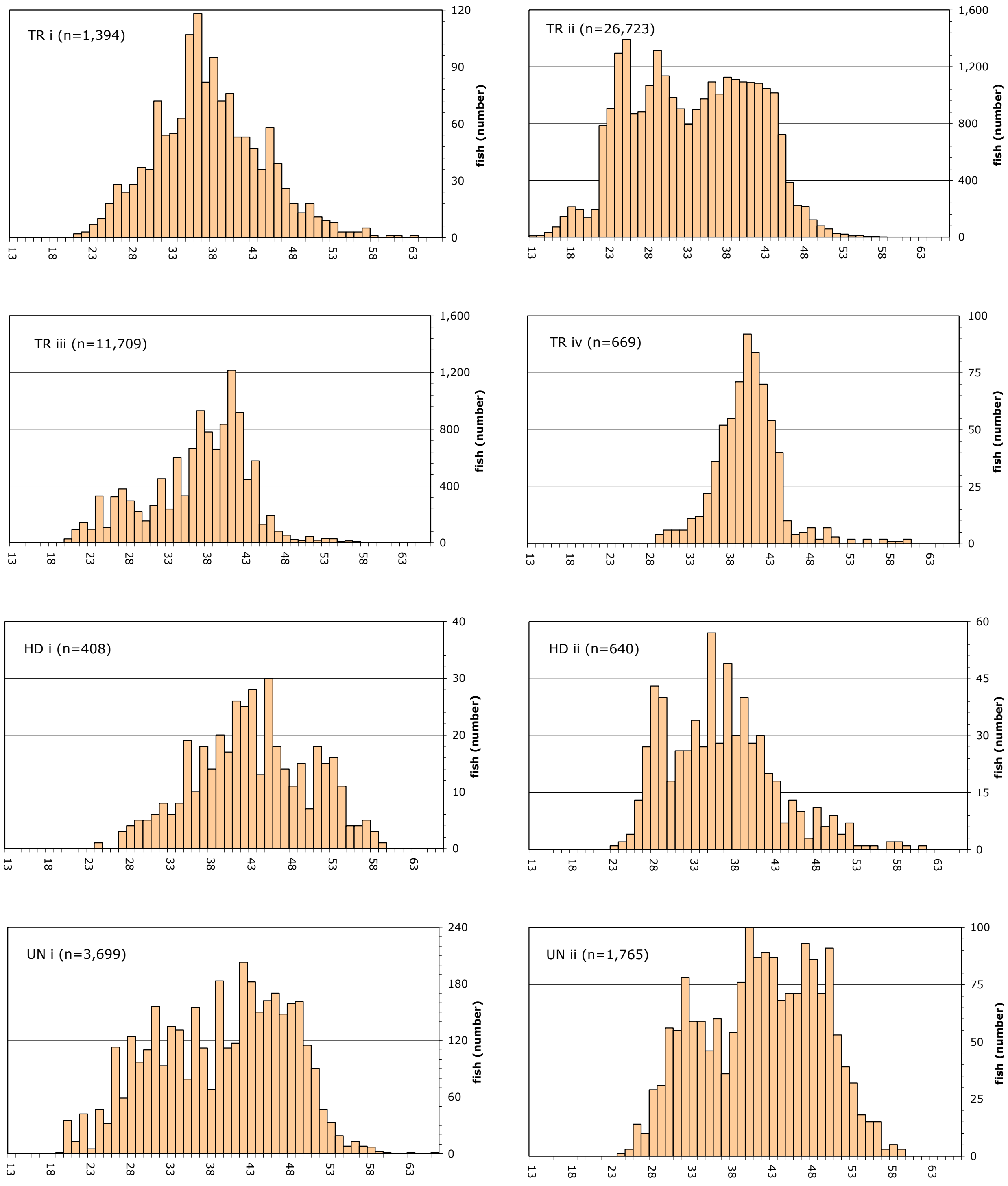


Fig. 5 (cont). Kawakawa: Length frequency distributions (total amount of fish measured by 1cm length class by decade) derived from the data available at the IOTC Secretariat for selected fisheries and periods. TR: Troll line fisheries: i. Indonesia 1980–89, ii. Malaysia 1980–89, iii. Sri Lanka 1990–99, iv. Sri Lanka 2000–06. HD: Hand line fisheries: i. Sri Lanka 1990–99, ii. Sri Lanka 2000–06. UN: Unclassified fisheries (mainly pole and line): i. Maldives 1990–99, ii. Maldives 2000–06

STOCK ASSESSMENT

A preliminary surplus production assessment indicates that the Indian Ocean stock may be fully exploited/over exploited and the current spawning stock size levels may be at optimal spawning stock size (0.99). Further exploratory analysis of the data available should be undertaken in preparation for the next WPNT meeting. The preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Indian and Thailand fisheres, and the Maldives baitboat and troll line fisheries (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 6. Kawakawa (*Euthynnus affinis*) stock status summary

Management Quantity	Aggregate Indian Ocean
2011 catch estimate	134,660 t
Mean catch from 2007–2011	143,314 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_0 (80% CI)	–
SB_{2011}/SB_0	–
$B_{2011}/B_{0,\ F=0}$	–
$SB_{2011}/SB_{0,\ F=0}$	–

Literature Cited

Abdussamad EM, Rohit P, Said Koya KP, Sivadas M (2012) Status and potential of neritic tunas exploited from Indian waters. IOTC–2012–WPNT02–10 Rev_1

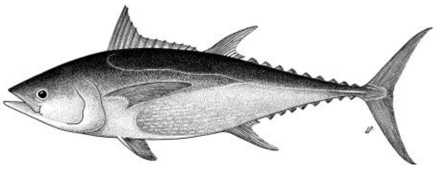
Kaymaram F, Darvishi M (2012) Growth and mortality parameters of *Euthynnus affinis* in the northern part of the Persian Gulf and Oman Sea. IOTC–2012–WPNT02–14 Rev_1

Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, www.fishbase.org.

Taghavi Motlagh SA, Hashemi SA and Kochanian P, 2010. Population biology and assessment of kawakawa (*Euthynnus affinis*) in coastal waters of the Persian Gulf and Sea of Oman (Hormozgan Province).

APPENDIX XXI
EXECUTIVE SUMMARY: LONGTAIL TUNA

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



Status of the Indian Ocean longtail tuna (LOT: *Thunnus tonggol*) resource

TABLE 1. Longtail tuna: Status of longtail tuna (*Thunnus tonggol*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Catch[2] 2011: Average catch[2] 2007–2011:	177,795 t 134,871 t	
	MSY: F_{2011}/F_{MSY}: SB_{2011}/SB_{MSY}: SB_{2011}/SB_0:	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about stock structure and about the total catches. A preliminary surplus production assessment undertaken in 2012 indicates that the Indian Ocean stock may be fully exploited/over exploited and the current spawning stock size levels may exceed S_{MSY} by 50% and spawning stock size levels currently and further work is urgently required in 2013. However, further exploratory analysis of the data available should be undertaken in preparation for the next WPNT meeting before the assessment results are used for stock status determination. Due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains uncertain (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for longtail tuna in recent years has further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. The apparent fidelity of longtail tuna to particular areas/regions is a matter for concern as overfishing in these areas can lead to localised depletion. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted. The following should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Bullet tuna in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting*

Parties (CPC's)

- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

Longtail tuna: General

Longtail tuna (*Thunnus tonggol*) is an oceanic species that forms schools of varying sizes. It is most abundant over areas of broad continental shelf. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Longtail tuna: Biology of Indian Ocean longtail tuna (*Thunnus tonggol*)

Parameter	Description
Range and stock structure	An oceanic species that forms schools of varying sizes. It is most abundant over areas of broad continental shelf. Feeds on a variety of fish, cephalopods, and crustaceans, particularly stomatopod larvae and prawns. No information is available on the stock structure of longtail tuna in the Indian Ocean.
Longevity	~20 years
Maturity (50%)	**Age**: n.a.; females n.a. males n.a. **Size:** females and males ~40 cm FL (Pacific Ocean).
Spawning season	The spawning season varies according to location. Off the west coast of Thailand there are two distinct spawning seasons: January-April and August-September.
Size (length and weight)	Maximum: Females and males 145 cm FL; weight 35.9 kgs. Most common size in Indian Ocean ranges 40–70 cm. Grows rapidly to reach 40–46 cm in FL by age 1.

n.a. = not available. Sources: Chang et al. 2001, Froese & Pauly 2009, Griffiths et al. 2010a, b, Kaymaran et al. 2011

Longtail tuna – Fisheries and catch trends

Longtail tuna is caught mainly by using gillnets and to a lesser extent, seine nets and trolling (Table 3; Fig. 1). The catch estimates for longtail tuna were derived from small amounts of information and are therefore uncertain[10]. The catches provided in Table 3 are based on the information available at the IOTC Secretariat and the following observations on catches cannot currently be verified. Estimated catches of longtail tuna increased steadily from the mid 1950's to the year 2000 when over 100,000 t were landed. Catches then declined until 2005 (77,361 t). Since 2005, catch have increased continually with the highest catches ever recorded at around 180,000 t, landed in 2011.

In recent years (2009–11), the countries attributed with the highest catches of longtail tuna are Iran (42%) and Indonesia (29%) and, to a lesser extent, Oman, Pakistan, Malaysia, India and Thailand (25%) (Table 3; Fig. 2). In particular, Iran has reported large increases in the catch of longtail tuna since 2009. The increase in catches of longtail tuna coincides with a decrease in the catches of skipjack tuna and is thought to be the consequence of increased gillnet effort in coastal waters due to the threat of Somali piracy in the western tropical Indian Ocean.

TABLE 3. Longtail tuna: Best scientific estimates of the catches of longtail tuna by type of fishery for the period 1950–2011 (in metric tonnes) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Purse seine	44	204	999	4,388	8,195	13,379	15,348	13,369	11,223	9,333	13,107	17,552	14,215	16,404	15,483	23,972
Gillnet	2,960	6,751	11,225	30,740	50,398	74,182	63,255	69,692	62,421	57,765	68,953	74,632	87,204	105,659	127,015	144,094
Line	978	1,277	2,697	3,484	5,630	8,085	7,839	6,984	8,220	8,974	10,538	10,742	6,573	6,487	6,503	7,003
Other	290	489	1,054	2,164	2,500	1,802	1,710	1,603	1,665	1,290	1,338	1,890	2,090	1,804	2,306	2,726

[10] The uncertainty in the catch estimates has been assessed by the IOTC Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of non-reporting fisheries for which catches had to be estimated.

Total	**4,272**	**8,722**	**15,975**	**40,776**	**66,724**	**97,448**	**88,153**	**91,647**	**83,529**	**77,361**	**93,935**	**104,815**	**110,082**	**130,354**	**151,307**	**177,795**

The size of longtail tuna taken by IOTC fisheries typically ranges between 15 and 120 cm depending on the type of gear used, season and location (Fig. 9). The fisheries operating in the Andaman Sea (coastal purse seines and troll lines) tend to catch longtail tuna of small size (15–55cm) while the gillnet fisheries operating in the Arabian Sea catch larger specimens (40–100cm).

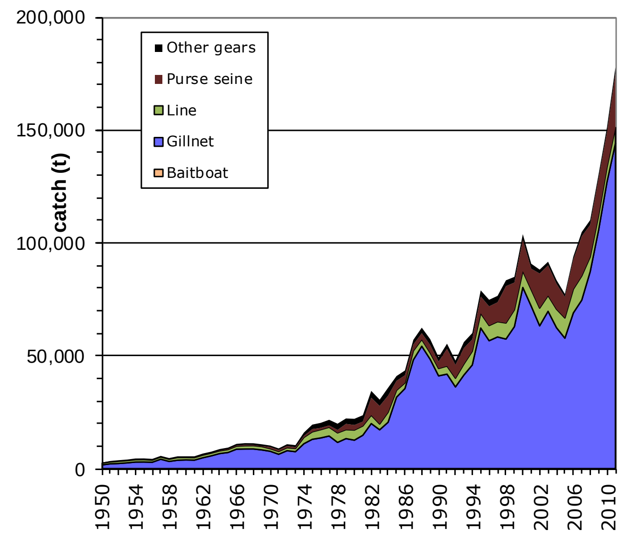


Fig. 1. Longtail tuna: Annual catches of longtail tuna by gear recorded in the IOTC Database (1950–2011)

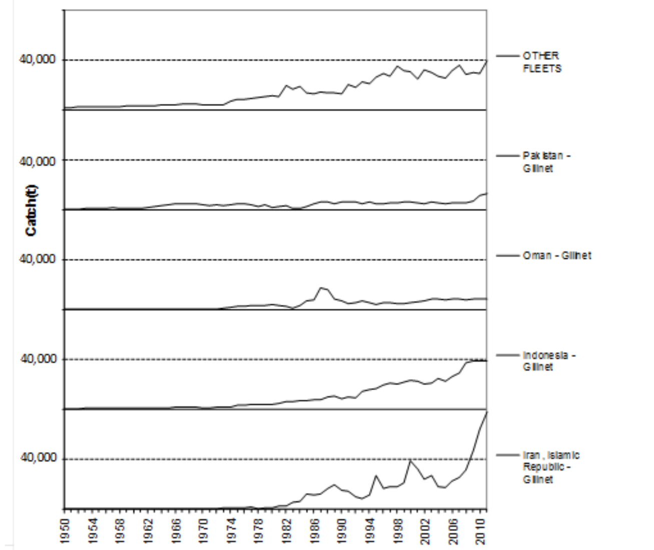


Fig. 2. Longtail tuna: Catches of longtail tuna recorded in the IOTC Database for main fishing fleets (1950–2011)

Longtail tuna: uncertainty of catches

Retained catches are uncertain (Fig. 3), notably for the following fisheries:

- Artisanal fisheries of Indonesia: Indonesia did not report catches of longtail tuna by species or by gear for 1950–2004; catches of longtail tuna, kawakawa and other species were reported aggregated for this period. The IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004 by gear and species. The catches estimated for the longtail tuna represent around 30% of the total catches of this species in the Indian Ocean in recent years.
- Artisanal fisheries of India and Oman: Although these countries report catches of longtail tuna, until recently the catches have not been reported by gear. The IOTC Secretariat used alternative information to assigning the catches reported by species. The catches of longtail tuna that had to be allocated by gear represented 9% of the total catches of this species in recent years.
- Artisanal fisheries of Mozambique, Myanmar (and Somalia): None of these countries have ever reported catches of longtail tuna to the IOTC Secretariat. Catch levels are unknown but are not considered substantial.
- Other artisanal fisheries: The IOTC Secretariat had to estimate catches of longtail tuna for the artisanal fisheries of Yemen (no data reported to the IOTC Secretariat) and Malaysia (catches not reported by species). The catches estimated for the longtail tuna represent 8% of the total catches of this species in recent years.
- Discard levels are believed to be very low although they are unknown for most fisheries.
- Changes to the catch series: There have not been significant changes to the catches of longtail tuna since the WPNT meeting in 2011.

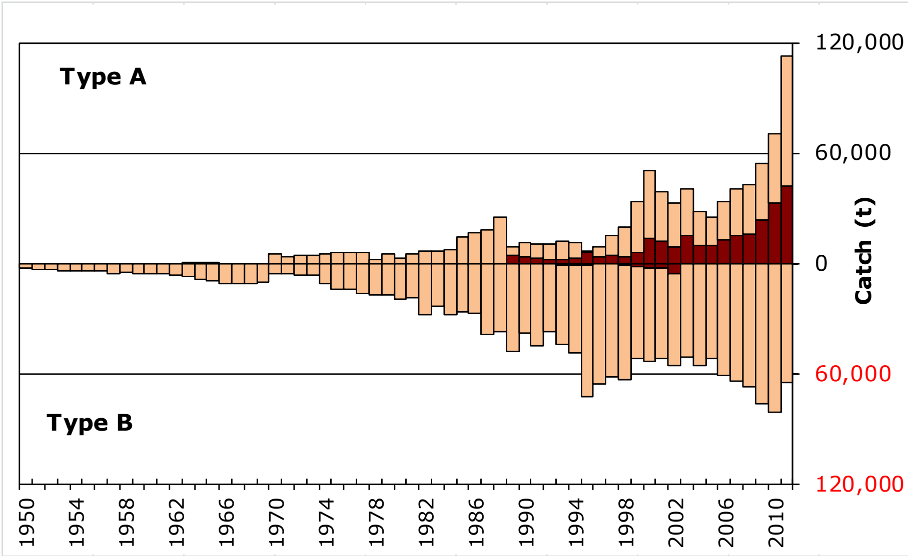


Fig. 3. Uncertainty of annual catch estimates for longtail tuna (1950–2011). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets (Data as of October 2012)

Longtail tuna – Effort trends

Effort trends are unknown for longtail tuna in the Indian Ocean.

Longtail tuna – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some fisheries but they are considered highly incomplete (Table 4). In most cases catch-and-effort data are only available for short periods of time. Reasonably long catch and effort series (extending for more than 10 years) are only available for Thailand small purse seines and gillnets (Fig. 4). No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya.

TABLE 4. Longtail tuna: Availability of catches and effort series, by fishery and year (1970–2011)[11]. Note that no catch and effort data are available for the period 1950–1971 in the IOTC Secretariat databases

Gear-Fleet	70		72		74		76		78		80		82		84		86		88		90		92		94		96		98		00		02		04		06		08		10	
PSS-Indonesia																■	■																									
PSS-Malaysia																														■												■
PSS-Thailand																											■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PS-Iran, IR																														■	■		■		■							
PS-Seychelles																															■			■								
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GILL-Oman																															■											
GILL-Pakistan																		■	■	■	■	■																				
GILL-Thailand			■								■	■	■	■	■	■	■	■	■		■						■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
LINE-Australia																									■	■	■	■	■	■	■	■	■	■	■	■	■					
LINE-Indonesia																■																										
LINE-Malaysia														■	■	■														■												■
LINE-Yemen																																		■	■	■		■				
OTHR-Australia																																		■		■	■					
OTHR-Malaysia																														■												■

[11] Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, catch-and-effort data are sometimes incomplete for a given year, existing only for short periods.

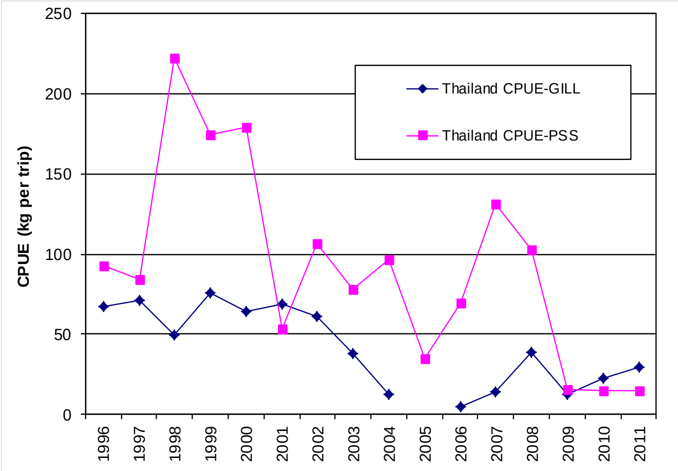
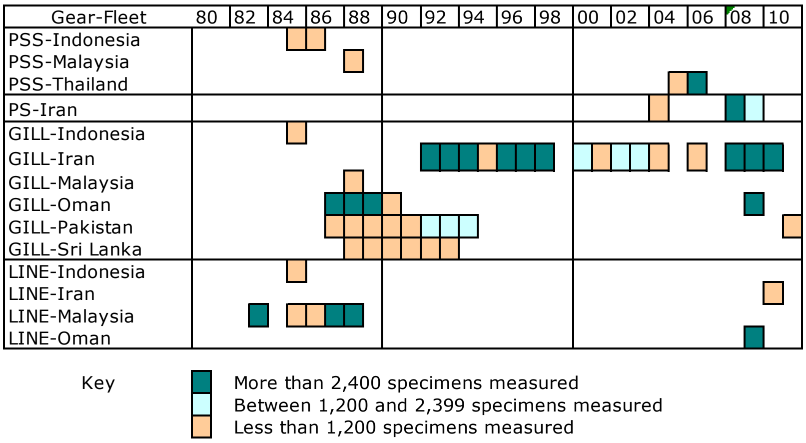


Fig. 4. Longtail tuna: Nominal CPUE series for the gillnet (GILL) and coastal purse seine (PSS) fisheries of Thailand derived from the available catches and effort data (1996–2011)

Longtail tuna – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- The size of longtail tuna taken by the Indian Ocean fisheries typically ranges between 15–120 cm depending on the type of gear used, season and location. The fisheries operating in the Andaman Sea (coastal purse seines and troll lines) tend to catch longtail tuna of small size (15–55cm) while the drifting gillnet fisheries operating in the Arabian Sea catch larger specimens (40–100cm).
- Trends in average weight can only be assessed for I.R. Iran drifting gillnets but the amount of specimens measured has been very low in recent years (Table 5). The length frequency data available from the mid-eighties to the early nineties was obtained with the support of the IPTP (Indo-Pacific Tuna Programme). Unfortunately, data collection did not continue after the end of the IPTP activities.
- Catch-at-Size(Age) tables are not available for the longtail tuna due to the paucity of size data available from most fleets and the uncertain status of the catches for this species. Length distributions derived from the data available for some selected fisheries are shown in Fig. 5.
- Sex ratio data have not been provided to the Secretariat by CPCs.
- Trends in average weight can only be assessed for Iranian gillnets but the amount of specimens measured has been very low in recent years (Table 5). The length frequency data available from the mid-eighties to the early nineties was obtained with the support of the IPTP (Indo-Pacific Tuna Programme). Unfortunately, data collection did not continue after the end of the IPTP activities.

TABLE 5. Longtail tuna: Availability of length frequency data, by fishery and year (1980–2011)[12]. Note that no catch and effort data are available for the period 1950–1982 in the IOTC Secretariat databases



[12] Note that the above list is not exhaustive, showing only the fisheries for which size data are available in the IOTC database. Furthermore, when available size data may not be available throughout the year existing only for short periods

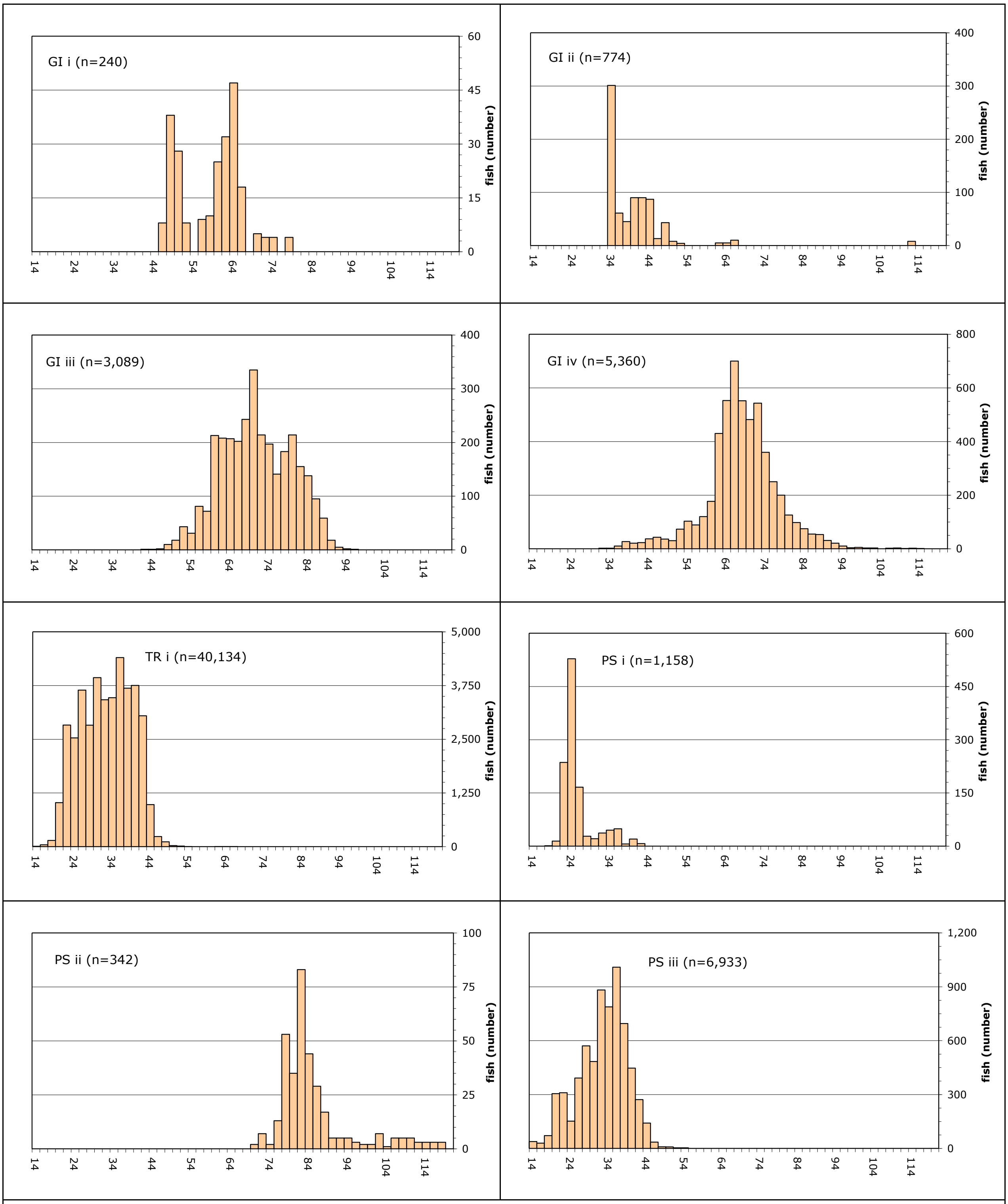


Fig. 5. Longtail tuna: Length frequency distributions (total amount of fish measured by 2 cm length class by decade) derived from the data available at the IOTC Secretariat for selected fisheries and periods. GI: Gillnet fisheries: i. Sri Lanka 1980–89, ii. Sri Lanka 1990–99, iii. Pakistan 1990–99, iv. Iran 2000–06. TR: Troll line fisheries: i. Malaysia 1980–89. PS: Coastal purse seine fisheries: i. Malaysia 1980–89, ii. Iran 2000–06, iii. Thailand 2000–06

STOCK ASSESSMENT

There are limited stock status indicators available for longtail tuna (although preliminary work by the IOTC secretariat, on a surplus production model in the Indian Ocean indicate that the stock may be fully exploited/overexploited and spawning stock size levels currently may exceed SMSY by 50%) and further work is urgently required in 2013. The preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Indian and Thailand gillnet and purse seine fisheries (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 6. Longtail tuna (*Thunnus tonggol*) stock status summary

Management Quantity	Aggregate Indian Ocean
2011 catch estimate	177,795 t
Mean catch from 2007–2011	134,871 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_0 (80% CI)	–
SB_{2011}/SB_0	–
$B_{2011}/B_{0,\ F=0}$	–
$SB_{2011}/SB_{0,\ F=0}$	–

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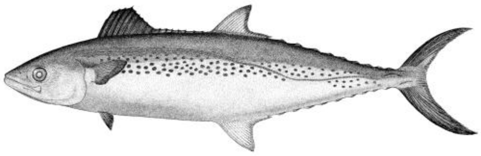
APPENDIX XXII
EXECUTIVE SUMMARY: INDO-PACIFIC KING MACKEREL

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



Status of the Indian Ocean Indo-Pacific king mackerel (GUT: *Scomberomorus guttatus*) resource

TABLE 1. Indo-Pacific king mackerel: Status of Indo-Pacific king mackerel (*Scomberomorus guttatus*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Catch[2] 2011: Average catch[2] 2007–2011:	49,832 t 44,457 t	
	MSY: F_{2011}/F_{MSY}: SB_{2011}/SB_{MSY}: SB_{2011}/SB_0:	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about stock structure and about the total catches. No quantitative stock assessment is currently available for Indo-Pacific king mackerel in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains uncertain (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for Indo-Pacific king mackerel is likely to have further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted. The following should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Indo-Pacific king mackerel in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

Indo-Pacific king mackerel: General

The Indo-Pacific king mackerel (*Scomberomorus guttatus*) is a migratory species that forms small schools and inhabits coastal waters, sometimes entering estuarine areas. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Indo-Pacific king mackerel: Biology of Indian Ocean Indo-Pacific king mackerel (*Scomberomorus guttatus*)

Parameter	Description
Range and stock structure	A migratory species that forms small schools and inhabits coastal waters, sometimes entering estuarine areas. It is found in waters from the Persian Gulf, India and Sri Lanka, Southeast Asia, as far north as the Sea of Japan. The Indo-Pacific king mackerel feeds mainly on small schooling fishes (e.g. sardines and anchovies), squids and crustaceans. No information is available on the stock structure of Indo-Pacific king mackerel stock structure in Indian Ocean.
Longevity	n.a.
Maturity (50%)	**Age**: 1–2 years; females n.a. males n.a. **Size:** females and males ~40–52 cm FL.
Spawning season	Based on the occurrence of ripe females and the size of maturing eggs, spawning probably occurs from March to July in southern India and in May in Thailand waters. Fecundity increases with age in the Indian waters, ranging from around 400,000 eggs at age 2 years to over one million eggs at age 4 years.
Size (length and weight)	Maximum: Females and males 76 cm FL; weight n.a.

n.a. = not available. Sources: Froese & Pauly 2009

Indo-Pacific king mackerel – Fisheries and catch trends

The Indo-Pacific king mackerel[13] is mostly caught by gillnet fisheries in the Indian Ocean but significant numbers are also caught trolling (Table 3; Fig. 1). The catch estimates for Indo-Pacific king mackerel were derived from very small amounts of information and are therefore highly uncertain[14] (Fig. 1).

TABLE 3. Indo-Pacific king mackerel: Best scientific estimates of the catches of Indo-Pacific king mackerel by type of fishery for the period 1950–2011 (in metric tonnes) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Purse seine	0	0	48	239	493	294	286	352	222	229	296	263	269	526	513	541
Gillnet	2,315	3,562	7,354	12,764	20,446	20,702	20,169	19,958	19,222	17,129	22,112	22,259	24,622	23,343	22,799	26,194
Line	455	585	1,330	2,017	2,512	5,189	3,132	3,743	4,529	4,829	6,364	7,033	8,220	9,494	9,306	9,740
Other	1,193	1,657	3,641	5,324	8,460	9,537	9,019	8,877	8,294	8,871	10,639	9,907	10,017	12,513	11,370	13,357
Total	**3,963**	**5,805**	**12,372**	**20,344**	**31,911**	**35,721**	**32,606**	**32,929**	**32,268**	**31,058**	**39,411**	**39,462**	**43,128**	**45,876**	**43,988**	**49,832**

The catches provided in Table 3 are based on the information available at the IOTC Secretariat and the following observations on the catches cannot currently be verified. Estimated catches have increased steadily since the mid

[13] Hereinafter referred to as King mackerel

[14] The uncertainty in the catch estimates has been assessed by the Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of unreporting fisheries for which catches had to be estimated.

1960's, reaching around 10,000 t in the early 1970's and over 25,000 t since the mid-1990's. Catches increased steadily since then until 1995, in which catches around 43,000 t were recorded. The catches of Indo-Pacific king mackerel between 1997 and 2005 were more or less stable, estimated at around 30,000 t. Current catches have been higher, close to 45,000 t. The highest catches were recorded in 2011, at around 50,000 t.

In recent years, the countries attributed with the highest catches are India (38%) and Indonesia (34%) and, to a lesser extent, Myanmar and Iran (17%) (Fig. 2).

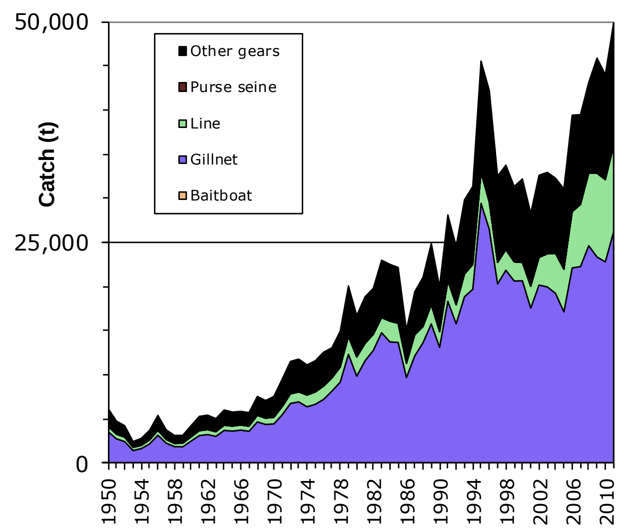


Fig. 1. Indo-Pacific king mackerel: Annual catches of Indo-Pacific king mackerel by gear recorded in the IOTC database (1950–2011)

Fig. 2. Indo-Pacific king mackerel: Catches of Indo-Pacific king mackerel recorded in the IOTC database for main fishing fleets (1950–2011)

Indo-Pacific king mackerel – Uncertainty of catches

Retained catches are highly uncertain (Fig. 3) for all fisheries due to:

- Aggregation: Indo-Pacific king mackerels are usually not reported by species being aggregated with narrow-barred Spanish mackerel or, less frequently, other small tuna species.
- Mislabelling: Indo-Pacific king mackerels are usually mislabelled as narrow-barred Spanish mackerel, their catches reported under the latter species.
- Underreporting: the catches of Indo-Pacific king mackerel may be not reported for some fisheries catching them as a bycatch.
- It is for the above reasons that the catches of Indo-Pacific king mackerel in the IOTC database are thought to represent only a small fraction of the total catches of this species in the Indian Ocean.
- Discard levels are believed to be low although they are unknown for most fisheries.
- Changes to the catch series: There have not been significant changes to the catches of Indo-Pacific king mackerel since the WPNT in 2011.

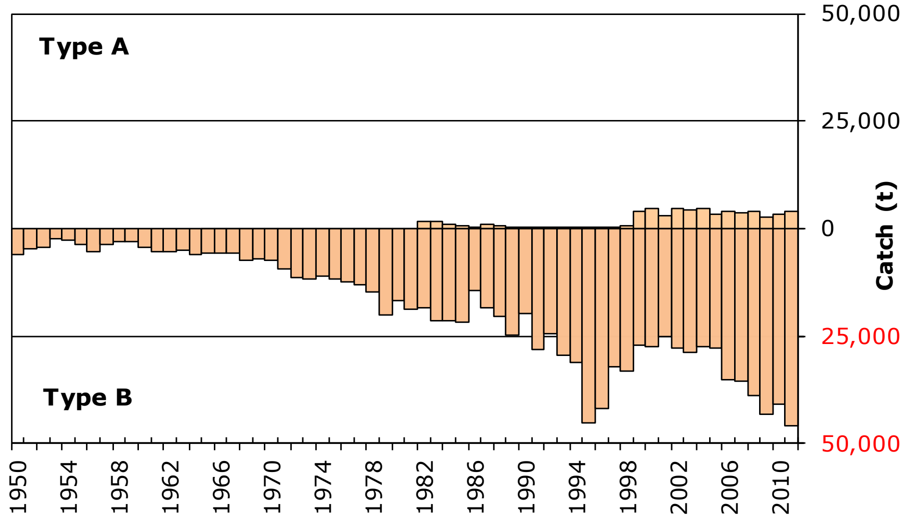


Fig. 3. Indo-Pacific king mackerel: Uncertainty of annual catch estimates for Indo-Pacific king mackerel (1950–2011). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets (Data as of October 2012)

Indo-Pacific king mackerel – Effort trends

Effort trends are unknown for Indo-Pacific King mackerel in the Indian Ocean.

Indo-Pacific king mackerel – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some fisheries but they are considered highly incomplete. In most cases catch-and-effort data are only available for short periods of time. This makes it impossible to derive any meaningful CPUE from the existing data (Table 4). This makes it impossible to derive any meaningful CPUE from the existing data.

TABLE 4. Indo-Pacific king mackerel: Availability of catches and effort series, by fishery and year (1970–2011)[15]. Note that no catches and effort are available for the period 1950–85 at the IOTC Secertariat

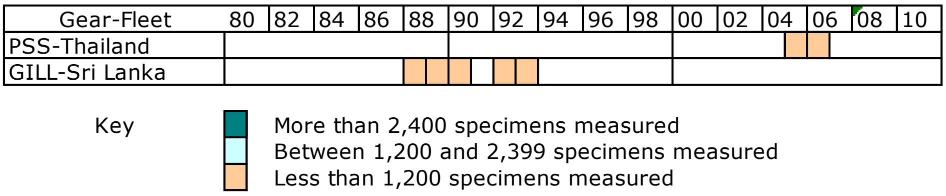
Gear-Fleet	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	00	02	04	06	08	10
PSS-Indonesia									■												
LINE-South Africa																		■			
LINE-Yemen																			■		

Indo-Pacific king mackerel – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- Trends in average weight cannot be assessed for most fisheries. Samples of Indo-Pacific king mackerel are only available for the coastal purse seiners of Thailand and gillnets of Sri Lanka but they refer to very short periods and the numbers sampled are very small (Table 5).
- Catch-at-Size(age) data are not available for the Indo-Pacific king mackerel due to the paucity of size data available from most fleets and the uncertain status of the catches for this species.
- Sex ratio data have not been provided to the Secretariat by CPCs.

[15] Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, when available catches and effort may not be available throughout the year existing only for short periods

TABLE 5. Indo-Pacific king mackerel: Availability of length frequency data, by fishery and year (1980–2011)[16]. Note that no length frequency data are available at all for 1950–82



STOCK ASSESSMENT

No quantitative stock assessment for Indo-Pacific king mackerel in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. Further work must be undertaken to derive stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 6. Indo-Pacific king mackerel (*Scomberomorus guttatus*) stock status summary

Management Quantity	**Aggregate Indian Ocean**
2011 catch estimate	49,832 t
Mean catch from 2007–2011	44,457 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_0 (80% CI)	–
SB_{2011}/SB_0	–
$B_{2011}/B_{0,\ F=0}$	–
$SB_{2011}/SB_{0,\ F=0}$	–

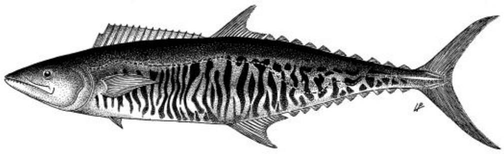
LITERATURE CITED

Froese R, Pauly DE (2009) FishBase, version 02/2009, FishBase Consortium, www.fishbase.org

[16] Note that the above list is not exhaustive, showing only the fisheries for which size data are available in the IOTC database. Furthermore, when available size data may not be available throughout the year existing only for short periods

APPENDIX XXIII
EXECUTIVE SUMMARY: NARROW-BARRED SPANISH MACKEREL

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



Status of the Indian Ocean narrow-barred Spanish mackerel (COM: *Scomberomorus commerson*) resource

TABLE 1. Narrow-barred Spanish mackerel: Status of narrow-barred Spanish mackerel (*Scomberomorus commerson*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Catch[2] 2011: Average catch[2] 2007–2011:	146,180 t 130,476 t	
	MSY: F_{2011}/F_{MSY}: SB_{2011}/SB_{MSY}: SB_{2011}/SB_0:	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about stock structure and about the total catches. No quantitative stock assessment is currently available for narrow-barred Spanish mackerel for the entire Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains uncertain (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Although indicators from the Gulf and Oman Sea suggest that overfishing is occurring in this area, the degree of connectivity with other regions remains unknown.

Outlook. The continued increase of annual catches for narrow-barred Spanish mackerel in recent years has further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. The apparent fidelity of narrow-barred Spanish mackerel to particular areas/regions is a matter for concern as overfishing in these areas can lead to localised depletion. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted. The following should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Bullet tuna in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting*

Parties (CPC's)
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

FISHERIES INDICATORS

Narrow-barred Spanish mackerel: General

The narrow-barred Spanish mackerel (*Scomberomorus commerson*) is a pelagic, top level predator found throughout tropical marine waters of the Indo-West Pacific. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Narrow-barred Spanish mackerel. Biology of Indian Ocean narrow-barred Spanish mackerel (*Scomberomorus commerson*)

Parameter	Description
Range and stock structure	A pelagic, top level predator found throughout tropical marine waters of the Indo-West Pacific. Juveniles inhabit shallow inshore areas whereas adults are found in coastal waters out to the continental shelf. Adults are usually found in small schools but often aggregate at particular locations on reefs and shoals to feed and spawn. They appear to undertake lengthy migrations, however, larger individuals may be resident which contributes to a metapopulation structure. Feed primarily on small fishes such as anchovies, clupeids, carangids, also squids and shrimps. Genetic studies carried out on *S. commerson* from Djibouti, Oman and U.A.E. showed there were small genetic differences among stocks in these three places.
Longevity	~16 years
Maturity (50%)	**Age**: 1.9 yrs for males and 2.1 yrs for females **Size:** 72.8 cm for males and 86.3 cm for females.
Spawning season	Females are multiple spawners. Year-round spawning has been observed in east African waters, with peaks during late spring to summer (April-July) and autumn (September-November) coinciding with the two seasonal monsoons which generate high abundances of plankton and small pelagic fish. Spawning in the southern Arabian Gulf occurs in the spring and summer months between April and August.
Size (length and weight)	Maximum: Females and males 240 cm FL; weight 70 kgs.

n.a. = not available. Sources: Grandcourt et al. 2005, Froese & Pauly 2009, Darvishi et al. 2011

Narrow-barred Spanish mackerel – Fisheries and catch trends

Narrow-barred Spanish mackerel is targeted throughout the Indian Ocean by artisanal and recreational fishers. The main method of capture is gillnet, but significant numbers of are also caught trolling (Table 3; Fig. 1).

TABLE 3. Narrow-barred Spanish mackerel: Best scientific estimates of the catches of narrow-barred Spanish mackerel by type of fishery for the period 1950–2011 (in metric tonnes) (Data as of October 2012)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Purse seine	0	0	237	1,137	2,633	2,252	1,953	2,350	1,610	2,136	3,950	1,902	1,969	3,275	4,126	3,781
Gillnet	7,161	15,163	26,820	57,670	73,907	80,768	73,513	77,674	75,970	67,372	78,848	84,687	97,639	91,822	98,972	107,815
Line	2,806	4,027	7,722	11,558	11,894	13,019	12,127	13,339	11,764	12,464	13,442	12,574	14,211	14,188	13,815	14,495
Other	1,368	2,011	4,257	6,630	11,340	15,379	15,646	14,856	13,245	13,792	16,549	15,851	16,015	18,521	16,631	20,090
Total	**11,336**	**21,201**	**39,036**	**76,996**	**99,774**	**111,418**	**103,239**	**108,220**	**102,587**	**95,764**	**112,789**	**115,014**	**129,834**	**127,806**	**133,544**	**146,180**

The catch estimates for narrow-barred Spanish mackerel were derived from very small amounts of information and are therefore highly uncertain[17]. The catches provided in Table 3 are based on the information available at the IOTC

[17] The uncertainty in the catch estimates has been assessed by the Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of unreporting fisheries for which catches had to be estimated

Secretariat and the following observations on the catches cannot currently be verified. The catches of narrow-barred Spanish mackerel increased from around 50,000 t the mid-1970's to over 100,000 t by the mid-1990's. The highest catches of narrow-barred Spanish mackerel were recorded in 2011, amounting to 146,000 t. Narrow-barred Spanish mackerel is caught in both Indian Ocean basins, with higher catches recorded in the west.

In recent years, the countries attributed with the highest catches of narrow-barred Spanish mackerel are Indonesia (27%) and India (25%) and, to a lesser extent, Iran, Myanmar, Pakistan, and the UAE (25%) (Fig. 2).

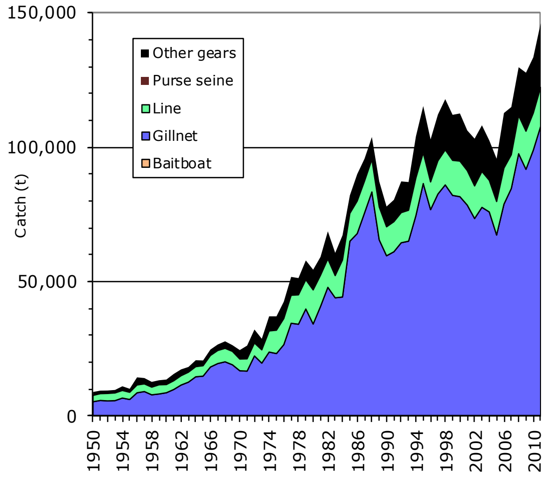


Fig. 1. Narrow-barred Spanish mackerel: Annual catches of narrow-barred Spanish mackerel by gear recorded in the IOTC database (1950–2011)

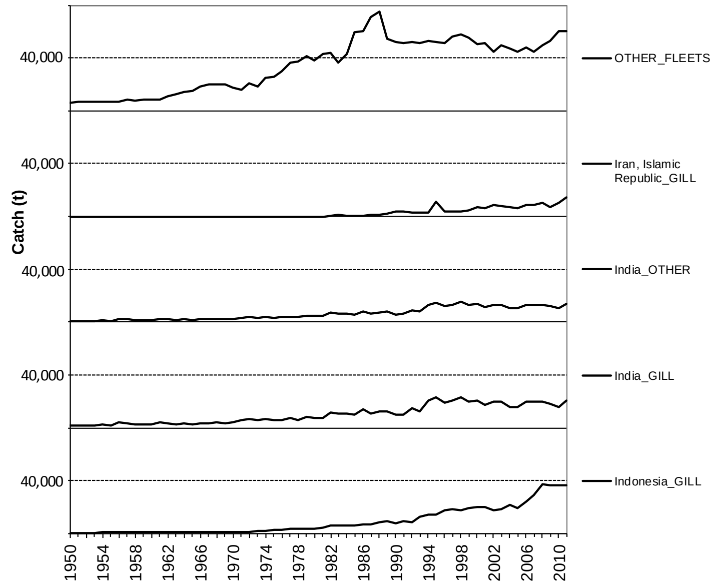


Fig. 2. Narrow-barred Spanish mackerel: Catches of narrow-barred Spanish mackerel recorded in the IOTC database for main fishing fleets (1950–2011)

Narrow-barred Spanish mackerel – uncertainty of catches

Retained catches are uncertain (Fig. 3), notably for the following fisheries:

- Artisanal fisheries of India and Indonesia: India and Indonesia have only recently reported catches of narrow-barred Spanish mackerel by gear, including catches by gear for the years 2005–08 and 2007–08, respectively. In both cases, the IOTC Secretariat used the catches reported by gear to break previous catches of this species by gear. The catches of narrow-barred Spanish mackerel estimated for this component represent more than 52% of the total catches of this species in recent years.
- Artisanal fisheries of Madagascar: To date, Madagascar has not reported catches of narrow-barred Spanish mackerel to the IOTC. During 2010 the IOTC Secretariat conducted a review aiming to break the catches recorded in the FAO database as narrow-barred Spanish mackerel by species, on the assumption that all catches of neritic tunas had been combined under this name. The new catches estimated are thought to be very uncertain.
- Artisanal fisheries of Mozambique (and Somalia): None of these countries have ever reported catches of narrow-barred Spanish mackerel to the IOTC Secretariat. Catch levels are unknown.
- Other artisanal fisheries: Oman and the UAE do not report catches of narrow-barred Spanish mackerel by gear. Although most of the catches are believed to be taken by gillnets, some narrow-barred Spanish mackerel may be also caught by using small surrounding nets, lines or other artisanal gears. Thailand and Malaysia report catches of narrow-barred Spanish mackerel and Indo-Pacific king mackerel aggregated.
- All fisheries: In some cases the catches of seerfish species are mislabelled, the catches of Indo-Pacific king mackerel and, to a lesser extent, other seerfish species, labelled as Spanish mackerel. Similarly, the catches of wahoo in some longline fisheries are thought to be mislabelled as narrow-barred Spanish mackerel. This mislabelling is thought to have little impact in the case of the narrow-barred Spanish mackerel but may be important for other seerfish species.
- Discard levels are believed to be low although they are unknown for most fisheries.
- Changes to the catch series: The catch series of narrow-barred Spanish mackerel has not changed substantially since the WPNT meeting in 2011.

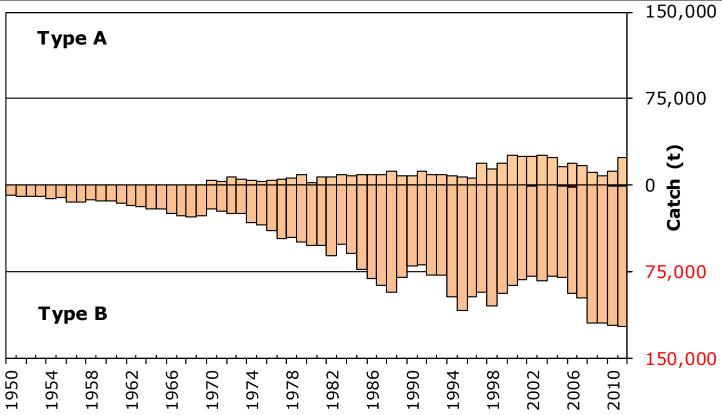


Fig. 3. Narrow-barred Spanish mackerel: Uncertainty of annual catch estimates for narrow-barred Spanish mackerel (1950–2011). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets (Data as of October 2012)

Narrow-barred Spanish mackerel – Effort trends

Effort trends are unknown for narrow-barred Spanish mackerel in the Indian Ocean.

Narrow-barred Spanish mackerel – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are available from some fisheries but they are considered highly incomplete (Table 4). In most cases catch-and-effort data are only available for short periods. Reasonably long catch-and-effort data series (extending for more than 10 years) are only available for Sri Lanka gillnets (Fig. 4). The catches and effort recorded are, however, thought to be unrealistic due to the dramatic changes in CPUE recorded in 2003 and 2004.

TABLE 4. Narrow-barred Spanish mackerel: Availability of catches and effort series, by fishery and year (1970–2011)[18]. Note that no catches and effort are available for the period 1950–84 and 2008–11

Gear-Fleet	70		72		74		76		78		80		82		84		86		88		90		92		94		96		98		00		02		04		06		08		10	
PSS-Indonesia																■	■																									
PSS-Sri Lanka																						■																				
PSS-Malaysia																														■												
GILL-Indonesia																■	■	■	■	■																						
GILL-Sri Lanka																		■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■							
GILL-Malaysia																														■												
GILL-Oman																															■											
GILL-Pakistan																		■	■	■	■	■																				
LINE-Australia																										■			■													
LINE-Malaysia																														■												
LINE-Yemen																																		■	■	■	■	■				
LINE-South Africa																■	■	■	■	■	■	■	■	■	■	■																
OTHR-Sri Lanka																									■	■	■	■	■	■	■	■	■	■	■							
OTHR-Malaysia																														■												

18 Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, when available catches and effort may not be available throughout the year existing only for short periods

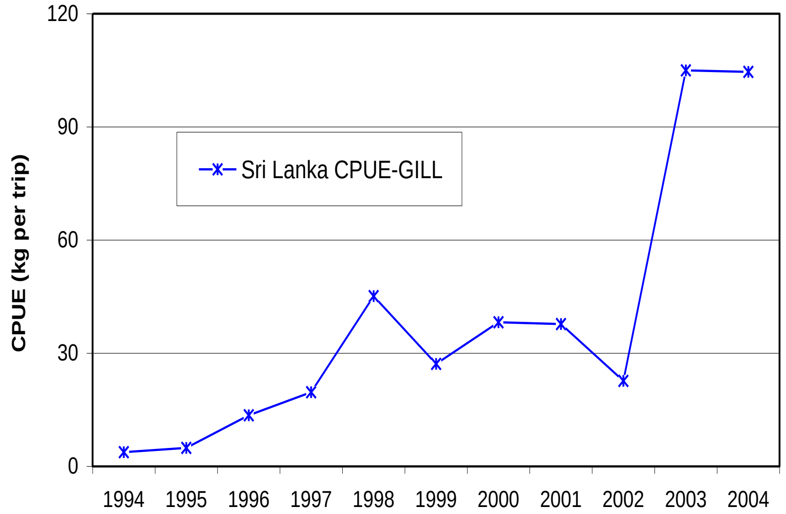
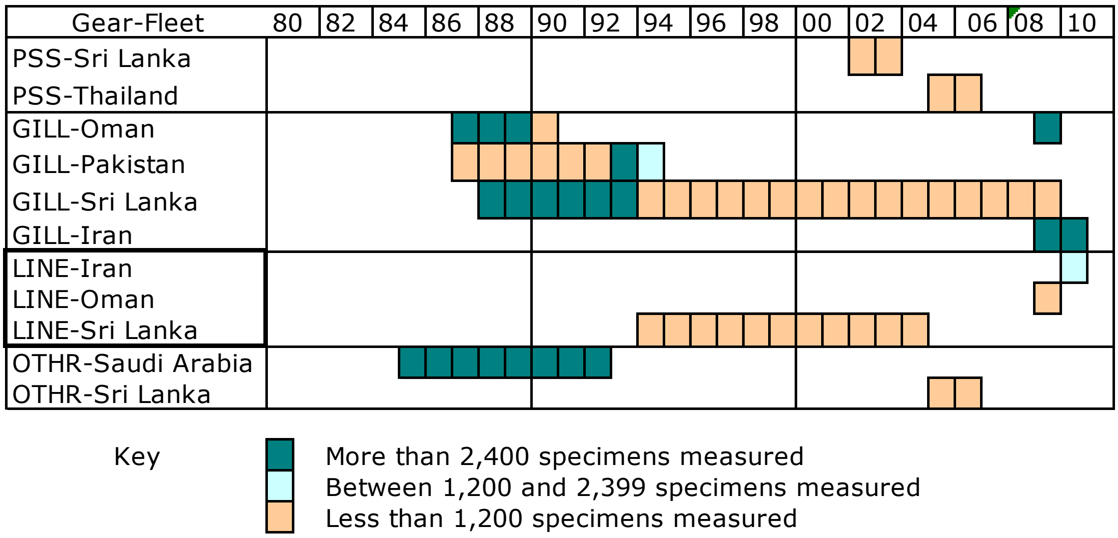


Fig. 4. Narrow-barred Spanish mackerel: Nominal CPUE series for the gillnet fishery of Sri Lanka derived from the available catches and effort data (1994–2004)

Narrow-barred Spanish mackerel – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- The size of narrow-barred Spanish mackerel taken by the Indian Ocean fisheries typically ranges between 30 and 140 cm depending on the type of gear used, season and location (Fig. 5). The size of narrow-barred Spanish mackerel taken varies by location with 32–119 cm fish taken in the Eastern Peninsular Malaysia area, 17–139 cm fish taken in the East Malaysia area and 50-90 cm fish taken in the Gulf of Thailand. Similarly, narrow-barred Spanish mackerel caught in the Oman Sea are typically larger than those caught in the Persian Gulf.
- Trends in average weight can only be assessed for Sri Lankan gillnets (Fig. 5) but the amount of specimens measured has been very low in recent years. The length frequency data available from the mid-eighties to the early nineties was obtained with the support of the IPTP (Indo-Pacific Tuna Programme). Unfortunately, data collection did not continue after the IPTP activities came to an end.
- Catch-at-Size(age) data are not available for the narrow-barred Spanish mackerel due to the paucity of size data available from most fleets (Table 5) and the uncertain status of the catches for this species. Length distributions derived from the data available for some selected fisheries are shown in Fig. 5.
- Sex ratio data have not been provided to the Secretariat by CPCs.

TABLE 5. Narrow-barred Spanish mackerel: Availability of length frequency data, by fishery and year (1980–2011). Note that no length frequency data are available for the period 1950–84



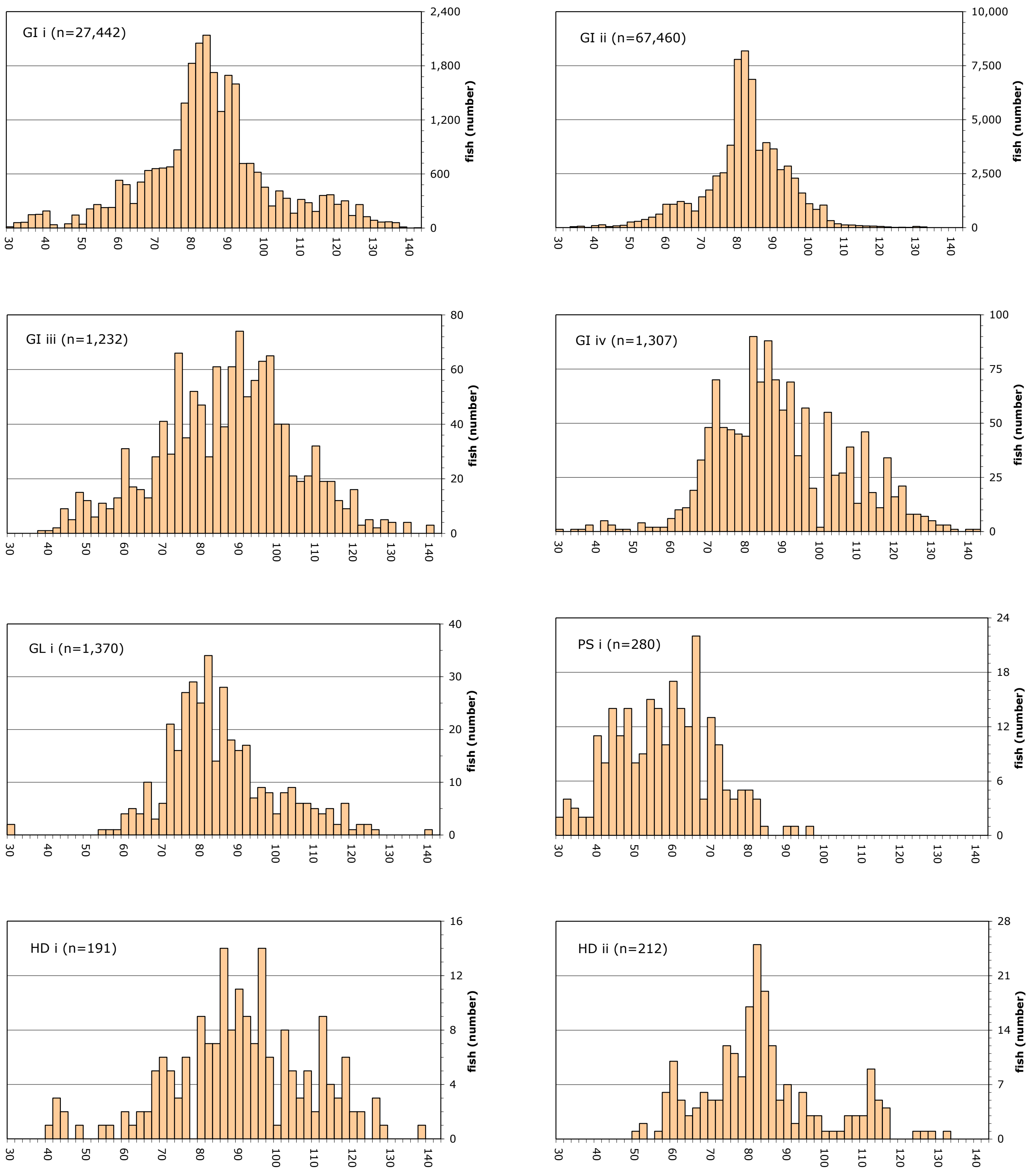


Fig. 5. Narrow-barred Spanish mackerel: Length frequency distributions (total amount of fish measured by 2cm length class by decade) derived from the data available at the IOTC Secretariat for selected fisheries and periods. GI: Gillnet fisheries: i. Sri Lanka 1980-89, ii. Sri Lanka 1990–99, iii. Pakistan 1990–99, iv. Sri Lanka 2000–06. GL: Gillnet and longline combination: i. Sri Lanka 2000–06. PS: Coastal purse seine fisheries: i. Thailand 2000–06. HD: Hand line fisheries: i. Sri Lanka 1990–99, ii. Sri Lanka 2000–06

STOCK ASSESSMENT

No quantitative stock assessment for narrow-barred Spanish mackerel in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. However, a preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Sri Lankan gillnet fishery (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 6. Narrow-barred Spanish mackerel (*Scomberomorus commerson*) stock status summary

Management Quantity	**Aggregate Indian Ocean**
2011 catch estimate	146,180 t
Mean catch from 2007–2011	130,476 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2011}/F_{MSY} (80% CI)	–
B_{2011}/B_{MSY} (80% CI)	–
SB_{2011}/SB_{MSY}	–
B_{2011}/B_0 (80% CI)	–
SB_{2011}/SB_0	–
$B_{2011}/B_{0,\ F=0}$	–
$SB_{2011}/SB_{0,\ F=0}$	–

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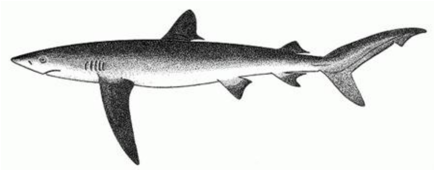
APPENDIX XXIV
EXECUTIVE SUMMARY: BLUE SHARK

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



Status of the Indian Ocean blue shark (BSH: *Prionace glauca*)

TABLE 1. Blue shark: Status of blue shark (*Prionace glauca*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Reported catch 2011:	9,540 t	Uncertain
	Not elsewhere included (nei) sharks:	55,135 t	
	Average reported catch 2007–2011:	9,452 t	
	Not elsewhere included (nei) sharks:	63,783 t	
	MSY:	unknown	
	F_{2011}/F_{MSY}:	unknown	
	SB_{2011}/SB_{MSY}:	unknown	
	SB_{2011}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

TABLE 2. Blue shark: IUCN threat status of blue shark (*Prionace glauca*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[19]		
		Global status	WIO	EIO
Blue shark	*Prionace glauca*	Near Threatened	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, Stevens 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance and the standardised CPUE series from the Japanese longline fleet, and about the total catches over the past decade (Table 1). The current IUCN threat status of 'Near Threatened' applies to blue sharks globally (Table 2). 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 and limited 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 relatively late (at 4–6 years), and have relativity few offspring (25–50 pups every year), the blue shark is vulnerable to overfishing. Blue shark assessments in the Atlantic and Pacific oceans seem to indicate that blue shark stocks can sustain relatively high fishing pressure.

Outlook. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on blue shark will decline in these areas in the near future, and may result in localised depletion. The following shold be noted:

- The available evidence indicates risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.

[19] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

- Noting that current reported catches (probably largely underestimated) are estimated at an average ~ 9,452 t over the last five years, ~ 9,540 t in 2011, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Blue shark in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on blue shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.
- Resolution 12/03 *On the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).

Extracts from Resolutions 05/05, 11/04 and 12/03

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

RESOLUTION 12/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

FISHERIES INDICATORS

Blue shark: General

Blue shark (*Prionace glauca*) is the most common shark in pelagic oceanic waters throughout the tropical and temperate oceans worldwide (Fig. 1). It has one of the widest ranges of all the shark species and may also be found close inshore. Adult blue sharks have no known predators; however, subadults and juveniles may be preyed upon by shortfin makos, great white sharks, and adult blue sharks. Fishing is a major contributor to adult mortality. Table 3 outlines some of the key life history traits of blue shark in the Indian Ocean.

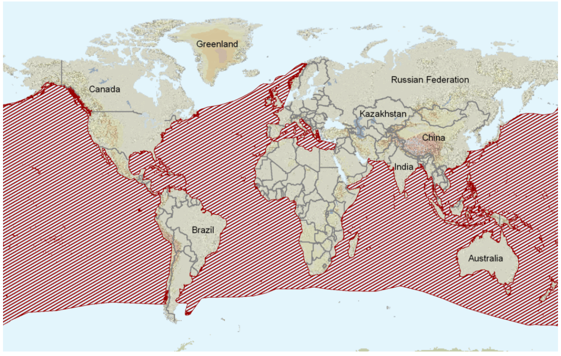


Fig. 1. Blue shark: The worldwide distribution of the blue shark (source: www.iucnredlist.org)

TABLE 3. Blue shark: Biology of Indian Ocean blue shark (*Prionace glauca*)

Parameter	**Description**
Range and stock structure	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. Long-distance movements have been observed for blue sharks, including transoceanic route from Australia to South Africa. The blue shark is often found in large single sex schools containing individuals of similar size. Subtropical and temperate waters appears to be nursery grounds south of 20°S, where small blue sharks dominate, but where all range of sizes from 55 to 311 cm FL are recorded. In contrast mature fish (FL > 185cm) dominate in the off-shore equatorial waters. Area of overlap with IOTC management area = high. No information is available on stock structure.
Longevity	Bomb radiocarbon dating of Indian Ocean blue sharks showed that males of 270 cm FL may attain 23 years of age. Preliminary data for Indian Ocean shows that male may reach 25 and females 21 years old. In the Atlantic Ocean, the oldest blue sharks reported were a 16 year old male and a 15 year old female. Longevity is estimated to be around 20 years of age in the Atlantic.
Maturity (50%)	Age: Sexual maturity is attained at about 5 years of age in both sexes. Size: not available for the Indian Ocean. In the Atlantic 182–218 cmTL for males; 173–221 cm TL for females. In the South Pacific: 229–235 cm TL for males and 205–229 cm TL for females.
Reproduction	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, very similar to the one reported in the Atlantic Ocean, 37. Generation time is about 8–10 years. In Indian Ocean, between latitude 2 ºN and 6 ºS, pregnant females are present for most of the year. • Fecundity: relatively high (25–50) • Generation time: 8–10 years • Gestation Period: 9–12 months • Annual reproductive cycle
Size (length and weight)	Maximum size is around 380 cm FL. New-born pups are around 40 to 51 cm TL. Length–weight relationship for both sexes combined in the Indian Ocean is $TW=0.159*10^{-4} * FL^{2.84554}$.

Sources: Gubanov & Gigor'yev 1975, Pratt 1979, Anderson & Ahmed 1993, ICES 1997, Scomal & Natansen 2003, Mejuto et al. 2005, Francis & Duffy 2005, Mejuto & Garcia-Cortes 2006, IOTC 2007, Matsunaga 2007, Rabehagosoa et al. 2009, Romanov & Romanova 2009, Anon 2010, Romano & Campana 2011

Blue shark: Fisheries

Blue sharks are often targeted by some semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and anecdotally in the purse seine fishery). However, in recent years longliners are occasionally targeting this species, due to an increase in its commercial value worldwide. The blue shark appears to have a similar distribution to swordfish. Typically, the fisheries take blue sharks between 180–240 cm FL or 30 to 52 kg. Males are slightly smaller than the females. In other Oceans, angling clubs are known to organise shark fishing competitions where blue sharks and mako sharks are targeted. Sport fisheries for oceanic 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 them but do not report it to IOTC. It appears that substantial 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. 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.

The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke et al. 2006, Clarke 2008) and the bycatch/release injury rate is unknown but probably high.

Preliminary estimations of at-haulback mortality showed that 24.7% of the blue shark specimens captured in longline fisheries targeting swordfish are captured dead at time of haulback (Table 4). Specimen size seems to be a significant factor, with larger specimens having a higher survival at-haulback (Coelho et al. 2011a).

TABLE 4. Blue shark: Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	rare	abundant		rare	unknown	unknown
Fishing Mortality	unknown	13 to 51 %	0 to 31%	unknown	unknown	unknown
Post release mortality	unknown	19%		unknown	unknown	unknown

Sources: Boggs 1992, Romanov 2002, 2008, Diaz & Serafy 2005, Ariz et al. 2006, Peterson et al. 2008, Romanov et al. 2008, Campana et al. 2009, Poisson et al. 2010

Blue shark: Catch trends

The catch estimates for blue shark (Table 5) are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 74% of the catch of sharks by longliners, all targeting swordfish, were blue sharks.

TABLE 5. Blue shark: Catch estimates for blue shark in the Indian Ocean for 2009, 2010 and 2011

Catch		2009	2010	2011
Most recent catch (reported)	Blue shark	9,687	9,829 t	9,540 t
	nei-sharks	65,380 t	64,387 t	55,135 t
Mean catch (reported) over the last 5 years (2007–2011)	Blue shark			9,452 t
	nei-sharks			63,783 t

Nei-sharks: not elsewhere indicated sharks

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2011 twelve countries reported catches of blue sharks in the IOTC region.

Blue shark: Nominal and standardised CPUE Trends

Statistics not available at the IOTC Secretariat by species.

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). Historical research data shows overall decline in CPUE while mean weight of blue shark in this time series are relatively stable (Romanov et al. 2008).

Trends in the Japanese CPUE series (Fig. 2) suggest that the longline vulnerable biomass was more or less stable during 2000–2006 and subsequently increased to higher levels for the period 2007–11 (Hiraoka & Yokawa 2012). The method of producing blue shark catch prior to 1994, when all sharks were combined, is not scientifically defensible. Based on the paper, all catches were considered to be blue shark for those trips in which 80% or more operations reported shark catch. This method seemed arbitrary, and until more work was done defending its validity, data prior to 1994 should not be used, as species-specific data is available since then.

The standardised CPUE of blue shark catches by the Portuguese longline fleet in the Indian Ocean show little variability between 1999–2011 (Fig. 2; Coelho et al. 2012).

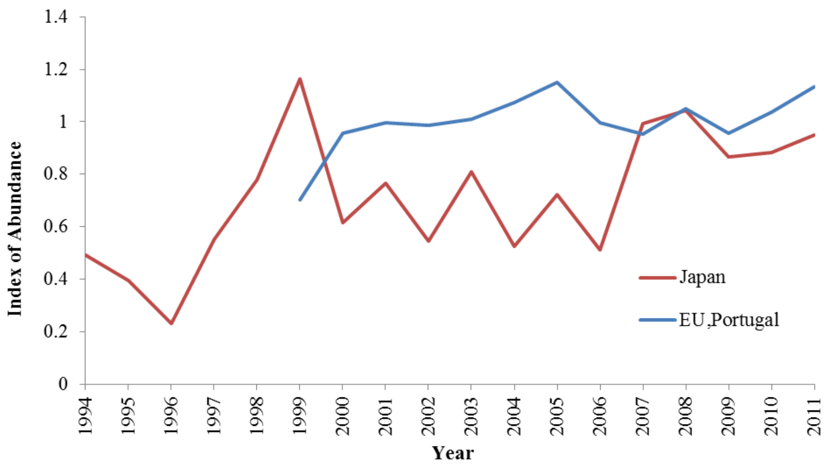


Fig. 2. Blue shark: Comparison of the blue shark standardised CPUE series for the longline fleets of Japan and EU,Portugal.

Blue shark: Average weight in the catch by fisheries

Data not available.

Blue shark: Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

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

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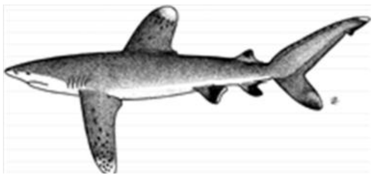
APPENDIX XXV
EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK

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



Status of the Indian Ocean oceanic whitetip shark (OCS: *Carcharhinus longimanus*)

TABLE 1. Oceanic whitetip shark: Status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Reported catch 2011:	388 t	Uncertain
	Not elsewhere included (nei) sharks:	55,135 t	
	Average reported catch 2007–2011:	347 t	
	Not elsewhere included (nei) sharks:	63,783 t	
	MSY:	unknown	
	F_{2011}/F_{MSY}:	unknown	
	SB_{2011}/SB_{MSY}:	unknown	
	SB_{2011}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

TABLE 2. Oceanic whitetip shark: IUCN threat status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean

Common name	**Scientific name**	**IUCN threat status**[20]		
		Global status	**WIO**	**EIO**
Oceanic whitetip shark	*Carcharhinus longimanus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, Baum et al. 2006

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance and the standardised CPUE series from the Japanese longline fleet, and about the total catches over the past decade (Table 1). The current IUCN threat status of 'Vulnerable' applies to oceanic whitetip sharks globally (Table 2). There is a paucity of information available on this species in the Indian Ocean and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available for oceanic whitetip sharks in the Indian Ocean therefore the stock status is highly uncertain (Table 1). 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. Despite the lack of data, it is apparent from the information that is available that oceanic whitetip shark abundance has declined significantly over recent decades.

Outlook. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore

[20] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

unlikely that catch and effort on oceanic whitetip sharks will decline in these areas in the near future, and may result in localised depletion. The following should be noted:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Noting that current catches (probably largely underestimated) are estimated at an average ~347 t over the last five years, ~388 t in 2011, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Oceanic whitetip shark in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on oceanic whitetip shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.
- Resolution 12/03 *On the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).

Extracts from Resolutions 05/05, 11/04 and 12/03

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

RESOLUTION 12/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

FISHERIES INDICATORS

Oceanic whitetip shark: General

Oceanic whitetip shark (*Carcharhinus longimanus*) was one of the most common large sharks in warm oceanic waters. It is typically found in the open ocean but also close to reefs and near oceanic islands (Fig. 1). Table 3 outlines some of the key life history traits of oceanic whitetip shark in the Indian Ocean.

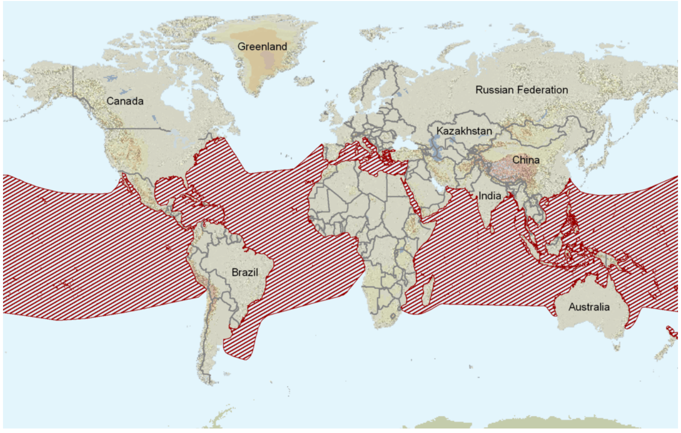


Fig. 1. Oceanic whitetip shark: The worldwide distribution of the oceanic whitetip shark (source: www.iucnredlist.org)

TABLE 3. Oceanic whitetip shark: Biology of Indian Ocean oceanic whitetip shark (*Carcharhinus longimanus*)

Parameter	Description
Range and stock structure	The population dynamics and stock structure of the oceanic whitetip shark in the Indian Ocean are not known. Area of overlap with IOTC management area = high.
Longevity	Maximum age observed was 11 years for the Central and Western Pacific and, 14 years for males and 17 years for females years for the South-Western Atlantic Ocean.
Maturity (50%)	Both males and females mature at around 6 to 7 years old or about 180–190 cm TL in the western South Atlantic Ocean and 4-5 years or 170–190 cm TL in the Central and western Pacific Ocean. Range of observed sizes-at-maturity was 160-196cm TL for males and 181-203cm TL for females.
Reproduction	Oceanic whitetip sharks are viviparous. Litter sizes range from 1–15 pups (mean=6.2) in the Pacific Ocean, with larger sharks producing more offspring. Each pup is approximately 60-65 cm at birth. In the south western Indian Ocean, oceanic whitetip sharks 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. • Fecundity: medium (<20 pups) • Gestation Period: 12 months • Generation time: 11 years • Reproductive cycle is biennial
Size (length and weight)	Oceanic whitetip sharks are relatively large sharks and grow to up to 350 cm FL. Females grow larger than males. The maximum weight reported for this species is 167.4 kg. Length–weight relationship for both sexes combined in the Indian Ocean is TW=0.386*10-4 * FL2.75586.

Sources: Mejuto et al. 2005, Romanov & Romanova 2009, Coelho et al. 2009

Oceanic whitetip shark: Fisheries

Oceanic whitetip sharks are targeted by some semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery) (Table 4).

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. 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.

The practice of shark finning is considered to be regularly occurring for this species (Clarke et al. 2006, Clarke 2008) and the bycatch/release injury rate is unknown but probably high.

At-haulback mortality of oceanic whitetip sharks in the Atlantic ocean longline fishery targeting swordfish was estimated to be at 30.6% (Coelho et al. 2011).

TABLE 4. Oceanic whitetip shark: Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	common	common		common	common	unknown
Fishing Mortality	Study in progress	58%		unknown	unknown	unknown
Post release mortality	Study in progress			unknown	unknown	unknown

Sources: Romanov 2002, 2008, Ariz et al. 2006, Peterson et al. 2008, Romanov et al. 2008, Poisson et al. 2010

Oceanic whitetip shark: Catch trends

The catch estimates for oceanic whitetip shark (Table 5) are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 0.6% of the catch of sharks by longliners, all targeting swordfish, were oceanic whitetip sharks, and for CPCs reporting gillnet data by species (i.e. Sri Lanka), 7% of the catches of shark were oceanic whitetip sharks.

TABLE 5. Oceanic whitetip shark: Catch estimates for oceanic whitetip shark in the Indian Ocean for 2009, 2010 and 2011

Catch		2009	2010	2011
Most recent catch (reported)	Oceanic whitetip shark	245 t	761 t	388 t
	nei-sharks	65,380 t	64,387 t	55,135 t
Mean catch (reported) over the last 5 years (2007–2011)	Oceanic whitetip shark			347 t
	nei-sharks			63,783 t

Nei-sharks: not elsewhere indicated sharks

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2011 four countries reported catches of oceanic whitetip sharks in the IOTC region.

Oceanic whitetip shark: Nominal and standardised CPUE Trends

Statistics not available at the IOTC Secretariat.

Historical research data shows overall decline in CPUE and mean weight of oceanic whitetip shark (Romanov et al. 2008). Anecdotal reports suggest that oceanic white tips have become rare throughout much of the Indian Ocean during the past 20 years. Indian longline research surveys reported zero catches from the Arabia Sea during 2004–09 (John & Varghese 2009).

Trends in the Japanese standardised CPUE series (2003–2011) suggest that the longline vulnerable biomass has decreased (Fig. 2; Yokawa & Semba 2012). The authors stated that the early CPUE (2000–02) were not reliable due to the data problems. The updated results are in line with those presented to the WPEB07, although there are some differences on the initial years of the data series, which were due to an improvement on the filtering process. However, the analysis is based on a relatively short period and may not be reflecting the abundance trend of the stock as the fishery started operating well before. Discarding data in an arbitrary manner was not desirable, and using more comprehensive statistical techniques for examining outliers should be presented, if data are not included in an analysis.

Trends in the EU,Spain standardised CPUE series (1998–2011) suggest that the longline vulnerable biomass declined until 2007 and has been variable since (Fig. 2; Ramos-Cartelle et al. 2012). There were concerns related to the areas used in the study and considering other criteria's such as examining Areas 1 and 2 (see paper) only may give a more appropriate CPUE signal. The use of other stratifications related to the biological distribution of the species or to the Longhurst ecological provinces in the Indian Ocean should be considered.

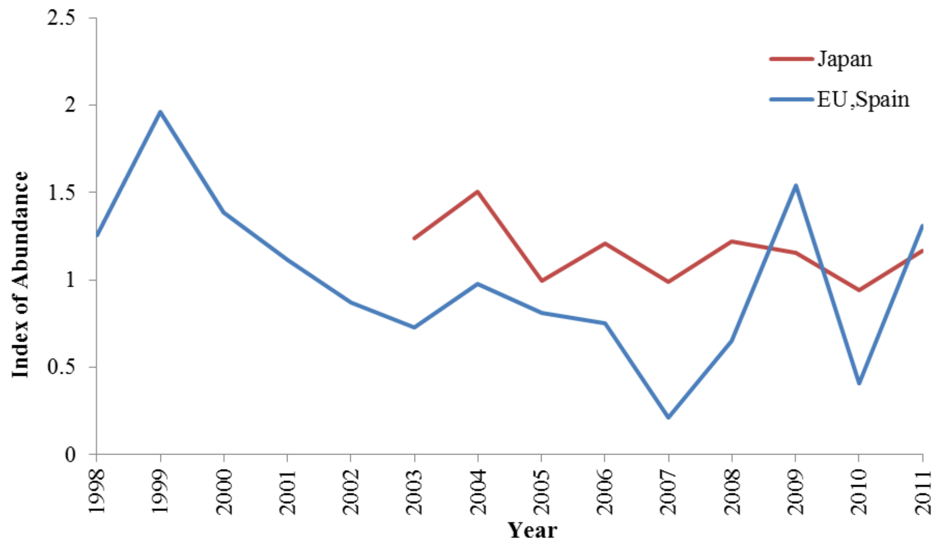


Fig. 2. Oceanic whitetip shark: Comparison of the oceanic whitetip shark standardised CPUE series for the longline fleets of Japan and EU,Spain

Oceanic whitetip shark: Average weight in the catch by fisheries

Data not available.

Oceanic whitetip shark: Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

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

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Romanov E, Romanova N (2009) Size distribution and length-weight relationships for some large pelagic sharks in the Indian Ocean. IOTC–2009–WPEB–06, 12 p

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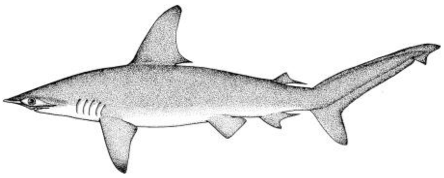
APPENDIX XXVI
EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK

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



Status of the Indian Ocean Scalloped Hammerhead Shark (SPL: *Sphyrna lewini*)

TABLE 1. Status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Reported catch 2011:	120 t	Uncertain
	Not elsewhere included (nei) sharks:	55,135 t	
	Average reported catch 2007–2011:	36 t	
	Not elsewhere included (nei) sharks:	63,783 t	
	MSY:	unknown	
	F_{2011}/F_{MSY}:	unknown	
	SB_{2011}/SB_{MSY}:	unknown	
	SB_{2011}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

TABLE 2. IUCN threat status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[21]		
		Global status	WIO	EIO
Scalloped hammerhead	*Sphyrna lewini*	Endangered	Endangered	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, Baum 2007

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The current IUCN threat status of 'Endangered' applies to scalloped hammerhead sharks globally and specifically for the western Indian Ocean (Table 1). 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.

Outlook. Maintaining or increasing effort will probably result in further declines in biomass and productivity. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on scalloped hammerhead shark will decline in these areas in the near future, and may result in localised depletion. The following should be noted:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- The primary source of data that drive the assessment (total catches) is highly uncertain and should be investigated further as a priority.

[21] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

- Noting that current reported catches (probably largely underestimated) are estimated at an average ~36 t over the last five years, ~120 t in 2011, maintaining or increasing effort will probably result in further declines in biomass and productivity.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Scalloped hammerhead shark in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on blue shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.
- Resolution 12/03 *On the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).

Extracts from Resolutions 05/05, 11/04 and 12/03

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Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

RESOLUTION 12/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

FISHERIES INDICATORS

Scalloped hammerhead shark: General

Scalloped hammerhead shark (*Sphyrna lewini*) is widely distributed and common in warm temperate and tropical waters (Fig. 1). It is also found in estuarine and inshore waters. In some areas, the scalloped hammerhead shark forms large resident populations. In other areas, large schools of small-sized sharks are known to make seasonal migrations polewards. Scalloped hammerhead sharks feeds on pelagic fishes, rays and occasionally other sharks, squids, lobsters, shrimps and crabs. Table 3 outlines some of the key life history traits of scalloped hammerhead shark in the Indian Ocean.

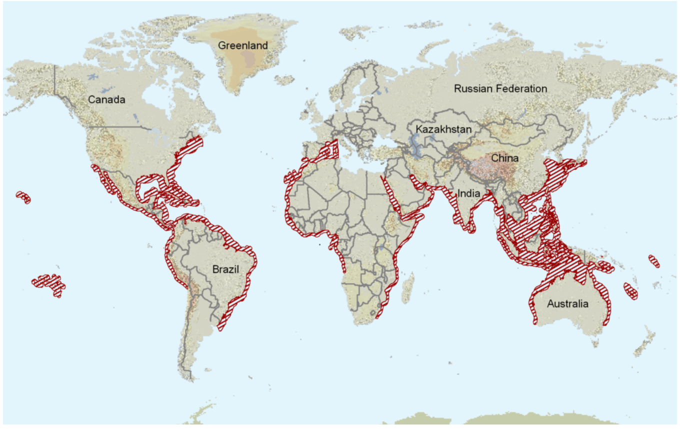

Fig. 1. Scalloped hammerhead shark: The worldwide distribution of the scalloped hammerhead shark (source: www.iucnredlist.org)

TABLE 3. Scalloped hammerhead shark: Biology of Indian Ocean scalloped hammerhead shark (*Sphyrna lewini*)

Parameter	**Description**
Range and stock structure	The scalloped hammerhead shark is widely distributed and common in warm temperate and tropical waters down to 900 m. It is also found in estuarine and inshore waters. In some areas, the scalloped hammerhead shark forms large resident populations. In other areas, large schools of small-sized sharks are known to migrate seasonally polewards. Area of overlap with IOTC management area = high. There is no information available on stock structure.
Longevity	The maximum age for Atlantic Ocean scalloped hammerheads is estimated to be over 30 years with the largest individuals reaching over 310 cm TL. In the Eastern Indian Ocean, females are reported to reach 350 m TL
Maturity (50%)	Males in the eastern Indian Ocean mature at around 140-165 cm TL. Females mature at about 200 cm TL. In the northern Gulf of Mexico females are believed to mature at about 15 years and males at 9–10 years.
Reproduction	The scalloped hammerhead shark is viviparous with a yolk sac-placenta. Litters consist of 13–31 pups (mean=16.5). The reproductive cycle is annual and the gestation period is 9–10 months. The nursery areas are in shallow coastal waters. • Fecundity: medium (<31 pups) • Generation time: 17–21 years • Gestation Period: 9–10 months • Reproductive cycle is annual
Size (length and weight)	The maximum size for Atlantic Ocean scalloped hammerheads is estimated to be over 310 cm TL. In the Eastern Indian Ocean, females are reported to reach 350 m TL New-born pups are around 45–50 cm TL at birth in the eastern Indian Ocean.

Sources: Stevens & Lyle 1989, Jorgensen et al. 2009

Scalloped hammerhead shark: 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) (Table 4). 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. 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.

The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke et al. 2006, Clarke 2008, Holmes et al. 2009) and the bycatch/release injury rate is unknown but probably high.

TABLE 4. Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	rare	common		absent	common	unknown
Fishing Mortality	unknown	unknown	unknown	unknown	unknown	unknown
Post release mortality	unknown	unknown	unknown	unknown	unknown	unknown

Sources: Romanov 2002, 2008, Dudley & Simpfendorfer 2006, Romanov et al. 2008

Scalloped hammerhead shark: Catch trends

The catch estimates for scalloped hammerhead (Table 5) are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories).

TABLE 5. Catch estimates for scalloped hammerhead shark* in the Indian Ocean for 2009, 2010 and 2011

Catch		2009	2010	2011
Most recent catch (reported)	Scalloped hammerhead shark	21 t	15 t	120 t
	nei-sharks	65,380 t	64,387 t	55,135 t
Mean catch (reported) over the last 5 years (2007–2011)	Scalloped hammerhead shark			36 t
	nei-sharks			63,783 t

* catches likely to be misidentified with the smooth hammerhead shark (*S. zygaena*) which is an oceanic species.
Nei-sharks: not elsewhere indicated sharks

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2011 one country reported catches of scalloped hammerhead sharks in the IOTC region.

Scalloped hammerhead shark: Nominal and standardised CPUE Trends

Data not available at the IOTC Secretariat. However, Indian longline research surveys, in which scalloped hammerhead sharks contributed up to 6% of regional catch, demonstrate declining catch rates over the period 1984–2006 (John & Varghese 2009). CPUE in South African protective net shows steady decline from 1978.

Scalloped hammerhead shark: Average weight in the catch by fisheries

Data not available.

Scalloped hammerhead shark: Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

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

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APPENDIX XXVII
EXECUTIVE SUMMARY: SHORTFIN MAKO SHARK

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

Status of the Indian Ocean shortfin mako shark (SMA: *Isurus oxyrinchus*)

TABLE 1. Shortfin mako shark: Status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Reported catch 2011:	1,361 t	Uncertain
	Not elsewhere included (nei) sharks:	55,135 t	
	Average reported catch 2007–2011:	1,207 t	
	Not elsewhere included (nei) sharks:	63,783 t	
	MSY:	unknown	
	F_{2011}/F_{MSY}:	unknown	
	SB_{2011}/SB_{MSY}:	unknown	
	SB_{2011}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

TABLE 2. Shortfin mako shark: IUCN threat status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[22]		
		Global status	WIO	EIO
Shortfin mako shark	*Isurus oxyrinchus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
SOURCES: IUCN 2007, Cailliet 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance and the standardised CPUE series from the Japanese longline fleet, and about the total catches over the past decade (Table 1). The current IUCN threat status of 'Vulnerable' applies to shortfin mako sharks globally (Table 2). Trends in the Japanese CPUE series suggest that the longline vulnerable biomass has declined from 1994 to 2003, and has been increasing since then. 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 30 years), females mature at 18–21 years, and have relativity few offspring (<25 pups every two or three years), the shortfin mako shark is vulnerable to overfishing.

Outlook. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on shortfin mako shark will decline in these areas in the near future, and may result in localised depletion. The following should be noted:

- The available evidence indicates considerable risk to the stock status at current effort levels.

[22] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Noting that current reported catches are estimated (probably largely underestimated) at an average ~1207 t over the last five years, ~1361 t in 2011, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Shortfin mako shark in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on shortfin mako shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.
- Resolution 12/03 *On the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).

Extracts from Resolutions 05/05, 11/04 and 12/03

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

RESOLUTION 12/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

FISHERIES INDICATORS

Shortfin mako shark: General

Shortfin mako shark (*Isurus oxyrinchus*) is widely distributed in tropical and temperate waters warmer than 16°C (Fig. 1) and is 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 fast-moving fishes such as swordfish and tunas and occasionally on other sharks. Table 3 outlines some of the key life history traits of shortfin mako shark in the Indian Ocean.

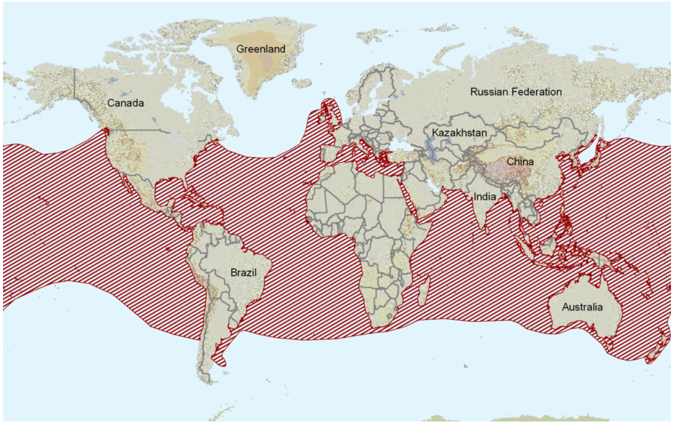

Fig. 1. Shortfin mako shark: The worldwide distribution of the shortfin mako shark (source: www.iucnredlist.org)

TABLE 3. Shortfin mako shark: Biology of Indian Ocean shortfin mako shark (*Isurus oxyrinchus*)

Parameter	Description
Range and stock structure	Widely distributed in tropical and temperate waters warmer than 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. Area of overlap with IOTC management area = high. No information is available on stock structure of shortfin mako sharks in the Indian Ocean.
Longevity	Maximum lifespans reported for this species are 32 years for females and 29 years for males in the western North Atlantic.
Maturity (50%)	Sexual maturity is estimated to be reached at 18-19 years or 290-300 m TL for females and 8 years or about 200 m TL for males in the western North Atlantic and 19-21 years or 207-290 m TL for females and 7-9 years or 180-190 m TL for males in the western South Pacific. In the western South Indian Ocean maturity was estimated at about 270 m TL for females and 190-210 m TL for males. The length at maturity of female shortfin mako sharks differs between the Northern and Southern hemispheres.
Reproduction	Female shortfin mako sharks are aplacental viviparous. Developing embryos feed on unfertilized eggs in the uterus during the gestation period, whose length is subject to debate but is believed to last 15-18 months. Litter size ranges from 4 to 25 pups (mean=12.5), with larger sharks producing more offspring. The nursery areas are apparently in deep tropical waters. The length of the reproductive cycle is up to three years. • Fecundity: medium (<25 pups) • Generation time: 23 years • Gestation Period: 15–18 months • Reproductive cycle is biennial or triennial
Size (length and weight)	Maximum size of shortfin mako sharks in Northwest Atlantic Ocean is 4 m and 570 kg. In the Indian Ocean a female individual of 248 cm FL and 130 kg TW was aged as 18 years old. Length–weight relationship for both sexes combined in the Indian Ocean is $TW=0.349*10-4 * FL^{2.76544}$. New-born pups are around 70 cm (TL).

Sources: Bass et al. 1973, Mollet et al. 2000, Mejuto et al. 2005, Romanov & Romanova 2009

Shortfin mako shark: 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 anecdotally by the purse seine fishery) (Table 4). In other Oceans, due to its energetic displays and edibility, the shortfin mako shark 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. 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.

The practice of shark finning is considered to be regularly occurring for this species (Clarke et al. 2006, Clarke 2008) and the bycatch/release injury rate is unknown but probably high.

TABLE 4. Shortfin mako shark: Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	rare	common		rare–common	unknown	unknown
Fishing Mortality	unknown	13 to 51 %	0 to 31%	unknown	unknown	unknown
Post release mortality	unknown	19%		unknown	unknown	unknown

Sources: Romanov 2002, 2008, Ariz et al. 2006, Dudley & Simpfendorfer 2006, Peterson et al. 2008, Romanov et al. 2008

Shortfin mako shark: Catch trends

The catch estimates for shortfin mako shark (Table 5) are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 12% of the catch of sharks by longliners, all targeting swordfish, were shortfin mako sharks.

TABLE 5. Shortfin mako shark: Catch estimates for shortfin mako shark in the Indian Ocean for 2009, 2010 and 2011.

Catch		2009	2010	2011
Most recent catch (report)	Shortfin mako shark	896 t	1,246 t	1,361
	nei-sharks	65,380 t	64,387 t	55,135 t
Mean catch (reported) over the last 5 years (2007–2011)	Shortfin mako shark			1,207 t
	nei-sharks			63,783 t

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2011, nine countries reported catches of shortfin mako sharks in the IOTC region.

Shortfin mako shark: Nominal and standardised CPUE Trends

Statistics not available at the IOTC Secretariat. Point estimates and 95% confidence interval for the standardised Japanese longline CPUE of shortfin mako shark data were not provided to the IOTC Secretariat.

Historical research data shows overall decline in CPUE and mean weight of mako sharks (Romanov et al. 2008). CPUE in South African protection net is fluctuating without any trend (Holmes et al. 2009). The CPUEs of shortfin mako catches by the Portuguese longline fleet in the Indian Ocean showed some significant variability between 1999–2010, but no noticeable trends. The standardised series for the more recent years (2006–10) also did not show significant trends. It should be noted that this time series of standardised CPUEs is very short (5 years), part of an ongoing analysis, and should therefore be regarded as preliminary (Coelho et al. 2011b).

The Japanese CPUE series (Fig. 2) suggest that the longline vulnerable biomass largely fluctuated during 1994–2010 (Kimoto et al. 2011) and there are no apparent trends.

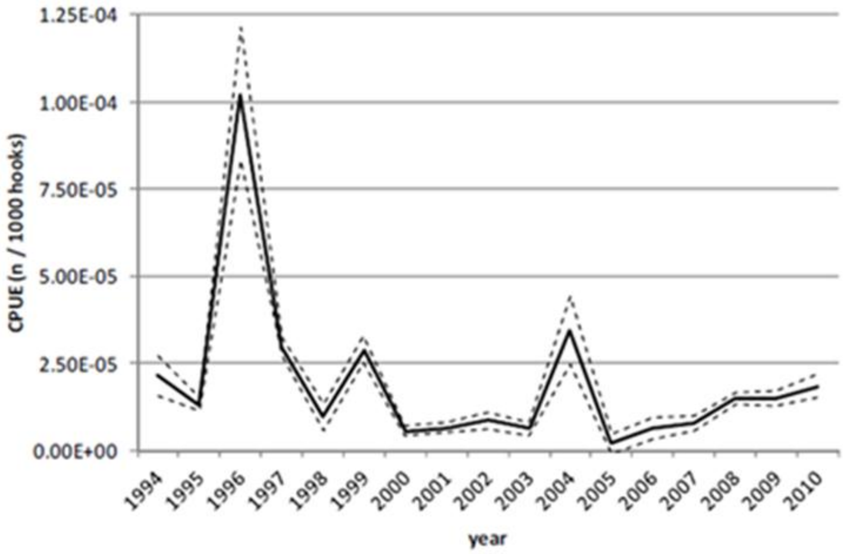

Fig. 2. Shortfin mako shark: Standardised Japanese longline CPUE series in the Indian Ocean from 1994 to 2010 for shortfin mako shark.

Shortfin mako shark: Average weight in the catch by fisheries

Data not available.

Shortfin mako shark: Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

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

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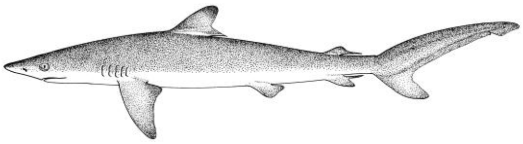
APPENDIX XXVIII
EXECUTIVE SUMMARY: SILKY SHARK

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



Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*)

TABLE 1. Silky shark: Status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Reported catch 2011:	3,353 t	Uncertain
	Not elsewhere included (nei) sharks:	55,135 t	
	Average reported catch 2007–2011:	1,396 t	
	Not elsewhere included (nei) sharks:	63,783 t	
	MSY:	unknown	
	F_{2011}/F_{MSY}:	unknown	
	SB_{2011}/SB_{MSY}:	unknown	
	SB_{2011}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)	(yellow)	(green)
Not assessed/Uncertain	(grey)	

TABLE 2. Silky shark: IUCN threat status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[23]		
		Global status	WIO	EIO
Silky shark	*Carcharhinus falciformis*	Near Threatened	Near Threatened	Near Threatened

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, 2012

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance and the nominal CPUE series from the main longline fleets, and about the total catches over the past decade (Table 1). The current IUCN threat status of 'Near Threatened' applies to silky sharks in the western and eastern Indian Ocean and globally (Table 2). 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. Silky 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 20 years), mature relatively late (at 6–12 years), and have relativity few offspring (<20 pups every two years), the silky shark is vulnerable to overfishing. Despite the lack of data, it is clear from the information that is available that silky shark abundance has declined significantly over recent decades.

Outlook. Maintaining or increasing effort will probably result in declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on silky shark will decline in these areas in the near future, and may result in localised depletion. The following should be noted:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- Total catches are highly uncertain and should be investigated further as a priority.

[23] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

- Noting that current reported catches (probably largely underestimated) are estimated at an average ~1,396 t over the last five years, ~ 3,353 t in 2011, maintaining or increasing effort will probably result in further declines in biomass.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Silky shark in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on silky shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.
- Resolution 12/03 *On the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).

Extracts from Resolutions 05/05, 11/04 and 12/03

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

RESOLUTION 12/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

FISHERIES INDICATORS

Silky sharks: General

Silky sharks (*Carcharhinus falciformis*) are one of the most abundant large sharks inhabiting warm tropical and subtropical waters throughout the world (Fig. 1). Table 3 outlines some of the key life history traits of silky shark in the Indian Ocean.

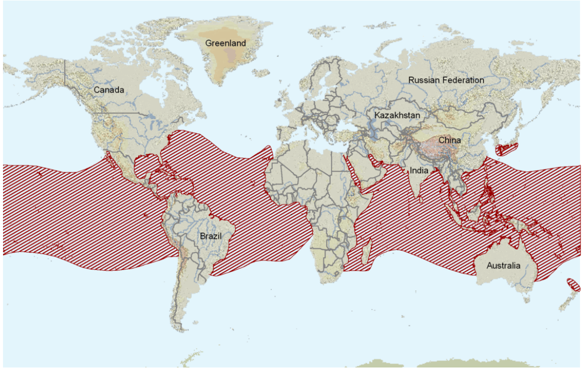


Fig. 1. The worldwide distribution of the silky shark (source: www.iucnredlist.org)

TABLE 3. Silky shark: Biology of Indian Ocean silky sharks (*Carcharhinus falciformis*).

Parameter	Description
Range and stock structure	Essentially pelagic, the silky shark is distributed from slopes to the open ocean. It also ranges to inshore areas and near the edges of continental shelves and over deepwater reefs. It also demonstrates strong fidelity to seamounts and natural or man-made objects (like FADs) floating at the sea surface. Silky sharks live down to 500 m. Typically, smaller individuals are found in coastal waters. Small silky sharks are also commonly associated with schools of tuna, particularly under floating objects. Large silky sharks associate with free-swimming tuna schools. Silky sharks often form mixed-sex schools containing similar sized individuals. Area of overlap with IOTC management area = high. No information is available on stock structure.
Longevity	20+ years for males; 22+ years for females in the southern Gulf of Mexico and maximum size is over 300 cm long. Generation time was estimated to be between 11 and 16 years in the Gulf of Mexico years.
Maturity (50%)	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 years. Size: 239 cm TL for males; 216 cm TL for females in Aldabra atoll. In South Africa: 240cm TL for males and 248-260cm TL for females.
Reproduction	The silky shark is a placental 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 Eastern Indian Ocean, and 2–11 in the Pacific Ocean. • Fecundity: medium (<20 pups) • Generation time: 11–16 years • Gestation period: 12 months • Reproductive cycle is biennial
Size (length and weight)	Maximum size is over 300 cm long FL. New-born pups are around 75–80 cm TL or less at birth. Reported as 56–63 cm TL in the Maldives. 78–87 cm TL in South Afrrica. Length–weight relationship for both sexes combined in the Indian Ocean is TW=0.160*10-4 * $FL^{2.91497}$.

Sources: Strasburg 1958, Bass et al. 1973, Stevens 1984, Anderson & Ahmed 1993, Mejuto et al. 2005, Matsunaga 2007, Romanov & Romanova 2009

Silky sharks: 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) (Table 4). Sri Lanka has had a large fishery for 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. 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.

The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke et al. 2006, Clarke 2008) and the bycatch/release injury rate is unknown but probably high.

TABLE 4. Silky shark: Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	common	abundant		common	abundant	abundant
Fishing Mortality	study in progress	study in progress	study in progress	unknown	unknown	unknown
Post release mortality	study in progress	unknown	unknown	unknown	unknown	unknown

Sources: Romanov 2002, 2008, Ariz et al. 2006, Peterson et al. 2008, Romanov et al. 2008

Silky sharks: Catch trends

The catch estimates for silky shark (Table 5) are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 1.5% of the catch of sharks by longliners, all targeting swordfish, were silky sharks, and for CPCs reporting gillnet data by species (i.e. Sri Lanka), 22% of the catches of shark were silky sharks.

TABLE 5. Silky shark: Catch estimates for silky shark in the Indian Ocean for 2009, 2010 and 2011

Catch		2009	2010	2011
Most recent catch (reported)	Silky shark	655 t	1,836 t	3,353 t
	nei-sharks	65,380 t	64,387 t	55,135 t
Mean catch (reported) over the last 5 years (2007–2011)	Silky shark			1,396 t
	nei-sharks			63,783 t

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2011, five countries reported catches of silky sharks in the IOTC region.

Silky sharks: Nominal and standardised CPUE Trends

Data not available at the IOTC Secretariat. However, Maldivian shark fishermen report significant declines in silky shark abundance over past 20 years (Anderson 2009). In addition, Indian longline research surveys, in which silky sharks contributed 7% of catch, demonstrate declining catch rates over the period 1984–2006 (John & Varghese 2009). No long-term data for purse-seine CPUE are available, however there is anecdotal evidences of five-fold decrease of silky shark catches per set between 1980s and 2005.

Silky sharks: Average weight in the catch by fisheries

Data not available.

Silky sharks: Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

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

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APPENDIX XXIX
EXECUTIVE SUMMARY: BIGEYE THRESHER SHARK

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

Status of the Indian Ocean bigeye thresher shark (BTH: *Alopias superciliosus*)

TABLE 1. Bigeye thresher shark: Status bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean

Area[1]	**Indicators**		**2012 stock status determination**
Indian Ocean	Reported catch 2011: Not elsewhere included (nei) sharks: Average reported catch 2007–2011: Not elsewhere included (nei) sharks:	330 t 55,135 t 68 t 63,783 t	Uncertain
	MSY: F_{2011}/F_{MSY}: SB_{2011}/SB_{MSY}: SB_{2011}/SB_0:	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

TABLE 2. Bigeye thresher shark: IUCN threat status of bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean

Common name	**Scientific name**	**IUCN threat status**[24]		
		Global status	**WIO**	**EIO**
Bigeye thresher shark	*Alopias superciliosus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, Amorim et al. 2009

NOTE: IOTC Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence*, prohibits retention onboard, transhipping, landing, storing, selling or offering for sale any part or whole carcaess of thresher sharks of all the species of the family Alopiidae[25].

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty in the stock status due to lack of information necessary for assessment or to for the development of other indicators of the stock (Table 1). The current IUCN threat status of 'Vulnerable' applies to bigeye thresher shark globally (Table 2). 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 and limited basic fishery indicators currently available for bigeye thresher shark in the Indian Ocean therefore the stock status is highly uncertain. Bigeye thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+20 years), mature at 9–3 years, and have few offspring (2–4 pups every year), the bigeye thresher shark is vulnerable to overfishing.

Outlook. Current longline fishing effort is directed to other species, however bigeye thresher sharks is a common bycatch these fisheries. Hooking mortality is apparently very high, therefore IOTC regulation 10/12 prohibiting retaining of any part of thresher sharks onboard and promoting life release of thresher shark are apparently ineffective

[24] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
[25] Scientific observers shall be allowed to collect biological samples from thresher sharks that are dead at haulback, provided that the samples are part of the research project approved by the Scientific Committee (or the Working Party on Ecosystems and Bycatch).

for species conservation. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. However there are few data to estimated CPUE trends, in view of IOTC Resolution 12/09 and reluctance of fishing fleet to report information on discards/non-retained catch. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into other areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on bigeye thresher shark will decline in these areas in the near future, which may result in localised depletion. The following should be noted:

- The available evidence indicates considerable risk to the status of the IO stock at current effort levels.
- Two important sources of data that inform the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Noting that current catches (probably largely underestimated) are estimated at an average ~68 t over the last five years, ~330 t in 2011, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Bigeye thresher shark in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on bigeye thresher shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.
- Resolution 12/03 *On the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
- Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence* prohibits fishing vessels flying the flag of IOTC Members and Cooperating non-Contracting Parties (CPCs) from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae.

Extracts from Resolutions 05/05, 11/04 and 12/03

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

RESOLUTION 12/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

RESOLUTION 12/09 ON THE CONSERVATION OF THRESHER SHARKS (FAMILY ALOPIIDAE) CAUGHT IN ASSOCIATION WITH FISHERIES IN THE IOTC AREA OF COMPETENCE

Para. 2 Fishing Vessels flying the flag of an IOTC Member or Cooperating non-Contracting Party (CPCs) are prohibited from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae, with the exception of paragraph 7.

Para. 3 CPCs shall require vessels flying their flag to promptly release unharmed, to the extent practicable, thresher sharks when brought along side for taking on board the vessel.

Para. 4 CPCs shall encourage their fishers to record and report incidental catches as well as live releases. These data will be then kept at the IOTC Secretariat.

FISHERIES INDICATORS

Bigeye thresher shark: General

Bigeye thresher shark (*Alopias superciliosus*) is found in pelagic coastal and oceanic waters throughout the tropical and temperate oceans worldwide (Fig. 1). Found in coastal waters over the continental shelves, sometimes close inshore in shallow waters, and on the high seas in the epipelagic zone far from land; also caught near the bottom in deep water on the continental slopes (Compagno 2001). It can be found near the surface, and has even been recorded in the intertidal, but it is commonest below 100m depth, occurs regularly to at least 500 m deep and has been recorded to 723 m deep (Compagno 2001, Nakano et al. 2003). No predation on bigeye thresher sharks has been reported to date; however it may be preyed upon by makos, white sharks, and killer whales. Fishing is the major contributor to adult mortality. This species used its long tail to attack prey (Compagno 2001, Aalbers et al. 2010). Table 3 outlines some of the key life history traits of bigeye thresher shark in the Indian Ocean.

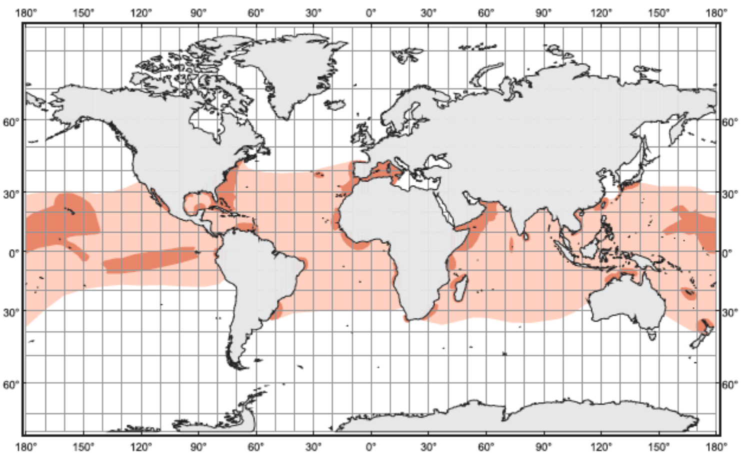

Fig. 1. Bigeye thresher shark: The worldwide distribution of the bigeye thresher shark (source: FAO)

TABLE 3. Bigeye thresher shark: Biology of Indian Ocean bigeye thresher shark (*Alopias superciliosus*)

Parameter	**Description**
Range and stock structure	In the tropical Indian Ocean, the greatest abundance of bigeye thresher shark occurs at depths of 50 to 300 m, in temperatures ranging from 8 to 25°C. It is considered a highly migratory species, however, no published information on horizontal movements of bigeye thresher shark is known for the Indian Ocean. This species exhibits a prominent diurnal pattern in vertical distribution spending daytime at the depth between 200 and 700 m depth and migrating to the upper layers at night. Bigeye thresher shark is a solitary fish however it is often caught in the same areas and habitats as pelagic thresher sharks *Alopias pelagicus*. Area of overlap with IOTC management area = high. No information is available on stock structure.
Longevity	No ageing studies is known for the Indian Ocean. In the Pacific Ocean (China, Taiwan Province) the oldest bigeye thresher sharks reported were a 19 year old male and a 20 year old female for fish ~ 370 cm TL. Taking into consideration that maximum length is exceed 400 cm longevity is apparently around 25–30 years. In the Eastern Atlantic Ocean, the maximum ages reported in a recent life history study were 22 years for females and 17 years for males.

Maturity (50%)	Age: Sexual maturity is attained at 12–13 years (females), 9–10 years (males). Size: Males mature at 270–300 cm total length (TL) and females at 332-355 cm TL. Size at 50% maturity from the eastern Atlantic Ocean was estimated at 206 cm FL for females (95% CI: 199–213 cm FL), and 160 cm FL for males (95% CI: 156–164 cm FL)
Reproduction	Bigeye thresher shark is an aplacental viviparous with oophagy species. • Fecundity: very low (2–4) • Generation time: around 15 years (due to oophagy) • Gestation Period: 12 months • Reproductive cycle: unknown Of the thresher sharks, the Bigeye Thresher has the lowest rate of annual increase, estimated at 1.6% under sustainable exploitation, or 0.002–0.009.
Size (length and weight)	Maximum size is around 461 cm TL. New-born pups are around 64–140 cm TL. Length–weight relationship for both sexes combined in the Indian Ocean is $TW=0.155*10^{-4}*FL^{2.97883}$

Sources: Chen et al. 1997, Lui et al. 1998, Compagno 2001, Nakano et al. 2003, Weng & Block 2004, Amorim et al. 2007, Cortés 2008, Dulvy et al. 2008, Smith et al. 2008, Stevens et al. 2010, Fernandez-Carvalho et al. 2011, Fernandez-Carvalho et al. in press

Bigeye thresher shark: Fisheries

Bigeye thresher shark are often targeted by some recreational, semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries) (Table 4). Typically, the fisheries take bigeye thresher sharks between 140–210 cm FL or 40 to 120 kg (Romanov pers comm). In Australia thresher sharks used to be a target of sport fishermen. Sport fisheries for oceanic sharks are apparently not so common in other Indian Ocean countries.

There is little information on the fisheries prior to the early 1970's. Some countries still fail to collect shark data while others do collect it but fail to report to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many existing 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. FAO also compiles landings data on elasmobranchs, but their statistics are limited by the lack of species-specific data and data from the major fleets. Thresher sharks were marketed both locally and in European markets until at least up until early 2011 despite IOTC Resolution 12/09. The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke et al. 2006, Clarke 2008). The post-release mortality is unknown but probably high. In longline fisheries bigeye thresher sharks are often hooked by the tail (Compagno 2001, Romanov pers comm) and die soon afterward. Therefore they are discarded dead if not retained. In most cases discarded sharks are not recorded in fisheries logbooks. Therefore the current measures (notably Resolution 12/09) appear to have limited conservation effect while contributing to further loss of fisheries data. Other types of conservation efforts such as protected areas should be considered for this species group by the WPEB, taking into account a detailed analysis of catch distribution and 'hotspots' of abundance derived from research data.

TABLE 4. Bigeye thresher shark: Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	absent	Common		rare	unknown	unknown
Fishing Mortality	no	high	high	unknown	unknown	unknown
Post release mortality	N/A	unknown	unknown	unknown	unknown	unknown

Sources: Boggs 1992, Anderson & Ahmed 1993, Romanov 2002, 2008, Ariz et al. 2006, Peterson et al. 2008, Romanov et al. 2008.

Bigeye thresher shark: Catch trends

The catch estimates for bigeye thresher shark are highly uncertain, as is their utility in terms of minimum catch estimates (Table 5). Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories).

TABLE 5. Bigeye thresher shark: Catch estimates for bigeye thresher shark in the Indian Ocean for 2009, 2010 and 2011.

Catch		**2009**	**2010**	**2011**
Most recent catch (reported)	bigeye thresher	5 t	2 t	330 t
	nei-sharks	65,380 t	64,387 t	55,135 t
Mean catch (reported) over the last 5 years (2007–2011)	bigeye thresher			68 t
	nei-sharks			63,783 t

Note that reported shark catches are incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2011, two countries reported catches of bigeye thresher sharks in the IOTC area of competence.

Bigeye thresher shark: Nominal and standardised CPUE trends

Data not available at the IOTC Secretariat. There are no surveys specifically designed to assess shark catch rates in the Indian Ocean. Historical research data shows overall decline both in CPUE and mean weight of thresher sharks (Romanov pers comm).

Bigeye thresher shark: Average weight in the catch by fisheries

Data not available.

Bigeye thresher shark: Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

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

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APPENDIX XXX
EXECUTIVE SUMMARY: PELAGIC THRESHER SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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Status of the Indian Ocean pelagic thresher shark (PTH: *Alopias pelagicus*)

TABLE 1. Pelagic thresher shark: Status pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Reported catch 2011:	10 t	Uncertain
	Not elsewhere included (nei) sharks:	55,135 t	
	Average reported catch 2007–2011:	4 t	
	Not elsewhere included (nei) sharks:	63,783 t	
	MSY:	unknown	
	F_{2011}/F_{MSY}:	unknown	
	SB_{2011}/SB_{MSY}:	unknown	
	SB_{2011}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

TABLE 2. Pelagic thresher shark: IUCN threat status of pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[26]		
		Global status	WIO	EIO
Pelagic thresher shark	*Alopias pelagicus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, Reardon et al. 2009

NOTE: IOTC Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence*, prohibits retention onboard, transhipping, landing, storing, selling or offering for sale any part or whole carcaess of thresher sharks of all the species of the family Alopiidae[27].

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty in the stock status due to lack of information necessary for assessment or to for the development of other indicators of the stock (Table 1). The current IUCN threat status of 'Vulnerable' applies to pelagic thresher shark globally (Table 2). 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 and limited basic fishery indicators currently available for pelagic thresher shark in the Indian Ocean therefore the stock status is highly uncertain. Pelagic thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+ 20 years), mature at 8-9 years, and have few offspring (2 pups every year), the pelagic thresher shark is vulnerable to overfishing.

Outlook. Current longline fishing effort is directed to other species, however pelagic thresher sharks is a common bycatch these fisheries. Hooking mortality is apparently very high, therefore IOTC regulation 10/12 prohibiting

[26] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
[27] Scientific observers shall be allowed to collect biological samples from thresher sharks that are dead at haulback, provided that the samples are part of the research project approved by the Scientific Committee (or the Working Party on Ecosystems and Bycatch).

retaining of any part of thresher sharks onboard and promoting life release of thresher shark are apparently ineffective for species conservation. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. However there are few data to estimated CPUE trends, in view of IOTC regulation 10/12 and reluctance of fishing fleet to report information on discards/non-retained catch. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into other areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on pelagic thresher shark will decline in these areas in the near future, which may result in localised depletion. The following should be noted:

- The available evidence indicates considerable risk to the status of the IO stock at current effort levels.
- Two important sources of data that inform the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Noting that current catches (probably largely underestimated) are estimated at at an average ~4 t over the last five years ~10 t in 2011, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Pelagic thresher shark in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on pelagic thresher shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.
- Resolution 12/03 *On the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
- Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence* prohibits fishing vessels flying the flag of IOTC Members and Cooperating non-Contracting Parties (CPCs) from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae.

Extracts from Resolutions 05/05, 11/04, 12/03 and 12/09

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

RESOLUTION 12/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

RESOLUTION 12/09 ON THE CONSERVATION OF THRESHER SHARKS (FAMILY ALOPIIDAE) CAUGHT IN ASSOCIATION WITH FISHERIES IN THE IOTC AREA OF COMPETENCE

Para. 2 Fishing Vessels flying the flag of an IOTC Member or Cooperating non-Contracting Party (CPCs) are prohibited from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae, with the exception of paragraph 7.

Para. 3 CPCs shall require vessels flying their flag to promptly release unharmed, to the extent practicable, thresher sharks when brought along side for taking on board the vessel.

Para. 4 CPCs shall encourage their fishers to record and report incidental catches as well as live releases. These data will be then kept at the IOTC Secretariat.

FISHERIES INDICATORS

Pelagic thresher shark: General

Pelagic thresher shark (*Alopias pelagicus*) is a common shark in pelagic coastal and oceanic waters throughout the tropical Indo-Pacific (Fig. 1). This species is commonly confused with common thresher shark (*Alopias vulpinus*), which is mostly temperate species and often recorded under wrong name. Apparently most of tropical records of common thresher sharks in the Indo-Pacific are misidentified pelagic threshers. Due to identification confusions actual distribution and biology of pelagic and common thresher sharks are poorly known. It is probably highly migratory and is epipelagic from the surface to at least 300 m depth (Compagno 2001). It aggregates around seamounts and continental slopes (Compagno 2001). No predation on pelagic thresher sharks has been reported to date; however being smalles species among thresher sharks it may be preyed upon by bigger species such as tiger shark, makos, white sharks, and killer whales. Fishing is a major contributor to adult mortality. This species used its long tail to attack prey (Compagno 2001, Aalbers et al. 2010). Table 3 outlines some of the key life history traits of pelagic thresher shark in the Indian Ocean.

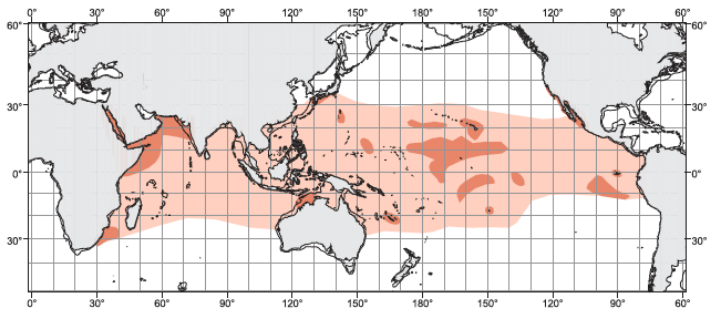

Fig. 1. Pelagic thresher shark: The worldwide distribution of the pelagic thresher shark (source: FAO).

TABLE 3. Pelagic thresher shark: Biology of Indian Ocean pelagic thresher shark (*Alopias pelagicus*).

Parameter	Description
Range and stock structure	In the tropical Indian Ocean, the greatest abundance of pelagic thresher shark occurs at depths of 50 to 300 m, in temperatures ranging from 8 to 25°C. It is considered as highly migratory species however no published information on horizontal movements of pelagic thresher shark is known for the Indian Ocean. Apparently pelagic thresher shark is a solitary fish however it is often aggregated around seamounts or over continental slopes. Area of overlap with IOTC management area = high. No information is available on stock structure.
Longevity	No ageing studies is known for the Indian Ocean, In the Pacific Ocean (China, Taiwan Province) the oldest pelagic thresher sharks reported were a 20 year old male (170 cm SL) and a 28 year old female for fish ~ 188 cm SL.
Maturity (50%)	Age: Sexual maturity is attained at 8-9 years (females), 7–8 years (males). Size: Males mature at 140-145 cm standard length (SL) and females at 145–150 cm TL.
Reproduction	Pelagic thresher shark is an ovoviviparous species, without a placental attachment. • Fecundity: very low (2)

	• Generation time: 8–10 years • Gestation period: <12 months • Reproductive cycle: unknown Its potential annual rate of population increase under sustainable fishing is thought to be very low and has been estimated at or 0.033
Size (length and weight)	Maximum size is around 365 cm TL. New-born pups are around 158–190 cm TL. Length–weight relationship for both sexes combined in the Indian Ocean is $TW=0.001*10^{-4}*FL^{2.15243}$

Sources: Lui et al. 1998, Compagno 2001, Reardon et al. 2004, Dulvy et al. 2008

Pelagic thresher shark: Fisheries

Pelagic thresher shark are often targeted by some recreational, semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries) (Table 4). Typically, the fisheries take pelagic thresher sharks between 120–190 cm FL or 20 to 90 kg (Romanov pers comm). In Australia thresher sharks used to be a target of sport fishermen. Sport fisheries for oceanic sharks are apparently not so common in other Indian Ocean countries.

There is little information on the fisheries prior to the early 1970's. Some countries still fail to collect shark data while others do collect it but fail to report to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many existing 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. FAO also compiles landings data on elasmobranchs, but their statistics are limited by the lack of species-specific data and data from the major fleets. Thresher sharks were marketed both locally and in European markets until at least up until early 2011 despite IOTC Resolution 12/09. The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke et al. 2006, Clarke 2008). The bycatch/release mortality rate is unknown but probably high. In longline fisheries pelagic thresher sharks are often hooked by the tail (Compagno 2001) and die soon afterward. Therefore they are discarded dead if not retained. In most cases discarded sharks are not recorded in fisheries logbooks. Therefore the current IOTC measures (notably Resolution 12/09) appear to have limited conservation effect while contributing to further loss of fisheries data. Other types of conservation efforts such as protected areas should be considered for this species group by the WPEB, taking into account a detailed analysis of catch distribution and 'hotspots' of abundance derived from research data. Extremely common misidentification of this species with common thresher shark aggravate situation with data collection.

TABLE 4. Pelagic thresher shark: Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	absent	Common		rare	unknown	unknown
Fishing Mortality	no	high	high	unknown	unknown	unknown
Post release mortality	N/A	unknown	unknown	unknown	unknown	unknown

Sources: Boggs 1992, Romanov 2002, 2008

Pelagic thresher shark: Catch trends

The catch estimates for pelagic thresher shark (Table 5) are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories).

TABLE 5. Pelagic thresher shark: Catch estimates for pelagic thresher shark in the Indian Ocean for 2009, 2010 and 2011.

Catch		2009	2010	2011
Most recent catch (reported)	pelagic thresher	1 t	1 t	10 t
	nei-sharks	65,380 t	64,387 t	55,135 t
Mean catch (reported) over the last 5 years (2007–2011)	pelagic thresher			13 t
	nei-sharks			63,783 t

Note that reported shark catches are incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2011, two CPCs reported catches of pelagic thresher sharks in the IOTC region.

Pelagic thresher shark: Nominal and standardised CPUE Trends

Data not available at the IOTC Secretariat. There are no surveys specifically designed to assess shark catch rates in the Indian Ocean. Historical research data shows overall decline both in CPUE and mean weight of thresher sharks (Romanov pers comm).

Pelagic thresher shark: Average weight in the catch by fisheries

Data not available.

Pelagic thresher shark: Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

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

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APPENDIX XXXI
EXECUTIVE SUMMARY: MARINE TURTLES

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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Status of marine turtles in the Indian Ocean

TABLE 1. Marine turtles: IUCN threat status for all marine turtle species reported as caught in fisheries within the IOTC area of competence

Common name	Scientific name	IUCN threat status[28]
Flatback turtle	*Natator depressus*	Data deficient
Green turtle	*Chelonia mydas*	Endangered
Hawksbill turtle	*Eretmochelys imbricata*	Critically Endangered
Leatherback turtle	*Dermochelys coriacea*	Critically Endangered
Loggerhead turtle	*Caretta caretta*	Endangered
Olive ridley turtle	*Lepidochelys olivacea*	Vulnerable

Sources: Marine Turtle Specialist Group 1996, Red List Standards & Petitions Subcommittee 1996, Sarti Martinez (Marine Turtle Specialist Group) 2000, Seminoff 2004, Abreu-Grobois & Plotkin 2008, Mortimer et al. 2008, IUCN 2012

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No assessment has been undertaken by the IOTC WPEB for marine turtles due to the lack of data being submitted by CPCs. However, the current International Union for Conservation of Nature (IUCN) threat status for each of the marine turtle species reported as caught in IOTC fisheries to date is provided in Table 1. It is important to note that a number of international global environmental accords (e.g. Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD)), as well as numerous fisheries agreements obligate States to provide protection for these species. While the status of marine turtles is affected by a range of factors such as degradation of nesting beaches and targeted harvesting of eggs and turtles, the level of mortality of marine turtles due to capture by gillnets and to a lesser extent purse seine fishing and longline is not known.

Outlook. Resolution 12/04 *On the conservation of marine turtles* includes an annual evaluation requirement (para. 17) by the Scientific Committee. However, given the lack of reporting of marine turtle interactions by CPCs to date, such an evaluation cannot not be undertaken. Unless IOTC CPCs become compliant with the data collection and reporting requirements for marine turtles, the WPEB and the SC will continue to be unable to address this issue. Notwithstanding this, it is acknowledged that the impact on marine turtle populations from fishing for tuna and tuna-like species may increase if fishing pressure increases, or if the status of the marine turtle populations worsens due to other factors such as an increase in fishing pressure from other fisheries or anthropological or climatic impacts. The following should be noted:

- The available evidence indicates considerable risk to the status of marine turtles in the Indian Ocean.
- The primary source of data that drive the ability of the WPEB to determination a status for the Indian Ocean, total interactions by fishing vessels, is highly uncertain and should be addressed as a matter of priority.
- Current reported interactionsare a known to be a severe underestimate: 39 interactions reported in 2010 by 3 CPCs.
- Maintaining or increasing effort in the Indian Ocean without appropriate mitigation measures in place, will likely result in further declines in biomass.
- That appropriate mechanisms are developed by the Compliance Commission to ensure CPCs comply with their data collection and reporting requirements for marine turtles.

[28] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Marine turtles in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 11/04 *on a Regional Observer Scheme* requires data on marine turtle interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010, and aims to collect scientific observer data on catch and bycatch on, at least, 5% of the fishing operations of vessel over 24 m and vessel under 24 m fishing outside their EEZ. The requirement under Resolution 11/04 in conjunction with the reporting requirements under Resolution 12/04, means that all CPCs should be reporting marine turtle interactions as part of their annual report to the Scientific Committee.
- Resolution 12/04 *On the conservation of marine turtles* recognizes the threatened status of the populations of the six marine turtle species found in the Indian Ocean and that some tuna fishing operations carried out in the Indian Ocean can adversely impact marine turtles. This resolution makes mandatory the collection and provision of data on marine turtle interactions and the use of best handling practices to ensure the best chances of survival for any marine turtles returned to the sea after capture.

Extracts from Resolutions 11/04 and 12//04

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency;

RESOLUTION 12/04 ON MARINE TURTLES

Para. 3. CPCs shall collect (including through logbooks and observer programs) and provide to the IOTC Secretariat no later than 30 June of the following year in accordance with Resolution 10/02 (or any subsequent revision), all data on their vessels' interactions with marine turtles. The data shall include the level of logbook or observer coverage and an estimation of total mortality of marine turtles incidentally caught in their fisheries.

Para. 7. CPCs with gillnet vessels that fish for species covered by the IOTC Agreement shall:

a) require that operators of such vessels record all incidents involving marine turtles during fishing operations in their logbooks[1] and report such incidents to the appropriate authorities of the CPC.

Para. 8. CPCs with longline vessels that fish for species covered by the IOTC Agreement shall:

...

c) require that operators of such vessels record all incidents involving marine turtles during fishing operations in their logbooks[1] and report such incidents to the appropriate authorities of the CPC

Para. 9. CPCs with purse seine vessels that fish for species covered by the IOTC Agreement shall:

…

c) require that operators of such vessels record all incidents involving marine turtles during fishing operations in their logbooks[1] and report such incidents to the appropriate authorities of the CPC

[1] This information should include where possible, details on species, location of capture, conditions, actions taken on board and location of release.

INDICATORS

Biology and ecology

Six species of marine turtles inhabit the Indian Ocean and likely interact with the fisheries for tuna and tuna-like species. The following section outlines some key aspects of their biology, distribution and historical exploitation.

Flatback turtle

The flatback turtle (*Natator depressus*) gets its name from its relatively flat, smooth shell, unlike other marine turtles which have a high domed shell. Flatback turtles have the smallest migratory range of any marine turtle species and this restricted range means that the flatback turtle is vulnerable to habitat loss, especially breeding sites. Table 2 outlines some of the key life history traits of flatback turtles.

TABLE 2. Biology of the flatback turtle (*Natator depressus*)

Parameter	Description
Range and stock structure	Flatback turtle turtles are found in northern coastal areas, from Western Australia's Kimberley region to the Torres Strait extending as far south as the Tropic of Capricorn. Feeding grounds also extend to the Indonesian Archipelago and the Papua New Guinea Coast. Flatback turtles have the smallest migratory range of any marine turtle species, though they do make long reproductive migrations of up to 1300 km. Although flatback turtles do occur in open seas, they are common in inshore waters and bays where they feed on the soft-bottomed seabed.It is carnivorous, feeding mostly on soft-bodied prey such as sea cucumbers, soft corals, jellyfish, molluscs and prawns.
Longevity	unknown
Maturity (50%)	unknown
Spawning season	Many females nest every 1 to 5 years, once or twice a season, laying clutches of between 50 and 60 eggs. The flatback turtle nests exclusively along the northern coast of Australia.
Size (length and weight)	The flatback turtle is a medium-sized marine turtle, growing to up to one meter long and weighing up to 90 kg.

Sources: Mortimer 1984, FAO 1990

Green turtle

The green turtle (*Chelonia mydas*) is the largest of all the hard-shelled marine turtles and is one of the most widely distributed and commonest of the marine turtle species in the Indian Ocean. The Indian Ocean hosts some of the largest nesting populations of green turtles in the world, particularly on oceanic islands in the southwest Indian Ocean and on islands in South East Asia. Many of these populations are now recovering after intense exploitation in the last century greatly reduced the populations; some populations are still declining.

During the 19th and 20th centuries intense exploitation of green turtles provided onboard red meat for sustained cruises of sailing vessels before the time of refrigeration, as well as meat and calipee (i.e. yellow glutinous/cartilage part of the turtle found next to the lower shell) for an international market. Several nesting populations in the Indian Ocean were devastated as a result. Table 3 outlines some of the key life history traits of green turtles.

TABLE 3. Biology of the green turtle (*Chelonia mydas*)

Parameter	Description
Range and stock structure	Globally distributed and generally found in tropical and subtropical waters along continental coasts and islands between 30°N and 30°S. Green turtles primarily use three types of habitat: oceanic beaches (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas. Adults migrate from foraging areas to mainland or island nesting beaches and may travel hundreds or thousands of kilometers each way. After emerging from the nest, hatchlings swim offshore, where they are believed to caught up in major oceanic current systems and live for several years, feeding close to the surface on a variety of pelagic plants and animals. Once the juveniles reach a certain age/size range, they leave the pelagic habitat and travel to nearshore foraging grounds. Adult green turtles are unique among marine turtles in that they are herbivorous, feeding on seagrasses and algae.
Longevity	unknown
Maturity (50%)	Exact age is unknown, it is believed that sexual maturity is reached between 25 and 30+ years
Spawning season	Females return to their natal beaches (i.e. the same beaches where they were born) every 2 to 4 years to nest, laying several clutches of about 125 eggs at roughly 14-day intervals several times in a season. However, very few hatchlings survive to reach maturity – perhaps fewer than one in 1,000.
Size (length and weight)	The largest of all the hard-shelled marine turtles, growing up to one meter long and weighing 130–160 kg.

Sources: Mortimer 1984, FAO 1990

Hawksbill turtle

The hawksbill turtle (*Eretmochelys imbricata*) is small to medium-sized compared to other marine turtle species and is although generally not found in large concentrations, are widely distributed in the Indian Ocean. The keratinous (horn-like) scutes of the hawksbill are known as "tortoise shell," and they were sought after for manufacture of diverse articles in both the Orient and Europe. In modern times hawksbill turtles are solitary nesters (although some scientists postulate that before their populations were devastated they may have nested on some beaches in concentrations) and thus, determining population trends or estimates on nesting beaches is difficult. Decades long protection programs in some places, particularly at several beaches in the Indian Ocean, have resulted in population recovery. Table 4 outlines some of the key life history traits of hawksbill turtles.

TABLE 4. Biology of the hawksbill turtle (*Eretmochelys imbricata*)

Parameter	**Description**
Range and stock structure	Circumtropical, typically occurring from 30°N to 30°S latitude. Adult hawksbill turtles are capable of migrating long distances between nesting beaches and foraging areas, which are generally shorter to migrations of green and loggerhead turtles.Hawksbill turtles use different habitats at different stages of their life cycle, but are most commonly associated with coral reefs. Post-hatchlings (oceanic stage juveniles) are believed to occupy the pelagic environment. After a few years in the pelagic zone, small juveniles recruit to coastal foraging grounds. This shift in habitat also involves a shift in feeding strategies, from feeding primarily at the surface to feeding below the surface primarily on animals associated with coral reef environments. Their narrow, pointed beaks allow them to prey selectively on soft-bodied animals like sponges and soft corals.
Longevity	unknown
Maturity (50%)	unknown
Spawning season	Female hawksbill turtles return to their natal beaches every 2–3 years to nest. A female may lay 3-5, or more, nests in a season, which contain an average of 130 eggs.The largest nesting populations of hawksbill turtles in or around the Indian Ocean (which are among the largest in the world) occur in the Seychelles, Indonesia and Australia.
Size (length and weight)	In the Indian Ocean, adults weigh 45 to 70 kg, but can grow to as large as 90 kg.

Sources: Mortimer 1984, FAO 1990

Leatherback turtle

The leatherback turtle (*Dermochelys coriacea*) is the largest turtle and the most widely distributed living reptile in the world. The leatherback turtle is the only marine turtle that lacks a hard shell: there are no large external keratinous scutes and the underlying bony shell is composed of a mosaic of hundreds of tiny bones. Table 5 outlines some of the key life history traits of leatherback turtles.

TABLE 5. Biology of the leatherback turtle (*Dermochelys coriacea*)

Parameter	**Description**
Range and stock structure	The leatherback turtle is the most wide ranging marine turtle species, and regularly migrates enormous distances, e.g. between the Indian and south Atlantic Oceans. They are commonly found in pelagic areas, but they also forage in coastal waters in certain areas. The distribution and developmental habitats of juvenile leatherback turtles are poorly understood. While the leatherback turtle is not as common in the Indian Ocean as other species, important nesting populations are found in and around the Indian Ocean, including in Indonesia, South Africa, Sri Lanka and India's Andaman and Nicobar Islands.Adults are capable of tolerating water temperatures well below tropical and subtropical conditions, and special physiological adaptations allow them to maintain body temperature above cool water temperatures. They specialise on soft bodied invertebrates found in the water column, particularly jelly fish and other sorts of "jellies."
Longevity	unknown
Maturity (50%)	Exact age is unknown, it is believed that sexual maturity is reached between 3 and 4 years
Spawning season	Females lay clutches of approximately 100 eggs on sandy, tropical beaches. They nest several times during a nesting season.
Size (length and weight)	Mature males and females can grow to 2 m and weigh almost 900 kg.

Sources: Mortimer 1984, FAO 1990

Loggerhead turtle

The loggerhead turtle (*Caretta caretta*) isglobally distributed. The hatchlings and juveniles are pelagic, living in the open ocean, while the adults forage in coastal areas. Table 6 outlines some of the key life history traits of loggerhead turtles.

TABLE 6. Biology of the loggerhead turtle (*Caretta caretta*)

Parameter	Description
Range and stock structure	Circumglobal, occurring throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. Studies in the Atlantic and Pacific Oceans show that loggerhead turtles can spend decades living on the high seas, crossing from one side of an ocean basin to another before taking up residence on benthic coastal waters. Their enormous heads and powerful jaws enable them to crush large marine molluscs, on which they specialise.
Longevity	unknown
Maturity (50%)	Exact age is unknown, it is believed that sexual maturity is reached between 12 and 30 years. Age at maturity was estimated at 21.6 years in Tongaland, South Africa, through tagging studies.
Spawning season	Many females nest every 2 to 3 year, once or twice a season, laying clutches of approximately 40 to 190 eggs. Loggerhead turtles nest in relatively few countries in the Indian Ocean and the number of nesting females is generally small, except on Masirah Island (Sultanate of Oman) which supports one of only two loggerhead turtles nesting beaches in the world that have greater than 10,000 females nesting per year.
Size (length and weight)	Mature males and females may grow to over one meter long and weigh around 110 kg or more.

Sources: Mortimer 1984, FAO 1990, Hughes 2010

Olive ridley turtle

The olive ridley turtle (*Lepidochelys olivacea*) is considered the most abundant marine turtle in the world, with an estimated 800,000 nesting females annually. The olive ridley turtle has one of the most extraordinary nesting habits in the natural world. Large groups of turtles gather off shore of nesting beaches. Then, all at once, vast numbers of turtles come ashore and nest in what is known as an "arribada". During these arribadas, hundreds to thousands of females come ashore to lay their eggs. In the northern Indian Ocean, arribadas occur on three different beaches along the coast of Orissa, India. Gahirmatha used to be one of the largest arribada nesting sites in the world. However, arribada nesting events have been less frequent there in recent years and the average size of nesting females has been smaller, indicative of a declining population. Declines in solitary nesting of olive ridley turtles have been recorded in Bangladesh, Myanmar, Malaysia, and Pakistan. In particular, the number of nests in Terengganu, Malaysia has declined from thousands of nests to just a few dozen per year. Solitary nesting also occurs extensively throughout this species' range. Despite the enormous numbers of olive ridley turtles that nest in Orissa, this species is not generally common throughout much of the Indian Ocean. Table 7 outlines some of the key life history traits of olive ridley turtles.

TABLE 7. Biology of the olive ridley turtle (*Lepidochelys olivacea*)

Parameter	Description
Range and stock structure	The olive ridley turtle is globally distributed in the tropical regions of the South Atlantic, Pacific, and Indian Oceans. It is mainly a pelagic species, but it has been known to inhabit coastal areas, including bays and estuaries. Olive ridley turtles often migrate great distances between feeding and breeding grounds.They have an annual migration from pelagic foraging, to coastal breeding and nesting grounds, back to pelagic foraging. They can dive to depths of about 150 m to forage.
Longevity	unknown
Maturity (50%)	Reach sexual maturity in around 15 years, a young age compared to some other marine turtle species.
Spawning season	Many females nest every year, once or twice a season, laying clutches of approximately 100 eggs.
Size (length and weight)	Adults are relatively small, weighing on average around 45 kg. As with other species of marine turtles, their size and morphology varies from region to region.

Sources: Mortimer 1984, FAO 1990

Availability of information on the interactions between marine turtles and fisheries for tuna and tuna-like species in the Indian Ocean

The IOTC has implemented data collection measures using onboard observers to better understand the nature and extent of the interactions between fisheries for tuna and tuna-like species in the Indian Ocean and marine turtles. Subsequently, IOTC members have implemented a number of national observer programmes that are providing information on the levels of marine turtle bycatch. Observer data from all fleets and gears remains very low with only Australia and South Africa reporting levels of marine turtle interactions to date (Table 8). However, data from other sources and in other regions indicate that threats to marine turtles are highest from gillnets and longline gear, and to a lesser extent purse-seine gear.

TABLE 8. Members and Cooperating non-Contracting Parties reporting of marine turtle interactions for the years 2008–2011 to the IOTC.

CPC's		2008	2009	2010	2011	Remarks
Australia		4	7	1	0	Nil interaction reported in 2011
Belize		0	0	0		Interaction not reported in 2011. No observers deployment
China				0	0	Nil interaction reported in 2011. No observer deployment in 2011
Taiwan,China		32	84	4	4	Non-raised observer data
Comoros						
European Union*	LL			7	25	For longline fleets: EU,France: 12, EU,Portugal: 10, EU,Spain: ni, EU,UK: 3
	PS	250 (SD=157)	250 (SD=157)	250 (SD=157)	250 (SD=157)	Average number of interactions estimated annually from observer data for the European and French(OT) purse seine fleets. 77% of the marine turtle being released alive on average.
Eritrea						
France (territories)		*See European Union for PS fleet*				
Guinea						
India						
Indonesia		51 & 71				51 & 71 turtles caught between 2005 and 2012 during 2 observers programs (non-raised observer data)
Iran, Islamic Republic of						
Japan				14		Non-raised observer data (6 observered trips, July2010-Januaray2011)
Kenya						
Korea, Republic of			36	0		Non-raised observer data. No observer in 2008 and 2011
Madagascar						
Malaysia						
Maldives, Republic of				0	0	Nil interaction reported
Mauritius						
Mozambique						
Oman, Sultanate of						
Pakistan						
Philippines		0	0	0		
Seychelles						
Sierra Leone						
Sri Lanka						
Sudan						
Tanzania						
Thailand						
United Kingdon (OT)		0	0	0	0	No active fleet
Vanuatu				0		
Yemen						
Cooperating Non-Contracting Parties						
Senegal		0	0	0	0	No activity since 2007
South Africa		15	13	24	14	Non-raised observer data

Green = CPC reported level of marine turtle interactions; Red = CPC did not report level marine turtle interactions

*Observer data was reported for the French purse-seine fleet for 2009 as well as for the La Réunion longline fleet. Moreover, the observer programme on-board the EU Purse-seine fleet has been discontinued because of piracy activities.

Purse seine

European Union observers (covering on average 5% of the operations annually from 2003 to 2007) reported 74 marine turtles caught by EU,France and EU,Spain purse seiners over the period 2003–2007[29]. The most common species reported was olive ridley, green and hawksbill turtles, and these were mostly caught on log (natural Fish Aggregation Devices – FAD) sets and returned to the sea alive (although there is no systematic information on survivorship after release). Mortality levels of marine turtles due to entanglement in drifting FADs set by the fishery are still unknown and need to be assessed. The EU has indicated that its purse-seine fleet is making progress towards improved FAD designs aimed at reducing the incidence of entanglement of marine turtles, including the use of biodegradable materials. EU,France has indicated that it is already deploying FADs that are likely to reduce the entangled of marine turtles in both the Atlantic and Indian Oceans, while EU,Spain has indicated that it will conduct experiments in the Atlantic Ocean on several FADs designs aimed at reducing the incidence of entanglement of marine turtles, before recommending a final FAD design to replace current FADs.

Longline

Information on most of the major longline fleets in the IOTC is currently not available and it is not known if this fishing activity represents a serious threat to marine turtles, as is the case in most other regions of the world.

The South African longline fleets have reported that marine turtle bycatch mainly comprises leatherback turtles, with lesser amounts of loggerhead, hawksbill and green turtles[30]. Estimated average catch rates of marine turtles ranged from 0.005 to 0.3 marine turtles per 1000 hooks and varied by location, season and year. The highest catch rate reported in one trip was 1.7 marine turtles per 1000 hooks in oceanic waters.

Over the period 1997 to 2000, the Programme PalangreRéunionnais[31] examined marine turtle bycatch on 5,885 longline sets in the vicinity of Reunion Island (19-25° S, 48-54° E). The fishery caught 47 leatherback, 30 hawksbill, 16 green and 25 unidentified marine turtles, equating to an average catch rate of less than 0.02 marine turtles per 1000 hooks over the 4 year study period.

The Fishery Survey of India (FSI) carried out survey in the whole Indian EEZ using four longline vesselsfrom 2005 to 2009. During this period around 800,000 hooks were deployed in the Arabian Sea, in the Bay of Bengal and in the waters of Andaman and Nicobar. In total 87 marine turtles (79 olive ridley, 4 green and 2 hawksbill turtles) were caught. Catch rates were of 0.302 marine turtles per 1000 hooks in the Bay of Bengal area, 0.068 marine turtles per 1000 hooks in the Arabian sea and 0.008 marine turtles per 1000 hooks in the Andaman and Nicobar waters. The highest occurrence of incidental catches in the Bay of Bengal area is probably due to the large abundance of olive ridley turtles whose main nesting ground in the Indian Ocean is on the east coast of India, in the Orissa region.

Gillnets

Due to the nature of this gear, the incidental catch of marine turtles is thought to be relatively high compared to that of purse-seine and longline gears, however, quantified data for this gear type are almost non-existent.While the IOTC currently has virtually no information on interactions between marine turtles and gillnets, the IOSEA database indicates that the coastal mesh net fisheries occur in about 90% of IOSEA Signatory States in the Indian Ocean, and the fishery is considered to have moderate to relatively high impact on marine turtles in about half of those IOSEA member States. Given the widespread abundance of mesh net fisheries in the Indian Ocean, there is clearly an urgent need for careful, systematic information to be collected and report on this gear type and its impacts on marine turtles.

Other data sources

The IOTC and the Indian Ocean – South-East Asian Marine Turtle Memorandum of Understanding (IOSEA), an agreement under the Convention on Migratory Species, are actively collecting a range of information on fisheries and marine turtle interactions. The IOSEA database covers information from a wider range of fisheries and gears than those held by the IOTC. The IOSEA Online Reporting Facility[32] compiles information through IOSEA National Reports on potential marine turtle fisheries interactions, as well as various mitigation measures put in place by its Signatory States and collaborating organisations. For example, members provide information on fishing effort and perceived impacts of fisheries that may interact with marine turtles, including longlines, purse seines, FADs, and gillnets. While the information is incomplete for some countries and is generally descriptive rather than quantitative, it

[29] IOTC-2008-WPEB-08
[30] IOTC-2006-WPBy-15
[31] Poisson F. and Taquet M. (2001) L'espadon: de la recherche à l'exploitation durable. Programme palangre réunionnais, rapport final, 248 p. available in the website www.ifremer.fr/drvreunion
[32] (www.ioseaturtles.org/report.php)

has begun to provide a general overview of potential fisheries interactions as well as their extent. No information is available for China, Taiwan,China, Japan, Rep. of Korea (among others) which are not yet signatories to IOSEA. Information is also provided on such mitigation measures as appropriate handling techniques, gear modifications, spatial/temporal closures etc. IOSEA is collecting all of the above information with a view to providing a regional assessment of member States' compliance with the FAO Guidelines on reducing fisheries interactions with marine turtles.

ASSESSMENT

A number of comprehensive assessments of the status of Indian Ocean marine turtles are available, in addition to the IUCN threat status:

- Hawksbill turtle – Marine Turtle Specialist Group 2008 IUCN Red List status assessment[33].
- Loggerhead turtle – 2009 status review under the U.S. endangered species act[34].
- Leatherback turtle – Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia (IOSEA Marine Turtle MoU, 2006)[35].

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[33] http://www.iucnredlist.org/documents/attach/8005.pdf
[34] http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/loggerheadturtle2009.pdf
[35] http://www.ioseaturtles.org/content.php?page=Leatherback%20Assessment

APPENDIX XXXII
EXECUTIVE SUMMARY: SEABIRDS

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

Status of seabirds in the Indian Ocean

TABLE 1. IUCN threat status for all seabird species reported as caught in fisheries within the IOTC area of competence.

Common name	**Scientific name**	**IUCN threat status[36]**
Albatross		
Atlantic Yellow-nosed Albatross	*Thalassarche chlororynchos*	Endangered
Black-browed albatross	*Thalassarche melanophrys*	Endangered
Indian yellow-nosed albatross	*Thalassarche car teri*	Endangered
Shy albatross	*Thalassarche cauta*	Near Threatened
Sooty albatross	*Phoebetria fusca*	Endangered
Light-mantled albatross	*Phoebetria palpebrata*	Near Threatened
Amsterdam albatross	*Diomedea amsterdamensis*	Critically Endangered
Tristan albatross	*Diomedea dabbenena*	Critically Endangered
Wandering albatross	*Diomedia exulans*	Vulnerable
White-capped albatross	*Thalassarche steadi*	Near Threatened
Petrels		
Cape/Pintado petrel	*Daption capense*	Least Concern
Great-winged petrel	*Pterodroma macroptera*	Least Concern
Grey petrel	*Procellaria cinerea*	Near Threatened
Northern giant-petrel	*Macronectes halli*	Least Concern
White-chinned petrel	*Procellaria aequinoctialis*	Vulnerable
Others		
Cape gannet	*Morus capensis*	Vulnerable
Flesh-footed shearwater	*Puffinus carneipes*	Least Concern

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No assessment has been undertaken by the IOTC WPEB for seabirds due to the lack of data being submitted by CPCs. However, the current International Union for Conservation of Nature (IUCN) threat status for each of the seabird species reported as caught in IOTC fisheries to date is provided in Table 1. It is important to note that a number of international global environmental accords (e.g. Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD)), as well as numerous fisheries agreements obligate States to provide protection for these species. While the status of seabirds is affected by a range of factors such as degradation of nesting habitats and targeted harvesting of eggs, the level of mortality of seabirds due to fishing gear in the Indian Ocean is poorly known, although where there has been rigorous assessment of impacts in areas south of 25 degrees (e.g. in South Africa), very high seabird bycatch rates have been recorded in the absence of a suite of proven bycatch mitigation measures.

Outlook. Resolution 10/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* (to be superseded by Resolution 12/06 on 1 July, 2014) includes an evaluation requirement (para. 8) by the Scientific Committee in time for the 2011 meeting of the Commission. However, given the lack of reporting of seabird interactions by CPCs to date, such an evaluation cannot be undertaken at this stage. Unless IOTC CPCs become compliant with the data collection and reporting requirements for seabirds, the WPEB will continue to be unable to address this issue. Notwithstanding this, it is acknowledged that the impact on seabird populations from fishing for tuna and tuna-like species, particularly

[36] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

using longline gear may increase if fishing pressure increases. Any fishing in areas with high abundance of procellariiform seabirds is likely to cause incidental capture and mortality of these seabirds unless measures that have been proven to be effective against Southern Ocean seabird assemblages are employed. The following should be noted:

- The available evidence indicates considerable risk to the status of seabirds in the Indian Ocean.
- The primary source of data that drive the ability of the WPEB to determination a status for the Indian Ocean, total interactions by fishing vessels, is highly uncertain and should be addressed as a matter of priority.
- Current reported interactions are a known to be a severe underestimate.
- That more research is conducting on the identification of hot spots of interactions between seabirds and fishing vessels.
- Maintaining or increasing effort in the Indian Ocean without refining and implementing appropriate mitigation measures, will likely result in further declines in biomass.
- That appropriate mechanisms are developed by the Compliance Commission to ensure CPCs comply with their data collection and reporting requirements for seabirds.
- Resolution 10/06 on reducing the incidental bycatch of seabirds in longline fisheries includes an evaluation requirement (para. 8) by the Scientific Committee in time for the 2011 meeting of the Commission, noting that this deadline is now overdue.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Seabirds in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 10/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* recognizes the threatened status of some of the seabird species found in the Indian Ocean and that longline fishing operations can adversely impact seabirds. The Resolution makes mandatory for vessels fishing south of 25°S, the use of at least two seabird bycatch mitigation measures selected from a table, including at least one measure from Column A (Table shown below) aimed at effectively reducing the mortality of seabirds due to longline operations. In addition, CPCs are required to provide to the Commission all available information on interactions with seabirds. However, it does not include a mandatory requirement for CPCs to record seabird interactions while fishing for tuna and tuna-like species in the IOTC area of competence, but rather to report "*all available information on interactions with seabirds*".

Column A	Column B
Night setting with minimum deck lighting	Night setting with minimum deck lighting
Bird-scaring lines (Tori Lines)	Bird-scaring lines (Tori Lines)
Weighted branch lines	Weighted branch lines
	Blue-dyed squid bait
	Offal discharge control
	Line shooting device

- However, Resolution 12/06 *On reducing the incidental bycatch of seabirds in longline fisheries*, which to due to come into force on 1 July, 2014, will require all longline vessels in the area south of 25 degrees South latitude, to use at least two of the following three mitigation measures:
  - Night setting with minimum deck lighting
  - Bird-scaring lines (Tori Lines)
  - Line weighting.
- Resolution 10/02 *Mandatory Statistical Requirements For IOTC Members and Cooperating non-Contracting Parties (CPC's)* encourages CPCs to record and report data on seabird interactions. However, if a CPC chooses not to record data on seabird interactions, as permitted under Resolution 10/02, then the requirements of Resolution 10/06 *on Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* become void, as the wording of Resolution 10/06 only requires reporting of data where it is available.
- Resolution 11/04 *on a Regional Observer Scheme* (commenced on 1 July 2010) requires data on seabird interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) aims to collect scientific observer data on catch and bycatch on, at least, 5% of the fishing operations of vessel over 24m and vessel under 24m fishing outside their EEZ. The requirement under

Resolution 11/04 in conjunction with the reporting requirements under Resolution 10/06, means that all CPCs should be reporting seabird interactions as part of their annual report to the Scientific Committee.

RESOLUTION 10/06 ON REDUCING THE INCIDENTAL BYCATCH OF SEABIRDS IN LONGLINE FISHERIES:

7. CPCs shall provide to the Commission, as part of their annual reports, information on how they are implementing this measure and all available information on interactions with seabirds, including bycatch by fishing vessels carrying their flag or authorised to fish by them. This is to include details of species where available to enable the Scientific Committee to annually estimate seabird mortality in all fisheries within the IOTC area of competence;

RESOLUTION 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S):

3. Catch and effort data:

(…)CPC's are also encouraged to record and provide data on species other than sharks and tunas taken as bycatch.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency.

RESOLUTION 12/06 ON REDUCING BYCATCH OF SEABIRDS IN LONGLINE FISHERIES

1. CPCs shall record data on seabird incidental bycatch by species, notably through scientific observers in accordance with Resolution 11/04 and report these annually.
2. CPCs that have not fully implemented the provisions of the IOTC Regionao Observer Scheme outlined in paragraph 2 of Resolution 11/04 shall report seabrd incidental bycatch through logbooks, including details of species, if possible.
3. CPCs shall provide to the Commission, as part of their annual reports, information on how they are implementing this measure.

CONSERVATION AND MANAGEMENT MEASURES IN OTHER REGIONS

Evidence from areas where seabird bycatch was formerly high but has been reduced (e.g. Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) and South Africa) has shown that it is important to employ, simultaneously, a suite of mitigation measures. Research conducted in South Africa by Japanese and US researchers (Melvin et al. 2010) showed that bird scaring lines (BSL, also known as tori or streamer lines) displace seabird attacks on baits, but only as far astern as the BSL extends. If baits are sufficiently close to the surface behind the aerial extent of the BSL, the rate of attack by seabirds on baited hooks, and hence risk of bycatch, remains high. This research shows clearly that appropriate sink rates must be used in tandem with BSLs and that unweighted branch lines or those with small weights placed well away from the hook pose the highest risks to seabirds. The research also suggests no negative effect of line-weighting on target catches, but limited sample sizes preclude definitive analysis (Melvin et al. 2010). In addition, experience from CCAMLR and elsewhere has indicated a number of additional factors contribute to successful reduction of seabird bycatch (FAO 2008, Waugh et al. 2008). These include research to optimise the effectiveness of mitigation measures and their ease of implementation, the use of onboard observer programs to collect seabird bycatch data and evaluate the effectiveness of bycatch mitigation measures, training of both fishermen and observers in relation to the problem and its solutions, and ongoing review of the effectiveness of these activities. Mitigation measures recommended by ACAP (Agreement on the Conservation of Albatrosses and Petrels) as effective include weighted branch lines that ensure that baits quickly sink below the reach of diving seabirds, night setting, and appropriate deployment of well designed BSLs.

Reduction of seabird bycatch may even bring benefits to fishing operations, for example by reducing the loss of bait to seabirds. Recent research in Brazil showed a reduction of 60% of the capture of seabirds and higher catch rates (20–30%) of target species when effective mitigation measures were applied (Mancini et al. 2009). However, more detailed economic assessments across a diversity of regions, fishing gears and seasons are required to get a fuller picture of economic benefits.

The International Commission for the Conservation of Atlantic Tunas (ICCAT) established a new conservation measure for seabirds at the November 2011 meeting of the Commission. In keeping with scientific advice given to the ICCAT, which is harmonious with the advice from the WPEB 2011, the new measure requires the use of only three technologies to reduce risk to seabirds, namely bird scaring lines, line weighting and night setting. In areas of high bycatch (or bycatch risk), currently defined in the South Atlantic as of 25˚S, longline fishing vessels are required to use two of the three measures.

INDICATORS – FOR SEABIRD SPECIES KNOWN OR LIKELY TO BE VULNERABLE TO MORTALITY FROM FISHING OPERATIONS IN THE IOTC AREA OF COMPETENCE.

Seabirds are species that derive their sustenance primarily from the ocean and which spend the bulk of their time (when not on land at breeding sites) at sea. Seventeen species of seabirds known to interact with longline fisheries for tuna and tuna-like species in the Indian Ocean are listed in Table 1. However, not all reports identify birds to species level and, overall, information on seabird bycatch in the IOTC area remains very limited (Gauffier 2007, IOTC–2011–SC13–R). Due to gaps in tracking and observer data, it is likely that there are other species at risk of bycatch which are not identified in this Executive Summary.

Worldwide, 17 of the 22 species of albatross are listed by the IUCN as globally threatened, with bycatch in fisheries identified as the key threat to the majority of these species (Robertson & Gales 1998). Impacts of longline fisheries on seabird populations have been demonstrated (e.g. Weimerskirch & Jouventin 1987, Croxall et al. 1990, Weimerskirch et al. 1997, Tuck et al. 2001, Nel et al. 2003). In general, other IOTC gear types (including purse seine, bait boats, troll lines, and gillnets) are considered to have low incidental catch of seabirds, however data remain limited. The Convention on Migratory Species (CMS) is finalising a global review of the bycatch levels in gillnet fisheries, and the findings of this report may be relevant to seabird bycatch in gillnet fisheries operating in the IOTC.

Range and stock structure

Eleven seabird families occur within the IOTC area of competence as breeding species. They are typically referred to as penguins (Spheniscidae), albatrosses (Diomedeidae), petrels and allies (Procellariidae), storm-petrels (Hydrobatidae), diving-petrels (Pelecanoididae), tropicbirds (Phaethonidae), gannets and boobies (Sulidae), cormorants (Phalocrocoracidae), frigatebirds (Fregatidae), skuas (Stercorariidae), gulls and terns (Laridae). Of these, the Order Procellariiformes (albatrosses and petrels) are most susceptible to being caught as bycatch in longline fisheries (Wooller et al. 1992, Brothers et al. 1999), and therefore are most susceptible to direct interactions with IOTC fisheries.

The southern Indian Ocean is of global importance in relation to albatross distribution: seven of the 18 species of southern hemisphere albatrosses have breeding colonies on Indian Ocean islands[37]. In addition, all but one[38] of the 18 southern hemisphere albatrosses forage in the Indian Ocean at some stage in their life cycle. The Indian Ocean is particularly important for Amsterdam albatross (*Diomedea amsterdamensis* – Critically Endangered) and Indian yellow-nosed albatross (*Thalassarche carteri* – Endangered), which are endemic to the southern Indian Ocean, white-capped albatross (*Thalassarche steadi* – endemic to New Zealand), shy albatross (*T. cauta* – endemic to Tasmania, and which forage in the area of overlap between IOTC and WCPFC), wandering albatross (*D. exulans* – 74% global breeding pairs), sooty albatross (*Phoebetria fusca* – 39% global breeding pairs), light-mantled sooty albatross (*P. palpebrata* – 32% global breeding pairs), grey-headed albatross (*T. chrysotoma* – 20% global breeding pairs) and northern and southern giant-petrel (*Macronectes halli* and *M. giganteus* – 26% and 30% global breeding pairs, respectively).

In the absence of data from observer programs reporting seabird bycatch, risk of bycatch has been identified through analysis of the overlap between albatross and petrel distribution and IOTC longline fishing effort, based on data from the Global Procellariiform Tracking Database (ACAP 2007). A summary map indicating distribution is shown in Figure 1 and the overlap between seabird distribution and IOTC longline fishing effort is shown in Table 2. The 2007 analysis of tracking data indicated that albatrosses breeding on Southern Indian Ocean islands spent 70–100% of their foraging time within areas overlapping with IOTC longline fishing effort. The analysis identified the proximity of the Critically Endangered Amsterdam albatross and Endangered Indian yellow-nosed albatross to high levels of pelagic longline effort. Wandering, shy, grey-headed and sooty albatrosses and white-chinned petrels showed a high overlap with IOTC longline effort. Data on distribution during the non-breeding season was lacking for many species, including black-browed albatrosses and white-capped albatrosses (known from bycatch data to be amongst the species most frequently caught).

In 2009 and 2010, new tracking data were presented to the Working Party on Ecosystems and Bycatch (WPEB) which filled a number of gaps from the 2007 analysis, particularly for sooty albatross, and for distributions of juveniles of

[37] Amsterdam, black-browed, grey-headed, Indian yellow-nosed, light-mantled, sooty and wandering albatrosses

[38] Atlantic yellow-nosed albatross (*Thalassarche chlororhynchos)*

wandering, sooty and Amsterdam albatrosses, white-chinned and northern giant petrels (Delord & Weimerskirch 2009, 2010). This analysis indicated substantial overlap with IOTC longline fisheries.

Longevity, maturity, breeding season

Seabirds are long-lived, with natural adult mortality typically very low. Seabirds are characterised as being late to mature and slow to reproduce; some do not start to breed before they are ten years old. Most lay a single egg each year, with some albatross species only breeding every second year. These traits make any increase in human-induced adult mortality potentially damaging for population viability, as even small increases in mortality can result in population decreases.

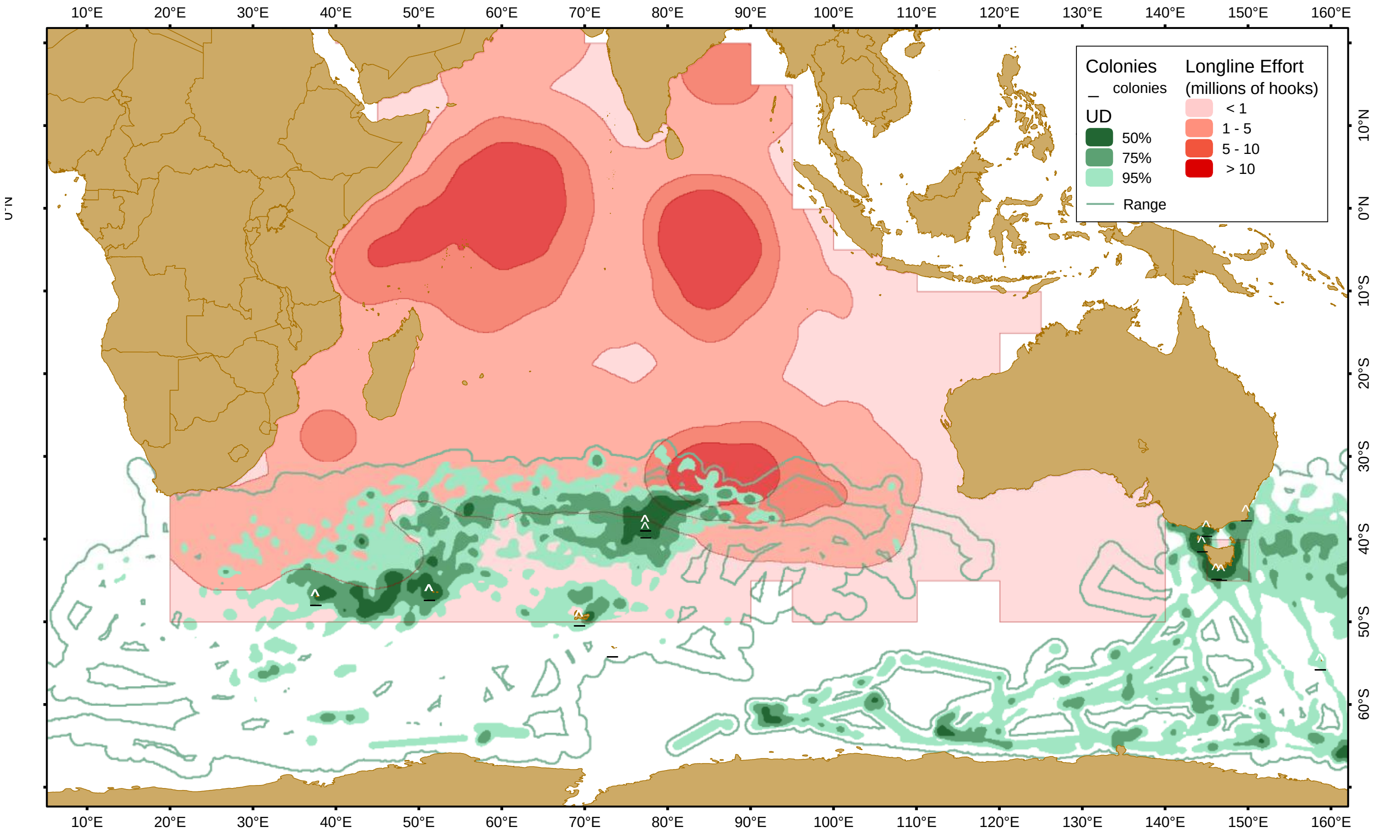

Fig. 1. Distribution of breeding albatrosses, petrels and shearwaters in the Indian Ocean (see Table 2 for a list of species included), and overlap with IOTC longline fishing effort for all gear types and fleets (average annual number of hooks set per 5° grid square from 2002 to 2005).

TABLE 2. Overlap between the distribution of breeding and non-breeding albatrosses, petrels and shearwaters and IOTC fishing effort* (Distributions derived from tracking data held in the Global Procellariiform Tracking Database.

Species/Population – Breeding	Global Population (%)	Overlap (%)
Amsterdam albatross (Amsterdam)	100	100
Antipodean (Gibson's) albatross		
Auckland Islands	59	1
Black-browed albatross		1
Iles Kerguelen	1	88
Macquarie Island	<1	1
Heard & McDonald	<1	
Iles Crozet	<1	
Buller's Albatross		2
Solander Islands	15	1
Snares Islands	27	2
Grey-headed albatross		7
Prince Edward Islands	7	70
Iles Crozet	6	
Iles Kerguelen	7	
Indian yellow-nosed albatross		
Ile Amsterdam	70	100
Ile St. Paul	<1	
Iles Crozet	12	

Iles Kerguelen	<1	
Prince Edward Island	17	
Light-mantled albatross	39	
Shy albatross		
Tasmania	100	67
Sooty albatross		
Iles Crozet	17	87
Ile Amsterdam	3	
Ile St. Paul	<1	
Iles Kerguelen	<1	
Prince Edward Island	21	
Wandering albatross		75
Iles Crozet	26	93
Iles Kerguelen	14	96
Prince Edward Islands	34	95
Northern giant petrel	26	
Southern giant petrel	9	
White-chinned Petrel		
Iles Crozet	?	60
Iles Kerguelen	?	
Prince Edward Island	?	
Short-tailed shearwater		
Australia	?	3
Species/Population – Non-breeding	**Global Population (%)**	**Overlap (%)**
Amsterdam albatross (Amsterdam)	100	98
Antipodean (Gibson's) albatross		9
Antipodes Islands	41	3
Auckland Islands	59	13
Black-browed albatross		
South Georgia (GLS data)	16	3
Heard & McDonald Islands	<1	
Iles Crozet	<1	
Iles Kerguelen	1	
Buller's albatross		13
Solander Islands	15	9
Snares Islands	27	15
Grey-headed albatross		
South Georgia (GLS data)	58	16
Iles Crozet	6	
Iles Kerguelen	7	
Prince Edward Island	7	
Indian yellow-nosed albatross		
Light-mantled albatross		
Northern royal albatross		3
Chatham Islands	99	3
Taiaroa Head	1	1
Shy albatross		
Tasmania	100	72
Sooty albatross		
Southern royal albatross		
Wandering albatross		59
White-capped albatross		
Northern giant petrel		
Southern giant petrel		
White-chinned petrel		
Westland petrel		
Short-tailed shearwater		

*Fishing data are based on the average annual number of hooks set per 5° grid square from 2002 to 2005. Overlap is expressed as the percentage of time spent in grid squares with longline effort, and is given for each breeding site as well the species' global population where sufficient data exists. Shaded squares represent species/colonies for which no tracking data were available).

Availability of information on the interactions between seabirds and fisheries for tuna and tuna-like species in the Indian Ocean

Bycatch data from onboard observer programs

Globally it is recognized that onboard observer programs are vital for collecting data on catches of non-target species, particularly those species which are discarded at sea. More specifically, observers need to observe hooks during setting and monitor hooks during the hauling process to adequately assess seabird bycatch and evaluate the effectiveness of mitigation measures in use. Levels of observer coverage significantly in excess of 5% are likely to be needed to accurately monitor seabird bycatch levels in IOTC fisheries.

The IOTC has implemented data collection measures using onboard observers to better understand the nature and extent of the interactions between fisheries for tuna and tuna-like species in the Indian Ocean and seabirds. Subsequently, IOTC members have implemented a number of national observer programmes that are providing information on the levels of seabird interactions. Observer data from all fleets and gears remains very low with only Australia and South Africa reporting levels of seabird interactions to date (Table 3). However, data from other sources and in other regions indicate that threats to seabirds are highest from longline gear.

TABLE 3. Members and Cooperating Non-Contracting Parties reporting of seabird interactions for the years 2008–2011 to the IOTC.

CPC's	2008	2009	2010	2011	Remarks
Australia	0	2	0	0	Nil interaction reported in 2011
Belize	0	0	0		Interactions not reported in 2011. No observers deployment
China			0	0	No observers deployment in 2011
Taiwan,China	6	52	214	4	Non-raised observer data
Comoros					No longline activity
European Union*				4	EU,France: nil, EU,Spain: nil, EU,Portugal: 4, EU,UK: nil.
Eritrea					
France (territories)	0	0	0	0	Nil interaction reported, no observer on local longline fleet (<24m)
Guinea					
India				0	Nil interaction reported in 2011
Indonesia			42	0	42 seabirds caught between 2005 and 2010. Nil interaction reported by observers from January to October 2011.
Iran, Islamic Republic of					No longline activity
Japan			11		Non-raised observer data (6 observered trips, July 2010-January 2011)
Kenya					No longline activity en 2011
Korea, Republic of		94	72		Non-raised observer data. No observer in 2008 and 2011
Madagascar					Longine activities north of 25°S
Malaysia				0	Nil interaction reported en 2011
Maldives, Republic of				0	No longline activity
Mauritius	0	0	0	0	Nil interaction reported in 2011. Longine activities north of 25°S
Mozambique				0	Nil interaction reported in 2011
Oman, Sultanate of					
Pakistan	0	0	0		No longline activity
Philippines	0	0	0		Interaction not reported in 2011
Seychelles				0	Nil interactions reported
Sierra Leone					
Sri Lanka					Interaction not reported due to the nature of the fishery and the gear used
Sudan					No longline activity
Tanzania					

Thailand				0	Nil interaction reported in 2011
United Kingdom (OT)	0	0	0	0	No fishing activity
Vanuatu					
Yemen					
Cooperating Non-contracting Party					
Senegal	0	0	0	0	No fishing activity since 2007
South Africa	157	467	162	373	Current seabird mortality rate for 2011 below, for the 1st time, the stipulated rate of 0.05 birds/1000 hooks.

Green = CPC reported level of seabird interactions; Red = CPC did not report level of seabird interactions
*Observer data was reported for the French purse-seine fleet for 2009 as well as for the La Réunion longline fleet. Moreover, the observer programme on-board the EU Purse-seine fleet has been discontinued because of piracy activities.

Longline

Observer data from longline fisheries occurring north of 20˚S is very sparse (Gauffier 2007). While seabird bycatch rates in tropical areas are generally assumed to be low, a number of threatened seabirds forage in these northern waters. Due to their small population sizes, bycatch at significant levels could be occurring but not, or almost never being observed.

Others gears

The impact of purse-seine fishing on tropical seabird species, including larids (gulls, terns and skimmers) and sulids (gannets and boobies), is generally considered to be low, but data remain sparse and there are anecdotal observations which suggest that these interactions might merit closer investigation. However, no observation of incidental catch of seabird in the purse-seine fishery has been made in the Indian Ocean since the beginning of the fishery 25 years ago. The scale and impacts of gillnet fishing impacts on seabirds in the IOTC convention area is unknown. Outside the convention area, gillnet fishing has been recorded as catching high numbers of diving seabird species, including shearwaters and cormorants (e.g. Berkenbusch & Abraham 2007). The large coastal gillnet fisheries in the northern part of the IOTC clearly merit closer investigation, and should be considered a priority, as should the impact of lost or discarded gillnets (ghost fishing) on seabirds.

Indirect impacts of fisheries

Many tropical seabird species forage in association with tunas, which drive prey to the surface and thereby bring them within reach of the seabirds. The depletion of tuna stocks could therefore have impacts on these dependent species. More widely, the potential 'cascade' effects of reduced shark and tuna abundances on the ecosystem is largely unknown. Although these kinds of impacts are difficult to predict, there are some examples that suggest meso-predator release has occurred in the Convention area (e.g. Romanov & Levesque 2009)

Assessment

A number of comprehensive assessments of the status of Indian Ocean seabirds are available, in addition to the IUCN threat status:

- Modelling work on Crozet wandering albatrosses and impact of longline fisheries in the IOTC zone (Tuck et al. 2011).
- ACAP Species assessment for: Amsterdam Albatross, Indian Yellow-nosed Albatross, Northern Royal Albatross, Southern Royal Albatross, Shy Albatross, Sooty Albatross, Wandering Albatross, Northern Giant Petrel, Southern Giant Petrel, Grey Petrel, Spectacled Petrel, White-chinned Petrel (http://www.acap.aq/acap-species).

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APPENDIX XXXIII
UPDATE ON THE IMPLEMENTATION OF THE IOTC REGIONAL OBSERVER SCHEME

CPCs	Active Vessels LOA≥24m or High Seas vessels[39]				Progress	List of accredited observers submitted	Observer Trip Reports[40]		
	LL	PS	GN	BB			2010	2011	2012
MEMBERS									
Australia	6	5			Australia has implemented an observer programme that complies with the IOTC Regional Observer Scheme.	**YES: 21**	**2**	**1**	**2**
Belize	7				No information received by the Secretariat.	**No**	**No**	**No**	**No**
China –Taiwan,China	15 447				China has an observer programme. No information received by the Secretariat.	**YES: 2** **- YES: 54**	**1** **- No**	**No** **- No**	**No** **- No**
Comoros					Comoros does not have vessel more than 24m on which observer should be placed. 2 observers were trained under the IOC Regional Monitoring Project, and 5 by SWIOFP.	**YES: 6**	N/A	N/A	N/A
Eritrea	No information received				No information received by the Secretariat.	**No**	**No**	**No**	**No**
European Union	23	15			EU has an observer programme on-board its purse seine fleets, however the programme is limited due to the piracy activity in the western Indian Ocean. EU has or is developing observer programmes on-board its longline fleets, i.e. La Réunion, Spanish and Portuguese fleets.	Fra: 24 Prt: 4 Spn: no UK: no	**No**	Fra: 12 Prt: 1 Spn: no UK: no	Fra: 1 Prt: 1 Spn: no UK: no
France (OT)		5			France has an observer programme on board it purse seine fleet.	**YES: 19**	**No**	**9**	**No**
Guinea	No information received				No information received by the Secretariat.	**No**	**No**	**No**	**No**
India	51				India has not developed any observer programme so far.	**No**	**No**	**No**	**No**
Indonesia	1183	13	2		Indonesia has an observer programme based in Benoa, Bali with 5 trained observers. The number of observers should double in 2012.	**No**	**No**	**No**	**No**
Iran, Isl. Rep. of		5	1244		No information received by the Secretariat.	**No**	**No**	**No**	**No**
Japan	69	1			Japan has started its observer programme on the 1st of July 2010, and 14 observers are currently being deployed in the Indian Ocean.	**YES: 14**	**6**	**No**	**No**
Kenya	4				Kenya is developing an observer programme and 5 observers have been trained under the SWIOFP training.	**No**	**No**	**No**	**No**
Korea, Rep. of	7				Korea has started an observer programme since 2002 and 11 observers are currently being deployed onboard.	**YES: 11**	**2**	**No**	**No**

[39] The number of active vessels is given for 2011.

[40] Year in which the observed trip has started

Madagascar	3				Madagascar is developing an observer programme. Five and three observers have been trained respectively under the SWIOFP and the IOC projects.	**YES: 7**	**No**	**No**	**No**
Malaysia	8				No information received by the Secretariat.	**No**	**No**	**No**	**No**
Maldives	No information received				Maldives vessels are monitored by field samplers at landing sites. Have in excess of 250 vessels larger than 24m.	**No**	**No**	**No**	**No**
Mauritius					Mauritius is developing an observer programme, and, 5 and 3 observers have been trained respectively under the SWIOFP and the IOC projects.	**No**	**No**	**No**	**No**
Mozambique	1				No information received by the Secretariat.	**YES: 11**	**No**	**No**	**No**
Oman	No information received				No information received by the Secretariat.	**No**	**No**	**No**	**No**
Pakistan			10		No information received by the Secretariat.	**No**	**No**	**No**	**No**
Philippines	3				No information received by the Secretariat.	**No**	**No**	**No**	**No**
Seychelles	23	8			Seychelles is developing an observer programme. Four and three observers have been trained respectively under the SWIOFP and the IOC projects.	**YES: 7**	**No**	**No**	**No**
Sierra Leone	0	0	0	0				**No**	**No**
Sri Lanka	749				Sri Lanka has not started the implementation of an observer programme.	**No**	**No**	**No**	**No**
Sudan	No information received				No information received by the Secretariat.	**No**	**No**	**No**	**No**
Tanzania, United Rep.of	1				No information received by the Secretariat.	**No**	**No**	**No**	**No**
Thailand	2				Thailand has not developed an observer programme so far.	**No**	**No**	**No**	**No**
United Kingdom	0	0	0	0	UK does not have any active vessels in the Indian Ocean.	N/A	N/A	N/A	N/A
Vanuatu					No information received by the Secretariat.	**No**	**No**	**No**	**No**
Yemen	No information received				No information received by the Secretariat.	**No**	**No**	**No**	**No**
COOPERATING NON-CONTRACTING PARTIES									
Senegal	0	0	0	0	Senegal does not have any active vessels in the Indian Ocean.	**No**	**No**	**No**	**No**
South Africa	15				South Africa has only an observer programme for foreign vessels operating in the EEZ of South Africa at the moment.	**YES: 16**	**No**	**13**[41]	**10**[41]

[41] Reports from South African observers onboard foreign vessels operating in the EEZ of South Africa.

APPENDIX XXXIV
UPDATE ON PROGRESS REGARDING RESOLUTION 09/01 – ON THE PERFORMANCE REVIEW FOLLOW–UP

(NOTE: NUMBERING AND RECOMMENDATIONS AS PER APPENDIX I OF RESOLUTION 09/01)

ON CONSERVATION AND MANAGEMENT	RESPONSIBILITY	UPDATE/STATUS	WORKPLAN/TIMELINE	PRIORITY
Data collection and sharing				
The Panel identified a poor level of compliance by many IOTC Members. with their obligations, notably those related to the statistical requirements on artisanal fisheries and sharks, and recommends that:				
3. The timing of data reporting be modified to ensure that the most recent data are available to the working parties and the Scientific Committee.	*Scientific Committee*	**Completed**: Currently CPCs are required to submit information on their flag vessels by 30th June every year. The timeline for coastal CPCs who license foreign vessels has been brought forward to 15th February every year. The timing of the Working Parties will be reviewed annually to ensure that assessments can be completed and results reported to the Scientific Committee each year.	Review annually at IOTC WP and SC meetings.	Medium
5. The scheduling of meetings of the working parties and Scientific Committee be investigated based on the experience of other RFMOs. This should bear in mind the optimal delivery of scientific advice to the Commission.	*Scientific Committee*	**Completed**: Given the large number of meetings of other RFMOs, it is becoming increasingly difficult to find a schedule of meetings that would be better than the one currently in practice. However, the Working Parties and the Scientific Committee will annually review the timing of the Working Parties.	Review annually at IOTC WP and SC meetings.	Low
6. The Commission task the Scientific Committee with exploring alternative means of communicating data to improve timeliness of data provision.	*Scientific Committee*	**Partially completed & Ongoing**: The Secretariat encourages members to utilise electronic means to expedite reporting. A study was commissioned for 2011 to determine the feasibility of reporting near real–time for various fleets. Outcome: Real time reporting not currently possible for most CPCs.	Review annually at IOTC WP and SC meetings.	Medium

10. There is a need to improve the quality and quantity of the data collected and reported by the Members, including the information necessary for implementing the ecosystem approach. The most immediate emphasis should be placed on catch, effort and size frequency. The Panel also recommends that:	*Scientific Committee*	**Ongoing**: See below recommendation 11.		High
12. A regional scientific observer programme to enhance data collection (also for non–target species) and ensure a unified approach be established, building on the experience of other RFMOs, Regional standards on data collection, data exchanged and training should be developed.	*Scientific Committee*	**Completed**: Resolution 11/04 (superseding Res.09/04 and Res. 10/04) provides CPCs with the necessary framework for putting in place national scientific observer programmes. The Regional Observers Scheme commenced July 1st 2010, and is based on national implementation. The Secretariat coordinated the preparation of standards for data requirements, training and forms.	Review annually at IOTC WP and SC meetings.	High
15. The Secretariat's capacity for data dissemination and quality assurance be enhanced, including through the employment of a fisheries statistician.	*Standing Committee on Administration and Finance via Scientific Committee* *Commission*	**Partially completed**: The existing post of Data Analyst was converted to a Fisheries Statistician to join the Data Section of the Secretariat. A new Fisheries Officer (data/stats) has joined the Secretariat in early 2012.	Staffing needs to be assessed annually at IOTC meetings.	Medium
16. A statistical working party be established to provide a more efficient way to identify and solve the technical statistical questions.	*Scientific Committee*	**Completed**: The Working Party on Data Collection and Statistics resumed its annual meeting in 2009, 2010 and 2011. However, no meeting is being scheduled for 2012 as the SC felt that this WP meeting shold only be held when there are specific tasks to be considered.	Annual meeting.	High
21. Innovative or alternative means of data collection (e.g. port sampling) should be explored and, as appropriate, implemented.	*Scientific Committee*	**Ongoing**: The Secretariat has been implementing sampling programmes since 1999. The IOTC–OFCF Programme has supported sampling programmes and other means of data collection since 2002. In 2011, the SC recommended the continuation of the IOTC-OFCF project.	Review annually at IOTC WP and SC meetings.	Medium

Quality and provision of scientific advice				
23. For species with little data available, the Scientific Committee should be tasked with making use of more qualitative scientific methods that are less data intensive.	*Scientific Committee*	**In progress**: The species Working Parties have been using informal analyses of stock status indicators when data are considered insufficient to conduct full assessments for some time. However, a formal system that reviews those qualitative indicators and provides a recommendation on the current status, based on the weight–of–evidence has yet to be developed.	To be considered at the WPM and others. Review annually at IOTC WP and SC meetings.	High
25. Confidentiality provisions and issues of accessibility to data by the scientists concerned needs to be clearly delineated, and/or amended, so that analysis can be replicated.	*Scientific Committee*	**Ongoing**: Input, output and executable files for the assessment of major stocks are archived with the Secretariat to allow replication of analyses. Access to operational data under cooperative arrangements, and those subject to confidentiality rules is still limited. In some cases the Secretariat is bound by the domestic data confidentiality rules of Members and Cooperating non–Contracting Parties. The SC recommended to include observer data under the confidentiality policy of IOTC, which was Adopted by the Commission in 2012 as Resolution 12/02.	Review annually at IOTC WP and SC meetings.	Medium
27. To enhance the quality of scientific advice and the technical soundness of the papers being considered by the Scientific Committee and its working parties, and to encourage publication of IOTC scientific papers in relevant journals, future consideration should be given to the establishment of a scientific editorial board within the Scientific Committee	*Scientific Committee*	**Partially completed**: Guidelines for the presentation of stock assessment papers were revised and agreed to by the Scientific Committee in 2010 and have been proposed for revision at the 2012 SC meeting.	Review annually at IOTC WP and SC meetings.	Medium
29. Ongoing peer review by external experts should be incorporated as standard business practice of working parties and the Scientific Committee.	*Scientific Committee*	**Pending:** External experts (Invited Experts) are regularly invited to provide additional expertise at Working Party meetings, although this does not constitute a formal process of peer review. The Scientific Committee in 2010 and 2011, agreed that once stock assessment models were considered robust, that peer review would be advantageous and funds will be requested to undertake peer reviews of stock assessments. The Scientific Committee reviewed the processes for Invited Experts, Consultants and Peer review at its 14th Session in 2011.	Review annually at IOTC WP and SC meetings.	Medium

30. New guidelines for the presentation of more user friendly scientific reports in terms of stock assessments should be developed. In this respect, Kobe plots are considered to be the most desirable method of graphical presentation, especially to non–technical audience.	*Scientific Committee*	**Ongoing**: All recent stock assessment results have been presented using the Kobe plot, and the species Working Parties are progressing in presenting the Kobe matrix. The 2010,2011and 2012 Scientific Committee reports included, and will include Kobe Matrices for all stock assessments. The format of the Working Party reports and the resultant Executive Summaries has been revised to improve readability and content.	Review annually at IOTC WP and SC meetings.	Medium
Adoption of conservation and management measures				
35. IOTC should consider developing a framework to take action in the face of uncertainty in scientific advice.	*Scientific Committee and Commission*	**In progress**: The Scientific Committee has agreed that the development of a Management Strategy Evaluation process be initiated to provide better advice that would incorporate explicit consideration of uncertainty. The 2012 meeting of the Working Party on Methods will focus on this process. At the WPM meeting, it was agreed that a smaller group of experts shall meet twice in 2013 to advance this work.	Intersessional start of the MSE process by correspondence, as of Jan.2012 Progress at 2012 WPM annual meeting.	High
Capacity management				
42. IOTC should establish a stronger policy on fishing capacity to prevent or eliminate excess fishing capacity.	*Working Party on Fishing Capacity* *Scientific Committee* *Commission*	**Ongoing**: The Commission has since 2003 adopted a series of Resolutions (03/01, 06/05, 07/05 and 09/02) with the objective of addressing the issue of fishing capacity. However, to date these resolutions have not resulted in a strong control on fishing capacity, and the concern remains that overcapacity might result from this lack of control. The Secretariat is actively involved in developing the global vessels record for vessels fishing for tuna and tuna–like species that would contribute to the assessment of existing fishing capacity.	See Recommendation 33, which has been agreed as the priority path in this regard.	Medium

APPENDIX XXXV
RESEARCH RECOMMENDATIONS AND PRIORITIES FOR IOTC WORKING PARTIES IN 2013 AND 2014

The IOTC Scientific Committee **RECOMMENDED** that each of its Working Parties undertake the following research tasks as priorities in 2013 and tentatively for 2014:

Working Party on Temperate Tunas (WPTmT)

CPUE standardisation

The SC **AGREED** that there was an urgent need to investigate the CPUE issues as outlined in paragraph 72 [of the WPTmT04 Report] and for this to be a high priority research activity for the albacore resource in the Indian Ocean in 2013.

The SC **ENCOURAGED** data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and **RECOMMENDED** that data to be used in stock assessments, including CPUE standardisations be made available not less than 30 days before each meeting by CPCs.

Stock assessment

NOTING that with the exception of the SS3 stock assessment paper, all others stock assessment papers for albacore were made available by the authors immediately prior to the WPTmT04 meeting, which did not allow the other participants of the meeting to adequately review the methodology, the SC **REMINDED** working party participants of the 2010 Scientific Committee recommendation that stock assessment papers need to be provided to the Secretariat for posting to the IOTC website **no later than 15 days before** the commencement of the relevant meeting.

The SC **AGREED** that future projections for stock assessments should firstly examine scenarios under constant catch projections of +/-20% and +/-40%, and then refine the catch projects to finer l scale levels depending on the initial outcomes, noting that the aim to develop useful projections for the development of management advice.

Stock structure

NOTING that at present very little is known about the population structure and migratory range of albacore in the Indian Ocean, other than the possible connectivity with the southern Atlantic, the SC **RECOMMENDED** that research aimed at determining albacore stock structure, migratory range and movement rates in the Indian Ocean be considered a high priority research project.

Spawning

NOTING that there are difficulties faced by some CPCs in collecting gonad samples from albacore, as a result of fish generally being frozen whole after being gutted, the SC **RECOMMENDED** that CPCs collect gonad samples from albacore to confirm the spawning time and location of the spawning area that are presently hypothesized for albacore, over the coming year and to report findings at the next WPTmT meeting.

Additional core topics for research

The SC **ENCOURAGED** China and other CPCs to provide further research reports on albacore biology, including using through the use of fish otolith studies, either from data collected through observer programs or other research programs, at the next WPTmT meeting.

The SC **RECOMMENDED** the following core topic areas as priorities for research over the coming two years:

- Size data analyses
- Growth rates and ageing studies
- Stock status indicators – exploration of indicators from available data
- Collaborate with SPC-OFP to examine their current simulation approach to determine priority research areas.

Working Party on Billfish (WPB)

Core topics for research

The SC **AGREED** that there was no urgent need to carry out stock assessments for the swordfish resources in the Indian Ocean in 2013, and therefore that efforts over the coming year be focused on the other billfish species, in particular on striped marlin, blue marlin and black marlin.

The SC **RECOMMENDED** that the Istiophorids (striped marlin, blue marlin, black marlin and Indo-Pacific sailfish) undergo new or revised CPUE analysis in 2013, taking into account the various points in the CPUE discussion summaries throughout the WPB10 report.

The SC **RECOMMENDED** the following core areas as priorities for research over the coming year:

- Billfish species biology (i.e. growth reproduction)
- Size data analyses
- Stock status indicators – exploration of indicators from the available data
- Striped marlin, blue marlin and black marlin CPUE standardisation
- Stock assessment – Istiophorids

Working Party on Ecosystems and Bycatch (WPEB)

Core topics for research

The SC **RECOMMENDED** the following core topic areas as priorities for research over the coming two years, taking into account data gaps, capacity among CPCs, and areas for implementation:

- ***Ecological Risk Assessment***
  i. Sharks – interpretation of consultant report
  ii. Marine turtles – interpretation of consultant report
- ***Shark stock status analyses (development of abundance indices)***
  i. Develop/improve accurate CPUE indices for analysis
  ii. Develop methods to estimate historical catch series by gear.
  iii. Develop life history and biological patterns for the species (namely migration patterns and distribution patterns).
- ***Depredation***
  i. Longline fishery depredation
- ***Bycatch mitigation***
  i. Sharks
  ii. Seabirds – line weighting
  iii. Marine turtles
  iv. Marine mammals
- ***Capacity building***
  i. Scientific assistance to CPCs and specific fleets considered to have the highest risk to bycatch species (e.g. gillnet fleets and longline fleets).

Working Party on Methods (WPM)

MSE workplan

The SC **ENDORSED** the workplan for the development of the IOTC MSE process, provided at Appendix IV. [of the WPM04 Report]

Working Party on Tropical Tunas (WPTT)

Size data improvements

The SC **NOTED** that the evaluation of length frequency samples collected by the longline fisheries of Japan and Taiwan,China, has been postponed until later in 2013, or will occur via correspondence only.

The SC **NOTED** the indication from Japan that over the last two years, problems had been identified by the WPTT in the Japanese size data for tropical tunas. However, the planned size data meeting, to be held in Taiwan,China in January 2013 had been cancelled. The intention of the meeting was for Japan, Taiwan,China and the IOTC Secretariat to work towards resolving the size data issues for these two fleets.

The SC **NOTED** the efforts by Japan and Taiwan,China, and **URGED** all parties to resolve the problems as soon as possible, and before the next WPTT meeting.

CPUE standardisation

NOTING the importance of the various CPUE indices for stock assessment of the tuna tropical species, the SC **AGREED** that there was an urgent need to investigate the CPUE issues as detailed for bigeye tuna, skipjack tuna and yellowfin tuna in the WPTT14 report, and for these to be a high priority research activity for the tropical tuna resources in the Indian Ocean in 2013.

NOTING that nominal juvenile purse seine CPUE, once standardised, can be used as an indicator of the recruitment index in the stock assessment models, the SC **RECOMMENDED** that the standardised CPUE index for juvenile yellowfin tuna and bigeye tuna caught by the EU purse seiner fleets, be estimated and submitted to the WPTT before the next round of stock assessments of tropical tunas.

The SC **RECOMMENDED** that standardisation of purse seine CPUE be made where possible using the operational data on the fishery.

The SC **REQUESTED** that the following matters be taken into account when undertaking CPUE standardisation analysis for bigeye tuna as well as yellowfin tuna in 2013, noting that this is a modified list produced at the previous WPTT meeting in 2011:

- The SC **AGREED** that changes in species targeting is the most important issue to address in CPUE standardisations, and
- time, or there may need to be careful that the following points should be taken into consideration:
  ii. While hooks between floats (HBF) provides some indication of setting depth, it is generally considered not to be a sufficient indicator of species targeting. HBF is just one aspect of the setting technique, which can vary by species, area, set-time, and other factors.
  iii. Highly aggregated (e.g. 5x5 degrees) data can make it difficult to observe the factors driving CPUE in a fishery, in particular the targeting effects. Operational data provides additional information that may allow effort to be classified according to fishing strategy (e.g. using cluster analyses or regression trees to estimate species targeting as a function of spatial areas, bait type, catch species composition, set-time, vessel-identity, skipper, etc.). Operational data also permits vessel effects to be included in analyses.
  iv. The inclusion of other species as factors in a Generalized Linear Model (GLM) standardization may be misleading, because the abundance of all species changes over time. Including these factors may also fail to resolve problems due to changes in targeting, particularly when modeling aggregated data. However, comparing models with and without the other species factors can be useful to identify whether there is likely to be a targeting problem.
- The SC **AGREED** that appropriate spatial structure needs to be considered carefully as fish density (and targeting practices) can be highly variable on a fine spatial scale, and it can be misleading to assume that large areas are homogenous when there are large shifts in the spatial distribution of effort. The following points should also be taken into consideration:
  i. Addition of finer scale (e.g. 1x1 degrees or latitude/longitude) fixed spatial effects in the model can help to account for heterogeneity within sub-regions.
  ii. Efforts should be made to identify spatial units that are relatively homogeneous in terms of the population and fishery to the extent possible (e.g. uniform catch size composition and targeting practices).
  iii. There may be advantages in conducting separate analyses for different sub-regions. The error distribution may differ by sub-region (e.g. proportion of zero sets), and there may be very different interactions among explanatory variables.
  iv. If the selectivity differs among regions (e.g. due to spatial variability in the age composition of the population), it may not be appropriate to pool sub-regional indices into a regional index.
  v. The possibility of defining a representative ‘space-time’ window: if this leads to the identification of a fishery with homogeneous targeting practices, it is probably worthwhile. However, it may not be possible to identify an appropriate window, or the window may be so small that it is not representative of the larger population (or has a high variance).
- The SC **NOTED** that the appropriate inclusion of environmental variables in CPUE standardisation is an ongoing research topic. The SC **AGREED** that often these variables do not have as much explanatory power as, or may be confounded with, fixed spatial effects. This may indicate that model-derived environmental fields are not accurate enough at this consideration of the mechanisms of interaction to include the variable in the most informative way.

Impacts if Piracy

The SC **NOTED** that the development of Somalian piracy has produced major changes in purse seine fisheries in the western Indian Ocean, which has resulted in a change in their effort levels and distribution, catch and catch-per-unit-effort. Some of those changes are visible in the basic fishery statistics, such as the decline of purse seine fishing effort and their changes in effort distribution. This was the case when after 2005, the purse seine fleets moved offshore, far from the Somalian coast, due to the end of fishing agreements and to the expansion of piracy. The SC **RECOMMENDED** that effects of the Somalian “quasi MPA” on the productivity of the stocks and on CPUEs and catches should be better evaluated, because this area is positioned in a highly productive area of the Indian Ocean that was actively fished by many fleets up until 2005. This study should be done in parallel for the three tropical tuna species (skipjack tuna, yellowfin tuna and bigeye tuna: by decreasing order of priority).

The SC **NOTED** that other changes of the purse seine fisheries due to piracy are not visible in the basic data presently available, for instance the changes in the purse seine fishing tactics and efficiency, due to “military operations”. Various changes in the targeting of FAD associated or free schools due to the new fishing conditions may have also been occurring during recent years. The SC **RECOMMENDED** that the effects on the FAD CPUEs by the EU,Spain purse seine fleet, including the reduced number of supply vessels, should be tentatively estimated. The potential reduction of free school fishing power of EU,France purse seine fleet during their period of “twin vessels” fishing operations should be evaluated (and this period identified for IOTC scientists). If estimations are significant, all of these changes in the tactics and efficiency of the purse seine fleets should be taken into account in future stock assessment models.

The SC **NOTED** that longline fisheries have also been facing since 2007 similar effects of the Somalian piracy as those experienced by purse seine vessels. The major and more visible effect has been their change of fishing zones, all longliners abandoning since 2009 there best yellowfin tuna and bigeye tuna fishing zones of Indian Ocean, also creating in the north-west Indian Ocean a “quasi MPA” for the population of adult deep yellowfin tuna and bigeye tuna. These major changes in the longline fisheries have been widely altering the regional catches and CPUEs of longliners, but these effects remain difficult to incorporate in most stock assessment models. Furthermore, the SC has been informed that some armed longliners were now back in the “piracy area” where they are obtaining high CPUEs.

The SC **RECOMMENDED** that all these changes in fishing strategy, tactics and efficiency of the purse seine and longline fisheries in relation to piracy should be identified and analysed for the purse seine and longline fleets, and later carefully taken into account in future stock assessment models of the 3 species of tropical tunas.

Working Party on Neritic Tunas (WPNT)

Priority projects for 2013 and 2014

The SC **ENDORSED** the list of priority research topics for neritic tunas as provided in Table 1, and those CPCs and others, who have committed to undertake / commence the projects in 2013.

Table 3. Priority research projects for obtaining the information necessary to develop stock status indicators for neritic tuna species in the Indian Ocean

Research project	Sub-projects	Priority	Interested parties
Stock structure (connectivity)	Genetic research to determine the connectivity of neritic tunas throughout their distributions	High	Bay of Bengal countries (proposal to be initiated by Malaysia); QUT (Australia); Maldives; Iran, Pakistan, Oman, U.A.E.
	Tagging research to better understand the movement dynamics, possible spawning locations, natural mortality, fishing mortality and post-release mortality of neritic tunas from various fisheries in the Indian Ocean	Med	Maldives, Malaysia, Indonesia
	Gen-tag methodology	Med	
	Otolith microchemistry/isotope research	Low	
Biological information (parameters for stock assessment)	Age and growth research	High	
	Age-at-Maturity	High	
	Fecundity-at-age/length relationships	Medium	
Ecological information	Feeding ecology	Low	
	Life history research	Low	
CPUE standardisation	Develop standardised CPUE series for each neritic tuna species for the Indian Ocean	High	
Stock assessment / Stock indicators	At present the data held at the IOTC Secretariat would be insufficient to undertake stock assessments for any neritic tuna species under the IOTC mandate/simplified approaches could be pursued	High	
	Develop alternative approaches to determining stock status via and indicator based assessment	High	IOTC Secretariat

Stock structure

The SC **AGREED** that there was a clear need to determine the degree of shared stocks for all neritic tunas under the IOTC mandate in the Indian Ocean, so as to better equip the SC in providing management advice based on defensible management units.

The SC **AGREED** that Table 2 should be used as a starting point for research project development to delineate potential stock structure for neritic tunas in the Indian Ocean, and that in the absence of reliable evidence relating to stock structure, a precautionary approach should be undertaken whereby bullet tuna, frigate tuna, kawakawa, longtail tuna, Indo-Pacific king mackerel and narrow-barred Spanish mackerel are assumed to exist as single stocks throughout the Indian Ocean, until proven otherwise.

The SC **AGREED** that research on stock structure should take two separate approaches:

- genetic research to determine the connectivity of neritic tunas throughout their distributions: such studies should be developed at the sub-regional level (Table 2), with the assistance and support from the IOTC Secretariat for the development of project proposals.
- tagging research to better understand and estimate exploitation rates, the movement dynamics, possible spawning locations, natural mortality, fishing mortality and post-release mortality of neritic tunas from various fisheries in the Indian Ocean.

The SC **NOTED** that tagging projects could potentially be more expensive for neritic tunas than for oceanic tunas, due to their lower abundance and that catches are mainly by artisanal vessels for which an extensive recovery network would need to be developed through the different coastal states of the Indian Ocean.

The SC **NOTED** the range of tagging projects which have been carried out on neritic tunas in the Indian Ocean and **REQUESTED** that Malaysia/SEAFDEC provide the results of the studies at the next WPNT meeting.

The SC **NOTED** that the Maldives has prepared a project proposal to undertake tagging studies in its waters, and **ENCOURAGED** other countries to develop similar proposals, with the assistance of the IOTC Secretariat if required.

The SC **AGREED** that genetic studies be given a higher priority for immediate research over tagging studies until appropriate funding has been identified. Any study should be designed in a such a way as to simultaneously collect biological material (e.g. tissue/fin clippings, ototliths, gonads, length/weight, and possibly morphometrics) in order to estimate biological parameters for future stock assessments. Both genetic, tagging and biological studies would need to be rigorously planned and preferably combined, to ensure data is collected across all temporal and spatial strata for each gear type to ensure biological parameters are representative of the population(s) being fished.

The SC **NOTED** the offer by the Invited Experts to assist in developing stock structure studies at the Queensland University of Technology (QUT), Australia and in developing genetic studies with collaboration from CSIRO and welcomed students from coastal CPCs to undertake such analysis at QUT. As the first step, QUT offered to facilitate workshops and training for IOTC CPCs to encourage technology transfer with partial funding from QUT and other sources to be identified.

Biological information

The SC **AGREED** that quantitative biological studies are necessary for all neritic tunas throughout their range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth.

The SC **NOTED** that I.R. Iran, U.A.E., Oman and Australia all have laboratories equipped with otolith and/or genetic processing facilities and associated expertise. CPCs interested in undertaking biological research should make contact with the relevant agencies to make use of this regional expertise/facilities.

The SC **AGREED** that in situations where direct ageing has not been undertaken, age composition could be derived from a well designed length frequency analysis.

CPUE standardisation

The SC **AGREED** that there was an urgent need to develop standardised CPUE series for each neritic tuna species for the Indian Ocean as a whole or by sub-region as appropriate, once stock structure and management units have been determined.

The SC **AGREED** that where feasible, support should be provided by the IOTC Secretariat and other CPCs, to aid in the development of standardised CPUE series for each neritic tuna species.

The SC **RECOMMENDED** that the IOTC Secretariat undertake a series of initial training workshops/capacity building exercises on CPUE standardisation, stock assessments and other data analysis in 2013 and 2014, and for the SC to request that the Commission allocate additional funds for this purpose in the IOTC budget.

Stock assessment

NOTING that there is an urgent need to carry out stock status determinations for neritic tunas and tuna-like species under the IOTC mandate, and that at present the data held at the IOTC Secretariat would be insufficient to undertake integrated stock assessments for any stock, the SC **AGREED** that alternative approaches be considered to determine stock status, by building layers of partial evidence, such as CPUE indices combined with catch data, life-history parameters and yield-per recruit metrics.

Priority species for research in 2013

The SC **AGREED** that as regionally appropriate, kawakawa, longtail tuna and narrow-barred Spanish mackerel, should be the priority species for research in 2013, although research should also continue on other neritic tuna species. Capacity building activities by the IOTC Secretariat should focus on using a single species as an example.

Table 2. Neritic tunas and tuna-like species under the IOTC mandate with potential sub-regions/stock identified

<table>
<tr><th rowspan="2">Species / Stock</th><th colspan="5">Possible sub-regions and countries / Management Units</th></tr>
<tr><th>East Africa
(Kenya, Tanzania, Mozambique, Madagascar, Seychelles, Mauritius, La Réunion, Comoros, Somalia)</th><th>Gulf, Oman Sea
(I.R. Iran, Oman, Pakistan, U.A.E., Yemen, Somalia, Qatar)</th><th>West India
(India, Pakistan, Sri Lanka, Maldives)</th><th>East India/Bay of Bengal
(India, Sri Lanka, Malaysia, Indonesia, Thailand, Myanmar, Bangladesh)</th><th>Indonesia and Australia
(Australia, Malaysia, Indonesia, Thailand)</th></tr>
<tr><td>Bullet tuna
(Auxis rochei)</td><td>–</td><td>–</td><td colspan="2">━━━━━━━━</td><td>━━━━</td></tr>
<tr><td>Frigate tuna
(Auxis thazard)</td><td>━━━━</td><td>━━━━</td><td colspan="2">━━━━━━━━</td><td>━━━━</td></tr>
<tr><td>Kawakawa
(Euthynnus affinis)</td><td>━━━━</td><td colspan="2">━━━━━━━━</td><td colspan="2">━━━━━━━━</td></tr>
<tr><td>Longtail tuna
(Thunnus tonggol)</td><td>━━━━</td><td colspan="2">━━━━━━━━</td><td colspan="2">━━━━━━━━</td></tr>
<tr><td>Indo-Pacific king mackerel
(Scomberomorus guttatus)</td><td>━━━━</td><td>━━━━</td><td colspan="2">━━━━━━━━</td><td>━━━━</td></tr>
<tr><td>Narrow-barred Spanish mackerel
(Scomberomorus commerson)</td><td>━━━━</td><td colspan="3">━━━━━━━━━━━━</td><td>━━━━</td></tr>
</table>

Black bars refer to potential management units for further examination/research, by species. Countries in red text are not yet Members of the IOTC, however collaborative research is encouraged.

APPENDIX XXXVI
ASSESSMENT SCHEDULE FOR IOTC WORKING PARTIES

The IOTC Scientific Committee **RECOMMENDED** that each of its Working Parties undertake stock assessments and development of stock status indicators following the schedule shown in Table 1.

Table 1. Schedule of stock assessments for IOTC species and species of interest in 2013 and tentatively for 2014–2017, and for the WPM priorities.

Species	2013	2014	2015	2016	2017
Working Party on Tropical Tunas					
Bigeye tuna	**Full assessment**	Indicators	Indicators	**Full assessment**	Indicators
Skipjack tuna	Indicators	**Full assessment**	Indicators	Indicators	**Full assessment**
Yellowfin tuna	Indicators	Indicators	**Full assessment**	Indicators	Indicators
Working Party on Temperate Tunas					
Albacore	**Full assessment**	Indicators			
Working Party on Billfish					
Black marlin	**Full assessment**				
Blue marlin	**Full assessment**				
Striped marlin	**Full assessment**				
Swordfish	Indicators	**Full assessment**			
Indo-Pacific sailfish	Indicators				
Working Party on Neritic Tunas					
Bullet tuna	Indicators				
Frigate tuna	Indicators				
Kawakawa	Indicators	**Full assessment**			
Longtail tuna	Indicators	**Full assessment**			
Indo-Pacific king mackerel	Indicators				
Narrow-barred Spanish mackerel	Indicators	**Full assessment**			
Working Party on Ecosystems and Bycatch					
Bigeye thresher sharks	Indicators				
Blue sharks	Indicators				
Silky sharks	Indicators				
Oceanic whitetip sharks	Indicators				
Pelagic thresher sharks	Indicators				
Shortfin mako sharks	Indicators				
Scalloped hammerhead sharks	Indicators				
Working Party on Methods					
Management Strategy Evaluation	Initial operating model for ALB, first run on ALB MSE and analysis of reference points for ALB	Extension of the MSE process to tropical tunas			

Note: the assessment schedule may be changed dependant on the annual review of fishery indicators, or SC and Commission requests.

APPENDIX XXXVII

GUIDELINES FOR THE PRESENTATION OF STOCK ASSESSMENT MODELS

These guidelines attempt to ensure greater transparency and facilitate peer-review of models employed in the provision of advice on the status of the stocks. Scientists presenting stock assessment model runs should provide to the IOTC Secretariat a copy of all input and output files, for all runs presented, and of the executable file or files used within 10 days of the end of each meeting. These will be archived for future testing and replication. Scientists are encouraged to freely share the source code of the methods used. The IOTC scientists/Stock Assessment Expert will support CPC's in meeting these guidelines.

While this is not an all encompassing list, these documents should describe:

1) The available catch data and mention, if necessary, data sources or observations not included in the analysis.
2) Available indices of abundance used.
3) Available tag data used
4) Assumptions made on parameter values used as constants.
5) Parameters estimated and priors specified if used in parameter estimation.
6) Population trajectories and dynamics with respect to reference points.
7) Residual diagnostics on both CPUE derived indices (e.g. qq plots, observed versus fitted values, fitted versus residuals scatter plots).
8) Residual plots of model versus observed CPUE, and observed versus actual catch compositions should be presented.
9) When referring to datasets provided by the Secretariat, the date, coverage and precise database should be mentioned.
10) Data sources not previously seen by a Working Party may need a separate document presenting them. This includes standardized CPUE series or other data sources processed prior to use.
11) The population dynamics that are modelled and the techniques used should be clearly presented including a description of the partition, annual cycle, and other relevant population processes.
12) Alternative scenarios and retrospective analyses should ideally be carried and, if included, a description of the motivation for the selection of base and alternative cases should be added, giving detail of how the alternative case assumptions differ from those of the base case.
13) The description of any retrospective analyses should cover the assumptions involved and results obtained.
14) Projections should be similarly documented as detailed below

Documentation requirement and guidelines

While these guidelines are basic good practices to include in the assessments and background data that go into the assessments (including CPUEs), they are not meant to preclude CPC's from presenting data or assessment models.

Software inspection and archival

- Input and output files of all alternative runs or scenarios presented should be made available during the meeting for inspection by interested members and for later archiving by the Secretariat. Ideally, these should be stored together with a copy of the software used in the analysis. When this is not possible due to licensing issues, a complete reference of the versions of both software and operating system employed should be made. Similarly, confidential inputs need not be provided but they should be documented and identified.
- Software used should ideally be open sourced using an appropriate license, or at least be made available to interested parties for inspection under a limited license. If closed source software is used, this should be clearly justified and sufficient tests as to its validity and reliability, under similar circumstances as those under which it will be used in IOTC-related work, should be carried out and its results made available. Even if the software is not available/open sourced, an executable should be part of the documentation so anyone could run the model.
- Comprehensive testing, including testing of the influence of various assumptions, is greatly encouraged in all cases.

Observations

- Describe the available data and mention, if necessary, data sources or observations not included in the analysis. When referring to datasets provided by the Secretariat, indicate the date, coverage (years, fleets, areas), and precise database (*e.g.* Nominal Catch, Catch and Effort).

- Data sources not previously seen by a Working Party might need their own document presenting them. This includes standardized CPUE series or other data sources processed prior to use.

Standardised CPUE indices of abundance

- Description of data pre-processing (*e.g.* treatment of outliers, selection of core areas if applicable)
- Efforts should be made to describe temporal and spatial patterns in the data, identifying gaps or sudden operational changes that that lead to an unbalanced design.
- Software and specific function calls
- Standard diagnostic plots (e.g. residuals, leverage plots, qq plots, observed versus fitted values, fitted versus residuals scatter plots)
- Parameter values, including error estimates for the final model used.
- For complicated models, a stepwise progression from simpler models should be documented to help identify confounding, and a distinction between statistical significance and practical significance.
- Efforts should be made to circulate these analyses well in advance of the relevant working party to allow discussion, and timely implementation in the stock assessment analyses.

Population dynamics

- Describe the population dynamics that are modelled and the techniques used including a description of the partition (age/length/sex groups, maturity, spatial structure, movement dynamics, if necessary), annual cycle (time steps, growth assumptions, natural and fishing mortality functions, recruitment, and sequence of those), and relevant population processes. Fixed parameters should be identified and documented. Emphasis should be placed in describing the formal statistical methods applied, including modelling methods, and form, limits and assumptions of both free and derived parameters.

Statistical methods

- Describe of the formal statistical methods, including
    1. Software name, version number, bibliographic references and source
    2. Maximum likelihood or objective function
    3. Bootstrap assumptions and MCMC algorithm, if used.
- Describe the free parameters used by the model, including
    1. Name and description of the parameter
    2. Details of the estimation bounds/functional relationships with other parameters
    3. Details of the prior assumed (if any), and source of the prior
    4. Weightings for likelihood terms
    5. Adjustment of variance by scaling/adding process error
    6. Penalties
- Describe the derived parameters used by the model, including
    1. Name, description and definitions of derived parameters (be precise with those that have alternative definitions, e.g., B0, MSY, BMSY)
    2. Details of any bounds/functional relationships with other parameters.
    3. Details of any priors assumed (including source).

Scenarios and retrospective analyses

- Alternative scenarios and retrospective analyses should be carried when possible and, if included, a description of the motivation for the selection of base and alternative cases should be added, giving detail of how the alternative case assumptions differ from those of the base case. Description of any retrospective analyses, should cover the assumptions involved and results obtained. Projections should be similarly documented.

Standards for assessment outputs:

Management quantities:

As **AGREED** by the IOTC Scientific Committee, assessments shall be presented with the minimum set of management quantities, where possible. Examples (Example 1) indicating the derived management quantities with uncertainty are shown below.

EXAMPLE 1: Species stock status summary

Management Quantity	Aggregate Indian Ocean
2011 catch estimate	38,946 t
Mean catch from 2007–2011	41,609 t
MSY (80% CI)	33,300 (31,100–35,600)
Data period used in assessment	1950–2010
$F_{current}/F_{MSY}$ (80% CI)	1.33 (0.90–1.76)
$B_{current}/B_{MSY}$ (80% CI)	–
$SB_{current}/SB_{MSY}$ (80% CI)	1.05 (0.54–1.56)
$B_{current}/B_0$ (80% CI)	–
$SB_{current}/SB_0$	0.29 (n.a.)
$B_{current}/B_{0,\ F=0}$	–
$SB_{current}/SB_{0,\ F=0}$	–

Kobe II Strategy Matrix

The Commission has requested that Kobe II management strategy matrices be provided for all stock assessments by the species Working Parties, and for these to be included in the report of the SC:

S16: "*The Commission **NOTED** the provision by the SC of the Kobe II strategy matrix for bigeye tuna, skipjack tuna, yellowfin tuna and swordfish (IO and SWIO) and recognized that it is a useful and necessary tool for management. The Commission **REQUESTS** that such matrices shall be provided for all stock assessments by the species Working Parties, and for these to be included in the report of the SC in 2012 and all future reports*." (para. 33 of the S16 report).

Initial projections should be at a coarse level, i.e. current catch levels, ± 20% and ± 40% (see example 2 below). However, once these initial projections have been run, finer scale projections (e.g. ± 5, 10 and 15%) should be undertaken and included in the assessment paper (see example 3 below) that are related to possible management actions being investigated.

EXAMPLE 2: Swordfish: Aggregated Indian Ocean assessment - Kobe 2 Strategy Matrix, indicating a range of probabilities across four assessment approaches. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to 2009) and probability (%) of violating reference point				
	60%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	0–4	0–8	0–11	2–12	4–16
$F_{2012} > F_{MSY}$	0–1	0–2	0–9	0–16	6–27
$B_{2019} < B_{MSY}$	0–4	0–8	0–11	0–13	6–26
$F_{2019} > F_{MSY}$	0–1	0–2	0–9	0–23	7–31

EXAMPLE 3: ASPIC Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the target MSY-based reference points for eight constant catch projections (2010 catch level, ± 10%, ± 20%, ± 40% and -15%) projected for 3 and 10 years.

Target Reference point and projection timeframe	Alternative catch projections (relative to 2010) and probability (%) of violating MSY reference points							
	60% (catch t)	**80%** (catch t)	**85%** (catch t)	**90%** (catch t)	**100%** (catch t)	**110%** (catch t)	**120%** (catch t)	**140%** (catch t)
$B_{2013} < B_{MSY}$	45	48	50	53	57	62	67	81
$F_{2013} > F_{MSY}$	11	47	54	58	66	71	76	82
$B_{2020} < B_{MSY}$	18	51	59	66	74	82	87	91
$F_{2020} > F_{MSY}$	<1	49	61	70	82	89	91	96

EXAMPLE 4: ASPIC Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the limit MSY-based reference points for eight constant catch projections (2010 catch level, ± 10%, ± 20%, ± 40% and -15%) projected for 3 and 10 years.

Limit Reference point and projection timeframe	Alternative catch projections (relative to 2010) and probability (%) of violating MSY reference points							
	60% (catch t)	**80%** (catch t)	**85%** (catch t)	**90%** (catch t)	**100%** (catch t)	**110%** (catch t)	**120%** (catch t)	**140%** (catch t)
$B_{2013} < B_{MSY}$	0	0	0	0	10	10	15	17
$F_{2013} > F_{MSY}$	0	0	0	0	9	12	12	12
$B_{2020} < B_{MSY}$	0	0	0	0	7		7	7
$F_{2020} > F_{MSY}$	0	0	0	0	5	5	5	5

KOBE Plots

1) A KOBE plot must be provided with each stock assessment paper as requested by the Commission

Some description describing the axes used (derived quantity, B_{MSY}, SB_{MSY}, F_{MSY}, C_{MSY}, etc). The plot trajectory should be described in recent years (example 4).

2) Interim target and limit reference points should be plotted as well.

As requested by the Commission and detailed in IOTC Recommendation 12/14 (para. 1):

> Para 1: *When assessing stock status and providing recommendations to the Commission, the Scientific Committee should apply the following interim target and limit reference points for the species of tuna and tuna-like species listed in **Table 1**. B_{MSY} refers to the biomass level for the stock that would produce the*

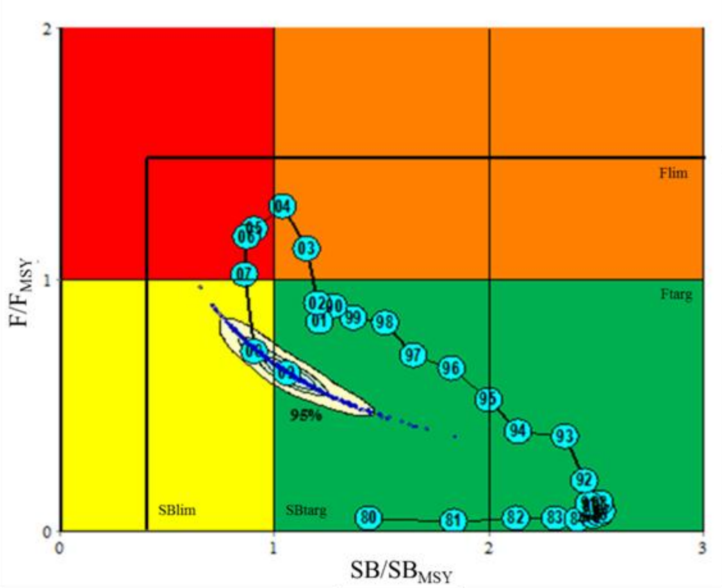
Maximum Sustainable Yield; F_{MSY} refers to the level of fishing mortality that produces the Maximum Sustainable Yield.

Table 1. Interim target and limit reference points.

Stock	Target Reference Point	Limit Reference Point
Albacore tuna	B_{MSY}; F_{MSY}	40% of B_{MSY}; 40% above F_{MSY}
Bigeye tuna	B_{MSY}; F_{MSY}	50% of B_{MSY}; 30% above F_{MSY}
Skipjack tuna	B_{MSY}; F_{MSY}	40% of B_{MSY}; 50% above F_{MSY}
Yellowfin tuna	B_{MSY}; F_{MSY}	40% of B_{MSY}; 40% above F_{MSY}
Swordfish	B_{MSY}; F_{MSY}	40% of B_{MSY}; 40% above F_{MSY}

If a stock assessment is undertaken for a species other than those listed in IOTC Recommendation 12/14 (shown above) then the following default interim target and limit reference points shall be shown on the Kobe plot:

Stock	Target Reference Point	Limit Reference Point
Other IOTC species	B_{MSY}; F_{MSY}	50% of B_{MSY}; 20% above F_{MSY}



EXAMPLE 4: Swordfish: ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2010. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown to be 0.4 and 1.4 of SB_{MSY} and F_{MSY} respectively.

Deadlines for availability of data for stock assessments need to be adhered to:

As **AGREED** by the Scientific Committee in 2011:

1) The SC also **ENCOURAGED** data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and **RECOMMENDED** that data to be used in stock assessments, including CPUE standardisations be made available not less than 30 days before each meeting by CPCs.
2) Stock assessment papers need to be provided to the Secretariat for posting to the IOTC website no later than 15 days before the commencement of the relevant meeting.

APPENDIX XXXVIII
CONSOLIDATED SET OF RECOMMENDATIONS OF THE FIFTEENTH SESSION OF THE SCIENTIFIC COMMITTEE (10–15 DECEMBER, 2012) TO THE COMMISSION

STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN

Tuna – Highly migratory species

SC15.01 (para. 207) The SC **RECOMMENDED** that the Commission note the management advice developed for each tropical and temperate tuna species as provided in the Executive Summary for each species.

- Albacore (*Thunnus alalunga*) – Appendix IX
- Bigeye tuna (*Thunnus obesus*) – Appendix X
- Skipjack tuna (*Katsuwonus pelamis*) – Appendix XI
- Yellowfin tuna (*Thunnus albacares*) – Appendix XII

Billfish

SC15.02 (para. 210) The SC **RECOMMENDED** that the Commission note the management advice developed for each billfish species as provided in the Executive Summary for each species:

- Swordfish (*Xiphias gladius*) – Appendix XIII
- Black marlin (*Makaira indica*) – Appendix XIV
- Blue marlin (*Makaira nigricans*) – Appendix XV
- Striped marlin (*Tetrapturus audax*) – Appendix XVI
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XVII

Tuna and mackerel – Neritic species

SC15.03 (para. 211) The SC **RECOMMENDED** that the Commission note the management advice developed for each neritic tuna species as provided in the Executive Summary for each species:

- Bullet tuna (*Auxis rochei*) – Appendix XVIII
- Frigate tuna (*Auxis thazard*) – Appendix XIX
- Kawakawa (*Euthynnus affinis*) – Appendix XX
- Longtail tuna (*Thunnus tonggol*) – Appendix XXI
- Indo-Pacific king mackerel (*Scomberomorus guttatus*) – Appendix XXII
- Narrow-barred Spanish mackerel (*Scomberomorus commerson*) – Appendix XXIII

STATUS OF MARINE TURTLES, SEABIRDS AND SHARKS IN THE INDIAN OCEAN

Sharks

SC15.04 (para. 212) The SC **RECOMMENDED** that the Commission note the management advice developed for a subset of shark species commonly caught in IOTC fisheries for tuna and tuna-like species:

- Blue sharks (*Prionace glauca*) – Appendix XXIV
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix XXV
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix XXVI
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix XXVII
- Silky sharks (*Carcharhinus falciformis*) – Appendix XXVIII
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XXIX
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XXX

Marine turtles

SC15.05 (para. 213) The SC **RECOMMENDED** that the Commission note the management advice developed for marine turtles, as provided in the Executive Summary encompassing all six species found in the Indian Ocean:

- Marine turtles – Appendix XXXI

Seabirds

SC15.06 (para. 214) The SC **RECOMMENDED** that the Commission note the management advice developed for seabirds, as provided in the Executive Summary encompassing all species commonly interacting with IOTC fisheries for tuna and tuna-like species:

- Seabirds – Appendix XXXII

GENERAL RECOMMENDATIONS TO THE COMMISSION

Meeting Participation Fund (MPF)

SC15.07 (para.13) The SC **NOTED** that the increased attendance by national scientists from developing CPCs to IOTC Working Parties and the SC in 2012 (46 in 2012; 33 in 2011) was partly due to the IOTC MPF, adopted by the Commission in 2010 (Resolution 10/05 *on the establishment of a Meeting Participation Fund for developing IOTC Members and non-Contracting Cooperating Parties*), and **RECOMMENDED** that the Commission maintain this fund into the future.

SC15.08 (para.15) The SC **RECOMMENDED** that the rules of procedure for the administration of the IOTC meeting participation fund be modified to include funding for Chairs and Vice-Chairs from IOTC developing coastal states, noting that without access to this fund, the ability of developing coastal state scientists to offer their services as Chairs and Vice-Chairs will be very limited. The same rules for document provision shall apply to Chairs and Vice-Chairs funded by the MPF.

National Reports from CPCs

SC15.09 (para.29) **NOTING** that the Commission, at its 15th Session, expressed concern regarding the limited submission of National Reports to the SC, and stressed the importance of providing the reports by all CPCs, the SC **RECOMMENDED** that the Commission note that in 2012, 26 reports were provided by CPCs, up from 25 in 2011, 15 in 2010 and 14 in 2009 (Table 2).

Status of development and implementation of Nation Plans of Action for seabirds and sharks

SC15.10 (para.37) The SC **NOTED** the current status of development and implementation of Nation Plans of Action for sharks and **RECOMMENDED** that all CPCs without an NPOA-Sharks expedite the development and implementation of their NPOA-Sharks, and to report progress to the WPEB in 2013, recalling that NPOA-Sharks are a framework that should facilitate estimation of shark catches, and development and implementation of appropriate management measures, which should also enhance the collection of bycatch data and compliance with IOTC Resolutions.

SC15.11 (para.38) The SC **RECOMMENDED** that the Commission note the updated status of development and implementation of National Plans of Action for sharks and seabirds, by each CPC as provided at Appendix V.

Report of the Fourth Session of the Working Party on Temperate Tunas (WPTmT04)

Sampling coverage

SC15.12 (para.48) The SC **RECOMMENDED** that IOTC CPCs having fleets targeting albacore or ports where albacore landings are high, in particular Mauritius and Indonesia, make every possible effort to collect biological information on albacore in the future. In this regard China informed the SC about the difficulties that Chinese observers are experiencing to collect biological samples of albacore onboard longliners flagged to China. China indicated that it would make every possible effort to maintain data collection at reasonable levels in the future.

Report of the Tenth Session of the Working Party on Billfish (WPB10)

Non-compliance matters

SC15.13 (para.87). **NOTING** that despite the mandatory reporting requirements detailed in Resolutions 10/02 and 12/03 data on billfish fisheries, in particular for the marlins, remain largely unreported by CPCs, the SC **RECOMMENDED** that the Compliance Committee and the Commission note these non-compliance matters, develop mechanisms to ensure that CPCs fulfil their reporting obligations.

Report of the Eighth Session of the Working Party on Ecosystems and Bycatch (WPEB08)

Data reporting requirements

SC15.14 (para.89) **NOTING** that despite the mandatory reporting requirements detailed in Resolutions 05/05, 10/02, 10/06, 12/03 and 12/04, bycatch data remain largely unreported by CPCs and the SC **RECOMMENDED** that the Compliance Committee and the Commission address this non-compliance by taking steps to develop mechanisms which would ensure that CPCs fulfil their bycatch reporting obligations.

Gillnet fisheries of the Indian Ocean

SC15.15 (para.90) The SC **NOTED** that gillnet fisheries are expanding rapidly in the Indian Ocean, with gillnets often being longer than 2.5 km in contravention with UN and IOTC Resolutions, and that their use is considered to have a substantial impact on marine ecosystems. **NOTING** that in 2012 the Commission adopted Resolution 12/01 on the implementation of the precautionary approach, the majority of the SC **RECOMMENDED** that the Commission freeze catch and effort by gillnet fisheries in the Indian Ocean in the near future, until sufficient information has been gathered to determine the impact of gillnet fleets on IOTC stocks and bycatch species caught by gillnet fisheries targeting tuna and tuna-like species, noting that the implementation of any such measure would be difficult.

SC15.16 (para.91) The SC **RECOMMENDED** that the Commission considers allocating funds to support a regional review of the data available for gillnet fleets operating in the Indian Ocean. The scientists from all CPCs having gillnet fleets in the Indian Ocean should provide at the next session of the WPEB, a report summarising the known information on bycatch in their gillnet fisheries, including sharks, marine turtles and marine mammals, with estimates of their likely order of magnitude where more detailed data are not available.

SC15.17 (para.92) The SC **RECOMMENDED** that the Commission allocate funds to carry out training for CPCs having gillnet fleets on species identification, bycatch mitigation and data collection methods and also to identify other potential sources of assistance to carry out such activities.

Sharks – Status of catch statistics and data reporting

SC15.18 (para.96) **NOTING** that the information on retained catches and discards of sharks contained in the IOTC database remains very incomplete for most fleets despite their mandatory reporting status, and that catch-and-effort as well as size data are essential to assess the status of shark stocks, the SC **RECOMMENDED** that all CPCs collect and report catches of sharks (including historical data), catch-and-effort and biological data on sharks, as per IOTC Resolutions, so that more detailed analysis can be undertaken for the next WPEB meeting.

SC15.19 (para.97) **NOTING** that there is extensive literature available on pelagic shark fisheries and interactions with fisheries targeting tuna and tuna-like species, in countries having fisheries for sharks, and in the databases of governmental or non-governmental organisations, the SC **AGREED** on the need for a major data mining exercise in order to compile data from as many sources as possible and attempt to rebuild historical catch series of the most commonly caught shark species. In this regard, the SC **RECOMMENDED** that the Commission allocates funds for this activity, in the 2013 IOTC budget.

SC15.20 (para.99) **NOTING** that Resolution 10/02 *mandatory statistical requirements for IOTC members and Cooperating Non-Contracting Parties (CPC's)*, makes provision for data to be reported to the IOTC on "*the most commonly caught shark species and, where possible, to the less common shark species*", without giving any list defining the most common and less common species, and recognising the general lack of shark data being recorded and reported to the IOTC Secretariat, the SC **RECOMMENDED** that Resolution 10/02 is revised in order to include the list of most commonly caught elasmobranch species (Table 3) for which nominal catch data shall be reported as part of the statistical requirement for IOTC CPCs.

TABLE 3. List of the most commonly caught elasmobranch species

Common name	**Species**	Code
Manta and devil rays	Mobulidae	MAN
Whale shark	*Rhincodon typus*	RHN
Thresher sharks	*Alopias spp.*	THR
Mako sharks	*Isurus spp.*	MAK
Silky shark	*Carcharhinus falciformis*	FAL
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS
Blue shark	*Prionace glauca*	BSH
Hammerhead shark	Sphyrnidae	SPY
Other Sharks and rays	–	SKH

Sharks – Mitigation measures

SC15.21 (para.100) The SC **RECOMMENDED** research and development of mitigation measures to minimise bycatch of the oceanic whitetip shark and its unharmed release for all types of fishing gears, and that CPCs with data on oceanic whitetip sharks (i.e. total annual catches, CPUE time series and size data) make these available to the next WPEB meeting.

Sharks – Shark mortality in relation with the use of drifting FADs

SC15.22 (para.103) The SC **RECOMMENDED** that the Commission note the following in regards to the request to the SC outlined in paragraph 11 of Resolution 12/04, on FAD design:

c) Develop improved FAD designs to reduce the incidence of entanglement of marine turtles, including the use of biodegradable materials

Only non-entangling FADs, both drifting and anchored, should be designed and deployed to prevent the entanglement of sharks, marine turtles or any other species, based on the following three basic principles:

1. The surface structure of the FAD should not be covered, or only covered with non-meshed material.
2. If a sub-surface component is used, it should not be made from netting but from non-meshed materials such as ropes or canvas sheets.
3. To reduce the amount of synthetic marine debris, the use of natural or biodegradable materials (such as Hessian canvas, hemp ropes, etc.) for drifting FADs should be promoted.

Sharks – Inclusion of two additional shark species to the list of mandatory data requirements for longline gear (Res 12/03)

SC15.23 (para.110) The SC **RECOMMENDED** that, in line with Recommendation 12/15 on the best available science, the list of shark species (or groups of species) for longline gear under Resolution 12/03 should be supplemented by two other shark species which were estimated to be at risk in longline fisheries by the ERA conducted in 2012, the silky shark (*Carcharinus falciformis*) and the oceanic whitetip shark (*Carcharinus longimanus*). The SC **ADVISED** the Commission to define the most appropriate means of collecting this additional information, considering the limitations of both options (logbooks and/or regional observer scheme) presented in paragraphs 108 and 109.

Sharks – Fin to body weight ratio

SC15.24 (para.111) The SC **ADVISED** the Commission to consider, that the best way to encourage full utilisation of sharks, to ensure accurate catch statistics, and to facilitate the collection of biological information, is to revise the IOTC Resolution 05/05 *concerning the conservation of sharks caught in association with fisheries managed by IOTC* such that all sharks must be landed with fins attached (naturally or by other means) to their respective carcass. However, the SC **NOTED** that such an action would have practical implementation and safety issues for some fleets and may degrade the quality of the product in some cases. The SC **RECOMMENDED** all CPCs to obtain and maintain the best possible data for IOTC fisheries impacting upon sharks, including improved species identification.

Sharks – Wire leaders/traces

SC15.25 (para.113) On the basis of information presented to the SC in 2011 and in previous years, the SC **RECOGNISED** that the use of wire leaders/traces in longline fisheries may imply targeting of sharks. The SC therefore **RECOMMENDED** to the Commission that if it wishes to reduce catch rates of sharks by longliners it should prohibit the use of wire leaders/traces.

Marine turtles – Data and reporting requirements

SC15.26 (para.114) The SC **RECOMMENDED** that IOTC Resolution 12/04 *on the conservation of marine turtles* is strengthened to ensure that CPCs report annually on the level of incidental catches of marine turtles by species, as provided at Table 6.

TABLE 6. Marine turtle species reported as caught in fisheries within the IOTC area of competence.

Common name	Scientific name
Flatback turtle	*Natator depressus*

Green turtle	*Chelonia mydas*
Hawksbill turtle	*Eretmochelys imbricata*
Leatherback turtle	*Dermochelys coriacea*
Loggerhead turtle	*Caretta caretta*
Olive ridley turtle	*Lepidochelys olivacea*

SC15.27 (para.117) The SC **NOTED** that it is mandatory for marine turtles (in number) to be recorded on logbooks for purse seine and gillnet but not for longline and **RECOMMENDED** that marine turtles, as a group, be added to Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*, in Annex II (Record once per set/shot/operation) paragraph 2.3 (SPECIES) for longline gear.

SC15.28 (para.118) **NOTING** that Resolution 10/02 does not make provisions for data to be reported to the IOTC on marine turtles, the SC **RECOMMENDED** that Resolution 10/02 is revised in order to make the reporting requirements coherent with those stated in Resolution 12/04 on the conservation of marine turtles.

Marine turtles – Ecological Risk Assessment Marine Turtles

SC15.29 (para.122) **NOTING** that only a few CPCs have made data available to the consultant, the SC **RECOMMENDED** that all IOTC CPCs contact the scientist leading the ERA in order to refine and complete the analysis before the next WPEB meeting.

SC15.30 (para.123) The SC **RECOMMENDED** that the IOTC Secretariat include an additional 20 day consultancy in the 2013 IOTC budget for the Commission's consideration, so that the Ecological Risk Assessment for marine turtles may be continued and that new information received may be incorporated.

Requests contained in IOTC Conservation and Management Measures

SC15.31 (para.124) The SC **RECOMMENDED** that the Commission note the following in regards to the requests to the SC outlined in paragraph 11 of Resolution 12/04:

a) *Develop recommendations on appropriate mitigation measures for gillnet, longline and purse seine fisheries in the IOTC area*

Gillnet: The absence of data for marine turtles on effort, spatial deployment and bycatch in the IOTC area of competence makes any recommendation regarding mitigation measures for this gear premature. Improvements in data collection and reporting of marine turtle interactions with gillnets, and research on the effect of gear types (i.e. net construction and colour, mesh size and soak times) are necessary.

Longline: Current information suggests inconsistent spatial catches (i.e. high catches in few sets) and by gear/fishery. The most important mitigation measures relevant for longline fisheries are to:

3. Support further research into the effectiveness of circle hooks as part of a multiple species approach, so as to avoid, as far as possible, promoting a mitigation measure for one bycatch taxon that might exacerbate bycatch problems for other taxa.
4. Release live animals after careful dehooking/disentangling/line cutting (see handling guidelines in the IOTC marine turtle identification cards).

Purse seine: see c) below

b) *Develop regional standards covering data collection, data exchange and training*

4. The development of standards using the IOTC guidelines for the implementation of the Regional Observer Scheme should be undertaken, as it is considered the best way to collect reliable data related to marine turtle bycatch in the IOTC area of competence.
5. The Chair of the WPDCS to work with the IOSEA MoU Secretariat, which has already developed regional standards for data collection, and revise the observer data collection forms and observer reporting template as appropriate, as well are current recording and reporting requirements through IOTC Resolutions, to ensure that the IOTC has the means to collect quantitative and qualitative data on marine turtle bycatch.
6. Encourage CPCs to use IOSEA expertise and facilities to train observers and crew to increase post-release survival rates of marine turtles.

c) *Develop improved FAD designs to reduce the incidence of entanglement of marine turtles,* *including the use of biodegradable materials*

2. Refer to paragraph 103 above.

Report of the Fourth Session of the Working Party on Methods (WPM04)

Capacity building

SC15.32 (para.128) The SC **RECOMMENDED** that the IOTC Secretariat coordinate the development and delivery of several training workshops focused on providing assistance to developing CPCs to better understand the MSE process, including how reference points and harvest control rules are likely to function in an IOTC context. The implications of IOTC Resolution 12/01 *on the implementation of the precautionary approach* and IOTC Recommendation 12/14 *on interim target and limit reference points* should be incorporated into the workshop. The SC **REQUESTED** that the Commission's budget incorporate appropriate funds for this purpose.

Work on MSE development

SC15.33 (para.134) The SC **RECOMMENDED** that the Commission allocate funds in the 2013 and 2014 IOTC budgets, for an external expert on MSE to be hired for 30 days per year, to supplement the skill set available within IOTC CPCs, and for the establishment of a participation fund to cover the planned WPM workshops.

Report of the Fourteenth Session of the Working Party on Tropical Tunas (WPTT14)

Yellowfin tuna – Stock Assessment

SC15.34 (para.158) The SC **AGREED** that a comparative analysis on the Multifan-CL / SS3 assessments in both the Indian Ocean and East Pacific Ocean should be performed by a small group of experts (at least the IOTC consultant and the IATTC expert) working jointly. The objective of this comparative work is to understand why the biomass estimated by the models differ by a ratio 1:10 when many parameters driving the assessment are very similar, i.e. spatial extent of the fishery, estimated MSY, size range of fish caught and growth pattern. One of the aims would be to understand why such differences exist in order to revisit some of the basic assumptions of the models. Therefore, the SC **RECOMMENDED** that the Commission consider funding this proposed work which would need to cover one consultant airfare (up to US$6,000), DSA (up to US$350 per day – 7 days), plus an FAO consultancy rate of US$450 per day (7 days). The total amount requested for this comparative study is US$11,600) per consultant.

Stock assessment consultant

SC15.35 (para.161) The SC **NOTED** the excellent work done by Mr. Adam Langley (consultant) and his contributions and expertise on integrated stock assessment models, and **RECOMMENDED** that his engagement be renewed for the coming year.

Report of the Second Session of the Working Party on Neritic Tunas (WPNT02)

SC15.36 (para.165) The SC **RECOMMENDED** that the Commission note that neritic tuna and tuna-like species under the IOTC mandate have become as important or more important as the three tropical tuna species (bigeye tuna, skipjack tuna and yellowfin tuna) to most IOTC coastal states with a total estimated catch of 605,359 t being landed in 2011, and as a result, should be receiving appropriate management resources from the IOTC. In fact, neritic tuna species are in many cases, the major commercial tuna and tuna-like species being exploited by the majority of Indian Ocean coastal states and as such, should be given the same status in terms of time and resource investment.

SC15.37 (para.166) **NOTING** that monofilament gillnets are recognised to have highly detrimental impacts on fishery ecosystems, as they are non-selective, and that the use of monofilament gillnets have already been banned in a large number of IOTC CPCs, the SC **RECOMMENDED** that the IOTC Secretariat facilitate a review of the use of monofilament gillnets by IOTC CPCs to i) determine the number of CPCs using then, ii) estimate total catch and bycatch, etc., taken by monofilament gillnets in comparison to other net material, and iii) to report the findings at the next WPNT meeting.

IOTC database for neritic tunas

SC15.38 (para.168) The SC **NOTED** that some CPCs have data collection systems that do not include provisions for the sampling of neritic tuna species, as required by the Commission, and

RECOMMENDED that the existing sampling systems are extended to facilitate data collection for neritic tunas, by species, so as to fulfil their mandatory reporting requirements regarding those species. The SC further **NOTED** that some CPCs have fisheries directed at neritic tuna species and may require assistance with the implementation of data collection for those fisheries and **RECOMMENDED** that such CPCs contact the IOTC Secretariat for further guidance.

Summary discussion of matters common to Working Parties

Capacity building activities

SC15.39 (para.177) The SC **RECOMMENDED** that the Commission increase the IOTC Capacity Building budget line so that capacity building workshops/training can be carried out in 2013 and 2014 on the collection, reporting and analyses of catch and effort data for neritic tuna and tuna-like species. Where appropriate this training session shall include information that explains the entire IOTC process from data collection to analysis and how the information collected is used by the Commission to develop Conservation and Management Measures.

Funding for Chairs and Vice-Chairs to attend IOTC meetings

SC15.40 (para.178) The SC **RECOMMENDED** that the IOTC Secretariat include a proposed budget line in the IOTC budget for 2013 and all future years, that would cover the travel expenses of Chairs and Vice-Chairs from developing countries (and developed countries when they are not attached to any national institutions) who are otherwise unable to obtain funding to support their attendance at their respective working party meeting, and for a Chair or Vice-Chair to attend the SC meeting each year.

IOTC species identification cards

Billfish identification cards

SC15.41 (para.179) **NOTING** that the IOTC Secretariat has developed identification cards for billfish species at the request of the WPB and SC, but no funds have yet been allocated to print the cards, the SC **RECOMMENDED** that the Commission allocate funds in the 2013 budget to print sets of identification cards for the billfish species, noting that the total estimated printing costs for the first 1000 sets of the identification cards is around a maximum of US$6,700 (Table 7). The IOTC Secretariat shall seek funds from potential donors to print additional sets of the identification cards at US$5,500 per 1000 sets of cards.

TABLE 7. Estimated production and printing costs for 1000 sets of billfish species identification cards

Description	Unit price	Units required	Total
Printing plates / plate	US$100	12	1,200
Printing /1000 sets	US$5500	1	5,500
Total estimate (US$)			**6,700**

Shark, marine turtle and seabird identification cards

SC15.42 (para.181) The SC **RECOMMENDED** that the Commission allocate additional funds in 2013 to print further sets of the shark, seabird and marine turtle identification cards developed by the IOTC Secretariat, noting that expected costs are in the vicinity of US$6,000 per 1000 sets of cards.

Tunas and mackerels

SC15.43 (para.183) The SC **RECOMMENDED** that the Commission allocate funds in the 2013 budget to develop and print sets of identification cards for the three tropical tuna, two temperate tuna, and six neritic tuna and seerfish species under the IOTC mandate, noting that the total estimated production and printing costs for the first 1000 sets of the identification cards is around a maximum of US$16,200 (Table 8). The IOTC Secretariat shall seek funds from potential donors to print additional sets of the identification cards at US$5,500 per 1000 sets of cards.

TABLE 8. Estimated production and printing costs for 1000 sets of tuna species identification cards (11 species of tropical, temperate and neritic tunas and mackerels)

Description	Unit price	Units required	Total
Purchase images	US$100	22 (2 per species, plus 2 covers)	2,200
Contract days	US$350	20	7,000
Printing plates / plate	US$100	15	1,500
Printing /1000 sets	US$5500	1	5,500

Total estimate (US$)	**16,200**

Fishing hook identification cards

SC15.44 (para.184) Noting the continued confusion in the terminology of various hook types being used in IOTC fisheries, (e.g. tuna hook vs. J-hook; definition of a circle hook), the SC **RECOMMENDED** that the IOTC Secretariat develop an identification guide for hooks and pelagic gears used in IOTC fisheries, as staffing and financial resources permit, and to distribute the guide to all CPCs once completed. The SC also **AGREED** that circle hooks are defined by hooks having their point turned at least 90° from their shank.

Identification cards – general

SC15.45 (para.185) The SC **RECOMMENDED** that IOTC CPCs translate, print and disseminate the identification cards to their observers and field samplers (Resolution 11/04), and as feasible, to their fishing fleets targeting tuna, tuna-like and shark species. This would allow accurate observer, sampling and logbook data on tuna and tuna-like species to be recorded and reported to the IOTC Secretariat as per IOTC requirements.

Dedicated workshop on CPUE standardisation

SC15.46 (para.189) **NOTING** the combined recommendations from the WPB, WPTmT and WPTT to hold a dedicated workshop on CPUE standardisation, the SC **RECOMMENDED** that a dedicated, informal workshop on CPUE standardisation, including issues of interest for other IOTC species, should be carried out before the next round of stock assessments in 2013. The terms of reference (TORs) for the workshop are provided in Appendix VII. Where possible it should include a range of invited experts, including those working on CPUE standardisation in other ocean/RFMOs, in conjunction with scientists from main tuna fishing countries, and supported by the IOTC Secretariat. The IOTC Secretariat shall include a budget item for this workshop, for the consideration of the Commission.

On Interim Target and Limit Reference Points

SC15.47 (para.194) **NOTING** the completion of the MSE work on tropical tunas is likely to take several years, and that the lack of data or information to improve the work on formal stock assessments should not hinder the application of the Precautionary Approach, the SC **RECOMMENDED** that the Commission consider the adoption of the interim target and limit reference points as a Resolution. Furthermore, interim harvest controls rules should be considered by the Commission for adoption in the Resolution.

Employment of a Fisheries Officer (Science)

SC15.48 (para.195) **NOTING** the rapidly increasing scientific workload at the IOTC Secretariat, including a wide range of additional science related duties assigned to it by the SC and the Commission, and that the current Fishery Officer supporting the IOTC scientific activities will depart at the end of February 2013, the SC strongly **RECOMMENDED** that the Commission approve the hiring of a Fishery Officer (Science) to work on a range of matters in support of the scientific process, including but not limited to science capacity building, bycatch and regional observer schemes.

Chairs and Vice-Chairs of the Working Parties

SC15.49 (para.196) The SC **RECOMMENDED** that the Commission note and endorse the Chairs and Vice-Chairs for each of the IOTC Working Parties, as provided in Appendix VIII.

Examination of the Effect of Piracy on Fleet Operations and Subsequent Catch and Effort Trends

SC15.50 (para.204) The SC **RECOMMENDED** that given the lack of quantitative analysis of the effects of piracy on fleet operations and subsequent catch and effort trends, and the potential impacts of piracy on fisheries in other areas of the Indian Ocean through the relocation of longliners to other fishing grounds, specific analysis should be carried out and presented at the next WPTT meeting by the CPCs most affected by these activities, including Japan, Republic of Korea and Taiwan,China. The Chair of the WPTT shall facilitate the analysis and report back to the SC in 2013.

Implementation of the Regional Observer Scheme

SC15.51 (para.218) The SC **RECOMMENDED** that all IOTC CPCs urgently submit, and keep up-to-date, their list of accredited observers to the IOTC Secretariat and implement the requirements of

Resolution 11/04 *on a Regional Observer Scheme*, which states that:
"The observer shall, within 30 days of completion of each trip, provide a report to the CPCs of the vessel. The CPCs shall send within 150 days at the latest each report, as far as continuous flow of report from observer placed on the longline fleet is ensured, which is recommended to be provided with 1°x1° format to the Executive Secretary, who shall make the report available to the Scientific Committee upon request. In a case where the vessel is fishing in the EEZ of a coastal state, the report shall equally be submitted to that Coastal State." (para. 11)

SC15.52 (para.220) The SC **RECOMMENDED** that the Commission consider how to address the lack of implementation of observer programmes by CPCs for their fleets and reporting to the IOTC Secretariat as per the provision of Resolution 11/04 *on a Regional Observer Scheme*, noting the update provided in Appendix XXXIII.

Outlook on Time-Area Closures

SC15.53 (para.225) The SC reiterated its previous **RECOMMENDATION** that the Commission note that the current closure is likely to be ineffective, as fishing effort will be redirected to other fishing grounds in the Indian Ocean. The positive impacts of the moratorium within the closed area would likely be offset by effort reallocation. For example, the WPTmT noted that longline fishing effort has been redistributed to traditional albacore fishing grounds in recent years, thereby further increasing fishing pressure on this stock.

SC15.54 (para.226) **NOTING** that the objective of Resolution 12/13 is to decrease the overall pressure on the main targeted stocks in the Indian Ocean, in particular yellowfin tuna and bigeye tuna, and also to evaluate the impact of the current time/area closure and any alternative scenarios on tropical tuna populations, the SC reiterated its previous **RECOMMENDATION** that the Commission specify the level of reduction or the long term management objectives to be achieved with the current or alternative time area closures and/or alternative measures, as these are not contained within the Resolution 12/13. This will, in turn, guide and facilitate the analysis of the SC, via the WPTT in 2013 and future years.

SC15.55 (para.227) **NOTING** the lack of research examining time-area closures in the Indian Ocean by the WPTT in 2011 and 2012, as well as the slow progress made in addressing the Commission request, the SC reiterated its **RECOMMENDATION** that the SC Chair begins a consultative process with the Commission in order to obtain clear guidance from the Commission about the management objectives intended with the current or any alternative closure. This will allow the SC to address the Commission request more thoroughly.

Impacts of Catching Bigeye Tuna and Yellowfin Tuna Juveniles and Spawners

SC15.56 (para.231) The SC **NOTED** however, that the fishery statistics available for many fleets, in particular for coastal fisheries, are not accurate enough for a comprehensive analysis as has been repeatedly noted in previous WPTT and SC reports. In particular, the SC **RECOMMENDED** that all CPCs catching yellowfin tuna should undertake scientific sampling of their yellowfin tuna catches to better identify the proportion of bigeye tuna catches. Therefore, the SC **RECOMMENDED** the countries engaged in those fisheries to take immediate actions to reverse the situation of fishery statistics reporting to the IOTC Secretariat.

Progress on the Implementation of the Recommendations of the Performance Review Panel

SC15.57 (para.235) The SC **RECOMMENDED** that the Commission note the updates on progress regarding Resolution 09/01 *on the performance review follow–up*, as provided at Appendix XXXIV.

Schedule and Priorities of Working Party and Scientific Committee Meetings for 2013 and Tentatively for 2014

Schedule of meetings for 2013 and 2014

SC15.58 (para.234) The SC **RECOMMENDED** that the Commission endorse the schedule of Working Party and Scientific Committee meetings for 2013, and tentatively for 2014 (Table 10).

TABLE 10. Schedule of Working Party and Scientific Committee meetings for 2013, and tentatively for 2014.

Meeting	2013		2014 (tentative)	
	Date	Location	Date	Location

Working Party on **Neritic Tunas**	2–5 July (4d)	Bali, Indonesia or Tanzania	13–16 July (4d)	Bali, Indonesia or Tanzania
Working Party on **Temperate Tunas**	Nil	Nil	5–8 Aug (4d)	TBD
Working Party on **Ecosystems and Bycatch**	12–16 Sept (5d)	La Réunion	9–13 Sept (5d)	TBD
Working Party on **Billfish**	18–22 Sept (5d)	La Réunion	17–21 Sept (5d)	TBD
Working Party on **Tropical Tunas**	22–27 Oct (6d)	Bilbao or San Sebastián, Spain	21–26 Oct (6d)	TBD
Working Party on **Methods**	Nil	Nil	30 Nov (1d)	Victoria, Seychelles
Working Party on **Data Collection and Statistics**	29–30 Nov (2d)	Victoria, Seychelles	Nil	Nil
Scientific Committee	2–6 Dec (5d)	Victoria, Seychelles	1–5 Dec (5d)	Victoria, Seychelles
Working Party on **Fishing Capacity**	Nil	Nil	Nil	Nil

Review of the Draft, and Adoption of the Report of the Fifteenth Session of the Scientific Committee

SC15.59 (para.251) The SC **RECOMMENDED** that the Commission consider the consolidated set of recommendations arising from SC15, provided at Appendix XXXVIII.

RECOMMENDATIONS TO SPECIFIC CPCS AND/OR OTHER BODIES

IOTC-OFCF Project, 2012

SC15.60 (para.18) The SC **THANKED** Japan and the IOTC Secretariat for providing financial and technical support to assist the implementation of the IOTC Observer Scheme in coastal countries of the IOTC area of competence and **RECOMMENDED** that Japan consider an extension of IOTC–OFCF Project activities in the future.

Report of the Fourth Session of the Working Party on Temperate Tunas (WPTmT04)

Data available at the Secretariat for temperate tuna species

SC15.61 (para.40) The SC **NOTED** the main albacore data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI of the WPTmT04 report (IOTC–2012–WPTmT04–R), and **RECOMMENDED** that the CPCs listed in the appendix, make efforts to remedy the data issues identified and to report back to the WPTmT at its next meeting.

SC15.62 (para.44) The SC **NOTED** that following a request by the Ministry of Fisheries of Mauritius, the IOTC-OFCF Project had provided assistance for an independent evaluation of data collection and reporting systems in Mauritius, in particular evaluation of catch, effort, and size data collection systems for albacore, as recommended by the SC in 2011. The SC **THANKED** Mauritius and the IOTC-OFCF Project for this initiative and **RECOMMENDED** that the Project considers extending support in the future to assist Mauritius to address the recommendations issuing from the evaluation, where possible.

Stock assessments

SC15.63 (para.50) **NOTING** that the Taiwan,China indices of abundance used by the WPTmT for the assessment of albacore covered the period from 1984 to 2010, despite the fact that catch-and-effort data for this fleet are available from the late 1960's, the SC **RECOMMENDED** that the WPTmT uses a standardised CPUE series using the complete catch-and-effort data series in the future.

Parameters for future analyses: CPUE standardisation and stock assessments

SC15.64 (para.52) The SC **AGREED** that there is value in undertaking a number of different modelling approaches to facilitate comparison, and **RECOMMENDED** that spatially structured integrated models, which are capable of more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simpler production models, be carried out for the next WPTmT, as data and resources permit.

Report of the Tenth Session of the Working Party on Billfish (WPB10)

Data available at the Secretariat for billfish species

SC15.65 (para.62) The SC **NOTED** the main billfish data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI of the WPB10 report (IOTC–2012–WPB10–R), and **RECOMMENDED** that the CPCs listed in the appendix, make efforts to remedy the data issues identified and to report back to the WPB at its next meeting.

Length-age keys

SC15.66 (para.64) The SC **RECOMMENDED** that as a matter of priority, CPCs that have important fisheries catching billfish (EU, Indonesia, Japan,Sri Lanka and Taiwan,China,) to collect and provide basic or analysed data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, by sex and area.

Data inconsistencies

SC15.67 (para.73) The SC **RECOMMENDED** that as a matter of priority, India, Iran and Pakistan provide catch-and-effort data and size data for billfish, in particular for gillnet fisheries, as soon as possible, noting that this is already a mandatory reporting requirement.

Madagascar's billfish landings

SC15.68 (para.78) **NOTING** that the longline fishery in Madagascar is a new and developing fishery, the SC **RECOMMENDED** that Madagascar ensure that it develops and implements a data collection system, including sampling, logbooks and observers, which would adequately cover the entire fishery.

Maldives billfish landings

SC15.690 (para.80) The SC **NOTED** that the level of capture of marlins from the Maldivian artisanal fishery appears to be very high compared to the total catches reported for the Indian Ocean and **RECOMMENDED** that the Maldives provide a review of its landings of each marlin species at the next WPB meeting

SC15.70 (para.81) The SC **RECOMMENDED** that the Maldives implement data collection systems, through logbooks and sampling for its fisheries that incorporate species level information requirements for billfish, as per IOTC Resolution 12/03. The information collected should allow the Maldives to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

Mozambique billfish landings

SC15.71 (para.82) **NOTING** that at present no scientific observers are being placed on board foreign flagged vessels licensed to fish in the Mozambique EEZ, the SC **RECOMMENDED** that Mozambique make it a licensing requirement for any foreign vessels fishing in the Mozambique EEZ to take on board scientific observers and to report the data collected as per IOTC requirements. Foreign vessels fishing in the Mozambique EEZ should ensure that scientific observers are brought onboard as per IOTC requirements.

Review of fleet dynamics

SC15.72 (para.83) The SC **RECOMMENDED** that both Japan and Taiwan,China undertake a complete historical review of their longline data and to document the changes in fleet dynamics for presentation at the next WPB meeting. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data.

Swordfish: European Union longline fisheries CPUE indices

SC15.73 (para.86) The SC **RECOMMENDED** that scientists from the EU undertake a revised CPUE analysis for their longline fleets, and consider combining the analysis prior to the next WPB meeting where swordfish will be dealt with as a priority.

Report of the Eighth Session of the Working Party on Ecosystems and Bycatch (WPEB08)

Sharks – Status of catch statistics and data reporting

SC15.74 (para.95) The SC **NOTED** the main shark data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VIII of the WPEB08 report (IOTC–2012–WPEB08–R), and **RECOMMENDED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPEB at its next meeting, noting the status and type of datasets that need to be provided for sharks, and other bycatch species provided at Appendix IX of the WPEB08 report (IOTC–2012–WPEB08–R).

SC15.75 (para.98) The SC **NOTED** the absence of information on shark catches from artisanal fisheries in Mozambique and **RECOMMENDED** that information on shark catches from those fisheries is collected and reported in due course.

Report of the Fourteenth Session of the Working Party on Tropical Tunas (WPTT14)

Data availability

SC15.76 (para.139) **NOTING** that the main tropical tuna data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI of the WPTT report (IOTC–2012–WPTT14–R), the SC **RECOMMENDED** that the CPCs listed in the appendix, make efforts to remedy the data issues identified and to report back to the WPTT at its next meeting.

SC15.77 (para.140) **NOTING** that the Maldivian skipjack tuna catch is not separated by association type, i.e. aFAD or free schools, and therefore the proportion of skipjack tuna caught under aFADs around the Maldives is unknown, the SC **RECOMMENDED** that the Maldivian data collection system is further improved in order to account for the association of the reported catch, as this could improve the standardisation of the pole-and-line CPUE.

SC15.78 (para.141) **NOTING** that there were discrepancies in catch, effort and notably size data (low sampling rate, uneven distribution of sampling in regard to the spatial extent of the fishery) in the Japanese and Taiwan,China tropical tuna data sets, the SC **RECOMMENDED** they review the data to assess reasons for discrepancies identified by the IOTC Secretariat and to report results at the next meeting of the WPTT, including a comparison of length frequency data samples collected from commercial, research and training vessels.

Skipjack tuna

SC15.79 (para.146) **NOTING** that concerns were expressed on the ability of both the Maldives pole and line CPUE and the EU purse seine CPUE to reflect the dynamics of the stock, and given their major role in driving the current stock assesment results, the SC **RECOMMENDED** that further investigation is carried out for both CPUE series prior to the next WPTT meeting, and during the planned WPM workshop on CPUE standardisation.

SC15.80 (para.147) The SC **RECOMMENDED** further investigation of the existing data to produce an improved standardised CPUE series for the FAD-associated school skipjack tuna fishery in the Indian Ocean, and for information on these matters to be presented to the next meeting of the WPTT.

SC15.81 (para.148) **NOTING** that the areas used in the various CPUE standardisations undertaken in 2012 varied, the SC **AGREED** that there is a need to define core area(s) for each gear (pole-and-line and purse seine) for the CPUE standardisation of skipjack tuna and **RECOMMENDED** that scientists from CPCs with pole-and-line, and purse seine fisheries for skipjack tuna, work together to explore their data in a manner to advance CPUE standardisation work for the next meeting of the WPTT in 2013, and defined such core areas for each gear, well in advance of the next WPTT meeting in 2013.

SC15.82 (para.149) **NOTING** that the tagging data is now more complete and available, including the tagging experiment results from Maldives in the 1990s the SC **RECOMMENDED** effective use of tagging data in the new assessment including any revision on the estimates of mortality and growth rates from the tagging data.

SC15.83 (para.150) **NOTING** the use and application of interim target and limit reference points, the SC **RECOMMENDED** that the Kobe II strategy matrix should include the risk levels associated with those reference points. Furthermore, the SC **AGREED** that the probability of breaching the interim limit reference points for skipjack tuna of $1.5*F_{MSY}$ and $0.4*SB_{MSY}$ is very low and this information should be added to the Executive Summary.

Taiwan, China – Catch-per-unit-of-effort (CPUE)

SC15.84 (para.160) The SC **NOTED** that data from Taiwanese vessels flagged to India was not used in the analysis, the SC **RECOMMENDED** that national scientists from Taiwan,China work with the IOTC Secretariat to gain a better estimate of catch in the Bay of Bengal.

Parameters for future analyses: Yellowfin tuna CPUE standardisation and stock assessments

SC15.85 (para.162) **NOTING** that the areas used in the various CPUE standardisations undertaken in 2012 were very different from one analysis to another, the SC **AGREED** that there is a need to define core area(s) for the CPUE standardisation of yellowfin tuna and **RECOMMENDED** that scientists from CPCs with longline and purse seine fisheries for yellowfin tuna, work together to explore their data and define such core areas, well in advance of the next WPTT meeting in 2013.

Development of priorities for an Invited Expert at the next WPTT meeting

SC15.86 (para.163) The SC **RECOMMENDED** the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPTT in 2013, by an Invited Expert:

- CPUE analysis and standardisation
- Tuna tagging data analysis
- Tuna stock assessment models

Where possible the Invited Expert should attend both the proposed CPUE workshop and the Working Party in 2013, noting that Invited Experts are unpaid.

Report of the Second Session of the Working Party on Neritic Tunas (WPNT02)

SC15.87 (para.166) **NOTING** that monofilament gillnets are recognised to have highly detrimental impacts on fishery ecosystems, as they are non-selective, and that the use of monofilament gillnets have already been banned in a large number of IOTC CPCs, the SC **RECOMMENDED** that the IOTC Secretariat facilitate a review of the use of monofilament gillnets by IOTC CPCs to i) determine the number of CPCs using then, ii) estimate total catch and bycatch, etc., taken by monofilament gillnets in comparison to other net material, and iii) to report the findings at the next WPNT meeting.

IOTC database for neritic tunas

SC15.88 (para.167) The SC **NOTED** the main data issues that are considered to negatively affect the quality of the statistics for neritic tunas available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI of the WPNT02 report, and **RECOMMENDED** that the CPCs listed in the appendix, make efforts to remedy the data issues identified and to report back to the WPNT at its next meeting.

SC15.89 (para.169) The SC **RECOMMENDED** that the IOTC Secretariat request that any datasets for neritic tuna species held by SWIOFP, or any other parties, be provided to the IOTC Secretariat before the next meeting of the WPNT.

SC15.90 (para.170) **NOTING** that the nominal catch data (NC) for India, Indonesia and Thailand provided at the WPNT02 meeting were found to conflict with the NC data history provided by these countries in recent years, and for catch-and-effort data for most of the history of the gillnet fleet, the SC **RECOMMENDED** that India, Indonesia and Thailand liaise with the IOTC Secretariat to provide a fully justified revised catch history which will replace the data currently held by the IOTC Secretariat before the next WPNT meeting.

Data set availability

SC15.91 (para.171) **NOTING** that some CPCs, in particular from India, Indonesia and Thailand, have collected large data sets on neritic tuna species over long time periods, the SC **RECOMMENDED** that this data, as well as data for other CPCs, be submitted to the IOTC Secretariat as per the requirements adopted by IOTC Members in Resolution 10/02. This would allow the WPNT to develop stock status indicators or comprehensive stock assessments of neritic tuna species in the future.

Priorities for an Invited Expert at the next WPNT meeting

SC15.92 (para.174) The SC **RECOMMENDED** the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPNT in 2013, by an Invited Expert:

- Expertise: stock structure/connectivity; including from regions other than the Indian Ocean; data poor assessment approaches.
- Priority areas for contribution: kawakawa, longtail tuna and narrow-barred Spanish mackerel biology, ecology and fisheries.

Summary discussion of matters common to Working Parties

CPUE discussion summary

SC15.93 (para.187) The SC **EXPRESSED** concern that the majority of the important recommendations issued by the SC to the various working parties in previous years in regards to CPUE standardisation have often not been addressed, and that there was no major progress on these issues during the past two years. Therefore, the SC **RECOMMENDED** that the scientists in charge of this work make every possible effort to consider those guidelines in future CPUE standardisation work in order to improve the quality of CPUE series which are essential to stock assessments.

SC15.94 (para.188) **NOTING** that a set of ‘core areas’ which are likely to be robust to frequent fluctuations of external factors, may be more informative than using all of the data available, especially when other species were being targeted, the SC **RECOMMENDED** that ‘core areas’ be identified and agreed to by each working party so as to facilitate and monitor population abundance trends across all fleets. This should be carried out intersessionally and presented at the proposed longline CPUE workshop, to be held in the second quarter of 2013.

Risk-based approaches to determining stock status

SC15.95 (para.190) The SC **RECOMMENDED** that the IOTC Secretariat facilitate a process to provide the necessary information to the SC so that it may consider the Weight-of-Evidence approach to determine species stock status, as an addition to the current approach of relying solely on fully quantitative stock assessment techniques.

Revised ‘Guidelines for the Presentation of Stock assessment Models’

SC15.96 (para.247) **NOTING** the conclusions and recommendation from the KOBE 3 meeting held in 2011,

> “*Kobe III participants* ***agreed*** *that the K2SM is a useful tool for evaluating management strategies or options,* ***provided that the uncertainties in assessments can be adequately quantified****. Participants acknowledged that* ***considerable work remains to be done*** *both to reduce uncertainty in stock assessments, and to develop common standards or guidelines for how uncertainty is reflected. Kobe III participants recommended that the scientific committees and bodies of the tRFMOs jointly develop methods to* ***better quantify the uncertainty*** *and understand how this uncertainty is reflected in the risk assessment inherent in the K2SM*.”

the SC **RECOMMENDED** that in 2013, collaborative efforts be developed among tRFMO on this matter, by targeting the development of how to build K2SM with well estimated levels of uncertainty.