**出國報告(出國類別：其他)**

# 參加「印度洋鮪類委員會（IOTC）第 16 屆科學次委員會（SC16）會議」出國報告

服務機關：行政院農業委員會漁業署
姓名職稱：技佐　藍聰文
派赴國家：韓國釜山
出國期間：102 年 12 月 1 日至 12 月 7 日
報告日期：103 年 3 月 4 日

# 摘要

本次印度洋鮪類委員會（IOTC）第 16 屆科學次委員會（SC16）會議於本（102）年 12 月 2 日至 6 日在韓國釜山舉行，參加國家有澳洲、日本、韓國、馬爾地夫、泰國、歐盟、馬來西亞、法國印度洋屬地、模里西斯、印尼、肯亞、印度、科莫羅群島、塞席爾、斯里蘭卡、英國海外領地、馬達加斯加、坦尚尼亞、中國及萬那杜等會員國代表出席，另有 WWF、SWIOFP（西南印度洋漁業計畫）、ISSF、Birdlife International、ACAP 等代表參與。我國由葉裕民助理教授率團，對外漁協於仁汾組長及本署藍聰文技佐參加，並以受邀專家（Invited experts）身分與會。有關本次會議重要結果摘述如次：

一、主要魚種資源狀態及管理建議：

(一)長鰭鮪：資源評估結果顯示漁獲量過漁（overfishing），但資源量未過漁（overfished）。建議至少減少 20%之漁獲死亡率以確保親魚資源量維持在 MSY 水準。

(二)大目鮪及正鰹：資源評估結果顯示漁獲量及資源量未過漁(not overfishing and not overfished)。建議大目鮪及正鰹漁獲量不應超過 MSY 水準，漁獲量持續低於 MSY 水準下，則不需要有立即性的管理措施。

(三)黃鰭鮪：資源評估結果顯示漁獲量及資源量未過漁(not overfishing and not overfished)。建議每年漁獲量應不超過 300,000 公噸，以確保資源可維持在 MSY 水準。

(四)紅肉旗魚：資源評估結果顯示漁獲量及資源量皆過漁（overfishing and overfished）。建議應改善資料收集與回報，以評估未來系群之資源量。

(五)劍旗魚：資源評估結果顯示漁獲量及資源量未過漁(not overfishing and not overfished)。建議每年漁獲量應不超過 30,000 公噸，若持續降低努力量，並維持漁獲量在 MSY 之下，則不需擔心資源狀況。

二、混獲議題：建議秘書處聘任混獲議題專家以及小組未來運作模式之三個選項：1.鯊魚及混獲議題分離成兩小組。2.鯊魚及混獲議題年間交替討論。3.每年討論鯊魚議題，混獲議題隔一年討論或視委員會要求不定期討論。

三、明（103）年重要會議安排：沿岸鮪類工作小組（7 月 2 至 5 日，泰國）、溫帶鮪類工作小組（7 月 28-31 日，日本或韓國）、旗魚工作小組（10 月 21-25 日，日本或坦薩尼亞）、生態與混獲工作小組（10 月 27-30 日，日本或坦薩尼亞）、管理策略評估工作小組（11 月 15-16 日，印尼）、熱帶鮪類工作小組（11 月 17-21 日，印尼）、資料蒐集與統計工作小組（12 月 10-13 日，塞昔爾）、方法論工作小組（12 月 13-14 日，塞昔爾）、科學次委員會（12 月 16-20 日，塞昔爾）。

四、重要魚種資源評估時程：大目鮪於 105 年進行、正鰹於 103 及 106 年進行、黃鰭鮪於 104 及 107 年進行、長鰭鮪於 103、105 及 107 年進行、劍旗魚於 103 及 106 年進行。

五、明年度 SC 主席及副主席仍分別由日本 Nishida 博士及塞昔爾 Jan Robinson 擔任。

關鍵詞：印度洋鮪類委員會，科學委員會，鮪旗魚類，資源評估

目次

## 壹、目的

印度洋鮪類委員會(IOTC)為負責印度洋鮪類資源管理之國際漁業組織，隸屬於聯合國糧農組織(FAO)。自 1996 年成立以來，該組織即積極對該洋區主要漁獲魚種進行資源評估，其中熱帶鮪類漁獲量大，且產值高，為近年來該組織最關切之魚種。

印度洋為我國鮪釣船主要作業漁場之一，近年來我國在該洋區作業之船隊規模大，年漁獲量達十萬公噸，位居各國前茅，IOTC 會議結果對我國產業極為重要。由於目前各國際組織為達資源永續利用之目標，正積極加強對各魚種資源的管理，並以漁獲配額為管理手段。因此為避免影響我國漁船於印度洋之作業權益，並善盡漁業國之責任，及獲取各國肯定支持我國科研之努力及對資源保育之貢獻，作為未來爭取參與 IOTC 之基礎，我國乃派員參加本次會議。

## 貳、會議過程及結果

IOTC 第 16 屆科學次委員會於本（102）年 12 月 2 日至 6 日在韓國釜山舉行，由 Dr. Tom Nishida 擔任主席，參加國家有澳洲、日本、韓國、馬爾地夫、泰國、歐盟、馬來西亞、法國印度洋屬地、模里西斯、印尼、肯亞、印度、科莫羅群島、塞席爾、斯里蘭卡、英國海外領地、馬達加斯加、坦尚尼亞、中國及萬那杜等會員國代表出席，另有 WWF、SWIOFP（西南印度洋漁業計畫）、ISSF、Birdlife International、ACAP 等代表參與。我國由葉裕民助理教授率團，對外漁協於仁汾組長及本署藍聰文技佐參加，並以受邀專家（Invited experts）身分與會。謹將會議重要結果摘述如下：

<u>12 月 2 日</u>

一、由主席 Dr. Tom Nishida 宣佈會議開始。

二、主席宣讀議程，歐盟代表提出在其他事項增加 16.2 氣候變遷及 16.3 海洋漁業資料庫，在與會代表無其他異議下通過本次會議議程。此外主席說明在會議期間將會有 MSE 討論，會議時間將在會中宣布。

三、與會員國及受邀專家自我介紹（略）。

四、由秘書處報告本年度第 17 屆委員會會議之各項進展與結論（IOTC–2013–SC16–03），並說明該委員會議所作之決定（IOTC–2013–SC16–04）。

五、由秘書處說明本（2013）年度各項活動（IOTC–2013–SC16–05），本年度 IOTC 秘書處共舉行「旗魚」、「熱帶鮪類」、「生態系及混獲」、「沿近海鮪類（neritic tuna，小鮪）」、「資料蒐集與統計」等工作小組會議，及本次的第 16 屆科學委員會；在受邀專家部份，除「第 14 屆科學委員會會議」及「資料蒐集與統計工作小組會議」外，前述各項會議之受邀專家包括：

(一)旗魚工作小組會議：Dr. Humber Andrade（Universidade Federal Rural de Pernambuco, Brazil）。

(二)熱帶鮪類工作小組會議：Dr. Andrew Cooper（Simon Fraser University, Canada）。

(三)生態系及混獲工作小組會議：Dr. Ronel Nel（Nelson Mandela Metropolitan University, South Africa）。

(四)沿近海鮪類工作小組會議：Dr. Shiji Zhou（CSIRO, Australia）。

本年度在印尼峇里島及韓國釜山舉辦兩場海鳥忌避措施技術研討會，以協助會員國能達成委員會決議案中要求之海鳥忌避措施施行。另舉辦一場為期 2 天的 CPUE 研討會。

六、網站更新

由副秘書長簡報目前 IOTC 網站更新進度，歐盟代表對此進度表示滿意，並希望能儘早更換上線。

七、資源現況證據權重體制

由澳洲代表簡報目前澳洲政府對其國內魚類資源評估使用之證據權重體制，該項體制希望透過多重與資源及開發努力量有關之證據，綜合考量分別給予權重評估資源現況，以降低資源現況之不確定，讓管理者有充分資訊進行資源管理，然與會者對於權重分配規則提出質疑，澳洲代表回復權重分配是由專家決定，考量的角度在於降低不確定性，歐盟代表希望此份簡報能有文件供參考，主席決定將簡報檔放置網路供與會者下載。

八、由秘書處簡報 IOTC–2013–SC16–06 號文件有關次委員會、會員國及秘書處及各工作小組正式報告之用語，主席表示將會在主要議題討論結束後再回頭討論該文件。

九、國家報告（IOTC–2013–SC16–NR01 to 33）：我國以受邀專家身份，由對外漁協於仁汾組長摘要我國國家報告，並由本署藍聰文技佐進行簡報。謹摘錄討論較為詳細之國家報告部份重點：

(一)中國（IOTC–2013–SC16–NR03）：混獲小組提問是否有提交觀察員航次報告，秘書處回復該報告皆放置於文件 14 中。

(二)印度（IOTC–2013–SC16–NR09）：歐盟提問是否有提交漁業資料，日本提問其國家報告中是否包含丟棄資訊。

(三)歐盟（IOTC–2013–SC16–NR06）：馬爾地夫要求應提供英文版本報告。

(四)馬爾地夫（IOTC–2013–SC16–NR17）：今年底將啟用漁撈作業日誌網路平台，可線上輸入作業日誌、銷售資料、維護漁船活動紀錄與漁業執照。

(五)斯里蘭卡（IOTC–2013–SC16–NR25）：由於大型鮪類具較高經濟價值，使得本國漁業傾向延繩釣漁業而減少刺網漁業，這將有效的減少混獲物種，如鯊魚及海龜等。

(六)賽席爾（IOTC–2013–SC16–NR23）：國際鳥盟提問是否實施海鳥忌避措施，賽席爾表示其船隊於南緯 25 度作業之船數較少；另日本提問是否執行觀察員計畫，賽席爾表示於 2014 年將會執行觀察員計畫。

(七)台灣：國際鳥盟提出各國應將海鳥忌避措施揭露於國家報告中。

12 月 3 日

2013 年各項工作小組會議報告：

一、第 9 屆生態系暨混獲工作小組會議報告（IOTC–2013–WPEB09–R）:

(一)由該小組法國籍副主席 Dr. Evgeny V. Romanov 說明本年 9 月 12 日至 16 日於法屬留尼旺群島召開之小組會議情形，小組提出 28 項建議案，其中大多為有關會員國資料提送相關建議，另其他重要建議包含秘書處聘任混獲議題專家以及小組未來運作三個選項(1.鯊魚及混獲分離成兩小組;2.鯊魚及混獲議題年間交替討論；3.每年討論鯊魚，混獲隔一年討論或視委員會要求不定期討論)等。

(二)日本代表提出因目前部分鯊種禁捕與混獲物種禁止留艙等規定，導致科學家無法取得研究樣本，希望建議委員會放寬科學研究所需樣本採樣。歐盟及澳洲均認為混獲物種資訊最佳來源為觀察員資料，因此應建立一套觀察員資料蒐集綱要，並支持小組提案秘書處應聘任混獲專家。英國表示支持小組以選項 3 運作。歐盟提出小組應發展生態系評估模式。

(三)另有關小組提案修正 12/03 號有關延繩釣作業報表增列鯊魚魚種案，日本及韓國均表示報表雖然可以增列但實際上還是觀察員資料比較可靠。小組主席表示分種可能有問題，鯊種小組建議蒐集到群(例如丫髻鮫不細分種)，小組強調延繩釣漁業應增加黑鯊填報。日本表示 WCPFC 僅有 8 種鯊種要蒐集，漁業管理組織不一致會讓會員國難以遵從，因此日本反對並要求列入會議紀錄。

(四)之後由葡萄牙籍 Dr. Miguel Neves Santos 報告 2JI 2JI 多年度鯊魚研究計畫(IOTC–2013–SC16–18)，該項研究計畫主要為回應委員會 13/06 號決議案，要求科學委員會在 2016 年完成鯊魚資源評估案，該研究計畫包含項目主要有資料蒐集、鯊魚生物及生態研究、鯊魚忌避措施研究以及資源評估。對此歐盟表示支持該項研究計畫並贊成編列預算，中國提出工作龐雜應尋求分工，日本提出希望能了解細部時程規劃，SC 主席表示該計畫仍須細部討論，請小組

在下屆會議討論決定，也請中國及韓國派代表與會。

(五)韓國代表簡報有關支繩加重實驗結果，該次實驗共進行 19 作業次，但試驗期間均無海鳥誤捕。

(六)秘書處提報各國有關海鳥、鯊魚及海龜 NPOA 進展，我國先前已經提報因此海鳥及鯊魚 NPOA 標示為綠色，其他會員國依照目前實際情況分別發言更正現況，韓國更正鯊魚 NPOA 已發展完成、馬爾地夫表示海鳥 NPOA 不適用該國、中國提問是否有 NPOA 格式可參考，斯里蘭卡享依循馬爾地夫海鳥 NPOA 不適用模式遭國際鳥盟質疑該國有流刺網漁業應適用。。

二、沿岸鮪工作小組會議報告(IOTC–2013–WPNT03–R)，由副秘書長 Dr. David Wilson 代替報告該小組第 3 屆會議情況，馬來西亞及印尼代表發言表示未來將持續配合進行有關沿岸鮪研究工作

三、第 11 屆旗魚工作小組會議報告（IOTC–2013–WPB11–R），由該小組副主席 Dr. Miguel Neves Santos 說明。

(一)本年度共進行黑皮旗魚、紅肉旗魚及白皮旗魚資源評估，評估結果分別為：

1.黑皮旗魚未過漁(not overfished)及過漁未發生(not overfishing)。

| Management Quantity | Indian Ocean |
|---|---|
| 2011 catch estimate | 10,340 |
| Mean catch from 2007–2011 | 10,074 |
| MSY (1000 t) (80% CI) | 11,690 (8,023–12,400) |
| Data period used in assessment | 1950–2011 |
| $F_{2011}/F_{MSY}$ (80% CI) | 0.85 (0.63–1.45) |
| $B_{2011}/B_{MSY}$ (80% CI) | 0.98 (0.57–1.18) |
| $SB_{2011}/SB_{MSY}$ | – |
| $B_{2011}/B_{1950}$ (80% CI) | 0.48 (n.a.) |
| $SB_{2011}/SB_{1950}$ | – |
| $B_{2011}/B_{1950, F=0}$ | – |
| $SB_{2011}/SB_{1950, F=0}$ | – |

2.紅肉旗魚已經過漁(overfished)且過漁發生中(overfishing)

| Management Quantity | Indian Ocean |
|---|---|
| 2011 catch estimate | 2,470 |
| Mean catch from 2007–2011 | 2,538 |
| MSY (1000 t) (95% CI) | 4,218 (3,831–4,645) |
| Data period used in assessment | 1950–2011 |
| $F_{2011}/F_{MSY}$ [plausible range of values] | 1.12 [0.74–5.95] |
| $B_{2011}/B_{MSY}$ [plausible range of values] | 0.52 [0.08–0.82] |
| $SB_{2011}/SB_{MSY}$ | – |
| $B_{2011}/B_{1950}$ [plausible range of values] | 0.26 [0.04–0.41] |
| $SB_{2011}/SB_{1950}$ | – |
| $B_{2011}/B_{1950,\ F=0}$ | – |
| $SB_{2011}/SB_{1950,\ F=0}$ | – |

3.白皮旗魚評估結果具有高度不確定性。

| Management Quantity | Stock Reduction Analysis |
|---|---|
| 2011 catch estimate | 10,291 |
| Mean catch from 2007–2011 | 9,345 |
| MSY (1000 t) (95% CI) | 8,605 (6,278–11,793) |
| Data period used in assessment | 1950–2011 |
| $F_{2011}/F_{MSY}$ (95% CI) | 1.17 (0.15–2.19) |
| $B_{2011}/B_{MSY}$ (95% CI) | 1.03 (0.75–1.55) |
| $SB_{2011}/SB_{MSY}$ | – |
| $B_{2011}/B_{1950}$ (95% CI) | – |
| $SB_{2011}/SB_{1950}$ | – |
| $B_{2011}/B_{1950,\ F=0}$ | – |
| $SB_{2011}/SB_{1950,\ F=0}$ | – |

(二)澳洲代表提議在紅肉旗魚資源現況加入”B2011 below the Bmsy and fishing mortality is in excess of Fmsy at recent catch level of around 2,500 tons”，遭歐盟代表提出此為小組報告不得更改文字而拒絕。歐盟代表提出此為旗魚類第一次資源評估具有高度不確定性，SC 主席也重申此一情況。日本代表提出資源評估僅使用日本及台灣 CPUE，可能有漁業變動，小組副主席回復下次會加入其他漁業 CPUE。日本提問旗魚類沿岸國捕獲量具有高度不確定性，小組副主席回覆其他魚種資源評估也有同樣問題，日本請大會紀錄相關討論。歐盟表示反對小組提案要求在莫三比克入漁漁船增加觀察員涵蓋率，SC 主席表示認同。

四、CPUE 研討會(IOTC–2013–SC16–12)及沿岸國能力建構報告(IOTC–2013–SC16–INF02、IOTC–2013–SC16–INF09)，由秘書處資源評估專家 Dr. Rishi Sharma 報告。其中有關能力建構部分，包含莫三比克、馬來西亞及印尼均發言表示希望秘書處能持續辦理，另澳洲及西南印度洋漁業計畫均發言表示將會持續贊助提升沿岸國能力。

12 月 4 日

一、第 15 屆熱帶鮪類工作組會議報告（IOTC–2013–WPTT 15–R），由該小組主席 Dr. Hilario Murua 說明今年 10 月 23 至 28 日會議結論。

本年度大目鮪資源評估結果顯示未過漁(not overfished)及過漁未發生(not overfishing)。

| Management Quantity | Aggregate Indian Ocean |
|---|---|
| 2012 catch estimate | 115,793 t |
| Mean catch from 2008–2012 | 107,603 t |
| MSY (80% CI) | 120,500 (90,700–150,300) |
| Data period used in assessment | 1952–2012 |
| $F_{2012}/F_{MSY}$ (80% CI) | 0.42 (0.27–0.56) |
| $B_{2012}/B_{MSY}$ | n.a. |
| $SB_{2012}/SB_{MSY}$ (80% CI) | 1.10 (0.88–1.32) |
| $B_{2012}/B_{1952}$ | 0.38 (n.a.) |
| $SB_{2012}/SB_{1952}$ (80% CI) | n.a. |
| $B_{2012}/B_{2012, F=0}$ | n.a. |
| $SB_{2012}/SB_{2012, F=0}$ (80% CI) | n.a. |

(一)歐盟代表提出大目鮪 50 公分以下成長速率目前無研究，以往科學界假定自然死亡率與年齡相關可能不符合實際情況，自然死亡率應該與體長較為相關，小組主席回復會加強大目鮪小魚成長曲線研究以及體長與自然死亡率相關性研究。

(二)歐盟代表提出資源評估應考慮到環境因素，且必須要以整體生態系角度來做管理建議，小組主席回復這是所有小組的共同議題。

(三)馬爾地夫代表提問有關秘書處彙整會員國即時漁獲資料議題，秘書處統計人員

回復近年沿岸國漁獲回報情況較好，熱帶鮪部分估算的漁獲量僅占總量之10%左右。

(四)英國代表提問有關會員國提報漁獲量是否有區分出在 EEZ 內外?小組主席回復目前無此類資訊。

(五)歐盟代表提出印度先前有 60 艘大型延繩釣漁船，這些船的漁獲量資料都沒提供給秘書處，導致資源評估資料有相當程度的不確定性。馬爾地夫代表提出因該國資料蒐集以島礁為單位，因此沒有細部作業地表資訊。

(六)日本代表提出有關小組所提建議中有關日本體長資料小魚不見的問題應該是台灣的資料問題，小組主席回復日本體長資料也有問題，SC 主席提議這部分建議作修改以正確反應問題。

二、西班牙 Dr. Maria Soto Ruiz 提報西班牙 FAD 管理計畫（IOTC–2013–SC16–INF05），說明目前西班牙在三大洋作業圍網船均需依照規定提報 FAD 作業資訊。

法國代表提出目前法國圍網船也已經開始提報相關資料。韓國代表提問是否 SC 要對 FAD 管理作建議?SC 主席回復目前僅是參考資訊並無提建議規劃。馬爾地夫提出該國有定置 FAD 作業，歐盟提出定置 FAD 是另外的議題，模里西斯提出該國有定置 FAD 管理計畫也會提送給委員會，模國圍網漁業也會提出 FAD 管理計畫。

三、方法小組會議報告（IOTC–2013–SC16–11），由小組主席 Dr. Iago Mosqueira 說明該小組今年會議結果。

小組目前正在發展作業模式(OM)及漁獲管制規則 (HCR)，將先以長鰭鮪為測試鮪種，之後將進行正鰹及熱帶鮪 MSE。

馬爾地夫發言支持 MSE 發展，並提出有關管理目標應該透過利益相關者對談來建立。歐盟提問目前是否會員國科學家小組可參加小組運作?小組主席回復目前由主席決定參加科學家。韓國提問為何長鰭鮪使用 SS3 模式作為操作模式?小組主席回復因為 SS3 模式中參數設定較具有彈性，操作模式並非要取代

資源評估模式。澳洲提出限制參考點及目標參考點目前設定情形，小組主席回復這些參考點必須由委員會決定，因為參考點會影響到 HCR。部分會員國提出希望小組能對開發中國家科學家進行能力提升讓會員國瞭解 MSE，小組主席回復會有相關研討會。

四、第 9 屆資料蒐集及統計工作小組會議報告（IOTC–2013– WPDCS09–R），由小組主席 Mr. Miguel Herrera 說明今年小組會議結論。

澳洲代表提出部分會員國未依照委員會規定提交資料，建議送紀律委員會討論。馬爾地夫提問有關 support vessel 的定義為何?是否在海上協助漁獲運搬也算?小組主席回復 support vessel 明確定義為協助漁船尋找魚群之船隻。歐盟提出支持秘書處持續對沿岸國統計資料蒐集提供協助，也認同澳洲觀點，對資料提送問題送交紀律委員會討論。印尼代表提出其國內有些問題無法提送資料，家計型漁業資料蒐集非常困難。澳洲提問有關小組提出以海上天數計算觀察員涵蓋率問題，烏盟亦提出 11/04 決議案有清楚涵蓋率定義為何要另提建議?小組主席回復秘書處沒有圍網網次數資料，僅有作業天資料。烏盟對小組提出以海上天數作涵蓋率估算表達不滿，但該案獲大多數國家支持，SC 主席決定將把小組建議案送委員會討論。

五、漁獲能力報告(IOTC–2013–SC16–INF04)，由秘書處統計人員作說明。

印度代表對報告中其船數資訊表達強烈不滿，認為與實際數值不符，秘書處說明印度船數資料從 7 個資料來源蒐集所得，每個來源的數值都不同。WPEB 副主席對法國及留尼旺漁船船數合併紀錄提出質疑，法國代表提出與會者可以從歐盟公布資料作切分，要分出法國與留尼旺船不是問題。WPEB 副主席提問是否有娛樂漁船資料?秘書處回復部分國家船數資訊有區分出來。馬來西亞提出家計型漁業船數資料蒐集困難，但如果委員會有決議，馬國政府會提出相關資訊，並提問該報告是否要送委員會?SC 主席回復該報告事委員會要求蒐集彙整相關資訊，因此會送下屆委員會討論。

12月5日

一、SC 主席提出依據 12/11 號決議案，會員國如果漁獲能力有增加必須先向 SC 作報告，由 SC 檢視相關漁獲能力增加，15-24 米漁船在沿岸國 EEZ 作業之漁船也應比照辦理。

二、SC 主席說明有關旗魚小組所提在莫三比克入漁之外國漁船觀察員派遣問題，必須依照委員會 11/04 號決議案辦理。

三、SC 主席要求 WPEB 副主席說明有關斯里蘭卡及印度聲稱該國不適用海鳥 NPOA 規範之審查程序，渠說明會員國必須在 WPEB 小組提出在漁業作業區海鳥鳥種調查、無漁業互動之科學證據及向 WPEB 提出說明並保證無漁業海鳥互動，WPEB 會議討論後將結果送 SC。

印尼提出是否有船在南緯 25 度以南作業的國家才要有 NPOA ?小組副主席回應所有會員國都要，不限於南緯 25 度以南有船作業之會員國。SC 主席建議此議題由下次小組會議討論。

四、海洋環境及生態系模式，由法國科學家 Dr. Francis Marsac 作說明，與會代表認為此議題所有魚種資源評估都適用，因此建議各魚種小組均須考量此議題。

五、魚種執行摘要檢視，因僅有長鰭鮪執行摘要有討論，討論內容下：該小組主席說明今年沒有資源評估，將會作漁獲量修正，歐盟提出實際上長鰭鮪有 13/09 號管理建議案，因此執行摘要內文要反映出來，澳洲提出相同觀點，SC 主席決議由小組主席、歐盟及澳洲代表共同檢視修正執行摘要，小組主席補充說明 2012 年長鰭鮪漁業有些改變，因為海盜危害減低，很多漁船回到熱帶區捕撈大目鮪，所以 2012 年漁獲量有減少跡象。

六、以下就資源有過漁或過漁發生中之長鰭鮪及紅肉旗魚資源現況及管理建議原文全摘，其他我國關切之魚種僅回報資源評估結果。

長鰭鮪資源現況及管理建議

| Area[1] | Indicators | | 2013 stock status determination[2] |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 33,960 t<br>37,082 t | (orange) |
| | MSY (80% CI):<br>$F_{2010}/F_{MSY}$ (80% CI):<br>$SB_{2010}/SB_{MSY}$ (80% CI):<br>$SB_{2010}/SB_{1950}$ (80% CI): | 33,300 t (31,100–35,600 t)<br>1.33 (0.9–1.76)<br>1.05 (0.54–1.56)<br>0.29 (n.a.) | |

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2] Reference year 2010 for most recent stock 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) | (red) | (orange) |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 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.*** No new stock assessment was carried out in 2013. In the 2010 assessment the WPTmT noted that 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). Thus, the 2012 assessment indicated that the stock is **subject to overfishing**, but **not overfished** (Table 1). Fishing mortality needs to be reduced by at least 20% to ensure that spawning biomass is maintained at MSY levels (Table 2). Revisions to the catch history in 2013 indicated that reported landings in 2012 (33,960 t), and those from 2011 (33,605 t) are only slightly above the MSY estimates from the previous assessment.

***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, but appears to have diminised, as longline effort has begun to return to previous levels in 2011. If recent (2008–10) patterns of fishing in the Indian Ocean continue, effort and catch directed at albacore are likley to be maintained and management action would be required. 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 37,802 t over the last five years, 33,960 t in 2012) 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% from the catch level of 2010 (42,915 t) 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 Resolution 13/10 *on interim target and limit reference points and a decision framework*, 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).

紅肉旗魚資源現況及管理建議

| Area[1] | Indicators | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 4,833 t<br>3,011 t | (red) |
| | MSY (range):<br>$F_{2011}/F_{MSY}$ (range):<br>$B_{2011}/B_{MSY}$ (range):<br>$B_{2011}/B_0$ (range): | 4,408 (3,539–4,578)<br>1.28 (0.95–1.92)<br>0.416 (0.2–0.42)<br>0.18 | |

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

| Colour key | Stock overfished($B_{year}/B_{MSY}$< 1) | Stock not overfished ($B_{year}/B_{MSY}$≥ 1) |
|---|---|---|
| Stock subject to overfishing($F_{year}/F_{MSY}$> 1) | (red) | (orange) |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 1) | (yellow) | (green) |

**INDIAN OCEAN STOCK – MANAGEMENT ADVICE**

***Stock status.*** The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicates the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method, Stock Reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicates that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the $B_{MSY}$ level and shows little signs of rebuilding despite the declining effort trend. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **overfished** and **subject to overfishing** (Table 1; Fig. 1).

***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 2013 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. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is 4,408 t (3,539–4,578). However, the biomass is well below the $B_{MSY}$ reference point and fishing mortality is in excess of $F_{MSY}$ at recent catch levels, of around 2,500 t.
- improvement in data collection and reporting is required to further assess the stock.
- research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are warranted.

## 大目鮪資源現況

| Area[1] | Indicators | | 2013 stock status[2] determination |
|---|---|---|---|
| Indian Ocean | Catch in 2012:<br>Average catch 2008–2012: | 115,793 t<br>107,603 t | |
| | MSY (1000 t):<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | 132 t (98.5–207 t)[3]<br>0.42 (0.21–0.80)[3]<br>1.44 (0.87–2.22)[3]<br>0.40 (0.27–0.54)[3] | |

[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]The point estimate is the median of the plausible models investigated in the 2013 SS3 assessment

| 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 ($F_{year}/F_{MSY}\leq 1$) | | |

## 正鰹資源現況

| Area[1] | Indicators | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 314,537 t<br>400,980 t | |
| | MSY (1000 t):<br>$F_{2011}/F_{MSY}$:<br>$SB_{2011}/SB_{MSY}$:<br>$SB_{2011}/SB_0$: | 478 t (359–598 t)<br>0.80 (0.68–0.92)<br>1.20 (1.01–1.40)<br>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 ($SB_{year}/SB_{MSY}\geq 1$) |
|---|---|---|
| Stock subject to overfishing($C_{year}/MSY> 1$) | | |
| Stock not subject to overfishing ($C_{year}/MSY\leq 1$) | | |

## 黃鰭鮪資源現況

| **Area[1]** | **Indicators** | | | **2013 stock status determination** |
|---|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 368,663 t<br>317,505 t | | |
| | | Multifan[2] | ASPM[3] | |
| | MSY (1000 t):<br>$F_{curr}/F_{MSY}$:<br>$SB_{curr}/SB_{MSY}$:<br>$SB_{curr}/SB_0$: | 344 t (290–453 t)<br>0.69 (0.59–0.90)<br>1.24 (0.91–1.40)<br>0.38 (0.28–0.38) | 320 (283–358 t)<br>0.61 (0.31–0.91)<br>1.35 (0.96–1.74)<br>- | |

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2] most recent years data 2010
[3] most recent years data 2011

| **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 ($F_{year}/F_{MSY}\leq 1$) | | |

劍旗魚資源現況

| Area[1] | Indicators | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 26,184 t<br>24,545 t | |
| | MSY (4 models):<br>$F_{2009}/F_{MSY}$ (4 models):<br>$SB_{2009}/SB_{MSY}$ (4 models):<br>$SB_{2009}/SB_0$ (4 models): | 29,900–34,200 t<br>0.50–0.63<br>1.07–1.59<br>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) | | |

西南印度洋劍旗魚資源現況

| Area[1] | Indicators | | 2013 stock status determination |
|---|---|---|---|
| Southwest Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 6,662 t<br>6,808 t | |
| | MSY (3 models):<br>$F_{2009}/F_{MSY}$ (3 models):<br>$SB_{2009}/SB_{MSY}$ (3 models):<br>$SB_{2009}/SB_0$ (3 models): | 7,100 t–9,400 t<br>0.64–1.19<br>0.73–1.44<br>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 ($SB_{year}/SB_{MSY}$≥ 1) |
|---|---|---|
| Stock subject to overfishing ($F_{year}/F_{MSY}$> 1) | | |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 1) | | |

白皮旗魚資源現況

| Area[1] | Indicators | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 8,315 t<br>9,417 t | Uncertain |
| | MSY (range):<br>$F_{2011}/F_{MSY}$ (range):<br>$B_{2011}/B_{MSY}$ (range):<br>$B_{2011}/B_{1950}$ (range): | 8,605 (6,278–11,793)<br>1.03 (0.15–2.19)<br>1.17 (0.75–1.55)<br>0.58 (0.38–0.78) | |

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

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

黑皮旗魚資源現況

| Area[1] | Indicators | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 13,885 t<br>10,640 t | |
| | MSY (range):<br>$F_{2011}/F_{MSY}$ (range):<br>$B_{2011}/B_{MSY}$ (range):<br>$B_{2011}/B_{1950}$ (range): | 11,690 (8,023–12,400)<br>0.85 (0.63–1.45)<br>0.98 (0.57–1.18)<br>0.48 (na) | |

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

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

雨傘旗魚資源現況

| Area[1] | Indicators | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 28,449t<br>26,283t | Uncertain |
| | MSY (range):<br>$F_{2012}/F_{MSY}$ (range):<br>$SB_{2012}/SB_{MSY}$ (range):<br>$SB_{2012}/SB_0$ (range): | unknown<br>unknown<br>unknown<br>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) | | |

七、區域性觀察員報告(IOTC–2013–SC16–14)，由秘書處統計人員說明各會員國執行情況，該文件顯示我國目前仍未繳交觀察員航次報告。

八、漁期及漁場關閉效果(IOTC–2013–SC16–INF11)，由秘書處統計人員說明分析結果，結果顯示因選定區域在海盜危害區域，因此並無實質效果。

九、未來工作計畫(IOTC–2013–SC16–16)，由秘書處作報告，各魚種小組資源評估時程如下：

| Species | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| *Working Party on Neritic Tunas* | | | | | |
| Bullet tuna | Indicators | **Full assessment** | | | |
| Frigate tuna | Indicators | **Full assessment** | | | |
| Kawakawa | **Full assessment** | Indicators | | | |
| Longtail tuna | **Full assessment** | Indicators | | | |
| Indo-Pacific king mackerel | Indicators | **Full assessment** | | | |
| Narrow-barred Spanish mackerel | **Full assessment** | Indicators | | | |

| Species | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| ***Working Party on Billfish*** | | | | | |
| Black marlin | Indicators | Indicators | **Full assessment** | Indicators | |
| Blue marlin | Indicators | Indicators | **Full assessment** | Indicators | |
| Striped marlin | Indicators | **Full assessment** | Indicators | Indicators | |
| Swordfish (IO, SWIO) | **Full assessment** | Indicators | Indicators | **Full assessment** | |
| Indo-Pacific sailfish | Indicators | **Full assessment** | Indicators | **Full assessment** | |
| ***Working Party on Tropical Tunas*** | | | | | |
| Bigeye tuna | Indicators | Indicators | **Full assessment** | Indicators | Indicators |
| Skipjack tuna | **Full assessment** | Indicators | Indicators | **Full assessment** | Indicators |
| Yellowfin tuna | Indicators | **Full assessment** | Indicators | Indicators | **Full assessment** |
| ***Working Party on Temperate Tunas*** | | | | | |
| Albacore | **Full assessment** | - | **Full assessment** | - | **Full assessment** |
| ***Working Party on Ecosystems and Bycatch*** | | | | | |
| Blue sharks | Indicators | Full assessment | | Indicators & data poor approaches | |
| Oceanic whitetip sharks | Indicators | | Full assessment | | |
| Scalloped hammerhead sharks | | Indicators | | | Revisit ERA |
| Shortfin mako sharks | | | Indicators | | Revisit ERA |
| Silky sharks | | Indicators | | | Revisit ERA |
| Bigeye thresher sharks | | | | Indicators | Revisit ERA |
| Pelagic thresher sharks | | | Indicators | | Revisit ERA |
| Marine turtles | | Review of mitigation measures in 12/04 | | Revisit ERA | |
| Seabirds | | Review of mitigation measures in 12/06 | | Review of mitigation measures in 12/06 | |
| Marine Mammals | | | | | |
| ***Working Party on Methods*** | | | | | |
| Management Strategy Evaluation | Extension of the MSE process to tropical tunas | | | | |

十、2014 及 2015 年相關會議時間及地點安排

| Meeting | 2014 | | 2015 (tentative) | |
|---|---|---|---|---|
| | Date | Location | Date | Location |
| Working Party on **Neritic Tunas** | 2–5 July (4d) | Phuket, Thailand | 1–9 July (4d) | TBD |
| Working Party on **Temperate Tunas** | 28–31 July (4d) | Japan (or Busan, Korea) | Nil | Nil |
| Working Party on **Billfish** | 21–25 Oct (5d) | Shimizu, Japan (or Tanzania; Kenya) | Early June (5d) or Late-October (5d) | Algarve, EU,Portugal |
| Working Party on **Ecosystems and Bycatch** | 27–30 Oct (4d) | Shimizu, Japan (or Tanzania; Kenya) | Prior to the WPEB (5d) | Algarve, EU,Portugal |
| Management Strategy Evaluation workshop | 15–16 Nov (2d) | Bali, Indonesia | | |
| Working Party on **Tropical Tunas** | 17–21 Nov | Bali, Indonesia | 13–17 or 20–24 Oct (5d) | TBD |
| Working Party on **Data Collection and Statistics** | 10–13 Dec (3d) | Victoria, Seychelles | TBD | TBD |
| Working Party on **Methods** | 13–14 Dec (2d) | Victoria, Seychelles | TBD | TBD |
| **Scientific Committee** | 16–20 Dec (5d) | Victoria, Seychelles | 24–28 Nov (5d) | Bali, Indonesia |
| Working Party on **Fishing Capacity** | Nil | Nil | Nil | Nil |

十一、有關 AFSA 資料庫

歐盟代表建議 IOTC 應繼續與 AFSA 簽約以協助出版 IOTC 相關小組及 SC 報告。

十二、主席與副主席選舉

與會代表一致同意現任主席日本 Dr. Tom Nishida 及副主席為賽席爾 Mr. Jan Robinson 續任。

## 參、心得與建議

一、下屆年會前之統計工作小組將增加 2 天議程討論有關我國及日本漁獲體長資料處理問題，對此我統計人員應就秘書處關切 2003 年以後之資料進行處理並提報相關處理程序，在下年度排定時程進行處理工作，並與行政科學家密切配合，審慎處理該案。

二、目前 IOTC SC 業已將 MSE 列為重要發展項目，預計今年年會就會討論有關限制參考點以及目標參考點設定，雖說該項議題在其他國際組織業已經過多年討論，或可參考其他組織討論過程預擬委員會討論該議題之立場。

三、區域性觀察員航次報告提送情形已經多次在 SC 檢視，雖說大部分會員國執行情況都不佳，然在今年已有會員國提出將送紀律委員會檢視執行成效，我國在觀察員航次報告整理部分應持續加強。

四、有關本次會議所建議各項科學研究議題，將視可行性及重要性規劃納入遠洋相關科技計畫。

## 肆、附件

附件一、我國代表團成員及議程

我國代表團成員

| 單位 | 職稱 | 姓名 |
|---|---|---|
| 漁業署 | 技佐 | 藍聰文 |
| 南華大學 | 助理教授 | 葉裕民 |
| 中華民國對外漁業合作發展協會 | 組長 | 於仁汾 |

議程

## AGENDA FOR THESIXTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

**Last updated: 18 November 2013**
**Date:** 2–6 December, 2013
**Location:** The Lotte Hotel Busan, Rep. of Korea
**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 2013 (Secretariat)**

**6. NATIONAL REPORTS FROM CPCs (CPCs)**

**7. REPORTS OF THE 2013 IOTC WORKING PARTY MEETINGS**

7.1 IOTC–2013–WPNT03–R Report of the Third Session of the Working Party on Neritic Tunas

7.2 IOTC–2013–WPEB09–R Report of the Ninth Session of the Working Party on Ecosystems and Bycatch

Best practice guidelines for the safe release and handling of encircled cetaceans
Best practice guidelines for the safe release and handling of encircled whale sharks
Shark year program

7.3 IOTC–2013–WPB11–R Report of the Eleventh Session of the Working Party on Billfish

7.4 IOTC–2013–WPTT15–R Report of the Fifteenth Session of the Working Party on Tropical Tunas

7.5 IOTC–2013–WPDCS09–R Report of the Ninth Session of the Working Party on Data Collection and Statistics

Revision to historical data sets held by the Secretariat

7.6 IOTC–2013–SC16–11 Update on the inter-sessional work of the WPM small working group

7.7 IOTC–2013–SC16–12 Outcomes of the informal workshop on CPUE standardisation

7.8 IOTC–2013–SC16–19 Estimation of fishing capacity by tuna fishing fleets in the Indian Ocean

7.9 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. REVIEW OF THE RESOLUTION 12/11: IMPLEMENTATION OF A**

**LIMITATION OF FISHING CAPACITY OF CONTRACTING PARTIES AND COOPERATING NON-CONTRACTING PARTIES (Chair)**

**10. STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN (Chair)**

10.1 Tuna – Highly migratory species

10.2 Tuna and mackerel – Neritic species

10.3 Billfish

**11. STATUS OF MARINE TURTLES, SEABIRDS AND SHARKS IN THE INDIAN OCEAN (Chair)**

11.1 Marine turtles

11.2 Seabirds

11.3 Sharks

**12. IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME (Secretariat)**

**13. OUTLOOK ON TIME-AREA CLOSURES (Chair)**

13.1 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 tuna and bigeye tuna;

13.2 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 tuna and bigeye tuna;

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

**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 2014 AND 2015 (Secretariat)**

**16. OTHER BUSINESS (Chair)**

16.1 Election of a Chair and a Vice-Chair for the next biennium (Chair and Secretariat)

**17. REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE SIXTEENTH SESSION OF THE SCIENTIFIC COMMITTEE (Chair)**

# Report of the Sixteenth Session of the IOTC Scientific Committee

Busan, Rep. of Korea, 2–6 December 2013

**DISTRIBUTION:**

Participants in the Session
Members of the Commission
Other interested Nations and International Organizations
FAO Fisheries Department
FAO Regional Fishery Officers

**BIBLIOGRAPHIC ENTRY**

IOTC–SC16 2013. Report of the Sixteenth Session of the IOTC Scientific Committee. Busan, Rep. of Korea, 2–6 December 2013. *IOTC–2013–SC16–R[E]: X308X pp.*

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



Contact details:

Indian Ocean Tuna Commission
Le Chantier Mall
PO Box 1011
Victoria, Mahé, Seychelles
Ph: +248 4225 494
Fax: +248 4224 364
Email: secretariat@iotc.org
Website: http://www.iotc.org

# 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 |

## HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

***Level 1:*** ***From a subsidiary body of the Commission to the next level in the structure of the Commission:***

**RECOMMENDED, RECOMMENDATION**: Any conclusion or request for an action to be undertaken, from a subsidiary body of the Commission (Committee or Working Party), which is to be formally provided to the next level in the structure of the Commission for its consideration/endorsement (e.g. from a Working Party to the Scientific Committee; from a Committee to the Commission). The intention is that the higher body will consider the recommended action for endorsement under its own mandate, if the subsidiary body does not already have the required mandate. Ideally this should be task specific and contain a timeframe for completion.

***Level 2:*** ***From a subsidiary body of the Commission to a CPC, the IOTC Secretariat, or other body (not the Commission) to carry out a specified task:***

**REQUESTED**: This term should only be used by a subsidiary body of the Commission if it does not wish to have the request formally adopted/endorsed by the next level in the structure of the Commission. For example, if a Committee wishes to seek additional input from a CPC on a particular topic, but does not wish to formalise the request beyond the mandate of the Committee, it may request that a set action be undertaken. Ideally this should be task specific and contain a timeframe for the completion.

***Level 3: General terms to be used for consistency:***

**AGREED**: Any point of discussion from a meeting which the IOTC body considers to be an agreed course of action covered by its mandate, which has not already been dealt with under Level 1 or level 2 above; a general point of agreement among delegations/participants of a meeting which does not need to be considered/adopted by the next level in the Commission's structure.

**NOTED/NOTING**: Any point of discussion from a meeting which the IOTC body considers to be important enough to record in a meeting report for future reference.

***Any other term:*** Any other term may be used in addition to the Level 3 terms to highlight to the reader of and IOTC report, the importance of the relevant paragraph. However, other terms used are considered for explanatory/informational purposes only and shall have no higher rating within the reporting terminology hierarchy than Level 3, described above (e.g. **CONSIDERED**; **URGED**; **ACKNOWLEDGED**).

**TABLE OF CONTENTS**

## EXECUTIVE SUMMARY

The Sixteenth Session of the Indian Ocean Tuna Commission's (IOTC) Scientific Committee (SC) was held in Busan, Rep. of Korea, from 2 to 6 December 2013. A total of 75 individuals (54 in 2012) attended the Session, comprised of 60 delegates (46 in 2012) from 21 Member countries (21 in 2012) and 2 delegates from Cooperating Non-Contracting Parties (0 in 2012), as well as 11 observers and invited experts (9 in 2012).

**NOTING** that 錯誤! 找不到參照來源。 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 SC16 to the Commission, which are provided at Appendix XXXVIII.

***Tuna – Highly migratory species***

<<TO BE COMPLETED POST-ADOPTION. WORD FOR WORD FROM THE REPORT ONLY>>

**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 | 2013 | 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<br>*Thunnus alalunga* | Catch 2012: 33,960 t<br>Average catch 2008–2012: 37,082 t<br>MSY (80% CI)): 33,300 t (31,100–35,600 t)<br>$F_{2010}/F_{MSY}$ (80% CI): 1.33 (0.9–1.76)<br>$SB_{2010}/SB_{MSY}$ (80% CI): 1.05 (0.54–1.56)<br>$SB_{2010}/SB_{1950}$ (80% CI): 0.29 (n.a.) | 2007 | | | | | Text to be added after adoption <click here for full stock status summary> |
| Bigeye tuna<br>*Thunnus obesus* | Catch in 2012: 115,793 t<br>Average catch 2008–2012: 107,603 t<br>MSY (1000 t): 132 t (98.5–207 t)[2]<br>$F_{2012}/F_{MSY}$: 0.42 (0.21–0.80)[2]<br>$SB_{2012}/SB_{MSY}$: 1.44 (0.87–2.22)[2]<br>$SB_{2012}/SB_0$: 0.40 (0.27–0.54)[2] | 2008 | | | | | Text to be added after adoption <click here for full stock status summary> |
| Skipjack tuna<br>*Katsuwonus pelamis* | Catch 2012: 314,537 t<br>Average catch 2008–2012: 400,980 t<br>MSY (1000 t): 478 t (359–598 t)<br>$F_{2011}/F_{MSY}$: 0.80 (0.68–0.92)<br>$SB_{2011}/SB_{MSY}$: 1.20 (1.01–1.40)<br>$SB_{2011}/SB_0$: 0.45 (0.25–0.65) | | | | | | Text to be added after adoption. <click here for full stock status summary> |
| Yellowfin tuna<br>*Thunnus albacares* | Catch 2012: 368,663 t<br>Average catch 2008–2012: 317,505 t<br>Multifan[3]<br>MSY (1000 t): 344 t (290–453 t)<br>$F_{curr}/F_{MSY}$: 0.69 (0.59–0.90)<br>$SB_{curr}/SB_{MSY}$: 1.24 (0.91–1.40)<br>$SB_{curr}/SB_0$: 0.38 (0.28–0.38) | 2008 | | | | | Text to be added after adoption <click here for full stock status summary> |

| Stock | Indicators | Prev[1] | 2010 | 2011 | 2012 | 2013 | 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)<br>*Xiphias gladius* | Catch 2012: 26,184 t<br>Average catch 2008–2012: 24,545 t<br>MSY (4 models): 29,900–34,200 t<br>$F_{2009}/F_{MSY}$ (4 models): 0.50–0.63<br>$SB_{2009}/SB_{MSY}$ (4 models): 1.07–1.59<br>$SB_{2009}/SB_0$ (4 models): 0.30–0.53 | 2007 | | | | | Text to be added after adoption <click here for full stock status summary> |
| Swordfish (southwest IO)<br>*Xiphias gladius* | Catch 2012: 6,662 t<br>Average catch 2008–2012: 6,808 t<br>MSY (3 models): 7,100 t–9,400 t<br>$F_{2009}/F_{MSY}$ (3 models): 0.64–1.19<br>$SB_{2009}/SB_{MSY}$ (3 models): 0.73–1.44<br>$SB_{2009}/SB_0$ (3 models): 0.16–0.58 | | | | | | Text to be added after adoption. <click here for full stock status summary> |
| Black marlin<br>*Makaira indica* | Catch 2012: 8,315 t<br>Average catch 2008–2012: 9,417 t<br>MSY (range): 8,605 (6,278–11,793)<br>$F_{2011}/F_{MSY}$ (range): 1.03 (0.15–2.19)<br>$B_{2011}/B_{MSY}$ (range): 1.17 (0.75–1.55)<br>$B_{2011}/B_{1950}$ (range): 0.58 (0.38–0.78) | | | | | | Text to be added after adoption. <click here for full stock status summary> |
| Blue marlin<br>*Makaira nigricans* | Catch 2012: 13,885 t<br>Average catch 2008–2012: 10,640 t<br>MSY (range): 11,690 (8,023–12,400)<br>$F_{2011}/F_{MSY}$ (range): 0.85 (0.63–1.45)<br>$B_{2011}/B_{MSY}$ (range): 0.98 (0.57–1.18)<br>$B_{2011}/B_{1950}$ (range): 0.48 (na) | | | | | | Text to be added after adoption <click here for full stock status summary> |
| Striped marlin<br>*Tetrapturus audax* | Catch 2012: 4,833 t<br>Average catch 2008–2012: 3,011 t<br>MSY (range): 4,408 (3,539–4,578)<br>$F_{2011}/F_{MSY}$ (range): 1.28 (0.95–1.92)<br>$B_{2011}/B_{MSY}$ (range): 0.416 (0.2–0.42)<br>$B_{2011}/B_0$ (range): 0.18 | | | | | | Text to be added after adoption <click here for full stock status summary> |
| Indo-Pacific Sailfish<br>*Istiophorus platypterus* | Catch 2012: 28,449t<br>Average catch 2008–2012: 26,283t<br>MSY (range): unknown<br>$F_{2012}/F_{MSY}$ (range): unknown<br>$SB_{2012}/SB_{MSY}$ (range): unknown<br>$SB_{2012}/SB_0$ (range): unknown | | | | | | Text to be added after adoption <click here for full stock status summary> |
| **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 589,774 t being landed in 2012. 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<br>*Auxis rochei* | Catch 2012: 8,862 t<br>Average catch 2008–2012: 8,468 t<br>MSY (range): unknown | | | | | | No quantitative stock assessment is currently available for these species 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 |

| Stock | Indicators | Prev[1] | 2010 | 2011 | 2012 | 2013 | Advice to the Commission |
|---|---|---|---|---|---|---|---|
| Frigate tuna<br>*Auxis thazard* | Catch 2012: 83,029 t<br>Average catch 2008–2012: 90,221 t<br>MSY (range): unknown | | | | | | remains **uncertain**. However, aspects of the fisheries for these species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.<br>Click on each species for a full stock status summary:<br>Bullet tuna (*Auxis rochei*)<br>Frigate tuna (*Auxis thazard*) |
| Kawakawa<br>*Euthynnus affinis* | Catch 2012: 152,391 t<br>Average catch 2008–2012: 147,951 t<br>MSY (range): unknown | | | | | | Preliminary analysis using a stock-reduction analysis (SRA) approach indicates that the stock in near optimal levels of $F_{MSY}$, or exceeding these targets, although stock biomass remains above the level that would produce MSY ($B_{MSY}$). Due to the quality of the data being used, the simplistic approach used here, and the rapid increase in kawakawa catch in recent years, some measures need to be taken to slow the increase in catches in the IO Region, despite the stock status remaining classified as **uncertain**.<br>Click for a full stock status summary: Kawakawa (*Euthynnus affinis*) |
| Longtail tuna<br>*Thunnus tonggol* | Catch 2011: 155,603 t<br>Average catch 2007–2011: 133,890 t<br>MSY (range): unknown | | | | | | Stock Reduction Analysis techniques indicate that the stock is being exploited at rates that exceed $F_{MSY}$ in recent years. Whether a four quadrant stock structure of catches in the Indian Ocean or a one stock assumption is used in the analysis, the conclusions remain the same. Given estimated values of current biomass are above the estimated abundance to produce $B_{MSY}$ in 2011, and that fishing mortality has exceeded $F_{MSY}$ values in recent years, the stock is considered to be **not overfished**, but **subject to overfishing.**<br>Click for a full stock status summary: Longtail tuna (*Thunnus tonggol*) |
| Indo-Pacific king mackerel<br>*Scomberomorus guttatus* | Catch 2012: 46,234 t<br>Average catch 2008–2012: 47,245 t<br>MSY (range): unknown | | | | | | No quantitative stock assessment is currently available for this species 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**. 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.<br>Click for a full stock status summary: Indo-Pacific king mackerel (*Scomberomorus guttatus*) |
| Narrow-barred Spanish mackerel<br>*Scomberomorus commerson* | Catch 2012: 136,301 t<br>Average catch 2008–2012: 133,692 t<br>MSY (range): unknown | | | | | | No quantitative stock assessment is currently available for this species 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**. 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.<br>Click for a full stock status summary: Narrow-barred Spanish mackerel (*Scomberomorus commerson*) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **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<br>*Prionace glauca* | Reported catch 2012: 21,901 t<br>Not elsewhere included (nei) sharks: 42,793 t<br>Average reported catch 2008–2012: 24,204 t<br>Not elsewhere included (nei) sharks: 48,708 t<br>MSY (range): unknown | | | | | | There is a paucity of information available for these 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. Therefore the stock status is highly uncertain. 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.<br>○ Blue sharks – Appendix X<br>○ Oceanic whitetip sharks – Appendix XI<br>○ Scalloped hammerhead sharks – Appendix XII<br>○ Shortfin mako sharks – Appendix XIII<br>○ Silky sharks – Appendix XIV<br>○ Bigeye thresher sharks – Appendix XV<br>○ Pelagic thresher sharks – Appendix XVI |
| Oceanic whitetip shark<br>*Carcharhinus longimanus* | Reported catch 2012: 412 t<br>Not elsewhere included (nei) sharks: 42,793 t<br>Average reported catch 2008–2012: 292 t<br>Not elsewhere included (nei) sharks: 48,708 t<br>MSY (range): unknown | | | | | | |
| Scalloped hammerhead shark<br>*Sphyrna lewini* | Reported catch 2012: 80 t<br>Not elsewhere included (nei) sharks: 42,793 t<br>Average reported catch 2008–2012: 74 t<br>Not elsewhere included (nei) sharks: 48,708 t<br>MSY (range): unknown | | | | | | |
| Shortfin mako<br>*Isurus oxyrinchus* | Reported catch 2012: 1,426 t<br>Not elsewhere included (nei) sharks: 42,793 t<br>Average reported catch 2008–2012: 1,300 t<br>Not elsewhere included (nei) sharks: 48,708 t<br>MSY (range): unknown | | | | | | |
| Silky shark<br>*Carcharhinus falciformis* | Reported catch 2012: 4,177 t<br>Not elsewhere included (nei) sharks: 42,793 t<br>Average reported catch 2008–2012: 3,443 t<br>Not elsewhere included (nei) sharks: 48,708 t<br>MSY (range): unknown | | | | | | |
| Bigeye thresher shark<br>*Alopias superciliosus* | Reported catch 2012: 465 t<br>Not elsewhere included (nei) sharks: 42,793 t<br>Average reported catch 2008–2012: 98 t<br>Not elsewhere included (nei) sharks: 48,708 t<br>MSY (range): unknown | | | | | | |
| Pelagic thresher shark<br>*Alopias pelagicus* | Reported catch 2012: 328 t<br>Not elsewhere included (nei) sharks: 42,793 t<br>Average reported catch 2008–2012: 76 t<br>Not elsewhere included (nei) sharks: 48,708 t<br>MSY (range): unknown | | | | | | |

[1] This indicates the last year taken into account for assessments carried out before 2010
[2] The point estimate is the median of the plausible models investigated in the 2013 SS3 assessment
[3] most recent years data 2010
[4] most recent years data 2011

| **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 | | |

# 1. Opening of the Session

1. The Sixteenth Session of the Indian Ocean Tuna Commission's (IOTC) Scientific Committee (SC) was held in Busan, Rep. of Korea, from 2 to 6 December 2013. A total of 75 individuals (54 in 2012) attended the Session, comprised of 60 delegates (46 in 2012) from 21 Member countries (21 in 2012) and 2 delegates from 1 Cooperating Non-Contracting Party (0 in 2012), as well as 11 observers and invited experts (9 in 2012). The list of participants is provided at Appendix I. The meeting was opened on 2 December 2013 by Mrs Shin Hee Cho, Director for Distant Water Fisheries Division of Ministry of Oceans and Fisheries (MOF) of Republic of Korea. The Chair (Dr. Tom Nishida – Japan) and the Executive Secretary (Mr Rondolph Payet – Secretariat) welcomed participants to Busan, Rep. of Korea.

# 2. Adoption of the Agenda and Arrangements for the Session

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

# 3. Admission of Observers

3. The SC **NOTED** that at the Seventeenth 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.

***Intergovernmental Organisations (IGO)***

4. In accordance with Rule X.4 and XIII.4 of the IOTC Rules of Procedure, the SC **ADMITTED** the following Inter-governmental organisations (IGO) as observers to the Sixteenth Session of the SC:
   - Agreement on the Conservation of Albatrosses and Petrels (ACAP)
   - Southwest Indian Ocean Fisheries Commission (SWIOFC)

***Non-governmental Organisations (NGO)***

5. In accordance with Rule X.4 and XIII.5 of the IOTC Rules of Procedure, the SC **ADMITTED** the following Non-governmental organisations (IGO) as observers to the Sixteenth Session of the SC:
   - Birdlife International (BI)
   - Greenpeace International (GI)
   - International Seafood Sustainability Foundation (ISSF)
   - World Wide Fund for Nature (a.k.a World Wildlife Fund, WWF)

***Invited experts***

6. In accordance with Rules X.4 and XIII.9 of the IOTC Rules of Procedure, which state that the Commission may invite experts, in their individual capacity, to enhance and broaden the expertise of the SC and of its Working Parties, the SC **ADMITTED** the invited experts from Taiwan,China.

# 4. Decisions of the Commission Related to the Work of the Scientific Committee

***Outcomes of the Seventeenth Session of the Commission***

7. The SC **NOTED** paper IOTC–2013–SC16–03 which outlined the decisions and requests made by the Commission at its Seventeenth Session, held from 6–10 May 2013, specifically relating to the work of the SC, including the 11 Conservation and Management Measures (11 Resolutions and 0 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.

***Previous decisions of the Commission***

8. The SC **NOTED** paper IOTC–2013–SC16–04 which outlined a number of Commission decisions, in the form of previous Resolutions that require a response from the SC in 2013, or for the SC to include the requested elements into its work plan for 2014, 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 2013

***Report of the Secretariat – Activities in support of the IOTC science process in 2013***

9. The SC **NOTED** paper IOTC–2013–SC16–05 which provided an overview of the work undertaken by the IOTC Secretariat in 2013, and thanked the Secretariat for the contributions to the science process in 2013, 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, billfish and draft tuna identification guides, and through the facilitation of invited experts to raise the standard of IOTC meetings.

**Meeting Participation Fund (MPF)**

10. The SC **NOTED** that the Commission, at its 17th Session adopted revised rules of procedure for the administration of the IOTC Meeting Participation Fund (MPF), which now permits the fund to be utilised to pay for the attendance of the Chair and Vice-Chair of each working party meeting, if they are from a developing coastal state.

11. The SC **RECALLED** that 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.

12. The SC **NOTED** that the continued increase in attendance by national scientists from developing CPCs to IOTC Working Parties and the SC in 2013 (58 in 2013; 46 in 2012; 33 in 2011; 19 in 2010) was largely 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.

13. The SC **NOTED** that for 2013, 2012 and 2011 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.

***Presentation on the Technical workshops for the implementation of measures to reduce seabird bycatch in IOTC longline fisheries***

14. The SC **NOTED** that two technical workshops for the implementation of measures to reduce seabird bycatch in IOTC longline fisheries were held in 2013 (Bali, Indonesia, from 8 to 9 July; Busan, Rep. of Korea from 29 to 30 December). A total of 19 participants attended the first workshop and 36 participants attended the second workshop. The workshops were a requirement by the Commission, as determined in IOTC Resolution 12/06. BirdLife International provided the technical expertise and the IOTC Secretariat facilitated the workshop and lead discussions on data submissions, observer programmes and reporting to IOTC.

15. The SC **NOTED** that the workshop objectives were to provide training and demonstrations of practical options for longline fishing vessels to become compliant with IOTC Resolution 12/06, which will come into force on 1 July 2014. Specifically the workshop presented the three seabird bycatch mitigation measures (bird scaring lines, line weighting options and night setting) to fishery managers and industry representatives; discuss safety and other practical concerns that may be raised in relation to implementation of the seabird bycatch mitigation measure requirements; and highlight data collection and reporting obligations relevant to longline fishing in the Southern Ocean, to improve the IOTC's capacity to understand and manage fishing impacts on seabirds.

***Presentation on the Weight-of-Evidence approach to determine stock status for data poor species***

16. The SC **RECALLED** that in 2012, due to growing interest and use of the Weight-of-Evidence approach to determine stock status for data poor fisheries, the SC requested 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.

17. The SC **NOTED** the presentation on the Weight-of-Evidence approach to determine stock status for data poor species by Australia, and that a Weight-of-Evidence approach is currently being used in a number of countries to routinely determine stock status for data poor fisheries. The approach involves developing and applying a decision-making framework by assembling an evidentiary base to support status determination. Specifically, the framework aims to provide a structured, scientific process for the assembly and review of indicators of biomass

status and levels of fishing mortality. Arguments for status determination are based upon layers of partial evidence. Ideally there would be independence between these layers which will be developed with a mixture of quantitative and qualitative reasoning. The framework provides guidance with which to interpret those indicators, and aims to provide a transparent and repeatable process for status determination. The framework includes elements to describe attributes of the stock and fishery; documentation of lines of evidence; and documentation of status determination.

18. The SC **NOTED** that for some IOTC billfish and neritic tuna stocks, particularly in smaller fisheries, only a subset of the types of evidence are likely to be available and/or useful. As a result, expert judgment has an important role in status determination, with an emphasis on documenting the key evidence and rationale for the decision.

19. The SC **ENCOURAGED** further exploration and potential utilisation of the weight-of-evidence approach to determine stock status by its Working Parties in 2014 and future years.

***IOTC website development***

20. The SC **NOTED** the work undertaken by the IOTC Secretariat, a consultant and a company to complete the new IOTC website. The new website is nearing completion and is expected to be publically available early in 2014. It is expected that the site will be modified and updated on a continuous basis.

***Standardisation of IOTC Working Party and Scientific Committee report terminology***

21. The SC **NOTED** paper IOTC–2013–SC16–06 which requested the SC to revisit the Interim Report Terminology informally adopted by the Scientific Committee at its 15th Session in 2012, with the aim of further refining the definitions following a year of use by the SC and its working parties.

22. The SC **NOTED** that Members of the Commission have called upon the Scientific Committee to improve the way in which it provides advice to the Commission as well as the overall format of its reports and those of its subsidiary bodies. These calls were made due to the lack of consistency and readability of the reports which has lead to the limited uptake of, or misinterpretation of scientific advice. As a result, for the past three years, the Scientific Committee and its working parties have been informally using and refining report terminology, with the aim of improving the consistency and readability of its reports. Subsequently, in 2012 the Scientific Committee encouraged the use and refinement of standardised reporting terminology.

23. The SC **ADOPTED** the reporting terminology contained in Appendix IV and **RECOMMENDED** that the Commission considers adopting the standardised IOTC Report terminology, to further improve the clarity of information sharing from, and among its subsidiary bodies.

## 6. NATIONAL REPORTS FROM CPCS

24. The SC **NOTED** the 28 (26 in 2012) National Reports submitted to the IOTC Secretariat in 2013 by CPCs (Contracting Parties and Cooperating Non-Contracting Parties), the abstracts of which are provided at Appendix V. The following matters were raised in regard to the content of specific reports:
    - **Australia**: Nil comments.
    - **Belize**: National Report not presented orally as Belize was absent from the SC16 meeting
    - **China**: The SC **NOTED** that in 2012, one observer report was submitted to the Secretariat, in accordance with Resolution 11/04.
    - **Comoros**: Nil comments.
    - **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 observer program, which resumed in 2011 for purse seine vessels, is limited to areas which are not impacted by piracy activities (most of the western Indian Ocean). Some CPCs indicated that the provision of the EU National Report summary and France sections in French only, meant that some CPCs could not read the important information in the reports. A request was made for the EU to provide the report entirely in English, in addition to the French components.
    - **France (OT)**: 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** that, to date, India has only reported nominal catch statistics for its coastal fisheries, despite the reiterated requests from the SC for India to provide data for its fisheries as per the

IOTC Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)*, which include specific provisions for the reporting of catch-and-effort and size data from coastal fisheries. To date, India has not provided size frequency statistics for its commercial longline fleet and has provided incomplete catch and effort statistics for this fleet for some years. The SC **RECALLED** recommendations from previous SC meetings for India to collect and report information as per the IOTC requirements, and urged India to address the concerns of the SC and report all outstanding statistics to the IOTC as a matter of priority.

**NOTING** that the lack of reporting from India may originate from a lack of understanding of IOTC requirements, the SC **REQUESTED** that statistical officers from India are invited to a workshop that the IOTC Secretariat will organize next year with the financial support of the IOC-SmartFish Project to assist CPCs in the region to understand IOTC data collection and reporting requirements and preparation of data sets to be reported to the IOTC.

- **Indonesia**: Nil comments.
- **Iran, Islamic Republic of**: National Report not presented orally as I.R. Iran was absent from the SC16 meeting.
- **Japan**: The SC **CONSIDERED** and **AGREED** that the new conversion factors for shark species presented by Japan could be used to review the catch history.
- **Kenya**: The SC NOTED that the decline in reported shark catches in recent years by recreational fishers, in particular in 2012, is not well understood and required further investigation by Kenya.
- **Korea, Republic of**: The SC **NOTED** that in 2011, no observers were dispatched on longline vessels of the Rep. of Korea. The 2011 data is therefore based on logbook data. In response to a question about the levels of shark discarding by longline vessels from the Rep. of 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 **NOTED** that 12 large-scale longliners flagged to the Maldives have been operating in the Indian Ocean since 2012 and, to date, have not been covered by scientific observers (Resolution 11/04). The Maldives indicated that it is taking steps to implement the provisions of Resolution 11/04 *on a regional observer scheme*, including the development of an observer manual (based on the IOTC observer manual), and will allocate sufficient funds in the future to ensure the deployment of the observers.

- **Mauritius**: The SC **NOTED** that the artisanal fleet of Mauritius fishing around FADs is mainly targeting albacore at depths of around 300 m.
- **Mozambique**: The SC **NOTED** that the report does not include the catch of DWFN vessels licenced to fish in the Mozambique EEZ. In recent year, high catches of yellowfin tuna have been reported by its own vessels.
- **Oman, Sultanate of**: National Report not presented orally as Oman was absent from the SC16 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 SC16 meeting.
- **Seychelles, Republic of**: The SC **NOTED** that there is an absence of marine turtle interactions reported by the Seychelles longline fleets. The reason given was that the Seychelles industrial longline fleets target mainly bigeye tuna at depth, and the semi-industrial fleet targets mainly swordfish, also at depth, and by night. Seychelles is planning on expanding is scientific observer scheme in the near future to cover its other industrial fleets.
- **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. Sri Lanka indicated that it has developed an MoU with a VMS supplier and are moving towards compliance with Resolution 06/03*On establishing a vessel monitoring system programme*.

- **Sudan**: National Report not presented orally as Sudan was absent from the SC16 meeting.
- **Tanzania, United Republic of**: The SC **NOTED** that at present, artisanal fisheries are not reporting data by species although efforts are being made to improve this in 2014. In response to a query of the large discrepancy (almost double) in the catch of tuna, sharks and rays between 2011 and 2012, Tanzania explained that this was because it was for the entire country instead of only for part of the country as in previously years. It undertook to provide an updated corrected report to the Secretariat subsequent to the SC.
- **Thailand**: Nil comments.
- **United Kingdom (OT)**: The SC **NOTED** that vessels have been apprehended by the UK(OT) with large shark catches found on board, suspected of fishing within the UK(OT) EEZ.
    i. The SC **NOTED** the following statement made by the Republic of Mauritius:

    "The Government of the Republic of Mauritius reaffirms that it 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 Republic of Mauritius is, however, being prevented from exercising its rights over the Chagos Archipelago because of the de facto and unlawful control of the United Kingdom over the Archipelago.

    Moreover, the Government of the Republic of Mauritius does not 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, UNCLOS to challenge the legality of the 'marine protected area'. The dispute is currently before the Arbitral Tribunal constituted under Annex VII to UNCLOS.

    In the light of the above, consideration of any documents which the United Kingdom has purported to submit to this Committee in respect of the Chagos Archipelago or which purport to refer to the Chagos Archipelago as the so-called "BIOT", as well as any action or decision that may be taken on the basis of such documents, cannot and should not be construed as implying that the United Kingdom has sovereignty or analogous rights over the Chagos Archipelago."

    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**: Nil comments.
- **Yemen**: The SC **EXPRESSED** its disappointment that Yemen did not provide a National Report and urged Yemen to fulfil its reporting obligations to the IOTC.
- **Senegal**: National Report not presented orally as Senegal was absent from the SC16 meeting.
- **South Africa, Republic of**: Nil comments.

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

26. 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. The National Report 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].

***Recommendation/s***

27. **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 2013, 28 reports were provided by CPCs, up from 26 in 2012, 25 in 2011, 15 in 2010 and 14 in 2009 (Table 2).

28. The SC **RECOMMENDED** that the Compliance Committee note the lack of compliance by several CPCs that did not submit a National Report in 2013, noting that the Commission agreed that the submission of the reports to the SC is mandatory (Table 2).

29. The SC **REQUESTED** that the IOTC Secretariat facilitate the translation of all abstracts/summaries from the National Reports to the Scientific Committee, into both English and French, if the reports are received before the 15 day pre-meeting deadline. Where possible, all CPCs are encouraged to provide the National Reports with abstracts in both English and French, as well as figure and table headings.

**TABLE 2.** CPC submission of National Reports to the SC from 2005 to 2013.

| CPC | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| **Australia** | Green | Green | Green | Green | Green | Green | Green | Green | Green |
| **Belize** | n.a. | n.a. | Red | Red | Red | Red | Green | Green | Green |
| **China** | Green | Green | Green | Green | Green | Green | Green | Green | Green |
| **Comoros** | Red | Red | Red | Red | Red | Green | Green | Green | Green |
| **Eritrea** | Red | Red | Red | Red | Red | Red | Red | Red | Red |
| **European Union** | Green | Green | Green | Green | Green | Green | Green | Green | Green |
| **France (OT)** | Green hash | Green hash | Green hash | Green hash | Green hash | Green hash | Green | Green | Green |
| **Guinea** | Red | Red | Red | Red | Red | Red | Red | Red | Red |
| **India** | Red | Green | Green | Red | Green | Green | Green | Green | Green |
| **Indonesia** | n.a. | n.a. | Red | Red | Red | Red | Green | Green | Green |
| **Iran, Islamic Rep. of** | Red | Red | Red | Red | Red | Red | Green | Green | Green |
| **Japan** | Green | Green | Green | Green | Green | Green | Green | Green | Green |
| **Kenya** | Red | Red | Green | Green | Green | Green | Green | Green | Green |
| **Korea, Republic of** | Green | Green | Green | Green | Green | Green | Green | Green | Green |
| **Madagascar** | Red | Red | Red | Red | Green | Green | Green | Green | Green |
| **Malaysia** | Red | Red | Red | Red | Red | Red | Green | Green | Green |
| **Maldives, Rep. of** | n.a. | n.a. | n.a. | n.a. | Green | Green | Green | Green | Green |
| **Mauritius** | Red | Red | Red | Green | Green | Green | Green | Green | Green |
| **Mozambique** | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | Green | Green | Green |
| **Oman, Sultanate of** | Red | Red | Red | Red | Red | Red | Red | Green | Green |
| **Pakistan** | Red | Red | Red | Red | Red | Red | Red | Red | Red |
| **Philippines** | Red | Red | Red | Red | Red | Red | Red | Green | Green |
| **Seychelles, Rep. of** | Green | Green | Green | Green | Green | Green | Green | Green | Green |
| **Sierra Leone** | n.a. | n.a. | n.a. | Red | Red | Red | Red | Red | Red |
| **Sri Lanka** | Red | Green | Green | Red | Red | Red | Green | Green | Green |
| **Sudan** | Red | Red | Red | Red | Red | Red | Red | Green | Green |
| **Tanzania, United Republic of** | n.a. | n.a. | Red | Red | Red | Red | Green | Red | Green |
| **Thailand** | Green | Green | Green | Green | Green | Green | Green | Green | Green |
| **United Kingdom (OT)** | Green | Green | Green | Green | Green | Green | Green | Green | Green |
| **Vanuatu** | Red | Red | Red | Red | Red | Red | Green | Red | Green |
| **Yemen** | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | Red | Red |
| **Senegal*** | Red | Red | Red | Red | Red | Red | Green | Green | Green |
| **South Africa, Rep. of*** | Green | Red | Green | Green | Green | Red | Green | Green | Green |

*Cooperating Non-Contracting Party in 2013. 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).

## 7. Reports of the 2013 IOTC Working Party Meetings

### *7.1 Report of the Third Session of the Working Party on Neritic Tunas (WPNT03)*

30. The SC **NOTED** the report of the Third Session of the Working Party on Neritic Tunas (IOTC–2013–WPNT03–R), including the consolidated list of recommendations provided as an appendix to the report. The

meeting was attended by 42 participants (35 in 2012; 28 in 2011), including 11 recipients of the MPF (10 in 2012; 9 in 2011).

***New Information on Fisheries and Associated Environmental Data Relating to Neritic Tunas***

***IOTC database***

31. 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 V of the WPNT03 report and **REQUESTED** 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.

***General discussion on data***

32. The SC **RECOMMENDED** that the Commission increase the IOTC Capacity Building budget line so that capacity building workshops/training can be carried out in 2014 and 2015 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.

33. **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 reiterated its previous **RECOMMENDATION** that this data, as well as data from 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.

34. **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 each CPC using monofilament gillnets to estimate total catch and bycatch, etc., taken by monofilament gillnets in comparison to other net material, and to report the findings at the next WPNT meeting.

***Stock structure research***

35. The SC **AGREED** 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 as a high priority.

36. The SC **RECOMMENDED** that the IOTC Secretariat act in a project coordination role, as well as to seek funding for stock structure projects in the Indian Ocean. Initially, this would require the establishment of an intersessional discussion group with participants from the WPNT, and experts in the field of stock structure differentiation. CPCs with current or planned stock structure studies are encouraged to circulate project proposals to the wider group for comment that may be considered for submitting to prospective funding partners with support from the IOTC Secretariat.

### *7.2 Report of the Ninth Session of the Working Party on Ecosystems and Bycatch (WPEB09)*

37. The SC **NOTED** the report of the Ninth Session of the Working Party on Ecosystems and Bycatch (IOTC–2013–WPEB09–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 32 participants (48 in 2012; 49 in 2011), including 11 recipients of the MPF (7 in 2012; 7 in 2011).

**Regional review of the current and historical data available for gillnet fleets operating in the Indian Ocean**

38. The SC reiterated its previous **RECOMMENDATION** that the Commission considers allocating funds to support a regional review of the current and historical data available for gillnet fleets operating in the Indian Ocean. As an essential contribution to this review, scientists from all CPCs having gillnet fleets in the Indian Ocean, in particular those from I.R. Iran, Oman, Pakistan and Sri Lanka, should collate the known information on bycatch in their gillnet fisheries, including sharks, marine turtles and marine mammals, with estimates of the likely order of magnitude where more detailed data are not available. A consultant should be hired for 30 days to assist CPCs with this task (budget estimate: Table 3).

**TABLE 3**. Estimated costs for the hiring of a consultant to undertake a regional review of gillnet fleets.

| Description | Unit price | Units required | Total |
|---|---|---|---|
| Contract days | $350 | 30 | 10,500 |
| Travel costs (field) | $3,000 | 3 | 9,000 |
| Travel costs to attend WPEB | $5,000 | 1 | 5,000 |
| Total estimate (US$) | | | **24,500** |

**Training for CPCs having gillnet fleets on species identification, bycatch mitigation and data collection methods and also to identify other potential sources of assistance – Development of plans of action**

39. The SC **RECOMMENDED** that the Commission allocate funds in its 2014 and 2015 budgets for the IOTC Secretariat to facilitate training for CPCs having gillnet fleets on bycatch mitigation methods, species identification, and data collection methods (budget estimate: Table 4).

**TABLE 4**. Estimated costs for CPCs with large gillnet fleets on bycatch mitigation methods, species identification and data collection methods. Two training workshops: I.R. Iran/Oman and Sri Lanka.

| Description | Unit price | Units required | Total |
|---|---|---|---|
| Production of training material | $1,000 | 1 | 1,000 |
| Travel costs (IOTC Staff) (I.R.Iran/Oman, Sri Lanka) | $4,000 | 3 | 12,000 |
| Travel costs (Experts) (I.R.Iran/Oman, Sri Lanka) | $4,000 | 3 | 12,000 |
| Workshop venue – to be paid by hosts | $0 | 2 | $0 |
| Total estimate (US$) | | | **25,000** |

**Sharks and rays**

**Review of new information on the status of sharks and rays**

40. **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 length frequency data on sharks, as per IOTC Resolutions, so that more detailed analysis can be undertaken for the next WPEB meeting.

41. **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 2014 and 2015 IOTC budgets (budget estimate: Table 5).

**TABLE 5**. Estimated costs for the hiring of a consultant to undertake a literature review of shark interactions.

| Description | Unit price | Units required | Total |
|---|---|---|---|
| Contract days | $350 | 30 | 10,500 |
| Travel costs (field) | $3,000 | 3 | 9,000 |
| Travel costs to attend WPEB | $5,000 | 1 | 5,000 |
| Total estimate (US$) | | | **24,500** |

42. The SC **RECOMMENDED** that the IOTC Secretariat facilitate a process to develop standardised sampling protocols for bycatch species which are thought to be heavily impacted by IOTC fisheries. The protocols established by the WCPFC may be a useful starting point. Given the lack of staffing resources at the Secretariat to undertake the work directly, the Commission may wish to allocate sufficient funds in its 2014 budget to hire a consultant to undertake this work, under the guidance of the Secretariat. The primary aim would be to gather the necessary information to determine stock status for key shark species, or in the case of marine turtles and seabirds, to be able to accurately monitor impacts of IOTC fisheries on those species or species groups. An approximate budget is provided in Table 6.

**TABLE 6**. Estimated costs for the hiring of a consultant to develop standardised guidelines for sampling bycatch.

| Description | Unit price | Units required | Total |
|---|---|---|---|
| Contract days | $350 | 30 | 10,500 |
| Travel costs to attend WPEB | $5,000 | 1 | 5,000 |
| Total estimate (US$) | | | **15,500** |

**Ecological Risk Assessment: review of current knowledge and potential management implications**

43. The SC **RECOMMENDED** that the Commission note the list of the 10 most vulnerable shark species to longline gear (Table 7) and purse seine gear (Table 8) in the Indian Ocean, as determined by a productivity susceptibility analysis, compared to the list of shark species/groups required to be recorded for each gear, contained in Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*. At the next revision to Resolution 13/03, the Commission may wish to add the missing species/groups of sharks and rays.

44. The SC **NOTED** that some CPCs considered 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.

45. The SC **EXPRESSED** concern that the silky shark (*Carcharhinus falciformis*), ranked 4$^{th}$ in terms of its vulnerability to longline gear by the ERA, is not contained in the list of shark species (or groups of species) to be recorded in logbooks under Resolution 13/03. Similarly, the recording requirements for purse seine gear included only three species (whale sharks, thresher sharks as a group, and oceanic whitetip sharks).

46. 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 13/03 (Table 7) should be supplemented with the silky shark (*Carcharhinus falciformis*), which was estimated to be at risk in longline fisheries by the ERA conducted in 2012 (ranked as the 4$^{th}$ most vulnerable species to longline gear). The SC **REQUESTED** the Commission to define the most appropriate means of collecting this additional information.

**TABLE 7**. 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 13/03 *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 currently listed in IOTC Resolution 13/03 for longline gear: mandatory recording | 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 | Other sharks | SKH |
| 6 | Smooth hammerhead (*Sphyrna zygaena*) | SPZ | Thresher sharks (*Alopias* spp.) | THR |
| 7 | Porbeagle (*Lamna nasus*) | POR | Oceanic whitetip shark (*Carcharhinus longimanus*) | OCS |
| 8 | Longfin mako (*Isurus paucus*) | LMA | | |
| 9 | Great hammerhead (*Sphyrna mokarran*) | SPM | | |
| 10 | Blue shark (*Prionace glauca*) | BSH | | |

47. 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 purse seine gear under Resolution 13/03 (Table 8) should be supplemented with the silky shark (*Carcharinus falciformis*), mako sharks (*Isurus* spp.), hammerhead sharks (*Sphyrna* spp.), pelagic stingray (*Pteroplatytrygon violacea*), dusky shark (*Carcharhinus obscurus*), tiger shark (*Galeocerdo cuvier*), which were estimated to be at risk in purse seine fisheries by the ERA conducted in 2012. The SC **ADVISED** the Commission to define the most appropriate means of collecting this additional information.

**TABLE 8**. 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 13/03 *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 13/03 for purse seine gear: Mandatory recording | FAO Code |
|---|---|---|---|---|
| 1 | Oceanic whitetip shark (*Carcharhinus longimanus*) | OCS | Whale sharks (*Rhincodon typus*) | RHN |
| 2 | Silky shark (*Carcharhinus falciformis*) | FAL | Thresher sharks (*Alopias* spp.) | THR |
| 3 | Shortfin mako (*Isurus oxyrinchus*) | SMA | Oceanic whitetip shark (*Carcharhinus longimanus*) | OCS |
| 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 | | |

**Review of data needs and way forward for the evaluation of shark stocks**

48. **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 9) for which nominal catch data shall be reported as part of the statistical requirement for IOTC CPCs.

**TABLE 9.** List of the most commonly elasmobranch species caught.

| 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 |

**Marine Turtles**

**Review of data available at the Secretariat for marine turtles**

49. The SC **NOTED** that the lack of data from 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.

**Ecological Risk Assessment: review of current knowledge and potential management implications**

50. The SC **AGREED** that the ERA for marine turtles be kept under review, and that consideration be given to updating it periodically in light of newly received data and other information.

**Review of Resolution 12/04 on the conservation of marine turtles**

51. The SC **RECOMMENDED** that at the next revision of IOTC Resolution 12/04 *on the conservation of marine turtles*, the measure is strengthened to ensure that where possible, CPCs report annually on the total estimated level of incidental catches of marine turtles, by species, as provided at Table 10.

**TABLE 10.** 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* |

**Resolution 10/02 Mandatory statistical [reporting] requirements for IOTC Members and Cooperating Non-Contracting Parties (CPCs)**

52. **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* and Resolution 13/03 on *On the recording of catch and effort by fishing vessels in the IOTC area of competence*.

**Requests contained in IOTC Conservation and Management Measures**

53. The SC **RECOMMENDED** that the Commission note the following in regards to the requests to the SC and WPEB 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, fishing 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, soak times, light deterrents) 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. Encourage the use of circle hooks, whilst developing further research into their effectiveness using a multiple species approach.
2. Release live animals after careful dehooking/disentangling/line cutting (See handling guidelines in the *Marine turtle identification cards for Indian Ocean fisheries*).

**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*

All FAD-directed purse seine fisheries should rapidly change to only use ecological FADs[1] based on the principles outlined in Annex III of Resolution 13/08 *Procedures on a fish aggregating devices (FADs) management plan, including more detailed specification of catch reporting from FAD sets, and the development of improved FAD designs to reduce the incidence of entanglement of non-target species*.

[1] This terms means improved FAD designs to reduce the incidence of entanglement of bycatch species, using biodegradable material as much as possible.

**Marine mammals**

**Review of Resolution 00/02 On a survey of predation of longline caught fish**

54. **NOTING** that the requirements contained in Resolution 00/02 o*n a survey of predation of longline caught fish* was completed by the WPEB and SC in past years, the SC **RECOMMENDED** that Resolution 00/02 be revoked by the Commission.

**Development of technical advice for marine mammals**

55. The SC **RECOMMENDED** that depredation events be incorporated into Resolution 13/03 at its next revision, so that interactions may be quantified at a range of spatial scales. Depredation events should also be quantified by the regional observer scheme.

***Employment of a Fisheries Officer (Bycatch)***

56. **NOTING** the rapidly increasing scientific workload at the IOTC Secretariat, including a wide range of additional duties on ecosystems and bycatch assigned to it by the SC and the Commission, and that the new Fishery Officer (Science) supporting the IOTC scientific activities has not been given a mandate by the Commission to work on ecosystems and bycatch matters, the SC **RECOMMENDED** that the Commission approve the hiring of a Fishery Officer (Bycatch) to work on bycatch matters in support of the scientific process.

**Format of future WPEB Sessions**

57. The SC **NOTED** that the WPEB had discussed the future format of its meetings with the aim of focusing the efforts of scientists working on different groups of bycatch species to address more efficiently, the mandate of the group. The WPEB **CONSIDERED** a range of options which the SC was asked to consider:
    - **Option 1**: The current WPEB be split into two; A dedicated Working Party on Sharks (WPS) and a Working Party on Ecosystems and Bycatch (WPEB).
    - **Option 2**: Retaining the WPEB in its current form, with alternating focus of sharks in one year, followed by other ecosystem and bycatch issues in the next year.
    - **Option 3**: Maintaining the WPEB with clear guidelines to deal with sharks every year, as well as other issues and bycatch groups in alternate years or as required.
  - The WPEB **AGREED** that shark issues were important to address on a yearly basis.

58. The SC **AGREED** that the WPEB should be maintained as a single working party for the next few years, to deal with sharks every year, as well as other issues and bycatch groups in alternate years or as required by the Commission.

**Invited Expert/s at the next Working Party on Ecosystems and Bycatch meeting**

59. The SC **NOTED** that the current process for determining the criteria to select invited experts to attend IOTC meetings involves discussions during working party meetings each year and the adoption of desired skills and areas for contribution. The selection process, as adopted by the Chairs and Vice-Chairs appears to be working well with the contributions of the invited experts greatly improving the work of the WPEB and other subsidiary bodies.

60. The SC **RECOMMENDED** that two Invited Experts be brought to the WPEB in 2014 so as to further increase the capacity of the WPEB to undertake work on sharks at the next meeting, and for this to be included in the IOTC budget for 2014.

#### *7.2.1 Status of development and implementation of Nation Plans of Action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations*

61. The SC **NOTED** paper IOTC–2013–SC16–07 which provided the SC with the opportunity to consider, update and comment on the current status of development and implementation of national plans of action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations, by each IOTC CPC.

62. The SC **REQUESTED** that all CPCs without an NPOA-Sharks and/or NPOA-Seabirds expedite the development and implementation of a NPOA, and to report progress to the WPEB and SC in 2014, 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.

63. The SC **RECOMMENDED** that the Commission note the updated status of development and implementation of National Plans of Action for seabirds and sharks, and the implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations, by each CPC as provided at Appendix VI.

### *7.2.2 Best practice guidelines for the safe release and handling of encircled cetaceans*

64. The SC **NOTED** paper IOTC–2013–SC16–08 which aimed to provide the SC with options for developing best practice guidelines for the safe release and handling of encircled cetaceans, as requested by the Commission in Resolution 13/03 *on the conservation of cetaceans*. The Resolution aims to mitigate the interactions between cetaceans and purse seine fishing gear; gather additional information from CPCs on the interaction rates with other fishing gears, in particular gillnets and longlines; and requests that the IOTC SC develop best practice mitigation and handling guidelines for consideration by the Commission at its 18th Session in 2014, to mitigate the impacts of fishing on cetaceans in the IOTC area of competence. Specifically, paragraph 6 of Resolution 13/04 *on the conservation of cetaceans* states:

> "*The Commission requests that the IOTC Scientific Committee develop best practice guidelines for the safe release and handling of encircled cetaceans, taking into account those developed in other Regional Fisheries Management Organisations, including the Western and Central Pacific Fisheries Commission, and that these guidelines be submitted to the 2014 Commission meeting for endorsement*."

65. The SC **RECOMMENDED** that the Commission allocates funds in its 2014 budget, to produce and print the IOTC best practice guidelines for the safe release and handling of encircled cetaceans. The guidelines could be incorporated into a set of IOTC cetacean identification cards: "*Cetacean identification for Indian Ocean fisheries*".

### *7.2.3 Best practice guidelines for the safe release and handling of encircled whale sharks*

66. The SC **NOTED** paper IOTC–2013–SC16–09 which aimed to provide the SC with options for developing best practice guidelines for the safe release and handling of encircled whale sharks, as requested by the Commission in Resolution 13/05 *on the conservation of whale sharks (Rhincodon typus)*. The Resolution aims to mitigate the interactions between whale sharks and purse seine fishing gear; gather additional information from CPCs on the interaction rates with other fishing gears, in particular gillnets and longlines; and requests that the IOTC Scientific Committee develop best practice mitigation and handling guidelines for consideration by the Commission at its 18th Session in 2014, to mitigate the impacts of fishing on whale sharks in the IOTC area of competence. Specifically, paragraph 6 of Resolution 13/05 *on the conservation of whale sharks (Rhincodon typus)* states:

> "*The Commission requests that the IOTC Scientific Committee develop best practice guidelines for the safe release and handling of encircled whale sharks, taking into account those developed in other regional fisheries management organisations including the Western and Central Pacific Fisheries Commission, and that these guidelines be submitted to the 2014 Commission meeting for endorsement*."

67. The SC **RECOMMENDED** the following *Guidelines for the safe release and handling of encircled whale* sharks, that should be added as an additional page in the IOTC shark identification guides:

> The methods listed below depend on the condition of the particular purse seine set, e.g. the size and orientation of the encircled animal, size of fish in the purse seine set and operation style.
> - Cutting the net when the whale shark is at the surface and separated from the tuna and when the operation presents no danger for the crew;
> - Standing the animal on the net and rolling it outside the bunt. A rope placed under the animal and attached to the float line could help rolling the whale shark out of the net;
> - Brailing sharks (only for small individual less than 2–3 meters).
>
> The crew should never:
> - Pull up the shark by its tail;
> - Tow the shark by its tail.

68. The SC **RECOMMENDED** that the Commission allocates funds in its 2014 budget, to produce and print the IOTC best practice guidelines for the safe release and handling of encircled whale sharks, and for these to be incorporated into the existing IOTC "*Shark and ray identification in Indian Ocean pelagic fisheries*", identification cards.

### *7.2.4 At-sea trials of line-weighting options for pelagic longline vessels*

69. The SC **NOTED** paper IOTC–2013–SC16–10 Rev_1 which detailed the outcomes of at-sea trials of different line-weighting options for pelagic longline vessels.

70. The SC **CONGRATULATED** the Government of the Republic of Korea, Sajo Industries and BirdLife International for the highly successful collaborative research undertaken to date. The results demonstrate that Korean-style branchlines can be optimised for a fast sink rate with a weighting regime that appears to have a very low risk of impacting negatively catch rates of target species, with no safety risks to crew and with no operational difficulties.

71. **NOTING** that further work is required, preferably in areas of high seabird abundance, to achieve robust sample sizes for assessing the impacts of weights on target and non-target catch rates, the SC strongly **ENCOURAGED** the collaborative research efforts to continue and for the findings to be presented to the WPEB in 2014.

#### *7.2.5 Shark Year (multi-year research) Program*

72. The SC **NOTED** paper IOTC–2013–SC16–18 which provided a Shark Year (multi-year research) Program for the consideration and potential endorsement by the SC, so that the requirements of IOTC Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*, may be fulfilled by the deadline specified by the Commission (2016 evaluation by the SC).

73. The SC **AGREED** that the Shark Year Program (SharkYP) represents a further step to align with the work of the WPEB with IOTC Conservation and Management Measures (CMMs), particularly to the recently adopted Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*. Moreover, the SharkYP aims to provide guidance to WPEB researchers, by prioritising issues related to data collection and research on species biology/ecology, fisheries and mitigation measures. Finally, by promoting cooperation and coordination among WPEB researchers, the SharkYP aims to improve the quality of the scientific advice on sharks provided to the Commission, and to better assess the impact on these species of the current CMMs.

74. The SC **ENDORSED** the Shark Year (multi-year research) Program provided at Appendix I of paper IOTC–2013–SC16–18 and **RECOMMENDED** that a detailed multi-year shark research program be prepared (by a small group of shark experts and the IOTC Secretariat) covering the various aspects raised in paper IOTC–2013–SC16–18. The IOTC budget for 2014 should include funding support to allow the small group of shark experts and the IOTC Secretariat to attend a short ad-hoc meeting (Table 11).

**TABLE 11**. Estimated costs for ad hoc expert meeting to draft detailed SharkYP proposal.

| **Description** | **Unit price** | **Units required** | **Total (US$)** |
|---|---|---|---|
| Meeting room* (3 days) | 1,000 | 3 | 3,000 |
| Travel costs (flights, DSA)<br>5 Shark experts plus IOTC Science Manager | estimate | 6 | 10,000 |
| Total estimate (US$) | | | **13,000** |

*possible in kind support from host institution

75. The SC **NOTED** that the Shark Year (multi-year research) Program will remain a work in progress and may need to be modified/updated periodically based on progress and the information available. Once the small working group has developed the detailed plan, funding should be sought from sources external to the IOTC, where possible (e.g. WWF, GEF, Shark Alliance, PEW). For the Shark Year Program to be successfully implemented, it will require the active engagement of industry, NGO's and IOTC scientists.

### *7.3 Report of the Eleventh Session of the Working Party on Billfish (WPB11)*

76. The SC **NOTED** the report of the Eleventh Session of the Working Party on Billfish (IOTC–2013–WPB11–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 24 participants (23 in 2012; 27 in 2011) including 10 recipients of the MPF (5 in 2012; 5 in 2011).

**Length-age keys**

77. The SC **RECOMMENDED** that as a matter of priority, CPCs that have important fisheries catching billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) 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**

78. The SC **RECOMMENDED** that all CPCs assess and improve the status of catch-and-effort data for marlins (by species) and sailfish, noting that improvements to the data for the EU fleets and its provision to the IOTC Secretariat, would be most beneficial to the work of the WPB.

**Data support**

79. **NOTING** that the work carried out during the meeting requires an IOTC data expert to be in attendance at each meeting to answer the many and varied questions from participants, the SC **RECOMMENDED** that the Secretariat support team attending the WPB meeting each year, also contain a staff member from the IOTC Data Section, in addition to the Science Manager and Fishery Officer (Stock Assessment), and for the attendance of the third team member to be incorporated into the IOTC budget for 2014 and for all future years.

**Pakistan gillnet fishery**

80. **RECALLING** IOTC Resolution 12/12 *to prohibit the use of large-scale driftnets on the high seas in the IOTC area*, paragraph 1, which states:

> *"1. The use of large-scale driftnets on the high seas within the IOTC area of competence shall be prohibited." "Large-scale driftnets" are defined as gillnets or other nets or a combination of nets that are more than 2.5 kilometers in length whose purpose is to enmesh, entrap, or entangle fish by drifting on the surface of, or in, the water column."*,

the SC **NOTED** the findings of the study that gillnets in excess of the 2.5 km limit are being used by the gillnet fleets of Pakistan on the high seas, in contravention of Resolution 12/12.

**Mozambique billfish fishery**

81. **NOTING** that at present few scientific observers are being placed on board vessels fishing in the Mozambique Channel (between parallels 10°- 30° South). Further NOTING the importance of that area for billfish fishery statistics, the SC recalled its **RECOMMENDATION** that CPCs whose vessels fish in that area take the necessary measures to take on board scientific observers as adopted in Resolution 11/04 and to report the data collected as per IOTC requirements.

**Recreational and sports fisheries for billfish**

82. **NOTING** that in 2011, the Chair of the WPB, in collaboration with the IOTC Secretariat, participating billfish foundations and other interested parties, commenced a process to facilitate the acquisition of catch-and-effort and size data from sport fisheries, by developing and disseminating reporting forms to Sport Fishing Centres in the region, the SC **RECOMMENDED** that the Chair and Vice-Chair work in collaboration with the IOTC Secretariat and the African Billfish Foundation to find a suitable funding source and lead investigator (university or consultant) to undertake the project outlined in Appendix VI of the WPB11 report (IOTC–2013–WPB11–R). The aim of the project will be to enhance data recovery from sports and other recreational fisheries in the western Indian Ocean region. The WPB Chair should circulate the concept note to potential funding bodies on behalf of the WPB. A similar concept note could be developed for other regions in the IOTC area of competence at a later date.

**Parameters for future analyses: stock assessments**

83. **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 **RECOMMENDED** 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)

**Swordfish Nominal and standardised CPUE indices**

84. **NOTING** the request from the Commission in 2013 that the southwest region continue to be analysed as a special resource, in addition to the full Indian Ocean assessment, the SC **RECOMMENDED** that CPCs with longline fleets with important swordfish catches in the southwest Indian Ocean (EU, Taiwan,China and Japan)

undertake revised CPUE analysis for their longline fleets in the southwest Indian Ocean, in addition to CPUE analysis for the entire Indian Ocean.

### *7.4 Report of the Fifteenth Session of the Working Party on Tropical Tunas (WPTT15)*

85. The SC **NOTED** the report of the Fifteenth Session of the Working Party on Tropical Tunas (IOTC–2013–WPTT15–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 46 participants (47 in 2012; 49 in 2011), including 10 recipients of the MPF (8 in 2012; 13 in 2011).

#### *Spatial assessment and management of tuna populations*

86. The SC **AGREED** on the necessity to perform additional research on population structure to challenge the current paradigm of a single panmictic spawning population throughout the entire Indian Ocean, which has strong implications for management. Applying genetics, otolith microchemistry, parasitology and analysis of the IOTC tag-recovery dataset is likely to provide the information required to determine if stocks are being managed at the appropriate scales.

#### *Data collection and processing systems*

87. The SC **THANKED** Japan and Taiwan,China for addressing some of the concerns raised by the WPTT in 2012 about data collection and length frequency processing, and **RECOMMENDED** that both Japan and Taiwan,China, as well as the IOTC Secretariat continue joint work, in cooperation with countries having longline fisheries, to address other issues identified by the WPTT, such as conflicting trends in the longline CPUE among the main longline fleets, the lack of specimens of small size from the samples for Taiwan,China longline fleet, and discrepancies in the average weights estimated using the available catch-and-effort and length frequency data.

#### *Length Frequency inter-sessional meeting guidelines*

88. **NOTING** the size data issues (discrepancies in size data (low sampling rate, uneven distribution of sampling in regard to the spatial extent of the fishery) in the Japan and Taiwan,China tropical tuna data sets) identified by the WPTT in 2012 and 2013 and the Scientific Committee in 2012, the SC **RECOMMENDED** that an inter-sessional meeting attached to the WPDCS and/or WPM on *data collection and processing systems for size data from the main longline fleets in the Indian Ocean*, be carried out in early 2014, under the guidelines contained in Appendix VII.

89. The SC **NOTED** that the data collection and processing systems used for distant-water longline fisheries tend to apply to all oceans **AGREEING** that it is likely that the issues identified for the Indian Ocean also apply to other areas. In this regard, the SC **REQUESTED** that the IOTC Secretariat informs other tuna-RFMO Secretariats about the issues identified and facilitates participation of their staff to the WPDCS, where required.

#### *European Union fishery statistics*

90. The SC **NOTED** errors in the procedure used to correct the species composition of the European Union purse seine catches on free-swimming schools. This error resulted in an over-representation (20–30%) of bigeye tuna in the statistics provided to the IOTC Secretariat, compared to the composition produced by the species sampling. Recalling the need for the European Union to submit corrected catches by species to the IOTC, the SC **REQUESTED** that EU scientists document all estimation procedures and the changes in species composition arising from them and report this information at the next session of the WPTT, in 2014.

#### *India fisheries*

91. **NOTING** the potential utility of the longline CPUEs derived from the research surveys conducted by the "Fishery Survey of India", the SC **RECOMMENDED** that as a high priority, India undertake a standardisation of the CPUE series, with the support of the IOTC Secretariat, and for this to be presented at the next WPTT meeting.

#### *Consultants*

92. The SC **NOTED** the excellent work done by IOTC consultants in 2013 on a range of projects from Management Strategy Evaluation to the bigeye tuna SS3 stock assessment, and **RECOMMENDED** that their engagement be renewed for the coming year to supplement the skill set available within IOTC CPCs. An indicative budget is provided at Table 12.

**TABLE 12**. Estimated budget for IOTC consultants to be engaged on tropical tunas in 2014

| Description | Unit price | Units required | Total |
|---|---|---|---|
| Tropical tuna Management Strategy Evaluation (fees) | US$450 | 35 | 15,750 |
| Tropical tuna Management Strategy Evaluation (travel) | US$8,000 | 1 | 8,000 |
| Tropical tuna Stock Assessment (fees) | US$450 | 35 | 15,750 |
| Tropical tuna Stock Assessment (travel) | US$8,000 | 1 | 8,000 |
| Total estimate (US$) | | | **47,500** |

***Data quality impacts***

93. The SC **NOTED** that the data quality was integral to the accuracy of stock assessments. IOTC is one of the only RFMO's that is transparent about the quality of the information used in its assessments. These issues are apparent in other RFMO's but rarely acknowledged in the assessment reports. A concern was expressed on the quality of information used in these assessments, as the coverage from CPC's is reducing over time, forcing the Secretariat to make estimates for a large number of fleets and areas.

***EU,Spain FAD management plan***

94. The SC **NOTED** paper IOTC–2013–SC16–INF05 which detailed the EU,Spain fish aggregating device management plan from 2010 to 2013. EU,Spain has been a pioneer in the development and implementation of a FAD management plan, and it was felt that the plan provided, may be a useful template for other CPCs to consider when developing their own management plans for submission to the Commission.

***Bigeye tuna growth***

95. The SC **NOTED** paper IOTC–2013–SC16–INF06 which suggested that there may be inconsistencies in the 2 stanza growth curve used in the assessment, as there is rapid growth in the early life history stages. An alternative growth curve was presented for bigeye tuna smaller than 50 cm based on tagging data which affect the catch at size used in the assessment. This may have an effect in the current stock assessment results for bigeye; however, preliminary analysis presented in the paper as well as further analysis done based on WPTT work showed that the results using the new growth curve were similar to the results gathered by the WPTT,which confirm the robustness of the bigeye tuna assessment to different source of uncertainty.

96. **NOTING** that any changes in growth curves should be considered in conjunction with changes in natural mortality and other biological parameters used in the assessment, the SC **REQUESTED** that the WPTT inter-sessionally investigate bigeye tuna growth rates for individuals less than 50 cm, in conjunction with the changes in other biological parameter (such as natural mortality) and the effect that this may have into stock assessment to be presented to the next WPTT meeting.

***7.5 Report of the Ninth Session of the Working Party on Data Collection and Statistics (WPDCS09)***

97. The SC **NOTED** the report of the Ninth Session of the Working Party on Data Collection and Statisitcs (IOTC–2013–WPDCS09–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 23 participants (21 in 2011), including 5 recipients of the MPF (2 in 2011).

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

98. The SC **RECOMMENDED** that the Commission amends IOTC Resolution 10/02 as follows:
- Adding the following definitions in order to clarify the type of fisheries, area and species covered by Resolution 10/02:
    - Longline fisheries: Fisheries undertaken by vessels in the IOTC Record of Authorized Vessels that use longline gear.
    - Surface fisheries: All fisheries undertaken by vessels in the IOTC Record of Authorized Vessels other than longline fisheries; in particular purse seine, pole-and-line, and gillnet fisheries.
    - Coastal fisheries: Fisheries other than longline or surface, as defined above, also called artisanal fisheries.
    - IOTC Area of Competence: as described in Annex A of the IOTC Agreement.
    - Species: refers to all species under the IOTC mandate as described in Annex B of the IOTC Agreement, and the most commonly caught elasmobranch species, as defined by the Commission in IOTC Resolution 13/03 or any subsequent revisions of this Resolution.
    - Support vessels: Any types of vessels that operate in support of the fishing activities of purse seine vessels.
- Specify the requirements for Nominal Catch data, including:

- Changing the term Nominal by Total;
- Change the time-period resolution of Total catch data from Year to Quarter, in order to be able to assess the seasonality of fisheries that do not report catch-and-effort data;
- Request separate reports for retained catches (in live weight) and discards (in live weight or number), as per the above resolution.

- Specify the requirements for Catch and effort data, including:
  - Surface fisheries: Extend the requirements to report catch and effort data by type of fishing mode to other fisheries that use FADs, drifting or anchored; and ensure that the effort units reported are consistent with those requested in Resolution 13/03 or any subsequent revisions to such Resolution;
  - Coastal fisheries: Specify the time-period to be used to report this information, preferably Month.
- Specify that Size Frequency data shall be reported according to the procedures described in the IOTC Guidelines for the Reporting of Fisheries Statistics (instead of those set out by the IOTC Scientific Committee).
- Specify the requirements for data on supply vessels, including:
  - Change the term Supply to Support (Support Vessels);
  - Indicate that data on the activities of support vessels shall be reported by the flag country of the vessels that receive the assistance of the support vessel (and not by the flag country or other parties);
  - Request the name of the purse seiners that receive assistance from each support vessel;
- Specify the data requirements for Fish Aggregating Devices, as requested in IOTC Resolution 13/08, which contains provisions calling for IOTC CPCs to collect more detailed information on FADs.

***Resolution 11/04 On a regional observer scheme.***

99. The SC **NOTED** that the number of trips covered by observers over the total number of trips estimated for longliners have been used to estimate levels of coverage on longline fleets, further noting the difficulties that some countries have to use the number of sets covered by observers over the total number of sets by their fleets, as requested by the Commission. Using the number of trips as unit of effort to measure coverage by observers may not be appropriate as longline fishing trips can extend for more than one year and are usually not fully covered by scientific observers. For this reason, and acknowledging the difficulties that some countries have to estimate the total number of sets for their fleets, the use of alternative units of effort may be appropriate to assess coverage, the SC **RECOMMENDED** that the total number of days-at-sea covered by observers versus the total number of days-at-sea for each fleet over a year is used instead of the number of sets.

***Availability of IOTC statistics for 2012***

100. **NOTING** that some coastal countries in the IOTC region, such as Iran, use the Lunar (Hijri) Calendar instead of the Gregorian Calendar, which poses difficulties to report data before the deadline, as they have four months instead of six to prepare all information, following the end of the Lunar year, the SC **REQUESTED** that the countries concerned bring this matter to the attention of the Commission, where required.

***General discussion on data issues***

101. The SC **NOTED** that India had reported very incomplete catches and effort, and no size data, for its commercial longline fleet, in particular for years before 2011. Over 60 longliners from India had operated in the Indian Ocean during 2006-07. The SC **RECALLED** the recommendation from the WPTT that scientists from Taiwan,China assist India in the estimation of catches of IOTC species and sharks for this fleet, with the majority of those vessels used the flag of Taiwan,China in the past. The SC thanked the scientists from Taiwan,China for offering assistance and **RECOMMENDED** that India reports a revised time-series of catch and effort for its longline fleet, where required, as soon as the review is finalised.

102. **NOTING** that to date, I.R. Iran has not reported catch and effort data to the IOTC Secretariat as per the IOTC Requirements; that the WPEB had previously recommended that I.R. Iran strengthen its monitoring of catches of sharks from both the logbook and observer programmes; and that I.R. Iran is setting procedures in its databases that will make it possible to report catch and effort data for its fisheries as per the IOTC standards in the future; the SC **RECOMMENDED** that I.R. Iran finalises this work and reports the available series of catch and effort data for its fisheries as a matter of priority.

103. The SC **NOTED** the difficulties that some countries have to report data to the IOTC as per the required standards, and that this lack of reporting originates in some cases from an insufficient understanding of the IOTC Requirements. In this regard the IOTC Secretariat will receive financial support from the EU-funded

IOC-SmartFish Project for the organisation of a regional workshop to understand the IOTC Data Requirements and **REQUESTED** that the IOTC Secretariat considers funding scientists and statistical officers from non IOC countries to the Workshop, in particular from Iran, Indonesia, and Sri Lanka.

***Review of length frequency data from longline fleets and likely impacts on the assessments***

104. The SC **REQUESTED** that joint work on the documentation of procedures for the collection, processing and reporting of size frequency data continues, based on a template produced by the IOTC Secretariat, in particular:
    - Full description of the type of sampling platforms used (e.g. commercial boats, research boats, training boats, etc.), and collecting sources (e.g. fishermen, researchers, scientific observers, etc.)
    - Full description of the sampling protocols used, on each (e.g. full enumeration of every set, every other set, first 30 fish from each set sampled for size, etc.), by type of sampling platform and collecting source.
    - Type of measurements collected (e.g. gilled-and-gutted weight, fork length, etc.) and measurement tools used (calliper, measuring board, measuring tape, scale, etc.) by type of sampling platform, collecting source, and species.
    - Type of time-area stratification used for each species (e.g. quarter and defined area) and procedures used for the estimation of sampled weights in each stratum, including all equations used for the conversion of non-standard measurements into standard measurements, by species (e.g. deterministic conversion using a single length weight equation for all areas and time periods, etc.).
    - Description of any other procedures which involve the use of length frequency data (e.g. estimation of weights from the numbers reported in logbooks and substitution scheme in the case that lengths are not available in areas where there are catches and effort recorded, etc.).

***Recommendations to improve the quality of the statistics at the IOTC***

105. **NOTING** that the SC had previously requested that the Maldives estimate the quantity of bigeye tuna being caught by its fisheries, in particular those operating around anchored FADs, the SC **NOTED** that Maldives is working with the IOTC Secretariat in the estimation of ratios of catch yellowfin tuna:bigeye tuna for its fisheries, and **ENCOURAGED** that Maldives finalises this work as soon as possible and reports a new series of catch to the IOTC and the results of this analysis to the next Meeting of the WPDCS and WPTT.

***Review of non-standard to standard measurement equations available for IOTC species***

106. **NOTING** that there is a need to select a set of official equations to be used in the preparation of input files for the assessments of stocks of IOTC species and sharks, or other procedures used on those assessments, it may be more appropriate that the sets of equations to be used for each stock are selected by the Working Parties responsible for the assessments of those stocks.

107. The SC **REQUESTED** that document IOTC–2013–WPDCS09–13 Rev_1 be forwarded, by the chair of the WPDCS, to the Working Parties concerned for further consideration. The official set of equations and the basic data used to derive those equations should be added to the IOTC website. Where possible, the Working Parties should contemplate the use of keys to convert from non-standard measurements to standard measurements over deterministic methods.

***Status and use of the data reported in Observer Trip Reports***

108. **NOTING** that the observer trip report is submitted in an electronic format, the SC **REQUESTED** that the IOTC Secretariat creates a template, preferably using MS Excel, to facilitate reporting of this information, and makes it available through the IOTC Web Page.

***IOTC Data Summary***

109. The SC **NOTED** the plans from the IOTC Secretariat to resume publication of the IOTC Data Summary in electronic form, including work on the set-up of an online querying facility in the IOTC Web Site, which will allow site users to filter nominal catch and catch-and-effort data using a range of criteria and visualise the output in table or graphic format, including different types of charts, figures and maps. The work will facilitate the use of information in the IOTC Databases by the general public. The SC **RECOMMENDED** that the IOTC Secretariat carries out this work during 2014 and presents the new system to the next meeting of the WPDCS for suggested improvements.

***IOTC-OFCF Project, 2013***

110. The SC **NOTED** that Phase III of the IOTC-OFCF Project came to an end in March 2013. All activities undertaken during Phase III of the Project are summarised in the IOTC-OFCF Project Comprehensive Report,

which can be made available upon request. In addition, as part of the ongoing cooperation between the EU-funded Project COI-SmartFish and the IOTC the IOTC Secretariat has coordinated the implementation of data collection activities in Madagascar and Comoros. Finally, the IOTC Secretariat is working with the Bay of Bengal Large Marine Ecosystems (BOBLME) Project to strengthen data collection and processing in Sri Lanka, as a continuation to activities previously covered by the IOTC-OFCF Project. Following is a summary of the activities undertaken since the end of SC15:

111. 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.

### *7.6 Update on the inter-sessional work of the WPM small working group on Management Strategy Evaluation*

112. The SC **NOTED** paper IOTC–2013–SC16–11 which provided an update on the inter-sessional work of the WPM small working group on Management Strategy Evaluation, as well as the two reports of the WPM small working groups provided in paper IOTC–2013–SC16–INF07 and IOTC–2013–SC16–INF08, which outline the main outcomes and recommendations from the two meetings on MSE work undertaken by the WPM small working group in 2013.

113. The SC **ACKNOWLEDGED** the work that has been carried out inter-sessionally by the WPM MSE group and thanked its members for the progress achieved so far. The development of tools that would best allow the evaluation of the likely impacts and the relative merits of alternative management options was considered to be a necessary step for the precautionary management of IOTC stocks.

114. 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. This should also cover a dialogue on issues related to the specific formulation of management objectives that are required for a complete formulation and evaluation of management plans through MSE.

115. 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 Resolution 13/10 *on interim target and limit reference points and a decision framework* should be incorporated into the workshops. The SC **REQUESTED** that the Commission's budget incorporate appropriate funds for this purpose, as detailed in Table 13.

116. The SC **RECOMMENDED** that the Commission allocate funds in the 2014 and 2015 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, as detailed in Table 13.

**TABLE 13**. Estimated budget for IOTC consultants to be engaged in MSE training workshops in 2014 and 2015

| Description | Unit price | Units required | Total |
|---|---|---|---|
| 2014 | | | |
| Training materials | US$2,000 | 1 | 2,000 |
| Consultant fees | $350 | 30 | 7,500 |
| Travel (2 trips) | US$10,000 | 2 | 20,000 |
| 2015 | | | |
| Training materials | US$2,000 | 1 | 2,000 |
| Consultant fees | $350 | 30 | 7,500 |
| Travel (2 trips) | US$10,000 | 2 | 20,000 |
| Total estimate (US$) | | | **59,000** |

117. The SC **REQUESTED** that CPCs with available expertise in this field make every effort to allocate personnel and funds to collaborate in this work, and that avenues of funding that might be available for this are fully explored.

118. The SC **REQUESTED** that the MSE development process be carried out in collaboration and with fluid communication with the species Working Parties, to better utilise the available expertise in all working parties. The WPM chair should ensure that this is carried out for all relevant working parties in 2014, as was done this year with the Working Party on Tropical Tunas.

119. The SC **REQUESTED** that the MSE process include as one of its outcomes the analysis of the robustness and suitability of the current set of interim reference points, and that the WPM include this in its workplan for 2014.

120. The SC **NOTED** that ISSF is actively proposing in all tuna RFMOs the adoption of fishery management decision frameworks (Harvest Control Rules and Reference Points) which are necessary components of any system for the sustainable management of tuna fisheries. ISSF strongly supports the work of the IOTC SC in this area and its work plan for carrying out a Management Strategy Evaluation exercise to inform the Commission on long term harvest control rules to best achieve its management objectives. As noted, this process requires jargon-free dialogue with Commissioners and stakeholders to promote an understanding of the trade-offs and risks of alternative harvest control rules designed to achieve the Commission's management objectives. It also requires capacity building efforts to ensure a common understanding of the approach. It was noted that the now approved FAO ABNJ Tuna project, provides opportunity for such capacity building via workshops to encourage dialogue.

121. The SC **NOTED** that the World Wide Fund for Nature (WWF) is a lead agency for a number of outputs of the Global Environment Facility (GEF) Areas Beyond National Jurisdiction (ABNJ) project "Sustainable Management of Tuna Fisheries and Biodiversity Conservation in the ABNJ". One of the components of the 5 year project focuses on supporting the implementation of sustainable and efficient fisheries management and fishing practices. The first workshop in support of this will take place in Sri Lanka in late March 2014 providing an opportunity for IOTC members to discuss the development and implementation of harvest strategies for Indian Ocean tuna stocks.

122. The SC **NOTED** that the range of management tools to be explored under the MSE approach should be kept as open as possible, including both input and output controls or others such as time/area closures, so as to be better able to inform the Commission on their likely merits. The currently available data limits the range of options that can be evaluated quantitatively with the necessary precision. Data availability is likely to limit the inclusion of socio-economic factors in the evaluation of management plans, at least in the short and medium term.

***Presentation on Management Strategy Evaluation for Fisheries Management***

123. The SC **NOTED** the presentation on the essential elements of Management Strategy Evaluation (MSE) carried out by members of WPM small working group. The basic ideas behind simulation testing and the structure of the simulation models being assembled were presented. The presentation furthered the SC's understanding of the issues involved in this line of work. The practical demonstration, in which a range of example results from various simple MSE runs were available for inspection and comparison was also considered very informative.

124. The SC **NOTED** the essential role that will be played by the explicit definition of existing multiple, and possible conflicting, objectives, and the quantification and perception of the risks associated with those objectives for both stocks and fisheries.

125. The SC **ACKNOWLEDGED** the need for further efforts at building up the capacity of the different bodies of IOTC to fully understand the complexities of some of the concepts and methods being utilised by this and other WPs, and **REQUESTED** that the WPM small working group organise and carry out, in co-ordination with the SC chair, future practical sessions to explain in detail the methods and results used it the MSE work being carried out.

### *7.7 Outcomes of the informal workshop on CPUE standardisation*

126. The SC **NOTED** paper IOTC–2013–SC16–12 which outlined the main outcomes and recommendations from the informal workshop on CPUE standardisation. A total of 24 people attended from 15 countries and 23 presentations were made. The workshop covered a large amount of information on the current status of standardisations across the different species in the IOTC area of compliance. Issues relating to fishery improvements over time or spatial complexity of the fishery and stocks were discussed, as well as details of the appropriate statistical methods that should be applied in standardisations. Finally, comparisons with other tuna RFMO's were made, and it was agreed having some objective criteria for usage of a CPUE series in an assessment would be a useful endeavour by the IOTC.

127. The SC **ENDORSED** all of the recommendations from the workshop, contained in paper IOTC–2013–SC16–12. In particular, the SC **RECOMMENDED** that in areas where CPUE's diverged the CPC's were encouraged to meet inter-sessionally to resolve the differences. In addition, the major CPC's were encouraged to develop a combined CPUE from multiple fleets so it may capture the true abundance better. Approaches to possibly pursue are the following: i) Assess filtering approaches on data and whether they have an effect, ii) examine spatial resolution on fleets operating and whether this is the primary reason for differences, and iii)

examine fleet efficiencies by area, iv) use operational data for the standardization, and v) have a meeting amongst all operational level data across all fleets to assess an approach where we may look at catch rates across the broad areas.

128. **NOTING** the CPUE issues identified by the WPTT in 2010, 2011, 2012 and 2013 and the Scientific Committee in 2012, as well as the informal CPUE workshop in 2013, the SC **RECOMMENDED** that further inter-sessional work be carried out in conjunction with the IOTC Secretariat on the major longline CPC's in the Indian Ocean in early 2014 using operational data to address issues identified in the CPUE Workshop Report.

129. 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 **REQUESTED** 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.

### *7.8 Estimation of fishing capacity by tuna fishing fleet in the Indian Ocean*

130. The SC **NOTED** paper IOTC–2013–SC16–19 which outlines the main outcomes and findings from the report on estimation of fishing capacity by tuna fishing fleets in the Indian Ocean.

131. **NOTING** that some CPCs will be providing updates on the numbers of fishing units operated under their flag, as requested in IOTC Circular 79/13, in the future, the SC **REQUESTED** the IOTC Secretariat to update the information in the IOTC databases accordingly. In particular India, France (OT) and Malaysia indicated that they will provide this information soon.

132. **NOTING** that the report highlights a number of issues that require further consideration, and the SC **REQUESTED** that the IOTC Secretariat forwarded the report to the relevant working parties for their consideration, in particular the WPDCS (and WPFC).

### *7.9 Summary discussion of matters common to Working Parties*

#### *Meeting participation fund*

133. **NOTING** that the IOTC Meeting Participation Fund (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*), was used to fund the participation of 58 national scientists to the Working Party meetings and SC in 2013 (42 in 2012), all of which were required to submit and present a working paper at the meeting, the SC strongly **RECOMMENDED** that this fund be maintained into the future. 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 specified in Resolution 10/05.

134. **NOTING** that the Commission had directed the Secretariat (via Resolution 10/05) to ensure that the MPF be utilised, as a first priority, to support the participation of scientists from developing CPCs in scientific meetings of the IOTC, including Working Parties, rather than non-science meetings, the SC **RECOMMENDED** that the Secretariat strictly adhere to the directives of the Commission contained in Resolution 10/05, including paragraph 8 which states that '*The Fund will be allocated in such a way that no more than 25% of the expenditures of the Fund in one year is used to fund attendance to non-scientific meetings*.' Thus, 75% of the annual MPF shall be allocated to facilitating the attendance of developing CPC scientists to the Scientific Committee and its Working Parties.

#### *Capacity building activities*

135. The SC **NOTED** paper IOTC–2013–SC16–INF09 which provided the SC with an opportunity to reconsider the science capacity building activities agreed to at SC15 in 2012, planned by the IOTC Secretariat 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.

136. The SC **RECOMMENDED** that the Commission increase the IOTC Capacity Building budget line so that capacity building workshops/training can be carried out in 2014 and 2015 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.

137. The SC **NOTED** that Australia had secured funding for 2014 to carry out science capacity building activities. Where possible, these activities will be combined with those planned by the IOTC Secretariat.

138. The SC **NOTED** that SWIOFC and BOBLME also planned to contribute financially to the IOTC's science capacity building activities in 2014.

***Environmental conditions/functioning***

139. **NOTING** the importance of the environmental conditions and their inter-annual variability on CPUE indices of IOTC species, and more generally, on recruitment and biomass, the SC **REQUESTED** that the working parties take into account more environment and ecosystem-related issues when undertaking stock assessment analyses. This could be achieved by encouraging a greater participation of oceanographers and ecosystem modellers in the work of the working parties. Additional funds may be needed to attract modellers to IOTC working parties.

***IOTC species identification cards***

***Billfish***

140. The SC **EXPRESSED** its thanks to the IOTC Secretariat and other experts involved in the development of the identification cards for billfish and **RECOMMENDED** that the cards be translated into the following languages, in priority order: Farsi, Arabic, Indonesian, Swahili, Spanish, Portuguese, Thai and Sri Lankan, and that the Commission allocate funds for this purpose. The Secretariat should utilise any remaining funds in the IOTC Capacity Building budget line for 2013 to translate the cards.

141. The SC **RECOMMENDED** that the Commission allocate additional funds in 2014 to further translate and print sets of the billfish identification cards (budget estimate: Table 14).

**TABLE 14**. Estimated translation, production and printing costs for 1000 sets of identification guides for billfish.

| **Description** | **Unit price** | **Units required** | **Total** |
|---|---|---|---|
| Translation (per language) | $1000 | 7 | 7,000 |
| Typesetting | $1000 | 4 | 4,000 |
| Billfish ID cards | $6 | 1000 | 6,000 |
| Total estimate (US$) | | | **17,000** |

***Seabirds, shark and marine turtles***

142. The SC **EXPRESSED** its thanks to the IOTC Secretariat and other experts involved in the development of the identification cards for marine turtles, seabirds and sharks and **RECOMMENDED** that the cards be translated into the following languages, in priority order: Farsi, Arabic, Spanish, Portuguese and Basa, and that the Commission allocate funds for this purpose.

143. The SC **RECOMMENDED** that the Commission allocate additional funds in 2014 to translate and print further sets of the shark, seabird and marine turtle identification cards (budget estimate: Table 15).

**TABLE 15**. Estimated translation, production and printing costs for 1000 sets of identification guides for marine turtles, seabirds and sharks.

| **Description** | **Unit price** | **Units required** | **Total** |
|---|---|---|---|
| Translation (per language) | $1000 | 3 | 3,000 |
| Typesetting | $1000 | 3 | 3,000 |
| Marine turtles ID cards | $5 | 1000 | 5,000 |
| Seabird ID cards | $7 | 1000 | 7,000 |
| Shark ID cards | $7 | 1000 | 7,000 |
| Total estimate (US$) | | | **24,000** |

***Tunas and mackerels***

144. The SC **NOTED** the status of 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), and interacting with IOTC

fisheries, which will be used to improve species identification and data quality being submitted to the IOTC Secretariat.

145. The SC **RECOMMENDED** that the Commission allocate additional funds in the 2014 budget to translate 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 1000 sets of the identification cards is around a maximum of US$16,200 (Table 16). 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 16**. 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***

146. **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 Commission allocate funds in the 2014 IOTC Budge to develop an identification guide for fishing hooks and pelagic fishing gears used in IOTC fisheries. The total estimated production and printing costs for the first 1000 sets of the identification cards is around a maximum of US$16,500 (Table 17). 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 17**. Estimated production and printing costs for 1000 sets of identification guide for fishing hooks and pelagic fishing gears used in IOTC fisheries.

| **Description** | **Unit price** | **Units required** | **Total** |
|---|---|---|---|
| Purchase images | US$100 | 25 | 2,500 |
| Contract days | US$350 | 20 | 7,000 |
| Printing plates / plate | US$100 | 15 | 1,500 |
| Printing /1000 sets | US$5500 | 1 | 5,500 |
| Total estimate (US$) | | | **16,500** |

***Identification cards – general***

147. The SC **AGREED** that IOTC CPCs should 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.

***Chairs and Vice-Chairs of the Working Parties***

148. 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

149. 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).

150. 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).

151. 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 2013, 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 longline catch and effort (Fig. 1) into traditional albacore fishing areas, thereby increasing fishing pressure on this species. Since 2004, annual catches have declined steadily, largely due to the continued decline in the number of active Taiwan,China longliners in the Indian Ocean (Fig. 2a). 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 gillnet 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 yellowfin tuna and longtail tuna in the Arabian Sea or neritic tuna and tuna-like species in the coastal waters of the I.R. Iran. This has resulted in substantial increases in the total catch and effort of neritic tuna and tuna-like species under the IOTC mandate.

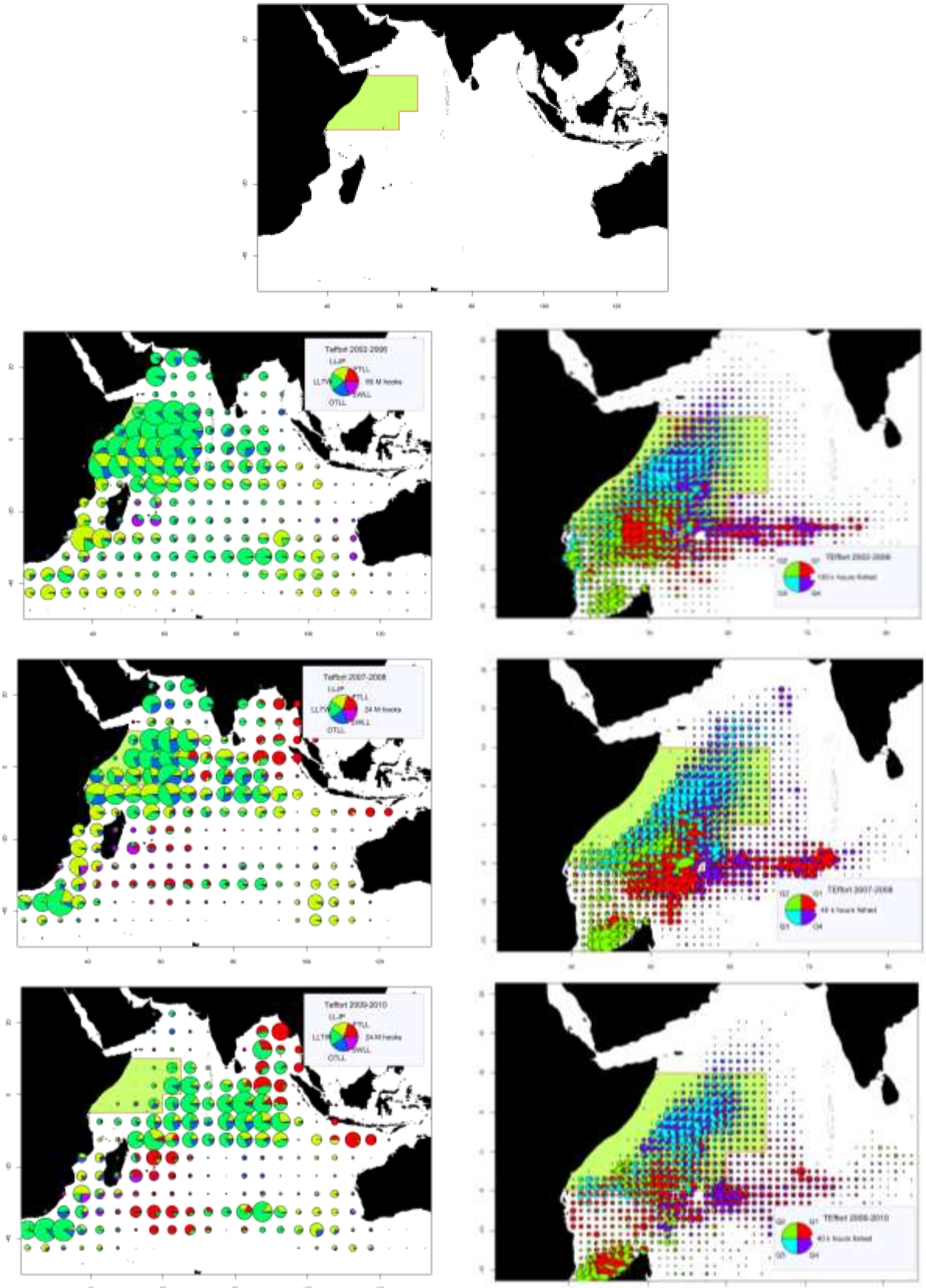
152. The SC **NOTED** that fishing effort by the purse seine fleets shifted east by at least 100 miles during 2008–11 compared to the historic distribution of effort (Fig. 1) although vessels remained in the area impacted by piracy due to the presence of onboard military personnel. Piracy was also likely to influence the behaviour of small-scale fishing vessels which have declined in number and effort within the region.

153. The SC **NOTED** that the relative number of active longline vessels in the IOTC area of competence declined substantially from 2008 until 2011 (Fig. 2a, b), as did the purse seine fleets (Fig. 2c).The decline was likely due to the impact of piracy activities in the western Indian Ocean. Japan reported a reduction of 120 longline vessels between 2006 and 2011, with 68 remaining in 2011,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 (7 in 2012); while the remaining longline 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) (Fig. 2c).

154. The SC **NOTED** that since 2011, there has been an increase in the number of active longline vessels in the Indian Ocean for Japan (68 in 2011 to 98 in 2012), China (10 in 2011 to 32 in 2012), Taiwan,China (132 in 2011 to 138 in 2012) and the Philippines (2 in 2011 to 14 in 2012) (Fig. 2a). Similarly, there has been an overall increase in the number of active purse seine vessels in the Indian Ocean for the European Union and assimilated fleets (34 in 2011 to 36 in 2012) and other for all other purse seine fleets combined (23 in 2011 to 35 in 2012) (Fig. 2c).

155. The SC **NOTED** that in the first half of 2011, 11 longline vessels from Taiwan,China, moved to the Atlantic Ocean and 2 to the Pacific Ocean. However, in the second half of 2011, 5 longline vessels returned from the Atlantic Ocean, and 1 longline vessel returned from the Pacific Ocean. The departure of the vessels from the Indian Ocean is reflected in the total effort deployed throughout not only the western Indian Ocean impacted by piracy, but also the entire Indian Ocean (Fig. 3a for longline and Fig. 3b for purse seine). In 2012, the trend was reversed, with a total of 15 longline vessels being transferred from the Atlantic Ocean back to the Indian Ocean, resulting in an overall increase in longline effort, particularly in the western Indian Ocean (Fig. 3a). Similarly, 6 longline vessels from Taiwan,China have been transferred from the Pacific Ocean back to the Indian Ocean in 2012. Although total levels of effort for the Taiwan,China longline fleet in the Indian Ocean remained low in 2012, effort levels in waters off Somalia increased markedly (Figs. 1 and 3a).

156. The SC **NOTED** the reports that both longline and purse seine vessels from some fleets appear to be moving back towards the western Indian Ocean in 2012, should be closely monitored and reported at the SC and the working party meetings in 2014.



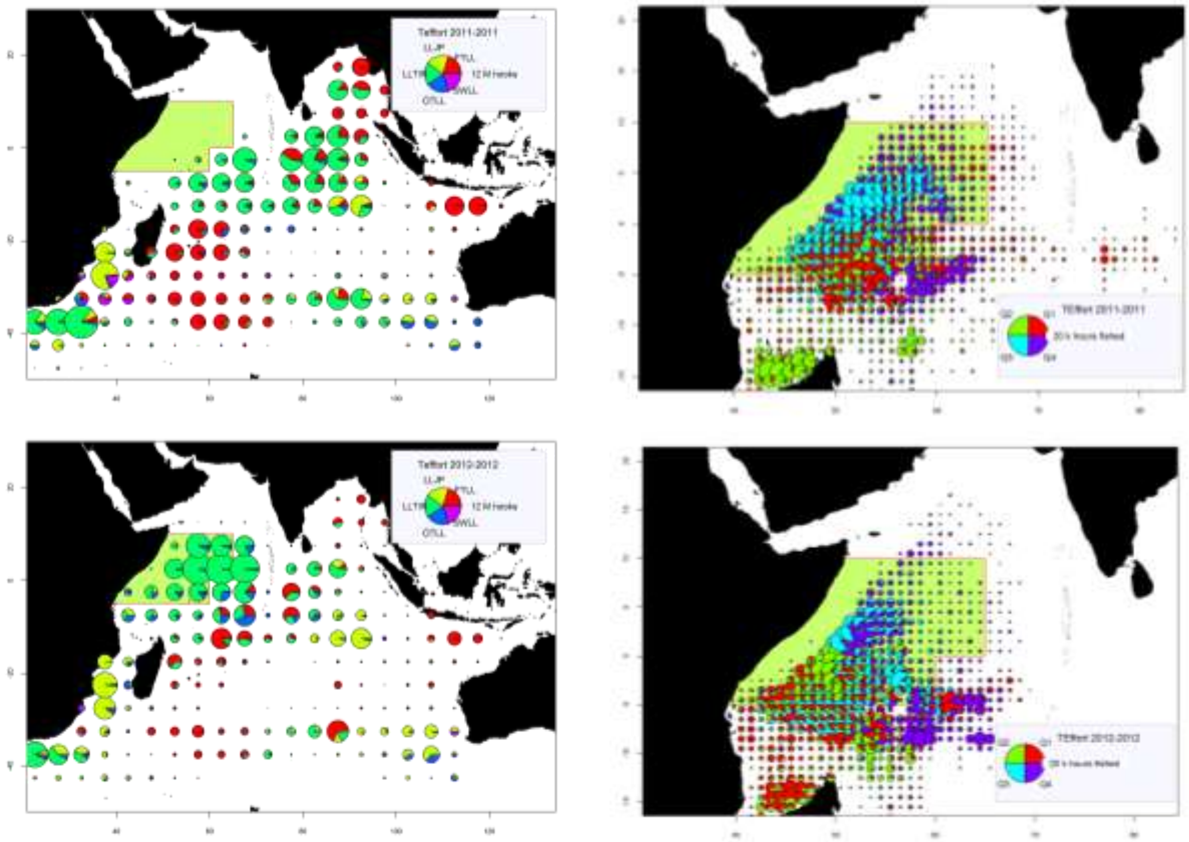


**Fig. 1.** The geographical distribution of fishing effort for longline (5 x 5 degrees; millions of hooks – left column) as reported for the longline fleets of Japan (LLJP), Taiwan,China (LLTW), fresh-tuna longline (FTLL), other longline (OTLL), and longline directed at swordfish (SWLL), and for purse seine (1 x 1 degrees; hours fished – right column) in the IOTC area of competence (Data as of September 2013), for 2002–06, 2007–08, 2009–10, 2011 and 2012. The area shaded in green is where piracy activities are considered highest. Longline effort: 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).

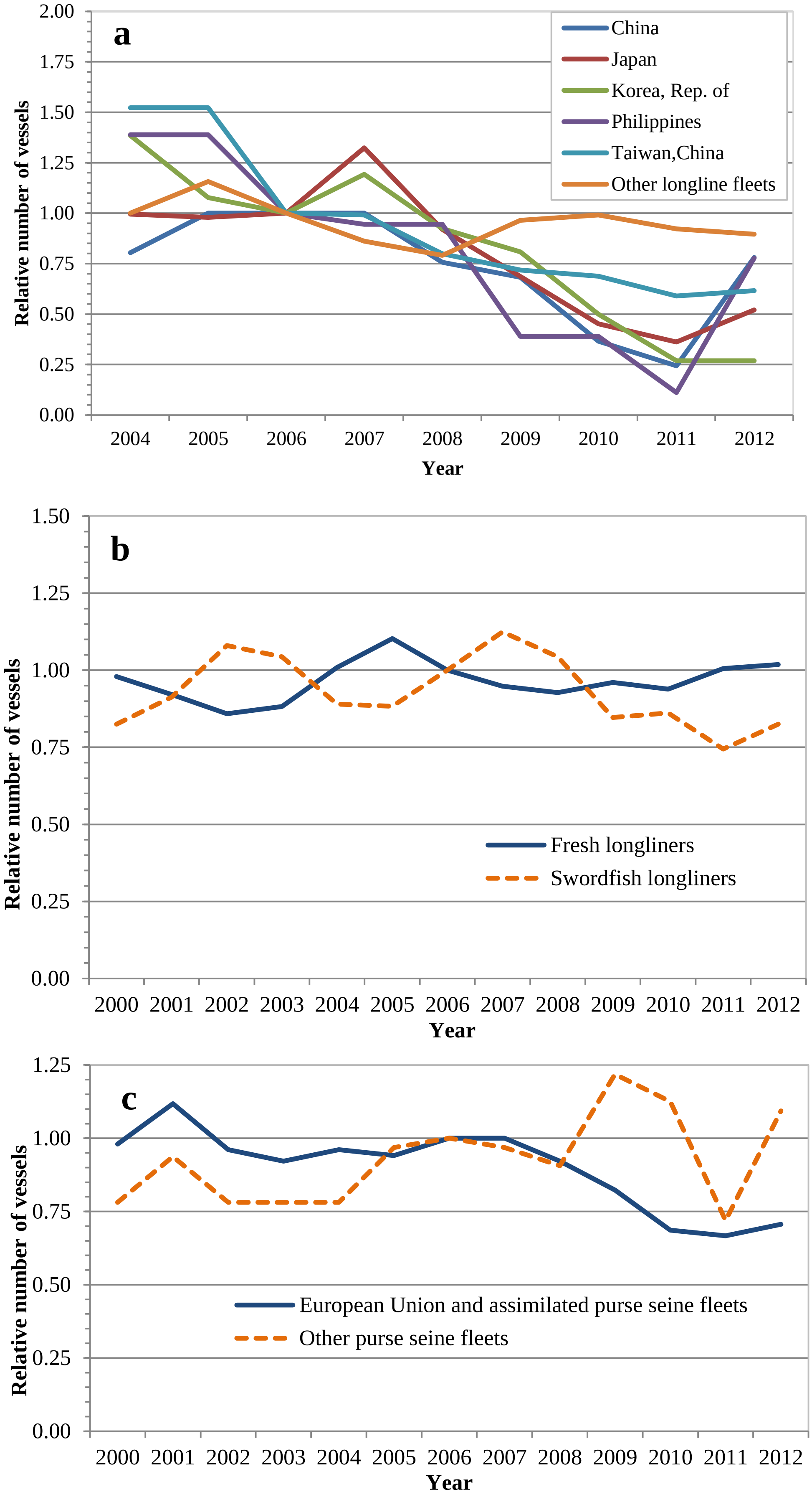



**Fig. 2.** The change in the relative number of some active a) deep freezing longline (numbers have been scaled to the number of active vessels in 2006), b) other longline and c) purse seine fleets since 2000 in the Indian Ocean.

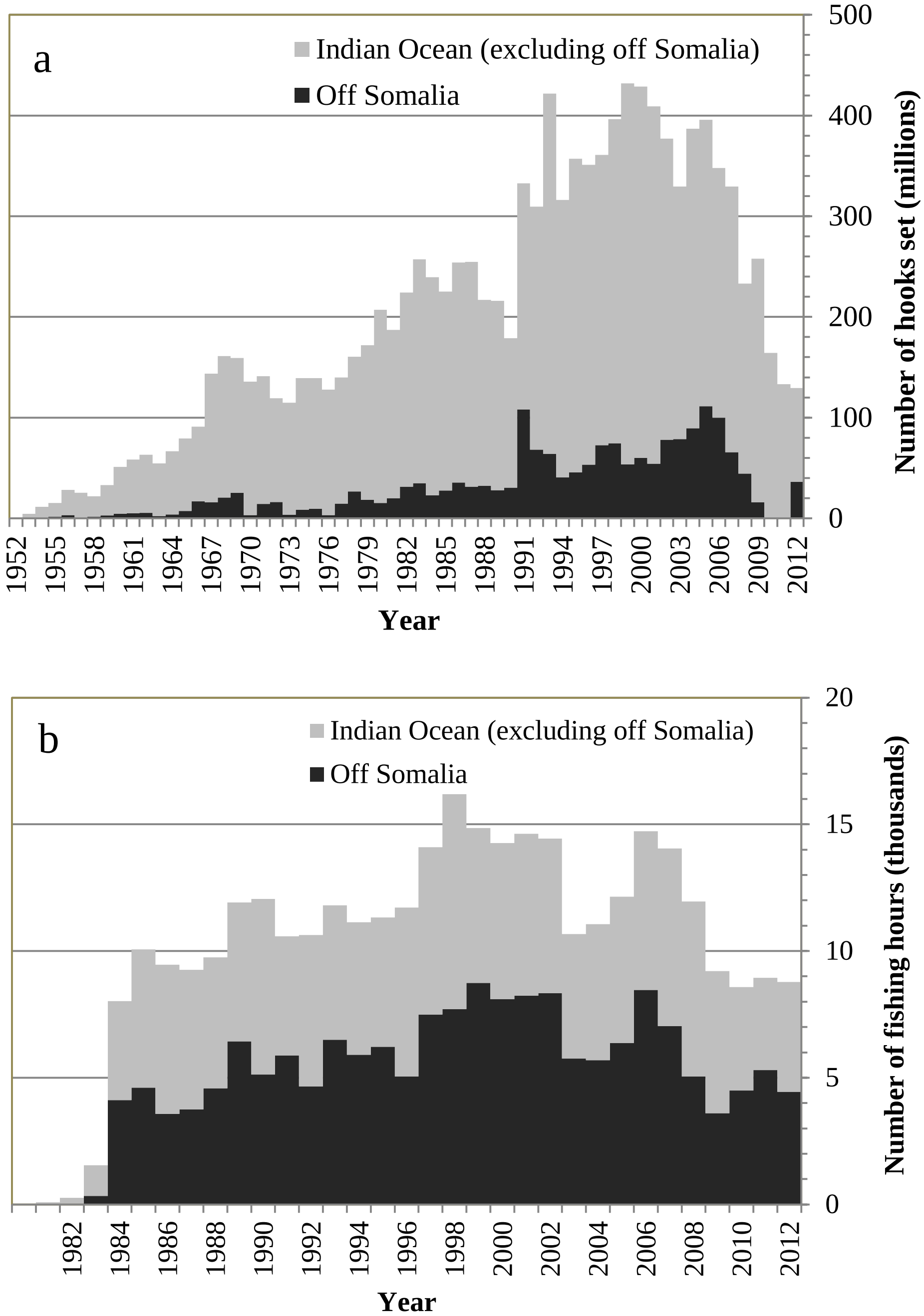



**Fig. 3.** Changes in total effort for a) longline (number of hooks set in millions), and b) purse seine (number of hours fished in thousands) vessels by year and geographical area: off the Somalia coastline (area shown in the insert of Fig. 1) and for the rest of the Indian Ocean.

# 9. Review of the Resolution 12/11: implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties

157. **NOTING** that Resolution 12/11 includes a requirement of the Scientific Committee to review and provide advice to the Commission as follows:

> "*Within the period of application of this Resolution, CPCs may change the number of their vessels, by gear type, provided that they can either demonstrate to the Commission, under the advice of the IOTC Scientific Committee that the change in the number of vessels, by gear type, does not lead to an increase of fishing effort on the fish stocks involved or where they are directly limiting catches using individual transferable quotas under a comprehensive national management plan which has been provided to the Commission*."

158. The SC **NOTED** that no formal submission for proposed changes in vessels numbers were provided to the SC in 2013.

# 10. Status of Tuna and Tuna-Like Resources in the Indian Ocean

159. **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.

### *10.1 Tuna – Highly migratory species*

160. 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

161. 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.

162. 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.

### *10.2 Billfish*

163. 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

### *10.3 Tuna and mackerel – Neritic species*

164. 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

# 11. Status of Marine Turtles, Seabirds and Sharks in the Indian Ocean

### *11.1 Sharks*

165. 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

### *11.2 Marine turtles*

166. 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

### *11.3 Seabirds*

167. 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

## 12. Implementation of the Regional Observer Scheme

168. The SC **NOTED** paper IOTC–2013–SC16–14 which provided an update on the status of implementation and reporting to the IOTC Secretariat of the Regional Observer Scheme (ROS) set out by Resolution 09/04 on a Regional Observer Scheme, and superseded by Resolution 11/04 on a Regional Observer Scheme at the 15th Session of the Commission (S15) in 2011.

169. The SC **NOTED** that as of 31 October 2013, 13 CPCs (Australia, China, Comoros, EU(France and Portugal), France(OT), Japan, Kenya, Korea (Rep. of), Madagascar, Mauritius, Mozambique, Seychelles and South Africa) have submitted a list of accredited observers.

170. The SC **NOTED** that as of 31 October 2013, 102 observer trip reports have been submitted to the IOTC Secretariat by Australia, China, the EU, France(OT), Japan, Korea, Madagascar, Mozambique, and South Africa. The levels of coverage estimated are still very low and, especially for longline fleets, they are well below the minimal levels recommended by the Commission (less than 0.1% of the number of hooks set covered by observers in 2012).

171. The SC **REQUESTED** 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)*

172. 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.

173. 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.

174. 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.

175. The SC **RECOMMENDED** that the Compliance Committee and the Commission consider how to address the continued lack of compliance with the implementation of regional observer schemes by CPCs for their fleets and lack of 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.

176. The SC **RECOMMENDED** that as a priority, the IOTC Secretariat should immediately commence work with CPCs that are yet to develop and implement a Regional Observer Scheme that would meet the requirements contained in Resolution 11/04, and provide an update at the next session of the WPEB.

***Observer programme training***

177. The SC **RECOMMENDED** that the Commission considers funding of future activities under the Regional Observer Scheme, by allocating specific funds to the implementation of capacity building activities in developing coastal countries of the IOTC Region, as detailed in Table 18.

**TABLE 18**. Estimated budget for IOTC consultants to be engaged in Regional Observer Program tranining in 2014

| **Description** | **Unit price** | **Units required** | **Total** |
|---|---|---|---|
| 2014 | | | |
| Regional Observer Scheme – training materials | US$2,000 | 1 | 2,000 |
| Regional Observer Scheme – travel (5 trips) | US$4,000 | 5 | 20,000 |
| 2015 | | | |
| Regional Observer Scheme – training materials | US$2,000 | 1 | 2,000 |
| Regional Observer Scheme – travel (5 trips) | US$4,000 | 5 | 20,000 |
| Total estimate (US$) | | | **42,000** |

178. The SC **AGREED** that, in addition to the implementation of the ROS which is likely to take time, the collection of scientific data by all other means available including auto-sampling (collection of data by trained crew) and electronic monitoring (sensors and video cameras) be encouraged and developed, and for CPCs to report on progress at the next WPEB meeting.

## 13. Outlook on Time-Area Closures

179. 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*

180. **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 population, 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, as these are not contained within Resolution 12/13.

### *13.1 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 tuna and bigeye tuna; and*

### *13.2 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 tuna and bigeye tuna;*

181. The SC **NOTED** paper IOTC–2013–SC16–INF11, 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, including the information available for the specific closed periods (February 2011–12 for longline,

November 2011–2012 for purse seine) when the measure is in place. Both the longline and purse seine effort had already been entirely redistributed to other areas.

182. The SC **NOTED** that the results obtained from the study are similar to the analysis carried out for the SC in 2010 and 2011, which emphasized that catch reduction expected from the current time-area closure were negligible. The study examined scenarios to investigate the impacts of a one, three and 12 month closure of the current IOTC time-area closure for longliners and purse seiners, on the assumption that effort is relocated to areas outside of the time-area closure, or fully eliminated (six different scenarios in total). The effects of each scenario were assessed for the combined catches of yellowfin tuna, skipjack tuna, bigeye tuna, and albacore on purse seine fleets; and yellowfin tuna, bigeye tuna, albacore and swordfish on longline caught tunas. In addition, the study looked at potential losses and gains in catch for each tropical tuna species and gear at the time the time-area closure was in place. .

183. The SC **NOTED** that, due to the high mobility of the fleets involved, and the fact that the overall levels of effort at the time of the time-area closure appeared to have remained constant for each fleet, relocation of effort to other areas was much more likely to have occurred during the time of the time-area closure. Piracy in the area off Somalia had led to the relocation of part of the effort from longline fleets to the South Indian Ocean, and increased pressure on the stock of Indian Ocean albacore, which is subject to overfishing according to the latest assessment undertaken by the WPTmT in 2011.

184. The SC **AGREED** that relocation of effort is a more plausible scenario and therefore the consequences of the time-area closure on the stocks of tropical tunas in the Indian Ocean are likely to be negligible (less than 4% reduction in the total purse seine catch, and almost no reduction at all on longline catch, over the entire time-series). In terms of reduction of purse seine catches, while the time-area closure appeared to have a positive, although minor, effect in reducing the catches of bigeye tuna and skipjack tuna, the effect on the catches of yellowfin tuna appeared to be nil (Fig. 4).

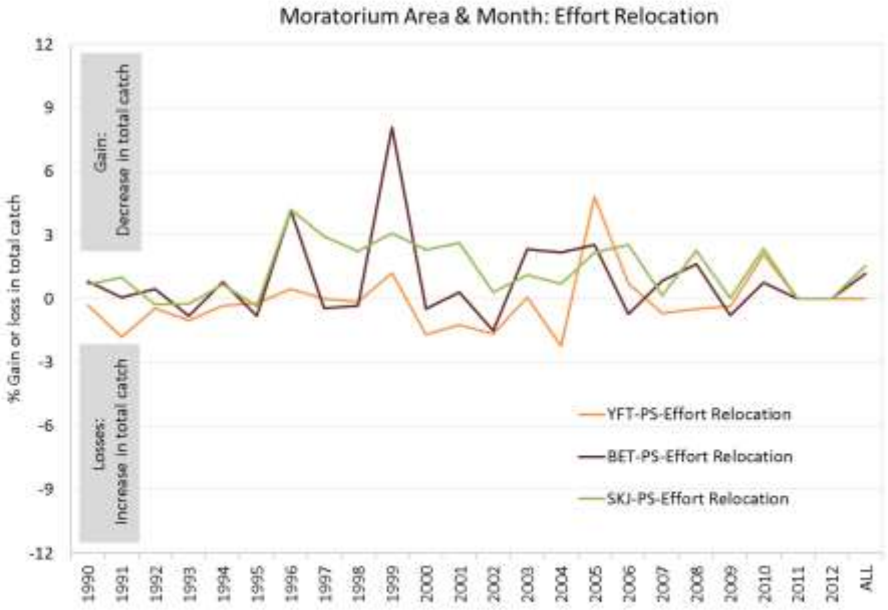



**Fig. 4.** Change in total catch for main tuna species from moratorium, assuming effort elimination or effort relocation.

185. 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.

186. **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.

187. **NOTING** 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.

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

#### *Impacts of Catching Bigeye Tuna and Yellowfin Tuna Juveniles and Spawners*

188. 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*

189. The SC **RECALLED** the discussions of the previous two SC meeting, 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 19 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 19**. 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

190. 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.

191. 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 **REQUESTED** that all CPCs catching yellowfin tuna should undertake scientific sampling of their yellowfin tuna catches to better identify the proportion of bigeye tuna catches. Countries engaged in those fisheries should take immediate actions to reverse the situation of fishery statistics reporting to the IOTC Secretariat.

192. 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.

# 14. Progress on the Implementation of the Recommendations of the Performance Review Panel

193. The SC **NOTED** paper IOTC–2013–SC16–15 which provided an update on progress regarding Resolution 09/01 *on the performance review follow–up*.

194. 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 2014 and 2015

***Research Recommendations and Priorities***

195. The SC **NOTED** paper IOTC–2013–SC15–16 which outlined the proposed research priorities for each of the Working Party meetings held in 2013, with the aim of developing an IOTC Science Work Plan for 2014, and future years.

196. 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.

197. The SC **REQUESTED** that all Working Parties provide their work plans with items prioritised based on the requests of the Commission of the SC.

198. The SC **ADOPTED** a revised assessment schedule, ecological risk assessment and other core projects for 2014–18, 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.

199. The SC **REQUESTED** that the IOTC Secretariat develop a template for each working party to use in developing their works plans in 2014, with the aim of standardising the way in which each working party presents a prioritised plan each year for the SC’s consideration.

***Schedule of meetings for 2014 and 2015***

200. **NOTING** paper IOTC–2013–SC16–17 which outlined the proposed schedule for IOTC Working Parties and SC meetings for 2014 and tentatively for 2015, 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.

201. The SC **NOTED** that the participation of developing coastal state scientists to the WPNT has increased dramatically in recent years, through the implementation of the IOTC MPF, as well as though the hosting of the WPNT in developing coastal states (WPNT01: India, WPNT02: Malaysia and WPNT03: Indonesia). In 2011, 11 national scientists from India attended the first meeting, while in 2012, 13 attended from Malaysia and finally, in 2013, a total of 16 national scientists from Indonesia were able to attend the WPNT meeting.

202. The SC **NOTED** that an Albacore project presented briefly last year at the SC started one month ago. The objective of this project is to understand the links between south Atlantic and the western Indian Ocean based on genetics, chemical tracers, with an important component on reproduction and trophic behaviour. The research project brings together scientists from La Reunion, South Africa and the ICCAT Secretariat.

203. The SC **RECOMMENDED** that the Commission endorse the schedule of Working Party and Scientific Committee meetings for 2014, and tentatively for 2015, noting that the SC agreed that flexibility in the dates proposed should be retained (Appendix XXXVII).

# 16. OTHER BUSINESS

### *16.1 Building 21st century scenarios for global oceanic ecosystems and fisheries*

204. Nil discussion.

### *16.2 Discussion of the ASFA database*

205. The SC **NOTED** that the Aquatic Sciences and Fisheries Information System (ASFIS) is an international cooperative information system for the collection and dissemination of information covering the science, technology and management of marine, brackish water and freshwater environments.

206. The SC **NOTED** that the Aquatic Sciences and Fisheries Abstracts Bibliographic Database is (ASFA) is the principal information product or module of the ASFIS system, therefore the two terms ASFIS and ASFA are often used interchangeably.

207. The SC **NOTED** that the IOTC has been a member of ASFA from the early 2000s http://www.fao.org/fishery/topic/18125/en. In accordance with ASFA partnership agreement, advantages of membership include the possibility of access to the ASFA database (IOTC documents) and to make scientific publications of the IOTC visible to the scientific community (in addition to the IOTC website). Under partnership agreement, each ASFA partner has an obligation to allocate efforts and resources for monitoring of its publications and to entry abstracts from these publications into ASFA bibliographic database. Since 2008, the IOTC has ceased information entry to the ASFA database due to a lack of staffing resources and financial allocation from the Commission to undertake this task.

208. The SC **RECOMMENDED** that the Commission consider allocating the necessary funds and staffing resources in order to renew data entry under the ASFA Partnership Agreement, which would be in addition to the current information sharing of IOTC documents, via the IOTC website where all papers are publically available. If the Commission does not wish to continue the partnership, then it may wish to ask the Secretariat to withdraw from the agreement.

### *16.3 Considerations for a strategic science plan for IOTC*

209. Nil discussion.

### *16.4 Election of a Chair and a Vice-Chair for the next biennium*

210. The SC participants were unanimous in **THANKING** the Chairperson (Dr. Tom Nishida) and Vice-Chairperson (Mr. Jan Robinson) for their outstanding contributions over the past two years.

211. **NOTING** the rules of procedure of the IOTC: Rule X.6: The Scientific Committee shall elect, preferably by consensus, a Chairperson and a Vice-Chairperson from among its members for two years, the SC **CALLED** for nominations for the positions of Chairperson and Vice-Chairperson of the SC for the next biennium. Dr. Tom Nishida (Japan) was nominated and re-elected as Chair, and Mr. Jan Robinson (Seychelles) was nominated and re-elected as Vice-Chairperson of the SC for the next biennium.

212. The SC **RECOMMENDED** that the Commission note the re-election of Dr. Tom Nishida (Japan) as Chairperson, and Mr. Jan Robinson (Seychelles) as Vice-Chairperson of the SC for the next biennium, as well as the Chairs and Vice-Chairs of each of the Working Parties as provided in Appendix VIII.

# 17. REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE SIXTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

213. The SC **RECOMMENDED** that the Commission consider the consolidated set of recommendations arising from SC16, provided at Appendix XXXIX.

214. The SC **ADOPTED** the report of the Sixteenth Session of the Scientific Committee (IOTC–2013–SC16–R) on 6 December 2013.

# APPENDIX I
# LIST OF PARTICIPANTS

**CHAIRPERSON**
Dr Tsutomu **Nishida**
National Research Institute of Far Seas Fisheries
Email: tnishida@affrc.go.jp

**VICE CHAIRPERSON**
Mr Jan **Robinson**
Seychelles Fishing Authority
Email: janrobinson71@gmail.com

**IOTC MEMBERS**

**AUSTRALIA**
**Head of Delegation**
Mr James **Larcombe**
Department of Agriculture
Email: james.larcombe@daff.gov.au

**BELIZE**
Absent

**CHINA**
**Head of Delegation**
Mr Liuxiong **Xu**
Shanghai Ocean University
Email: lxxu@shou.edu.cn

**Alternate**
Dr Jiangfeng **Zhu**
Shanghai Ocean University
Email: jfzhu@shou.edu.cn

**COMOROS**
**Head of Delegation**
Mr Ahmed Said **Soilihi**
Ministère de l'Agriculture, de la Pêche, de l'Environnement, de l'Energie, de l'Industrie et de l'Artisanat
Email: ahmed_ndevou@yahoo.fr

**ERITREA**
Absent

**EUROPEAN UNION**
**Head of Delegation**
Mr. Alain Fonteneau
IRD, France, European Union
Email: alain.fonteneau@ird.fr

**Alternate**
Mr Patrick **Daniel**
Commission Européenne - DG Mare (Affaires maritimes & Pêche)
Email: patrick.daniel@ec.europa.eu

**Advisor(s)**
Dr Emmanuel **Chassot**
Institut de Recherche pour le Développement (IRD)
Email: emmanuel.chassot@ird.fr

Dr Michel **Goujon**
ORTHONGEL
Email: mgoujon@orthongel.fr

Dr. Francis **Marsac**
IRD, France, European Union
Email: francis.marsac@ird.fr

Mr Juan Pedro **Monteagudo**
OPAGAC/Scientific Advisor
E-mail: opagac@arrakis.es

Dr. Iago **Mosqueira**
European Commission Joint Research Centre, European Union
Email: iago.mosqueira-sanchez@jrc.ec.europa.eu

Dr Hilario **Murua**
AZTI Tecnalia
Email: hmurua@azti.es

Dr Miguel **Neves dos Santos**
Portuguese Sea and Atmosphere Institute
Email: mnsantos@ipma.pt

Ms Maria **Soto**
Instituto Espanol de Oceanografia (IEO)
Email: maria.soto@md.ieo.es

**FRANCE**
**Head of Delegation**
Dr Pierre **Chavance**
Institut de Recherche pour le Développement (IRD)
Email: pierre.chavance@ird.fr

**Alternate**
Mme Johanna **Herfaut**
Agence des aires marines protégées
Email: Johanna.herfaut@aires-marines.fr

**GUINEA**
Absent

**INDIA**
**Head of Delegation**
Dr Premchand
Fishery Survey of India
Ministry of Agriculture
Email: premchandsngh@yahoo.co.in

**Alternate**
Dr. Saya Kogga **Naik**
Fishery Survey of India
Ministry of Agriculture
Email: drsknaik@gmail.com

Ms. Shubani **Thapa**
Forum for Nature Protection
Email: basant222@gmail.com

**INDONESIA**
**Head of Delegation**
Dr Hari Eko **Irianto**
RIFEC-RCFMC, Ministry of Marine Affairs and Fisheries
Email: harieko_irianto@yahoo.com

**Alternate**
Dr Fayakun **SATRIA**
Ministry of Marine Affairs and Fisheries
Email: fsatria_2@yahoo.com

Mr. Archmad **IRFANSYAH**
Ministry of Marine Affairs and Fisheries
Email:

Mr Yuliadi **Kadarmo**
Ministry of Marine Affairs and Fisheries
Email: adhie.multilateral@gmail.com

Mr Januarli **Marino**
Ministry of Marine Affairs and Fisheries
Email: rinosib@yahoo.com

Mr Rudi **Sujono**
Ministry of Marine Affairs and Fisheries
Email:

Mrs. Dyah Retnowati
Ministry of Marine Affairs and Fisheries
Email: retnowatii@yahoo.com

**IRAN (ISLAMIC REPUBLIC OF)**
Absent

**JAPAN**
**Head of Delegation**
Dr Hiroaki **Okamoto**
National Research Institute of Far Seas Fisheries
Email: okamoto@affrc.go.jp

**Alternate**
Dr Takayuki **Matsumoto**
National Research Institute of Far Seas Fisheries
Email: matumot@affrc.go.jp

**Advisor(s)**
Dr Tishihide **Kitakado**
Tokyo University of Marine Science and Technology
Email: kitakado@kaiyodai.ac.jp

Dr Yuji **Uozumi**
National Research Institute of Far Seas
Email: uozumi@fra.affrc.go.jp

Ms Akane **Yamaguchi**
Fisheries Agency of JAPAN
Email: akane_yamaguchi@nm.maff.go.jp

Dr Kotaro **Yokawa**
National research Institute of Far Seas Fisheries
Email: yokawa@fra.affrc.go.jp

**KENYA**
**Head of Delegation**
Mr Peter Nyongesa **Wekesa**
Ministry of Agriculture, Livestock and Fisheries
Email: penyongesa@yahoo.co.uk

**KOREA (REPUBLIC OF)**
**Head of Delegation**
Dr Zang Geun **Kim**
National Fisheries Research and Development Institute
Email: zgkim@korea.kr

**Alternate**
Mr Jeongseok **Park**
Ministry of Oceans and Fisheries
Email: jeongseok.korea@gmail.com

Ms. Hee Won **Park**
National Fisheries Research and Development Instititue, Rep. of Korea
Email: heewon81@gmail.com

Ms. Jeong Zun **Ku**
National Fisheries Research and Development Instititue, Rep. of Korea
Email: red1594@gmail.com

Ms. Mikyung **Lee**
National Fisheries Research and Development Institute, Republic of Korea
Email: mklee790505@gmail.com

Dr. Sung il **Lee**
National Fisheries Research and Development Institute, Republic of Korea
Email: k.sungillee@gmail.com

**MADAGASCAR**
**Head of Delegation**
Mr Diary **Rahombanjanahary**
Ministère de la pêche et des Ressources Halieutiques
Email: diarmirindra@yahoo.fr

**MALAYSIA**
**Head of Delegation**
Mr Samsudin Bin **Basir**
Department of Fisheries Malaysia
Email: s_basir@yahoo.com

**MALDIVES**
**Head of Delegation**
Dr M. Shiham **Adam**
Ministry of Fisheries and Agriculture
Email: msadam@mrc.gov.mv

**MAURITIUS**
**Head of Delegation**
Mr Sreenivasan **Soondron**
Ministry of Fisheries
Email: ssoondron@gmail.com

**MOZAMBIQUE**
**Head of Delegation**
Dr Atanasio **Brito**
Ministry of Fisheries (Fisheries Research Institute)
Email: atanasio.brito@iip.gov.mz

**Alternate**
Mr Osvaldo Ernesto **Chacate**
Instituto Nacional de Investigação Pesqueira
Email: chacatemz@gmail.com; osvaldo.chacate@iip.gov.mz

**Advisor(s)**
Mr Rui Jorge **Mutombene**
Instituto Nacional de Investigação Pesqueira
Email: ruimutombene@gmail.com

**OMAN**
Absent

**PAKISTAN**
Absent

**PHILIPPINES**
Absent

**SEYCHELLES**
**Head of Delegation**
Mr Vincent **Lucas**
Seychelles Fishing Authority
Email: vlucas@sfa.sc

**Alternate**
Mr Jan **Robinson**
Seychelles Fishing Authority
Email: janrobinson71@gmail.com

**SIERRA LEONE**
Absent

**SRI-LANKA**
**Head of Delegation**
Mr. H.M.B.C **Herath**
Ministry of Fisheries and Aquatic Resources Development
Email: herathhmbc@yahoo.com

**Alternate**
Ms Kalyani **Hewapathirana**
Dept. of Fisheries and Aquatic Resources
Email: hewakal2012@gmail.com

Dr Rekha **Maldeniya**
National Aquatic Resources Research and Development Agency
Email: rekhamaldeniya@gmail.com

**SUDAN**
Absent

**TANZANIA (UNITED REPUBLIC OF)**
Mr. Mathias **Igulu**
Tanzania Fisheries Research Insititute
Email: mathiasigulu@gmail.com

**THAILAND**
**Head of Delegation**
Cdr. Pornchai **Singhaboon**
Deepsea Fisheries Research and Technology Institute. Department of Fisheries
Email: pornslek@hotmail.com

**UNITED KINGDOM**
**Head of Delegation**
Dr Christopher **Mees**
MRAG LTD
Email: c.mees@Mrag.co.uk

**VANUATU**
Mr Tony **Taleo**
Vanuatu Fisheries
Email: ttaleo@gmail.com

**YEMEN**
Absent

## COOPERATING NON-CONTRACTING PARTIES

**SENEGAL**
Absent

**SOUTH AFRICA**
Dr. Sven **Kerwath**
Department of Agriculture, Forestry and Fisheries
Email: SvenK@daff.gov.za

Mr Tembaletu **Tanci**
Department of Agriculture, Forestry and Fisheries
Email: TembaletuT@daff.gov.za

## OBSERVERS

**Agreement on the Conservation of Albatrosses and Petrels (ACAP)**
Dr Anton **Wolfaardt**
Email: acwolfaardt@gmail.com

**BIRDLIFE INTERNATIONAL**
Ms. Yuna **Kim**
Email: yuna.kim@mq.edu.au

Mr Ross **Wanless**
Email: ross.wanless@birdlife.org.za

**GREENPEACE**
Ms. Catherine **Dorey**
Email: cat.dorey@greenpeace.org

**INTERNATIONAL SEAFOOD SUSTAINABILITY FOUNDATION**
Dr.Gerald **Scott**
Email: gpscott_fish@hotmail.com

**SOUTH WEST INDIAN OCEAN FISHERIES COMMISSION**
Mr Aubrey **Harris**
Email: aubrey.harris@fao.org

Mr Horea Gonza **Mbilinyi**
Email: horseagonza@yahoo.com

**WORLD WIDE FUND FOR NATURE**
Dr Wetjens Dimmlich
Email: wdimmlich@wwf.panda.org

## OTHER PARTICIPANTS

Dr. Evgeny **Romanov**
Vice-Chairperson WPEB
Email: evgeny.romanov@ird.fr

**INVITED EXPERTS**
Mr Ren-Fen **Wu**
Email: fan@ofdc.org.tw

Mr Tsung-Wen **Lan**
Email: tsungwen@ms1.fa.gov.tw

Dr Yu-Min **Yeh**
Email: ymyeh@mail.nhu.edu.tw

## INDIAN OCEAN TUNA COMMISSION (IOTC) SECRETARIAT

Mr Rondolph **Payet**
Executive Secretary
Email:rp@iotc.org

Dr David **Wilson**
Deputy Secretary / Science Manager
Email: dw@iotc.org

Dr Rishi **Sharma**
Fishery Officer (Stock Assessment)
Email: rs@iotc.org

Mr Miguel **Herrera**
Data Coordinator
Email: miguel.herrera@iotc.org

## TRANSLATORS AND INTERPRETERS

Ms Laurence **Bastit**
Email: laurence.bastit@gmail.com

Mr Jean-Luc **Genion**
Email: jl.genion@aiic.net

Mr Daniel **Glon**
Email: danglon@supralingua.com

Mr James **Jennings**
Email:jennings@un.org

Mr Olivier **Roux**
Email: olivier@otolithe

Ms Anne **Trottier**
Email: a.trottier@aiic.net

Ms Susan **Vo**
Email: vo1@un.org

## APPENDIX II
## AGENDA FOR THE SIXTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

**Date:** 2–6 December 2013

**Location:** The Lotte Hotel Busan, Rep. of Korea

**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 2013** (Secretariat)
6. **NATIONAL REPORTS FROM CPCs** (CPCs)
7. **REPORTS OF THE 2013 IOTC WORKING PARTY MEETINGS**
   - 7.1 IOTC–2013–WPNT03–R Report of the Third Session of the Working Party on Neritic Tunas
   - 7.2 IOTC–2013–WPEB09–R Report of the Ninth Session of the Working Party on Ecosystems and Bycatch
     - ➢ Best practice guidelines for the safe release and handling of encircled cetaceans
     - ➢ Best practice guidelines for the safe release and handling of encircled whale sharks
     - ➢ Shark year program
   - 7.3 IOTC–2013–WPB11–R Report of the Eleventh Session of the Working Party on Billfish
   - 7.4 IOTC–2013–WPTT15–R Report of the Fifteenth Session of the Working Party on Tropical Tunas
   - 7.5 IOTC–2013–WPDCS09–R Report of the Ninth Session of the Working Party on Data Collection and Statistics
     - ➢ Revision to historical data sets held by the Secretariat
   - 7.6 IOTC–2013–SC16–11 Update on the inter-sessional work of the WPM small working group
   - 7.7 IOTC–2013–SC16–12 Outcomes of the informal workshop on CPUE standardisation
   - 7.8 IOTC–2013–SC16–19 Estimation of fishing capacity by tuna fishing fleets in the Indian Ocean
   - 7.9 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. **REVIEW OF THE RESOLUTION 12/11: IMPLEMENTATION OF A LIMITATION OF FISHING CAPACITY OF CONTRACTING PARTIES AND COOPERATING NON-CONTRACTING PARTIES** (Chair)
10. **STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN** (Chair)
    - 10.1 Tuna – Highly migratory species
    - 10.2 Tuna and mackerel – Neritic species
    - 10.3 Billfish
11. **STATUS OF MARINE TURTLES, SEABIRDS AND SHARKS IN THE INDIAN OCEAN** (Chair)
    - 11.1 Marine turtles
    - 11.2 Seabirds
    - 11.3 Sharks
12. **IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME** (Secretariat)
13. **OUTLOOK ON TIME-AREA CLOSURES** (Chair)
    - 13.4 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 tuna and bigeye tuna;
    - 13.5 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 tuna and bigeye tuna;

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

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 2014 AND 2015** (Secretariat)

16. **OTHER BUSINESS** (Chair)
    16.1 Building 21st century scenarios for global oceanic ecosystems and fisheries
    16.2 Discussion of the ASFA database
    16.3 Considerations for a strategic science plan for IOTC
    16.4 Election of a Chair and a Vice-Chair for the next biennium

17. **REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE SIXTEENTH SESSION OF THE SCIENTIFIC COMMITTEE** (Chair)

# APPENDIX III
# LIST OF DOCUMENTS

| Document | Title | Availability |
|---|---|---|
| IOTC–2013–SC16–01a | Draft agenda of the Sixteenth Session of the Scientific Committee | ✓ (13 August 2013) |
| IOTC–2013–SC16–01b | Draft annotated agenda of the Sixteenth Session of the Scientific Committee | ✓ (17 November 2013) |
| IOTC–2013–SC16–02 | Draft list of documents of the Sixteenth Session of the Scientific Committee | ✓ (12 November 2013) |
| IOTC–2013–SC16–03 | Outcomes of the Seventeenth Session of the Commission (Secretariat) | ✓ (15 November 2013) |
| IOTC–2013–SC16–04 | Previous decisions of the Commission (Secretariat) | ✓ (13 November 2013) |
| IOTC–2013–SC16–05 | Report of the Secretariat – Activities in support of the IOTC science process in 2013 (Secretariat) | ✓ (15 November 2013) |
| IOTC–2013–SC16–06 | Standardisation of IOTC Working Party and Scientific Committee report terminology (Secretariat) | ✓ (16 November 2013) |
| IOTC–2013–SC16–07 | Status of development and implementation of national plans of action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations (Secretariat) | ✓ (16 November 2013) |
| IOTC–2013–SC16–08 | Best practice guidelines for the safe release and handling of encircled cetaceans (Secretariat) | ✓ (17 November 2013) |
| IOTC–2013–SC16–09 | Best practice guidelines for the safe release and handling of encircled whale sharks (Secretariat) | ✓ (17 November 2013) |
| IOTC–2013–SC16–10 Rev_1 | Outcomes of at-sea trials into different line-weighting options for pelagic longline vessels (Birdlife International & Rep. of Korea) | ✓ (17 November 2013)<br>✓ (25 November 2013) |
| IOTC–2013–SC16–11 | Update on the inter-sessional work of the WPM small working group on Management Strategy Evaluation (WPM Chairperson, Vice Chairperson and IOTC Secretariat) | ✓ (17 November 2013) |
| IOTC–2013–SC16–12 | Outcomes of the informal workshop on CPUE standardisation (Secretariat) | ✓ (11 November 2013) |
| IOTC–2013–SC16–13 | Examination of the effects of piracy on fleet operations and subsequent catch and effort trends (Secretariat) | ✓ (12 November 2013) |
| IOTC–2013–SC16–14 | Update on the implementation of the regional observer scheme (Secretariat) | ✓ (13 November 2013) |
| IOTC–2013–SC16–15 | Update on progress regarding Resolution 09/01 – on the performance review follow–up (Secretariat) | ✓ (15 November 2013) |
| IOTC–2013–SC16–16 | IOTC Science work plan 2014–18 (Secretariat) | ✓ (16 November 2013) |
| IOTC–2013–SC16–17 | Proposed schedule of Working Party and Scientific Committee meetings for 2014 and tentatively for 2015 (Secretariat) | ✓ (16 November 2013) |
| IOTC–2013–SC16–18 | Shark Year (multi-year research) Program (WPEB small working group & Secretariat) | ✓ (17 November 2013) |
| IOTC–2013–SC16–19 | Summary: Estimation of fishing capacity by tuna fishing fleets in the Indian Ocean (Secretariat) | ✓ (14 November 2013) |
| ***Executive Summaries*** | | |
| IOTC–2013–SC16–ES01 | Status of the Indian Ocean Albacore Resource (ALB: *Thunnus alalunga*) | ✓ (13 November 2013) |
| IOTC–2013–SC16–ES02 | Status of the Indian Ocean bigeye tuna (BET: *Thunnus obesus*) resource | ✓ (17 November 2013) |
| IOTC–2013–SC16–ES03 | Status of the Indian Ocean skipjack tuna (SKJ: *Katsuwonus pelamis*) resource | ✓ (17 November 2013) |
| IOTC–2013–SC16–ES04 | Status of the Indian Ocean yellowfin tuna (YFT: *Thunnus albacares*) resource | ✓ (17 November 2013) |
| IOTC–2013–SC16–ES05 | Report on biology, stock status and management of southern bluefin tuna: 2012 (from CCSBT) | ✓ (14 November 2013) |
| IOTC–2013–SC16–ES06 | Status of the Indian Ocean bullet tuna (BLT: *Auxis rochei*) resource | ✓ (13 November 2013) |

| Document | Title | Availability |
|---|---|---|
| IOTC–2013–SC16–ES07 | Status of the Indian Ocean frigate tuna (FRI: *Auxis thazard*) resource | ✓ (13 November 2013) |
| IOTC–2013–SC16–ES08 | Status of the Indian Ocean kawakawa (KAW: *Euthynnus affinis*) resource | ✓ (13 November 2013) |
| IOTC–2013–SC16–ES09 | Status of the Indian Ocean longtail tuna (LOT: *Thunnus tonggol*) resource | ✓ (13 November 2013) |
| IOTC–2013–SC16–ES10 | Status of the Indian Ocean Indo-Pacific king mackerel (GUT: *Scomberomorus guttatus*) resource | ✓ (14 November 2013) |
| IOTC–2013–SC16–ES11 | Status of the Indian Ocean narrow-barred Spanish mackerel (COM: *Scomberomorus commerson*) resource | ✓ (14 November 2013) |
| IOTC–2013–SC16–ES12 | Status of the Indian Ocean black marlin (BLM: *Makaira indica*) resource | ✓ (13 November 2013) |
| IOTC–2013–SC16–ES13 | Status of the Indian Ocean blue marlin (BUM: *Makaira nigricans*) resource | ✓ (13 November 2013) |
| IOTC–2013–SC16–ES14 | Status of the Indian Ocean striped marlin (MLS: *Tetrapturus audax*) resource | ✓ (16 November 2013) |
| IOTC–2013–SC16–ES15 | Status of the Indian Ocean Indo-Pacific sailfish (SFA: *Istiophorus platypterus*) resource | ✓ (16 November 2013) |
| IOTC–2013–SC16–ES16 | Status of the Indian Ocean swordfish (SWO: *Xiphias gladius*) resource | ✓ (16 November 2013) |
| IOTC–2013–SC16–ES17 | Status of the Indian Ocean blue shark (BSH: *Prionace glauca*) | ✓ (15 November 2013) |
| IOTC–2013–SC16–ES18 | Status of the Indian Ocean oceanic whitetip shark (OCS: *Carcharhinus longimanus*) | ✓ (15 November 2013) |
| IOTC–2013–SC16–ES19 | Status of the Indian Ocean scalloped hammerhead shark (SPL: *Sphyrna lewini*) | ✓ (15 November 2013) |
| IOTC–2013–SC16–ES20 | Status of the Indian Ocean shortfin mako shark (SMA: *Isurus oxyrinchus*) | ✓ (15 November 2013) |
| IOTC–2013–SC16–ES21 | Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*) | ✓ (15 November 2013) |
| IOTC–2013–SC16–ES22 | Status of the Indian Ocean bigeye thresher shark (BTH: *Alopias superciliosus*) | ✓ (16 November 2013) |
| IOTC–2013–SC16–ES23 | Status of the Indian Ocean pelagic thresher shark (PTH: *Alopias pelagicus*) | ✓ (16 November 2013) |
| IOTC–2013–SC16–ES24 | Status of marine turtles in the Indian Ocean | ✓ (16 November 2013) |
| IOTC–2013–SC16–ES25 | Status of seabirds in the Indian Ocean | ✓ (16 November 2013) |
| ***Working Party Reports*** | | |
| IOTC–2013–WPNT03–R | Report of the Second Session of the Working Party on Neritic Tunas | ✓ (30 July 2013) |
| IOTC–2013–WPEB09–R | Report of the Eighth Session of the Working Party on Ecosystems and Bycatch | ✓ (26 September 2013) |
| IOTC–2013–WPB11–R | Report of the Tenth Session of the Working Party on Billfish | ✓ (2 October 2013) |
| IOTC–2013–WPTT15–R | Report of the Fifteenth Session of the Working Party on Tropical Tunas | ✓ (6 October 2013) |
| IOTC–2013–WPDCS09–R | Report of the Ninth Session of the Working Party on Data collection and Statistics | Expected: 2 December 2013 |
| ***National Reports*** | | |
| IOTC–2013–SC16–NR01 | Australia | ✓ (8 November 2013) |
| IOTC–2013–SC16–NR02 | Belize | ✓ (17 November 2013) |
| IOTC–2013–SC16–NR03 | China | ✓ (16 November 2013) |
| IOTC–2013–SC16–NR04 | Comoros | ✓ (17 November 2013) |
| IOTC–2013–SC16–NR05 | Eritrea | Due: 17 November 2013 |
| IOTC–2013–SC16–NR06 | European Union | ✓ (22 November 2013) |
| IOTC–2013–SC16–NR07 | France (OT) | ✓ (13 November 2013) |
| IOTC–2013–SC16–NR08 | Guinea | Due: 17 November 2013 |

| Document | Title | Availability |
|---|---|---|
| IOTC–2013–SC16–NR09 | India | ✓ (19 November 2013) |
| IOTC–2013–SC16–NR10 | Indonesia | ✓ (27 November 2013) |
| IOTC–2013–SC16–NR11 | Iran, Islamic Republic of | ✓ (16 November 2013) |
| IOTC–2013–SC16–NR12 | Japan | ✓ (20 November 2013) |
| IOTC–2013–SC16–NR13 | Kenya | ✓ (15 November 2013) |
| IOTC–2013–SC16–NR14 Rev_1 | Korea, Republic of | ✓ (18 November 2013)<br>✓ (1 December 2013) |
| IOTC–2013–SC16–NR15 Rev_1 | Madagascar | ✓ (19 November 2013)<br>✓ (4 December 2013) |
| IOTC–2013–SC16–NR16 | Malaysia | ✓ (18 October 2013) |
| IOTC–2013–SC16–NR17 | Maldives, Republic of | ✓ (19 November 2013) |
| IOTC–2013–SC16–NR18 | Mauritius | ✓ (16 November 2013) |
| IOTC–2013–SC16–NR19 | Mozambique | ✓ (14 November 2013) |
| IOTC–2013–SC16–NR20 | Oman, Sultanate of | ✓ (1 December 2013) |
| IOTC–2013–SC16–NR21 | Pakistan | Due: 17 November 2013 |
| IOTC–2013–SC16–NR22 | Philippines | ✓ (30 November 2013) |
| IOTC–2013–SC16–NR23 Rev_1 | Seychelles, Republic of | ✓ (29 November 2013)<br>✓ (3 December 2013) |
| IOTC–2013–SC16–NR24 | Sierra Leone | Due: 17 November 2013 |
| IOTC–2013–SC16–NR25 | Sri Lanka | ✓ (15 November 2013) |
| IOTC–2013–SC16–NR26 | Sudan | ✓ (13 November 2013) |
| IOTC–2013–SC16–NR27 | Tanzania | ✓ (18 November 2013) |
| IOTC–2013–SC16–NR28 Rev_1 | Thailand | ✓ (17 November 2013)<br>✓ (5 November 2013) |
| IOTC–2013–SC16–NR29 | United Kingdom (OT) | ✓ (15 November 2013) |
| IOTC–2013–SC16–NR30 | Vanuatu | ✓ (21 November 2013) |
| IOTC–2013–SC16–NR31 | Yemen | Due: 17 November 2013 |
| ***Cooperating Non-Contracting Parties*** | | |
| IOTC–2013–SC16–NR32 | Senegal | ✓ (25 November 2013) |
| IOTC–2013–SC16–NR33 | South Africa, Republic of | ✓ (17 November 2013) |
| ***Information papers*** | | |
| IOTC–2013–SC16–INF01 | Guidelines for the presentation of stock assessment models (IOTC Scientific Committee) | ✓ (3 October 2013) |
| IOTC–2013–SC16–INF02 | BOBLME/IOTC – Stock Assessment Course (Bangkok, TH) May $20^{th}$–$24^{th}$, 201: Final Report | ✓ (2 October 2013) |
| IOTC–2013–SC16–INF03 | Report of the IOTC CPUE Workshop | ✓ (11 November 2013) |
| IOTC–2013–SC16–INF04 | Estimation of fishing capacity by tuna fishing fleets in the Indian Ocean (G. Moreno & M. Herrera–IOTC Secretariat) | ✓ (17 November 2013) |
| IOTC–2013–SC16–INF05 | The Spanish Fish Aggregating Device Management Plan from 2010-2013 (A.D. de Molina, J. Ariz, J.C. Santana , S. Rodriguez, M. Soto & H. Murua) | ✓ (25 November 2013) |
| IOTC–2013–SC16–INF06 | On the growth of bigeye tuna in the Indian Ocean: what is the real age of a 50 cm/2.6kg bigeye? (A. Fonteneau) | ✓ (15 November 2013) |
| IOTC–2013–SC16–INF07 | Report of the $1^{st}$ workshop on Management Strategy Evaluation | ✓ (19 November 2013) |
| IOTC–2013–SC16–INF08 | Report of the $2^{nd}$ workshop on Management Strategy Evaluation | ✓ (19 November 2013) |
| IOTC–2013–SC16–INF09 | Building science capacity and understanding among IOTC CPCs | ✓ (26 November 2013) |
| IOTC–2013–SC16–INF10 | DRAFT: Identification cards for tuna and tuna-like species caught in Indian Ocean fisheries | ✓ (27 November 2013) |

| Document | Title | Availability |
|---|---|---|
| IOTC–2013–SC16–INF11 | Update on estimates of the catch reductions achieved through the application of the time/area closures proposed in IOTC Resolution 10/01 | ✓ (1 December 2013) |
| IOTC–2013–SC16–INF12 | Re-processing of the fisheries statistics for the French purse seine fishing fleet during 1981-1990 (E. Chassot, L. Floch, P. Dewals, P. Chavance & V. Fonteneau) | ✓ (2 December 2013) |
| IOTC–2013–SC16–INF13 | An update on the length-weight relationships for bigeye and yellowfin caught by purse seiners in the Indian Ocean (E. Chassot, J. Esparon, A. Tyrant, P. Dewals, A. Delgado de Molina, J.J.A. Areso & N. Bodin) | ✓ (2 December 2013) |
| IOTC–2013–SC16–INF14 | Weight of Evidence framework: Stock status assessment (J. Larcombe – Australia) | ✓ (2 December 2013) |
| IOTC–2013–SC16–INF15 | South Africa: National Plan of Action for the conservation and management of sharks (NPOA-Sharks) (South Africa) | ✓ (3 December 2013) |

# APPENDIX IV
# IOTC SCIENTIFIC COMMITTEE REPORT TERMINOLOGY

***Level 1: From a subsidiary body of the Commission to the next level in the structure of the Commission:***

**RECOMMENDED, RECOMMENDATION**: Any conclusion or request for an action to be undertaken, from a subsidiary body of the Commission (Committee or Working Party), which is to be formally provided to the next level in the structure of the Commission for its consideration/endorsement (e.g. from a Working Party to the Scientific Committee; from a Committee to the Commission). The intention is that the higher body will consider the recommended action for endorsement under its own mandate, if the subsidiary body does not already have the required mandate. Ideally this should be task specific and contain a timeframe for completion.

***Level 2: From a subsidiary body of the Commission to a CPC, the IOTC Secretariat, or other body (not the Commission) to carry out a specified task:***

**REQUESTED**: This term should only be used by a subsidiary body of the Commission if it does not wish to have the request formally adopted/endorsed by the next level in the structure of the Commission. For example, if a Committee wishes to seek additional input from a CPC on a particular topic, but does not wish to formalise the request beyond the mandate of the Committee, it may request that a set action be undertaken. Ideally this should be task specific and contain a timeframe for the completion.

***Level 3: General terms to be used for consistency:***

**AGREED**: Any point of discussion from a meeting which the IOTC body considers to be an agreed course of action covered by its mandate, which has not already been dealt with under Level 1 or level 2 above; a general point of agreement among delegations/participants of a meeting which does not need to be considered/adopted by the next level in the Commission's structure.

**NOTED/NOTING**: Any point of discussion from a meeting which the IOTC body considers to be important enough to record in a meeting report for future reference.

***Any other term:*** Any other term may be used in addition to the Level 3 terms to highlight to the reader of and IOTC report, the importance of the relevant paragraph. However, other terms used are considered for explanatory/informational purposes only and shall have no higher rating within the reporting terminology hierarchy than Level 3, described above (e.g. **CONSIDERED**; **URGED**; **ACKNOWLEDGED**).

# APPENDIX V
# 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 2012, three Australian longliners from the Western Tuna and Billfish Fishery and one longliner from the Eastern Tuna and Billfish Fishery operated in the IOTC Area of Competence. They caught 13.1 t of albacore (*Thunnus alalunga*), 167.4 t of bigeye tuna (*Thunnus obesus*), 23.0 t of yellowfin tuna (Thunnus albacares), 209.3 t of swordfish (*Xiphius gladius*) and 2.5 t of striped marlin (*Tetrapturus audax*). These catches represent approximately 13 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 4503 t in 2012. A small amount of skipjack tuna (Katsuwonus pelamis) was caught by purse seine fishing in 2012 (0.2 t). In 2012, less than 1 t of shark was landed by the Australian longline fleet operating in the IOTC Area of Competence and 11 371 sharks were discarded/released. In 2012, 17.8 per cent of all hooks set in WTBF longline operations were observed over three trips in the IOTC Area of Competence.

**Belize**

The Belize flagged vessels that target tuna and tuna like species in the Indian Ocean Tuna Commission (IOTC) Convention area are all long line fishing vessels. These vessels all foreign owned and operate primarily in this area which is outside the jurisdiction of Belize's territorial waters; however, they are all licensed to operate on the high seas or in the EEZ of other States under licensing agreements. In 2012, our fleet fluctuated between 4 to 8 long line tuna fishing vessels and one (1) refrigerated reefer carrier which operated mainly between 10°- 40°S and 55° - 75°E. Together, our vessels caught 52.5 m/t of Albacore tuna, 69.7 m/t of Yellowfin Tuna, 391.3 m/t of Bigeye Tuna, 32.4 m/t of Swordfish, 2.1 m/t of Black Marlin, 28.9 m/t of Blue Marlin, 6.7 of Stripped Marlin, 11.5 m/t of by-catch species consisting of Moonfish, Sailfish, Oilfish and Wahoo, 2.2 m/t of Blue Shark and 2.1 m/t of Moro Shark. There have been 47% reductions in our overall catches from 1257 m/t in 2007 to 599 m/t in 2012. There was a shift in the main target species in 2012 from Albacore to Bigeye 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 628gt. 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**

Deep-frozen longline and ice fresh-longline are the only two fishing gears used by Chinese vessels to catch tuna and tuna-like species in the IOTC waters. The number of active deep-frozen longline vessels increased from 10 in 2011 to 31 in 2012, while the number of ice-fresh longline vessels kept at five. Chinese longline fleet caught 2943 MT of tropical tunas (BET and YFT) in 2012, which is higher than the catch in 2011(431 MT). The albacore tuna catch in 2012 was 1835 MT, which is also higher than the catch in 2011 (1414 MT). Implementation of both the logbook and observer programs is going on for the Chinese longline fleet in the Indian Ocean. Catch and effort data collection of bycatch species have been improved. One scientific observer was dispatched in 2012 and the trip report has been submitted.

**Comoros**

La pêche aux Comores est exclusivement artisanale, pratiquée sur des embarcations non ponté en bois ou en fibre de verre, motorisé ou non motorisé d'une longueur de 3 m à 9 m. Elle exploite essentiellement les espèces pélagiques (*Thunnus albacares, Katsuwonus pelamis, Thunnus alalunga Istiophorus platypterus, Thunnus obesus, Euthynnus affinis*) et contribue pour sa totalité à l'alimentation de la population comorienne, tout en fournissant 55% de l'emploi total du secteur agricole soit environ 8000 pêcheurs. Les techniques de pêche utilisées sont essentiellement la ligne de traine, la palangrotte et peu de filet pour les petits pélagiques. La duré de la marée est d'une journée à 7 jours. Depuis février 2011 les Comores ont mis en place un système de collecte des données sur les lieux de débarquement grâce à l'appui technique et financière de la CTOI et l'OFCF. La production annuelle issue de cette enquête est estimé à 8088 tonnes toutes espèces confondu soit environ 5252 tonnes de thonidés sur un ensemble de 5623 embarcations. La pêche industrielle est inexistante au niveau national. Cette activité de pêche est pratiquée par une flottille Etrangère qui opère dans le cadre d'un Accord de pêche. Les captures de cette flottille ne sont ni débarquées ni transbordées dans le pays.

**Eritrea**
National Report not provided.

**European Union**
Need – currently in pdf only.

**France (OT)**
Les outre-mer français de l'Océan indien incluent Mayotte, Département depuis le 31 mars 2011 et les îles Eparses qui sont rattachées à l'administration supérieure des Terres australes et antarctiques françaises (TAAF). Depuis janvier 2010, Mayotte dispose d'un parc naturel marin (PNM) doté d'un conseil de gestion dont les limites maritimes sont celles de la ZEE de Mayotte. Un second parc naturel marin a été créé le 22 février 2012 (décret n°2012-245 du 22 février 2012), il s'agit du PNM des Glorieuses, qui dépend des îles Eparses, qui s'étend sur l'ensemble de la ZEE des Glorieuses. Les captures totales dans l'océan Indien des 5 senneurs français immatriculés à Mayotte se sont élevées en 2012 à 29 016 tonnes, soit une augmentation de 9% par rapport à 2011 (26 610 t) due à une augmentation de l'effort de pêche. Le programme observateur mis en place en 2005 puis interrompu en 2009 pour raison de sécurité face au développement de la piraterie somalienne, a repris en 2011 et s'est poursuivi en 2012 en particulier sur les plus grands senneurs de la flottille, grâce à une collaboration mise en place avec les TAAF. La flotte de pêche côtière artisanale de Mayotte, composée d'un grand nombre de pirogues et de barques pratiquant essentiellement la pêche à la palangrotte, à la traîne et au filet, et de quatre petits palangriers (palangre pélagique dérivante) ciblant les thons et espadons essentiellement. Les captures réalisées par les palangriers dans les eaux de Mayotte sont en augmentation et sont estimées à 52 tonnes en 2011 et 67 tonnes en 2012. Le dispositif de recherche thonière actuel de la France (IRD & Ifremer principalement) couvre des activités de type observatoire, l'étude des comportements migratoires des grands pélagiques, des études génétiques pour la délimitation des stocks, des études sur la biologie de la reproduction... – see paper for full abstract

**Guinea**
National Report not provided.

**India**
Fishing is an age old practice in India. Major share of the fish landings in India, where a multi species, multi gear fishery exists is from the coastal fishery (Sajeevan and Nair, 2006). Tuna fishery in India consists of both targeted longliners and multipurpose coastal fishing fleets. India's tuna fishing fleet includes traditional, motorized and mechanised boats operating various traditional gears, small pole and line boats, small longliners and industrial longliners. Except the Industrial tuna long liners and pole and line boats other fishing fleets are aimed at multi species fishery. Tuna and allied resources also caught by these fleets as by-catch. The total production of tunas and tuna-like fishes, including neritic and oceanic tunas, billfishes and seerfishes during the year 2012 was 179,625 tonnes against a total production of 159924 tonnes during the year 2011. An increase in the tuna landings by the oceanic and by coastal fishery sector was noticed during the year under report. Resource survey conducted by the Fishery Survey of India in the EEZ revealed that sharks constitute 38.66% 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, most of the shark species 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 (FMAs) 572 (Indian Ocean – west Sumatera) and 573 (South of Java – East Nusa Tenggara), 571 (Malaka strait and Andaman Sea) are three fisheries management areas among eleven FMAs that located within the IOTC area of competence. Long liners is the main fishing gear type operated in those FMAs, was 1227 vessels in 2013. The national catch of four main tuna species in 2012 was estimated 168,626 t while the total catch for all species by all gears type was estimated 398,540 t. Port sampling and scientific observer programs is still continuing and conducted by Research Institute for Tuna fisheries (RITF) Benoa. Recently ministerial regulation of MMAF no 01 year 2013 concerning observer onboard for fishing and carrier vessel was issued, furthermore Database Sharing Systems for Fisheries Management which integrate a number of databases, including the licensing, logbook and VMS databases has recently launched by the Minister of Marine Affairs and Fisheries on 19 November 2013 in Jakarta.

**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 are located between the longitude of 48° 30' North to 61° 25' East. There are 4 coastal provinces in that areas about 11 thousand vessels consist of fishing boat, dhows and vessel which are engaged in fishing in the coastal and offshore waters. There are three fishing methods targeting tuna and tuna-like species in the IOTC area which includes gillnet and purse seiner and also some of small boat 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, By-catch, and discard. It is noteworthy to say that in 2012 bycatch composition for gillnet fisheries were studied and some species of sharks and Billfish were identified, recorded in our data base and reported to the IOTC Secretariat.

**Japan**

This Japanese national report describes following 8 issues in recent five years (2009-2013), 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) working documents.

**Kenya**

Kenya’s current fishing fleet for tuna and tuna like species is composed of entirely artisanal fishery and recreational fishery. The National report therefore summarises the fishing activities of these fleets. The commercial artisanal tuna fishery is small-scale artisanal multi- species multi-gear fishery concentrated in the coastal areas. A majority of the vessels are wooden planked propelled by sails and some are increasingly being motorised. About 821 artisanal vessels are engaged in the fishing of tuna and tuna like species. Artisanal commercial fishing for tuna and tuna-like species in the territorial waters use artisanal long line hooks, gillnets and monofilament nets. Key species landed are tuna Yellowfin, Skipjack and Kawa kawa, sailfish, and king mackerel. Tuna catches decreased from 302 tons to 201 tons. Other important species landed were sailfish 142 tons, and King fish 121. Recreational fisheries species target billfishes (Marlins, swordfish and swordfish) and tuna however other small pelagic species such as barracuda, king mackerel Wahoo and sharks are also reported in the catches of recreational fishermen. The key ecosystem issues that are relevant to the Kenyan tuna fisheries relate to the incidences of shark bycatch which occur in artisanal fisheries.

**Korea, Republic of**

Korea has two type of fishing gears which are lonline fishery and purse seine fishery in the Indian Ocean. Korean tuna longline fishery in the Indian Ocean commenced in 1957. 7 longline vessels were operated in 2011 and 2012, which were the lowest in number of vessels during previous 5 years. With this fishing capacity, Korean tuna longline fishery caught 1,848 mt in 2012, which was 21% higher than that of 2011. The fishing efforts in 2012 were 4,290 thousand hooks and distributed higher in the western and eastern areas around 20°S-40°S, while the fishing efforts averaged for 5 recent years (2007-2011) were 7 million hooks and distributed in the tropical areas around 20°N-20°S as well as in the western and eastern areas around 20°S-40°S. It was noted that fishing efforts had not been deployed in the western Indian Ocean around 20°N-20°S in recent years. As results, the catch of bigeye tuna and yellowfin tuna significantly decreased, and albacore tuna became important in catch. Korean tuna purse seine fishery in the Indian Ocean commenced in 2012 and recorded about 29 hundreds mt in catch. 3 purse seine vessels have operated to fish skipjack tuna and yellowfin tuna in the western and central tropical areas around 5°N-10°S. The fishing efforts in 2012 were 145 sets, which mainly distributed in the tropical areas around 50°E-70°E. In 2012, 3 scientific observers were dispatched on board for implementing observer program and scientific data collection, which carried out 6.2% of observer coverage in terms of the number of hooks.

**Madagascar**

La pêche thonière nationale est pratiquée essentiellement par des palangriers inférieurs à 24 m. Le nombre de navires mis à la disposition de cette pêcherie ne cesse d’augmenter graduellement depuis son développement en 2007 (Tableau 1) dans la façade est des eaux de Madagascar. Notons que ces navires effectuent une marée relativement courte pour maintenir les thons et espèces assimilées frais sous glace. En termes de production, les prises mises à terre déclarées par les trois sociétés ayant des licences sur les thons et espèces associées ont connu une légère diminution au cours des trois dernières années, et ce, malgré l'augmentation du nombre de navires de pêche déployés. Jusqu'à présent, aucune explication ne peut être avancée à ce sujet vu que bon nombre d'incertitudes restent encore à élucider, d'autant plus que la collecte de logbook au débarquement n'a pas été mise en œuvre. Les seules données disponibles procurant des infirmations géographiques sont celles issues du VMS (Vessel Monitoring Système) et du programme observateur. Les navires de pêche ayant des licences sur les poissons démersaux peuvent aussi avoir une interaction accidentelle avec certaines espèces sous mandat de la CTOI notamment celles dites néritiques. Il s'agit des ligneurs, palangriers et polyvalent exploitant la partie benthique des façades Ouest et Est de la ZEE (Zone Economique Exclusive) de Madagascar. La pêche thonière traditionnelle reste un segment très méconnu à Madagascar. Des efforts conjoints de l'administration de la pêche et ses partenaires ont été développés récemment pour mettre en exergue les tenants et les aboutissants de cette pêcherie.

**Malaysia**

Tuna catches contributed about 5% of total marine finfish landing in Malaysia. Neritic tuna species formed large portion of the tuna catch and they were caught mainly by two commercial fishing gears; purse seine and trawl nets. The catch of neritic tuna from the west coast of Peninsular Malaysia (Malacca Straits) showed a slight increase in 2012 to 23,767 mt from 21,765 mt in 2011. In 2012, tuna longline of Malaysian flag vessels fully operated to catch albacore tuna in the southwest of Indian Ocean where their fishing areas extended to 35 0S. The fleet consisted of 5 fishing vessels and one carrier, and they unloaded and transhipped the catches at the Port Louis, Mauritius. Albacore tuna formed nearly 70% of the catches in the form of frozen tuna. Total catch of tuna in 2012 was 847 mt with the average catch rate of 17 tons/vessel/month. On catch and effort data recording, in 2012, Malaysia was able to improve quality of effort and catch data with the cooperation from the vessel operators. On observer program, it will be implemented accordingly when the size of Malaysian fleet increase to over 20 fishing vessels. However, for domestic vessels operating beyond 30 nm offshore, there are plan by the DoF to implement observer on board and logbook system. A new revised NPOA-sharks is near complete and is expected to be released and published by end of 2013. Beside, capacity building program for staff that involve in data collection at selected landing sites are continuously been carried out to improve shark data collection. On sea turtle, 2 sanctuary and information centres have regularly implementing awareness program for student and fishermen communities. Hatching program at these centres managed to release over 65,000 baby turtles back to the sea. There are several research programs on sea turtle been carried out at different areas in Malaysian waters.

**Maldives**

The Maldivian tuna fishery comprises of four components. The most important is the traditional liveabait pole-and-line fishery dating back hundreds of years. The fishery was certified in November 2012. The main target species is skipjack tuna (*Katsuwonus pelamis*). Small amounts (~15-17%) of juvenile yellowfin tuna (*Thunnus albacares*) are also caught in the fishery of which about 4% is bigeye tuna (*Thunnus obesus*). The second and growing component is the handline fishery, which targets exclusively surface dwelling large yellowfin tuna (> 70 cm FL). A Maldivian owned longline fishery is being developed following the termination of the foreign longline licensing in May 2010. A small-scale trolling fishery also exists, which targets neritic species of kawakawa (Euthynnus affinis) and frigate tuna (*Auxis thazard*). Catches of skipjack has been declining following an all time high of around 140,000 t in 2006. Recent years have been of the order of 50,000 – 60,000 t, less than half the recorded catch in 2006. Caches of yellowfin are increasing, thanks to the rapid growth of the handline fishery. No specialized gear is required for handline fishing and so many pole-and-line vessels have switched to handline fishing. Many also practice multi-day and multi-gear fishing, switching them opportunistically. Most recent catches of the yellowfin are around 45,000 t and about 80% of the catch is from handline fishery. The national data collection is based on an enumeration system which is now almost replaced by a modern logbook data collection system. A web-enabled database will become online by the end of this year to allow compilation and processing of catch and effort data. The web-enabled database will also be used to record tuna purchases by the exporters. The database when fully functional will help maintain records of active fishing vessel and fishing licenses. Maldives is taking lead in skipjack management strategy evaluation… - see paper for full abstract

**Mauritius**

Fisheries contribute to the national economy to the tune of 1.3% Gross Domestic Product, of which processed tuna for the export market is the main contributor. The majority of the tuna and tuna-like species fishing in the EEZ of Mauritius is carried out by distant water fishing fleets from Europe (purse seiners) and countries of the East and South East Asia (longliners). 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, 40 221 tonnes of tuna were transhipped through the Port Louis harbour and albacore tuna constituted more than 40% of the total catch. Five national fishing vessels, less than 24 meters in length, landed 36 tonnes of chilled fish with a total effort of 182,300 hooks. These vessels target swordfish (47.2%) but also land by-catch comprising yellowfin (*Thunnus albacares*, 15.8%), bigeye (*Thunnus obesus*, 8.2%) and albacore (*Thunnus alalunga*, 15.4 %) tunas, and billfishes (4%) while no encounter with seabirds and marine turtles were noted. The fishing areas were spread between latitudes 9°S and 26°S and longitudes 56°E and 62°E. A small amount (2.1 tonnes) of shortfin mako shark (*Isurus oxyrhinchus*) is landed by the national vessels. However, 2318 tonnes of sharks consisting mainly of blue shark (*Prionace glauca*, 78%) followed by shortfin mako shark (16%) were landed in port by foreign longliners during 2012. The FAD fishery which consists of around 380 small-scale fishermen operating around the 27 anchored Fish Aggregating Devices set around the island landed 235 tonnes of fish with albacore being the major species (69.3%) followed by yellowfin (21.2%) and skipjack tunas (4.2%). One purse-seiner flying Mauritius flag was registered in October 2013 and observers will be deployed to monitor the national purse-seiner.

**Mozambique**

The main tuna industrial fishery in Mozambique is operated by foreign distant water fishing fleets. In the last five years, to this industry, the Ministry of Fisheries has issued annually, an average of 125 licenses (44 purse seiner and 81 long liners). The fishing operations occur in the Mozambique EEZ from 12 nautical miles offshore from January to December. Purse seiner fishing occurs mainly between the parallels 10º 32’ and 20º south while the long-liner fishing occurs between 20º and 26º 52’ south with particular intensity below parallel 25° south. The recent official information, reports an annual catch ranging from 1,000 tons to 17,500 tons, with annual average between 5,000 to 7,000 tons. However, recent statistics particularly deposited on IOTC indicate that the real catch from Mozambican waters is close to 20,000 tons per year. This scenario clearly indicates some mistakes in reporting the catches which was explained by the wrong line border limit leading to miss reporting of Mozambican catches until June 2012. Apart from the more accurate and better structured information stated above, Mozambique has its tuna national fleet composed of one industrial long liner operating since 2011, the artisanal, sport and recreational fisheries coming from very long time, along the coast with some considerable impact in the tuna and tuna-like species. The catches of the industrial national fleet is around 240 tons per year and the picture from the artisanal, sport and recreational fisheries together, appoint to 4,014 tons by year. The estimates from artisanal, sport and recreational fisheries can be considered incomplete taking into account that gathering all the data on catch from these fisheries is actually a challenge for a country with a long coast of 2,780 Km, with insufficient funding of research activities and lack of well trained personnel at the provincial level where the fishery occurs.

**Oman**

Omani fishery sector is one of several sectors that contribute to the economy of the country. The total production of this sector in 2012 was 192,000 tons with a total value of 143 million OMR. Comparing with 2011 the value of fishery production was increased by 16% in 2012. The consumption of Tuna products in Oman is high. There is a fluctuations of the total annual production of Tuna which is 8753 mt in 2003 and it increased up to 16850 mt in 2007 and decreased to 5501 mt in 2012. 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 52 vessels in 2008 to 8 vessels in 2012. 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. On the other hand there is a massive increase in the number of vessels and fishermen of Artisanal and coastal fleets. Omani Government has introduced the logbook data collection scheme, the Vessel Monitoring System (VMS) and Port Sampling Program (PSP), observer programme (under/development) to monitor Tuna fishery and to enhance the quality of data gathered in order to manage and sustain efficiently the Omani fisheries. Moreover, 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**

Fishery is an important component of the agricultural sector in the Philippines. Marine fishery is an important source of protein, livelihood and export earnings for the Philippines. In 2011, total marine catch by the Philippine commercial fleet was estimated to 1,032,820 million tons which accounted for about 20.76% of the total fisheries production. (Bureau of Agricultural Statistics [BAS] 2012). The fisheries sector came down with 2.32 percent less output in 2012. From last year’s record of 4,973,587.75 metric tons, the 2012 volume of production was placed at 4,858,097.10 metric tons. Municipal fisheries and aquaculture posted 3.88 percent and 2.54 percent reductions in their volumes of production, respectively. Commercial fisheries gained 0.23 percent in volume of production. Commercial fisheries production in 2012 reached 1,035,213.92 metric tons. This was 2,393.80 metric tons more than last year's record of 1,032,820.12 metric tons. Production declined by 9.12 percent in the first quarter and by 0.59 percent in the second quarter. However, these were offset by the increase of 4.68 percent during the third quarter and 6.39 percent in the fourth quarter of 2012. The increased demand for fish from rapidly growing population and increasing exports has substantially increased fishing pressure on the marine fishery resources in the past two decades. The major key issues facing the fisheries sector are resource depletion and environmental degradation. Declining catch rates and the levelling off of marine landings also supports these conclusions. Philippines is still one of the top fish producing countries in the world. Over an estimated 1.5 million people depend on the fishing industry for their livelihood. Philippines is also considered a major tuna producer in the Western and Central Pacific Ocean (WCPO). 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 (Philippine Fisheries Profile, 2010).

**Seychelles**

The Seychelles National Report summarizes activities of the Seychelles' fishing fleet targeting tuna and tuna-like species in the WIO. It also summarizes research, and data collection related activities as well as actions undertaken in 2012 to implement Scientific Committee recommendations and IOTC resolutions. For the past three years Seychelles purse seine fleet has consisted of eight purse seiners, whilst the number of supply vessels has been reduced from five to three. Overall nominal effort has been on a downward trend over the past 5 years, and in 2012 it dropped further by 213 days (9%) when compared to 2011. The total annual catch reported by the purse seine fleet decreased by 32% over the past two years, from 75,787 MT in 2010 to 50,938 MT in 2012. Catches of skipjack tuna declined over the past 2 years and in 2012, yellowfin tuna was the dominant species making up 53% of the total reported catch, with skipjack making up only 39%. The total catch reported by the industrial longline fleet for 2012 is estimated at 12,164 MT, a significant increase of 60% over the 7,566 MT reported in 2011. Bigeye tuna has remained the dominant species caught by this fleet for the past seven years, accounting for an average of 55% of the total annual catch. The semi industrial longline fleet reported a total catch of 271 MT in 2012, representing an increase of 13% over the 238 MT reported in 2011. With an increase in the number of active vessels, fishing effort increase by 15% and catch rates stabilized at around 0.82 MT/1000 hooks over the 2011/ 2012 period. SFA is currently (2013) reviewing its data collection system for the domestic fishery, and is working in close collaboration with relevant stakeholders to develop and implement a more effective system that… - see paper for full abstract

**Sierra Leone**

National Report not provided.

**Sri Lanka**

The total production of tuna and tuna like species (TPTT) was 79% of the total large pelagic fish catch. It was 106,305t, in 2012, which shows a 5% increase than that of 2011. Skipjack tuna dominated the catches and amounted to 45% followed by yellowfin tuna represented 27%. Catch of bigeye tuna is relatively low and accounted for 2%. There was an 8% increment in yellowfin tuna yield than in 2011. This depicts the development of the longline fleet targeting the deep sea tuna. Billfish is the second most group; consisting three species of marlin; black marlin, blue marlin and striped marlin, and sail fish and sword fish, makes up 12% of the TPTT. The species identification is somewhat difficult due to nature of landing, sometimes beheading and cut in to pieces. A slight decrease in the billfish catch was observed in 2012 than in 2011. The total shark production of 2581t in 2012 shows 3% decline than in 2011. Silky shark dominated (44%) the incidental shark catch. The shifting of the gear targeting deep sea tuna employing tuna long line has influenced reducing of both billfish and sharks in 2012. Out of 4000 boats of length between 10-15m LOA, only 2483 were actively operated in the year 2012. Since majority of them do not equipped with fishing aids; line or net haulers the number of hooks or the pieces of nets deployed is limited due to manual operation and also the restricted deck space. The gear used is mainly gill net, long line, longline or gill net one at a time in a single operation and ring net. The use of gill net and long line joined together as a combined gear in a single operation shows a decline in practice. Skipjack mainly caught with gill net while yellowfin tuna with gillnet or long line. – see paper for full abstract

**Sudan**

The total annual fin fish production in Sudan is around 140000 tons from fresh water and 8000 tons from marine water (fully future operating estimate), marine resources divided into artisanal fishery (about 3000 tonnes), trawling (about 2000 tonnes), per sine fishery (about 2300 tonnes), shrimp from trawling (about 60 tonnes), shrimp from culture (about 6 tonnes), trochaus (about 724 tonnes), mother of pearl shell (about 12 tonnes) and sea cucumber (about 60 tonnes) Vine et al., (1980). Tuna fishes Not target to fish in Sudanese Red Sea coast, these retaining to limiting in fishing location and gear use by local fishers, most catch taken by hooks and line, seasonally foreign fleets come from Egypt under economic protocol, sign by Sudanese government and Egypt, use to fish in Sudanese trawling area (Southern area), also pure sine use by Egyptian vessels. But since 2010 this fishing activates was a stop. Since 2010 the only fishing activates running by local fishers with small fibber glass boat and wooding, no regular a statistical data had been taken for fish species or gear types. Only statistical data records taken from the fish market in Port Sudan, all tuna fishes record under name of mackerel fishes. Shark and other marine fish product were recorded also from the fish's local market. No statistical and regular data taken for marine mammal and seabird.

**Tanzania, United Republic of**

Presently the national fleet of Tanzania is all artisanal characterized by multi-species, multi-gear and multi-cultural fisheries. Most of the fishing takes place within 6 nm from shore predominantly on reef areas. However a small number of boats are involved in the fisheries of tuna, bill fish and sharks, using manually handled drift gill nets and long lines. The catch data is collected in terms of weight of fish group and is not based on gear type, vessel size and duration of fishing operations. Statistics from the Fisheries Departments for both Zanzibar and the main land Tanzania for the year 2012, shows 7702, 1411 and 6169 tonnes for tuna, billfish and sharks and rays were caught respectively. However, recreational fishing data are missing and the available catch data is missing geographic position, type of gear and effort. Logsheet data started to be collected in 2002 from all licensed EEZ fishing vessels and a Vessel Monitoring System has been monitoring the Tanzania EEZ since 2009. There have been no Observer and Port sampling programmes because Tanzanian Ports does not have facilities for handling commercial deep sea fishing vessels. No transhipment of fish cargo is allowed in our waters. Current research programmes are focusing on the potential of establishing a national fleet for small pelagics and tuna and tuna like species in the Exclusive Economic Zone with the aim of reducing the rapidly increasing fishing pressure within the inshore waters.

**Thailand**

Neritic tuna 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. Three Thai tuna longliners were operated in the Indian Ocean in 2007 and in 2008-2012 only two Thai tuna longliners kept on fishing there. Fishing grounds were mainly in the western coast of Indian Ocean. The fishing operations were recorded 2,276 fishing days. The highest total catch was in 2010 with 607.69 tonnes followed by 2012, 2007, 2011, 2009 and 2008, respectively (494.95, 461.64, 370.39, 295.23 and 265.57 tonnes). The highest CPUE was found in 2010 with 13.62 fish/1,000 hooks followed by 2012 and 2007, respectively (10.80 and 10.20 fish/1,000 hooks). The major catch species wer bigeye tuna (*Thunnus obesus*), yellowfin tuna (*T. albacores*) Albacore tuna (*T. alalunga*), swordfish and shark.

**United Kingdom (OT)**

UK (BIOT) waters have been a Marine Protected Area (MPA) since April 2010. Diego Garcia and its territorial waters are excluded from the MPA and include a recreational fishery. UK (BIOT) does not operate a flag registry and has no commercial tuna fleet or fishing port. The United Kingdom National Report summarises fishing in its recreational fishery in 2012 and provides details of research activities undertaken within the MPA. The recreational fishery landed 10.79t of tuna and tuna like species on Diego Garcia in 2012. Principle target tuna species of the industrial fisheries (yellowfin, bigeye and skipjack tunas) contributed 30% of the total catch of tuna and tuna like species of the recreational fishery. Length frequency data were recorded for a sample of 378 yellowfin tuna from this fishery. The mean length was 75cm. Sharks caught in the recreational fishery are released alive. IUU fishing remains the greatest threat to the BIOT ecosystem. 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**

There was only longline fishery operated by Vanuatu in 2012 in the Indian Ocean. 2 longliners targeted the 2 major tuna species, yellowfin tuna and bigeye tuna with albacore tuna, shark, blue marlin and sword fish as the by-catch. Total catch of 2012 was estimated to be 347.584 mt, comprising of 146.280 mt for yellowfin, 90.862 mt for bigeye tuna, 6.421 mt for albacore tuna, 107 mt for shark, 8 mt for striped marlin, 28.741-mt forblue marlin and 43.763 mt for sword fish. These data were compiled from the logsheets that submitted by the vessels to the Vanuatu Department of Fisheries.

**Yemen**
National Report not provided.

**Senegal**
In 2012, the Senegalese industrial tuna fishing fleet was composed of six pole-and-line vessels essentially targeting yellowfin (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*) and skipjack (*Katsuwonus pelamis*) and two longline vessels targeting swordfish. Furthermore, some artisanal fisheries (handline, trolling line and purse seine) and sport fisheries catch billfish species (marlins, swordfish and sailfish) and small tuna and tuna-like species (kawakawa, mackerels, bonito, frigate tuna, etc.). In 2012, total catches from Senegalese pole-and-line vessels were estimated at 6,181 metric tonnes (1,645 mt for yellowfin tuna, 4,276 mt for skipjack tuna and 225 mt of bigeye tuna). Catches have slightly increased compared to 2011 (6,118 mt): this increase reflects the increased catches of albacore tuna. In 2012, the longline fisheries total catches were estimated at 410 metric tonnes (312 mt in 2011). Catches are mostly made of swordfish, sharks and marlins. As far as artisanal fisheries are concerned, the total catches of small tuna and tuna-like species were estimated at 5,542 metric tonnes, a sharp decrease from 2011 (9,064 mt). The total catches from the sport fisheries were estimated at 180 metric tonnes in 2010 for a total fishing effort of 1428 trips. The continuous monitoring of tuna fishing activities continues to be implemented by the team set up at the Dakar port by the CRODT. Their work consists in collecting catch and effort statistics. This work is complemented by other information from various sources (processing plants, fishing companies, Marine Fisheries Directorate, etc.) Multispecies samples are also done in the industrial and artisanal fisheries. Thanks to the financial support of the *Programme de Recherche Intensive des Istiophoridés (EPBR)*, sampling for catches, effort and size of Istiophorids has been intensified in the main artisanal fisheries landing sites.

**South Africa, Republic of**
South Africa has two commercial fishing sectors which either target or catch tuna and tuna-like species as bycatch 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 boatbased recreational/sport fishery.

## Appendix VI

## 2013: Status of development and implementation of National Plans of Action (NPOA) for sharks and seabirds and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations

| CPC | Sharks | Date of Implementation | Seabirds | Date of implementation | Marine turtles | Date of implementation | Comments |
|---|---|---|---|---|---|---|---|
| **MEMBERS** | | | | | | | |
| **Australia** | | 14-Apr-2004 | | 2006 | | 2003 | **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. **Marine turtles:** Australia's current marine turtle bycatch management and mitigation measures fulfill Australia's obligations under the FAO-Sea turtles Guidelines. |
| **Belize** | | | | | | | Sharks: No information received by the Secretariat.<br>Seabirds: No information received by the Secretariat.<br>**Marine turtles:** No information received by the Secretariat. |
| **China** | | – | | – | | | Sharks: Development has not begun.<br>Seabirds: Development has not begun.<br>**Marine turtles:** No information received by the Secretariat. |
| **–Taiwan,China** | | May 2006 | | May 2006 | | | Sharks: No revision currently planned.<br>Seabirds: No revision currently planned. |
| **Comoros** | | – | | – | | | Sharks: Development has not begun.<br>Seabirds: Development has not begun.<br>**Marine turtles:** No information received by the Secretariat. |
| **Eritrea** | | | | | | | Sharks: No information received by the Secretariat.<br>Seabirds: No information received by the Secretariat.<br>**Marine turtles:** 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.<br>**Seabirds:** The EU adopted on Friday 16 November an Action Plan to address the problem of incidental catches of seabirds in fishing gears.<br>**Marine turtles**: Best practice guidleines for the safe handling and release of marine turtles have been developed and implemented. |
| **France (territories)** | | | | | | | **Sharks:** Approved on 05-Feb-2009 but not yet implemented.<br>**Seabirds:** No information received by the Secretariat.<br>**Marine turtles:** No information received by the Secretariat. |
| **Guinea** | | | | | | | **Sharks:** No information received by the Secretariat.<br>**Seabirds:** No information received by the Secretariat.<br>**Marine turtles:** No information received by the Secretariat. |

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| **India** | | | | | | | **Sharks:** Currently being drafted with the assistance of BOBP-IGO<br>**Seabirds:** India has determined that seabird interactions are not a problem for their fleets.<br>**Marine turtles:** No information received by the Secretariat. |
| **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.<br>**Seabirds:** Development has not begun.<br>**Marine turtles:** No information received by the Secretariat. |
| **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.<br>**Seabirds:** I.R. Iran determined that seabird interactions are not a problem for their fleet as they consist of gillnet vessels only.<br>**Marine turtles:** No information received by the Secretariat. |
| **Japan** | | 03-Dec-2009 | | 03-Dec-2009 | | | **Sharks:** NPOA–Shark assessment implementation report submitted to COFI in July 2012<br>**Seabirds:** NPOA–Seabird implementation report submitted to COFI in July 2012.<br>**Marine turtles:** No information received by the Secretariat. |
| **Kenya** | | | n.a. | – | | | **Sharks:** Due to paucity of the most basic information on shark stocks in Kenyan waters, it was decided the NPOA-Sharks be developed in the planning year 2014/ 2015. This will enable the country to carry out some baseline surveys on the shark fishery in the 2013/ 2014 planning year.<br>**Seabirds:** Kenya does not have any flagged longline vessels on its registry. There is no evidence of any gear seabird interaction with the current fishing fleet. Kenya does not therefore consider developing NPOA seabirds as necessary for the time being.<br>**Marine turtles:** No information received by the Secretariat. |
| **Korea, Republic of** | | – | | – | | | **Sharks:** Approved on 18/08/2011 and is currently being implemented.<br>**Seabirds:** Early stages of development. Will be finalised Dec 2013. Implementation expected in 2014.<br>**Marine turtles:** All Rep. of Korea vessels fully implement Res 12/04. |
| **Madagascar** | | – | | – | | | **Sharks:** Development has not begun.<br>**Seabirds:** Development has not begun.<br>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.<br>**Marine turtles:** No information received by the Secretariat. |
| **Malaysia** | | 2008 | n.a. | – | | | **Sharks:** A review of the NPOA-Shark (2008) is in the final stages, with stakeholder consultation due to be completed in September 2013. A revised NPOA-Sharks is expected to be published by the end of 2013.<br>**Seabirds:** Malaysia has carried out a review and determined that an NPOA-Seabirds is not necessary as no longline vessels flagged to Malaysia fish south of 20 degrees south.<br>**Marine turtles:** No information received by the Secretariat. |

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| **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 and is expected to be published in Government Gazette in 2014.<br>**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.<br>**Marine turtles:** Longline regulation has provisions to reduce marine turtle bycatch. The regulation urges longline vessels to have dehookers for removal of hook and a line cutter on board, to release the caught marine turtles as prescribed in Resolution 12/04. |
| **Mauritius** | | | | | | | **Sharks:** Mauritius does not issue national or foreign fishing licence to vessels targeting sharks in its Exclusive Economic Zone. However, sharks are usually landed as bycatch. Mauritius will work in consultation with the IOTC Secretariat to prepare a simplified NPOA-sharks for Mauritius.<br>**Seabirds:** Mauritius does not have national vessels operating beyond $25^0$S. However, fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions.<br>**Marine turtles:** Mauritius does not have national boats operating outside its EEZ. Moreover, marine turtles are protected by the national law. Fishing companies have been requested to carry line cutters and de-hookers in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled. |
| **Mozambique** | | – | | – | | | **Sharks**: drafting of new legislation is in progress which is considers the issues of shark conservation in the requirements to consider during the licensing process.<br>**Seabirds**: Mozambique is regularly briefing the Masters of their fishing vessels on the mandatory requirement to report any seabird interaction with longliner fleet. Recently, it was agreed at the national level to introduce in the national legislation all the requirements regarding seabird conservation and management measures in the terms and conditions for licensing.<br>**Marine turtles**: Marine turtle interactions with fisheries in Mozambique have been reported in the Sofala Bank trawlers since the onset of the fishery and there are efforts to update the information on marine turtle interactions with fisheries via specific studies. |
| **Oman, Sultinate of** | | | | | | | **Sharks:** No information received by the Secretariat.<br>**Seabirds:** No information received by the Secretariat.<br>**Marine turtles:** No information received by the Secretariat. |
| **Pakistan** | | | | | | | **Sharks:** No information received by the Secretariat.<br>**Seabirds:** No information received by the Secretariat.<br>**Marine turtles:** No information received by the Secretariat. |

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| **Philippines** | | Sept. 2009 | | – | | | **Sharks:** Under periodic review. Shark catches for 2010 provided to the Secretariat.<br>**Seabirds:** Development has not begun. No seabird interactions recorded.<br>**Marine turtles:** No information received by the Secretariat. |
| **Seychelles, Republic of** | | Apr-2007 | | – | | | **Sharks:** NPOA-sharks to be reviewed in 2014.<br>**Seabirds:** Development has not begun.<br>**Marine turtles:** No information received by the Secretariat. |
| **Sierra Leone** | | | | | | | **Sharks:** No information received by the Secretariat.<br>**Seabirds:** No information received by the Secretariat.<br>**Marine turtles:** No information received by the Secretariat. |
| **Sri Lanka** | | | | | | | **Sharks:** An NPOA-sharks has been finalized and is expected to be implemented in 2014.<br>**Seabirds:** Sri Lanka has determined that seabird interactions are not a problem for their fleets.<br>**Marine turtles:** No information received by the Secretariat. |
| **Sudan** | | | | | | | **Sharks:** No information received by the Secretariat.<br>**Seabirds:** No information received by the Secretariat.<br>**Marine turtles:** No information received by the Secretariat. |
| **Tanzania, United Republic of** | | – | | – | | | **Sharks:** Initial discussions have commenced.<br>**Seabirds:** Initial discussions have commenced.<br>Note: Terms and conditions related to protected sharks and seabirds contained within fishing licenses.<br>**Marine turtles:** No information received by the Secretariat. |
| **Thailand** | | 23-Nov-2005 | | – | | | **Sharks:** Second NPOA-sharks currently being drafted.<br>**Seabirds:** Development has not begun.<br>**Marine turtles:** No information received by the Secretariat. |
| **United Kingdom** | n.a. | – | n.a. | – | | – | British Indian Ocean Territory (Chagos Archipelago) waters are a Marine Protected Area closed to fishing except recreational fishing in the 3nm territorial waters around Diego Garcia. Separate NPOAs have not been developed within this context.<br>**Sharks/Seabirds:** 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.<br>**Marine turtles:** No marine turtles are captured in the recreational fishery. A monitoring programme is taking place to assess the marine turtle population in UK (OT). |
| **Vanuatu** | | | | | | | **Sharks:** No information received by the Secretariat.<br>**Seabirds:** No information received by the Secretariat.<br>**Marine turtles:** No information received by the Secretariat. |
| **Yemen** | | | | | | | **Sharks:** No information received by the Secretariat.<br>**Seabirds:** No information received by the Secretariat.<br>**Marine turtles:** No information received by the Secretariat. |

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| **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.<br>**Seabirds:** The need for a NPOA-seabirds has not yet been assessed.<br>**Marine turtles:** No information received by the Secretariat. |
| **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).<br>**Seabirds:** Published in August 2008 and fully implemented. The NPOA-seabirds has been earmarked for review.<br>**Marine turtles:** No information received by the Secretariat. |

| Colour key | |
|---|---|
| Completed | |
| Drafting being finalised | |
| Drafting commenced | |
| Not begun | |

# APPENDIX VII
## GUIDELINES FOR A REVIEW OF DATA COLLECTION AND PROCESSING SYSTEMS FOR SIZE DATA FROM MAIN LONGLINE FLEETS IN THE INDIAN OCEAN

**Background**

Each year, the IOTC Secretariat prepares input tables for the assessments of IOTC stocks, including catches in number and weight for tropical tunas, albacore and swordfish, by fishery, species, length class, year, quarter and fishing area, as defined by the IOTC working parties. Total numbers of tunas and billfish are derived from the available nominal catch, catch-and-effort and size frequency datasets, as provided by IOTC CPCs[2] or other Parties.

For a number of years the IOTC Scientific Committee has expressed concern about the poor coverage of length frequency samples for some important longline fleets, as the Japanese, Indonesian, and Indian longline fleets; and the difficulty to reconcile the catch-and-effort and size frequency datasets available for the Taiwan,China longline fleet. For the latter, in particular the fact that average weights derived from each dataset for the same area and time-period are highly conflicting, especially during the last decade when sampling coverage increased to values close to total enumeration.

In light of the above and additional information presented at the meeting of the WPTT15 in 2013 (IOTC–2013–WPTT15–41), the WPTT agreed on the need to extend the duration of the WPDCS to address the issues identified, with the participation of the IOTC Secretariat, invited experts, and scientists from Indonesia, Taiwan,China, Japan and other parties having important longline fisheries in the Indian Ocean. In addition, the WPTT agreed on the value to invite other tuna-RFMO Secretariats to attend the next WPDCS meeting, noting that some of the issues identified for longline fisheries may also affect other oceans.

**Proposed work**

1) Review the procedures used by the IOTC Secretariat to prepare input files for the assessments of IOTC species, in particular tropical tunas, albacore, swordfish and marlins.
2) Review the procedures used for the collection and processing of size data from large-scale tuna longline fisheries in the Indian Ocean, over the entire size frequency data series, in particular:
    a) Types of size data collected, data sources, and data validation and processing (e.g. stratification, procedures used to convert sizes into fork length, etc., where required)
    b) Other uses of size frequency data, where applicable (e.g. estimation of catches in weight from numbers recorded in logbooks, or contribution of size data to the estimation of nominal catches for the fishery)
3) Address the concerns raised by the IOTC Working Parties concerning the quality of size data available for longline fleets, in particular:
    a) Likely effects that changes in sampling coverage and contribution of length frequency data from longline fleets have on the assessments of IOTC species, in particular tropical tunas, albacore, swordfish and marlins.
    b) Further explore the reasons behind the sudden changes in the shape of length frequency distributions recorded during some periods for the Taiwan,China longline fleet, in particular the marked decrease in the amount of small fish in the samples recorded for the last decade.
    c) Further explore the reasons for average weights derived from the catch and effort and size frequency datasets to be conflicting over the entire time-series.
4) Where required, identify areas of future work and propose a road-map for these activities to be carried out, for consideration and endorsement by the IOTC Scientific Committee in 2014.

Initially, the WPDCS should report results to the meeting of the WPTT and IOTC Scientific Committee in 2014, in particular:

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[2] IOTC Contracting and Cooperating Non-Contracting Parties

a) Fully document size frequency data collection and processing procedures used by Taiwan,China, Japan and other important longline fisheries over the entire history of the fishery.
b) Where necessary, recommend changes to the data collection and/or processing systems for longline fleets, and propose a roadmap for the implementation of the activities recommended by the institutions concerned.
c) Provide guidance on the best use of the available length frequency data for the assessments of IOTC species, including the type of fisheries to be considered and the procedures that are recommended for the preparation of the different datasets.

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

| Group | Chair/Vice-Chair | Chair | CPC/Affiliation | 1st 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 2015 | 2nd term |
| | Vice-Chair | Mr. Jan Robinson | Seychelles | 17–Dec–11 | End of SC in 2015 | 2nd term |
| WPB | Chair | Mr. Jerome Bourjea | EU,France | 08–Jul–11 | End of WPB in 2015 | 2nd term |
| | Vice-Chair | Mr. Miguel Santos | EU,Portugal | 08–Jul–11 | End of WPB in 2015 | 2nd 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 | 06–Sep–12 | End of WPTmT in 2014 | 1st term |
| WPTT | Chair | Dr. Hilario Murua | EU,Spain | 25–Oct–10 | End of WPTT in 2014 | 2nd term |
| | Vice-Chair | Dr. Shiham Adam | Maldives, Rep. of | 23–Oct–11 | End of WPTT in 2015 | 2nd term |
| WPEB | Chair | Mr Rui Coelho | EU,Portugal | 16–Sept–13 | End of WPEB in 2015 | 1st erm |
| | Vice-Chair | Dr. Evgeny Romanov | EU,France | 27–Oct–11 | End of WPEB in 2015 | 2nd term |
| WPNT | Chair | Dr. Prathibha Rohit | India | 27–Nov–11 | End of WPNT in 2015 | 2nd term |
| | Vice-Chair | Mr. Farhad Kaymaram | I.R. Iran | 27–Nov–11 | End of WPNT in 2015 | 2nd term |
| WPDCS | Chair | Dr. Emmanual Chassot | EU,France | 30–Nov–13 | End of WPDCS in 2015 | 1st term |
| | Vice-Chair | Dr. Pierre Chavance | EU,France | 10–Dec–11 | End of WPDCS in 2013 | 1st term |
| WPM | Chair | Dr. Iago Mosqueira | EU,Spain | 18–Dec–11 | End of WPM in 2013 | 1st term |
| | Vice-Chair | Dr. Toshihide Kitakado | Japan | 18–Dec–11 | End of WPM in 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
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## 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** | | **2013 stock status determination**[2] |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 33,960 t<br>37,082 t | |
| | MSY (80% CI)):<br>$F_{2010}/F_{MSY}$ (80% CI):<br>$SB_{2010}/SB_{MSY}$ (80% CI):<br>$SB_{2010}/SB_{1950}$ (80% CI): | 33,300 t (31,100–35,600 t)<br>1.33 (0.9–1.76)<br>1.05 (0.54–1.56)<br>0.29 (n.a.) | |

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2] Reference year 2010 for most recent stock assessment.

| **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

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.*** No new stock assessment was carried out in 2013. In the 2010 assessment the WPTmT noted that 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). Thus, the 2012 assessment indicated that the stock is **subject to overfishing**, but **not overfished** (Table 1). Fishing mortality needs to be reduced by at least 20% to ensure that spawning biomass is maintained at MSY levels (Table 2). Revisions to the catch history in 2013 indicated that reported landings in 2012 (33,960 t), and those from 2011 (33,605 t) are only slightly above the MSY estimates from the previous assessment.

***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, but appears to have diminished, as longline effort has begun to return to previous levels in 2011. If recent (2008–10) patterns of fishing in the Indian Ocean continue, effort and catch directed at albacore are likley to be maintained and management action would be required. 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 37,802 t over the last five years, 33,960 t in 2012) 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% from the catch level of 2010 (42,915 t) 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 Resolution 13/10 *on interim target and limit reference points and a decision framework,* 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).

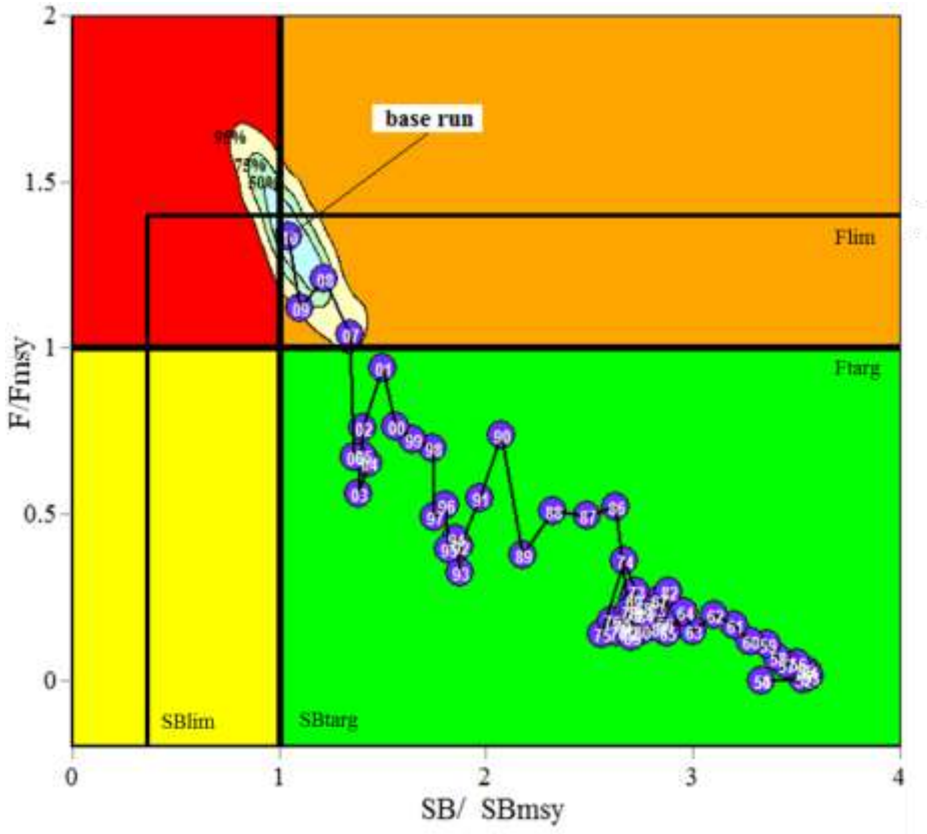


**Fig. 1.** Albacore: ASPM Aggregated Indian Ocean assessment Kobe plot (95% bootstrap confidence surfaces shown around 2010 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2010. Target (Ftarg and SBtarg) and limit (Flim and SBlim) 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 is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 13/09 *on the conservation of albacore caught in the IOTC area of competence*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- 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*

### FISHERIES INDICATORS

#### *Albacore: 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.<br><br>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.<br><br>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<br>**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<br>$W = aL^b$ 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 (86%) (Figs. 2, 3, 4; Table 5), South of 10°S (Table 6), with remaining catches recorded using coastal longlines, handline and trolling (10%), 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 around 21,000 t by 1993 (Figs. 2, 3). However, catches more than doubled over the period from 1993 (20,000 t) to 2001 (46,000 t), the year in which record catches of albacore were recorded. Catches for 2010 were estimated to be around 44,000 t, the second highest catch of albacore ever recorded, while catches in 2011 and 2012 amount to around 34,000 t (Table 5).

The majority of the catches of albacore in recent years have come from vessels from Indonesia and Taiwan,China, although the catches of albacore reported for longline and other fisheries in Indonesia have increased considerably in recent years, to around 12,000 t per year (average 2010–12; Fig. 3), which represents approximately 33% of the total catches of albacore in the Indian Ocean.

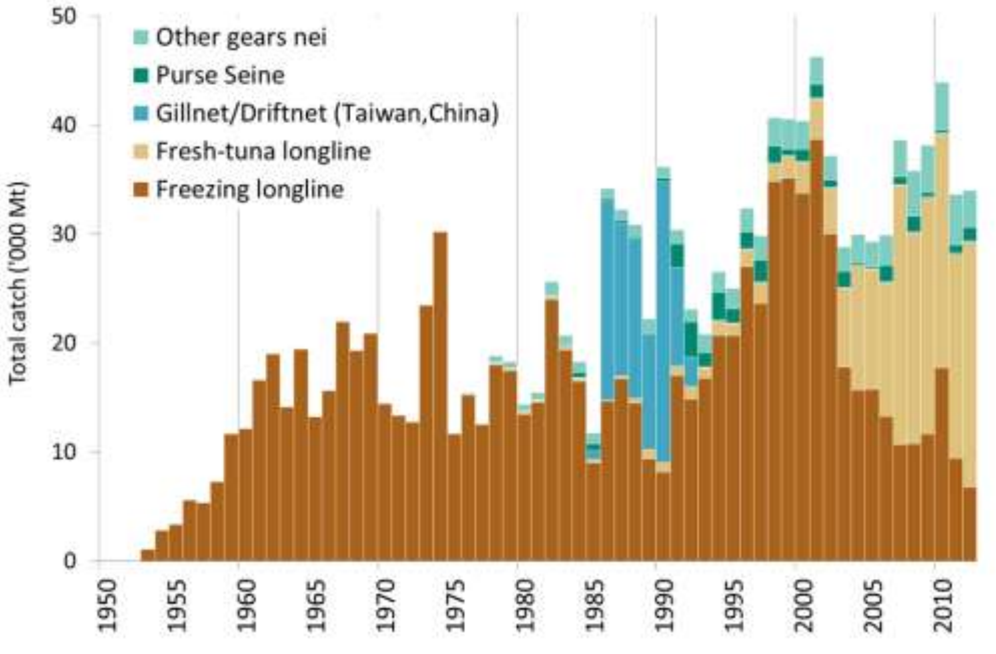


**Fig. 2.** Albacore: Annual catches of albacore by gear recorded in the IOTC Database (1950–2012) (Data as of October 2013).

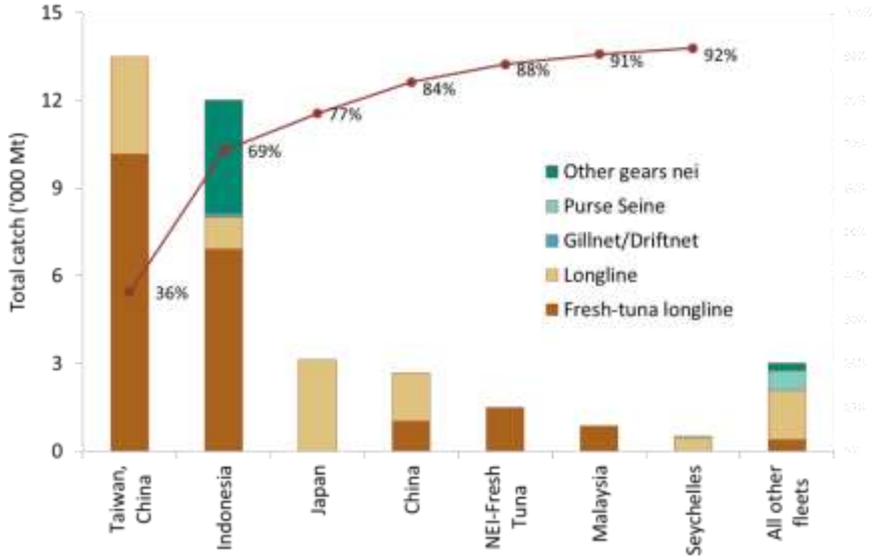


**Fig. 3.** Albacore**:** Average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of albacore reported. The red line indicates the (cumulative) proportion of catches of albacore for the countries concerned, over the total combined catches of albacore reported from all countries and fisheries. (Data as of October 2013)

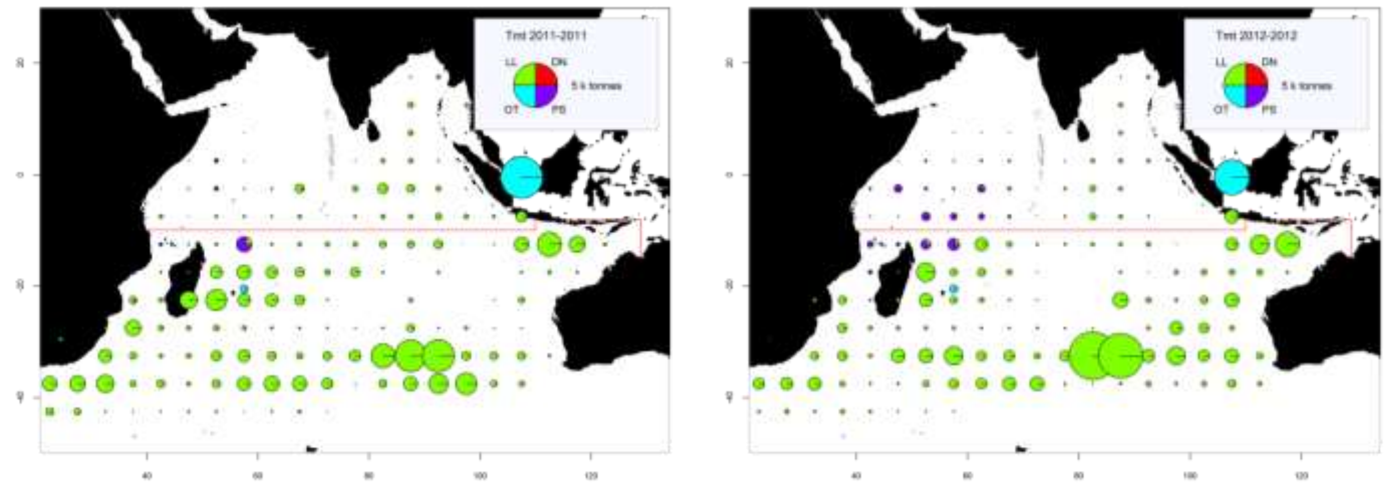

**Fig. 4a–b.** Albacore: Time-area catches (total combined in tonnes) of albacore estimated for 2011 (left) and 2012 (right) by type of gear: Longline (LL, green), Driftnet (DFRT, red), Purse seine (PS, purple), Other fleets (OT, blue). The catches of fleets for which the flag countries do not report 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 2013).

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 8,500 t to 18,000 t in the period 1959 to 1969, in 1972 catches rapidly decreased to around 1,500 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 and catches remained at values between 400 t and 2,500 t for 1972–96. Catches of albacore between 1997 and 2012 were around 2,500 to 6,000 t (Fig. 3), with the highest catches recorded between 2006 and 2008.

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 22,000 t to 27,000 t, equating to over 70% of the total Indian Ocean albacore longline catch. Between 2003 and 2010 the albacore catches by Taiwan,China longliners have been between 9,500 and 16,000 t, with catches in recent years dropping to values at around 12,000 t (2011–12). 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 (75% of the total longline catches for 2008–12) 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.

In recent years (2008–12) the fisheries of Indonesia have reported increasing catches of albacore, especially by fleets of fresh-tuna longliners operating in coastal waters or on the high seas, and vessels using trolling or hand lines in coastal waters off southern Indonesia. Catches for 2008–12 ranged between 9,000 and 15,000 t.

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 (2003–2012) in tonnes. Data as of October 2013. 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 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| DN | 0 | 0 | 0 | 5,823 | 3,735 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LL | 3,715 | 17,230 | 16,895 | 15,210 | 21,875 | 19,802 | 17,807 | 15,695 | 15,773 | 13,261 | 10,712 | 10,739 | 11,635 | 17,751 | 9,422 | 6,782 |
| FLL | 0 | 0 | 80 | 314 | 1,325 | 11,718 | 7,195 | 11,299 | 10,971 | 12,250 | 23,736 | 19,332 | 21,662 | 21,399 | 18,696 | 22,451 |
| PS | 0 | 0 | 0 | 194 | 1,683 | 912 | 1,496 | 232 | 164 | 1,548 | 725 | 1,424 | 392 | 207 | 725 | 1,297 |
| OT | 20 | 33 | 165 | 987 | 1,915 | 2,992 | 2,310 | 2,708 | 2,391 | 2,810 | 3,422 | 4,301 | 4,446 | 4,556 | 4,762 | 3,431 |
| **Total** | **3,736** | **17,264** | **17,140** | **22,527** | **30,533** | **35,424** | **28,808** | **29,934** | **29,300** | **29,870** | **38,596** | **35,797** | **38,134** | **43,914** | **33,605** | **33,960** |

**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 1950–2013 (in metric tons). Data as of October 2013.

| Area | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| N | 769 | 1,223 | 1,292 | 1,486 | 3,713 | 6,040 | 4,662 | 4,610 | 4,808 | 5,860 | 13,929 | 9,262 | 5,379 | 5,723 | 5,632 | 4,519 |
| S | 2,967 | 16,041 | 15,848 | 21,041 | 26,820 | 29,383 | 24,146 | 25,324 | 24,492 | 24,010 | 24,667 | 26,535 | 32,755 | 38,190 | 27,973 | 29,441 |
| **Total** | **3,736** | **17,264** | **17,140** | **22,527** | **30,533** | **35,424** | **28,808** | **29,934** | **29,300** | **29,870** | **38,596** | **35,797** | **38,134** | **43,914** | **33,605** | **33,960** |

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

***Albacore – Uncertainty of catches***

While retained catches were fairly well known until the early-1990s (Fig. 5), the quality of catch and effort 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). The IOTC Secretariat estimated these catches using alternative data, mainly vessel activity and landing data reported by third parties.
- 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.

- 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 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, and Malaysia;
    - no data for fresh-tuna longliners flagged in Taiwan,China during 1990–2006;
    - non-reporting by industrial purse seiners and longliners (NEI), especially during the 1990s.
- The catch series for albacore has changed since the WPTmT in 2012, following a review of the catch series of albacore for Indonesia. The major changes include revisions to the catch series for 2007 and 2008, with revised catches of between 30%-50% lower than those previously recorded by Indonesia (equivalent to a decrease in catch of ≈ 4,500 in 2007 and 7,500 in 2008).

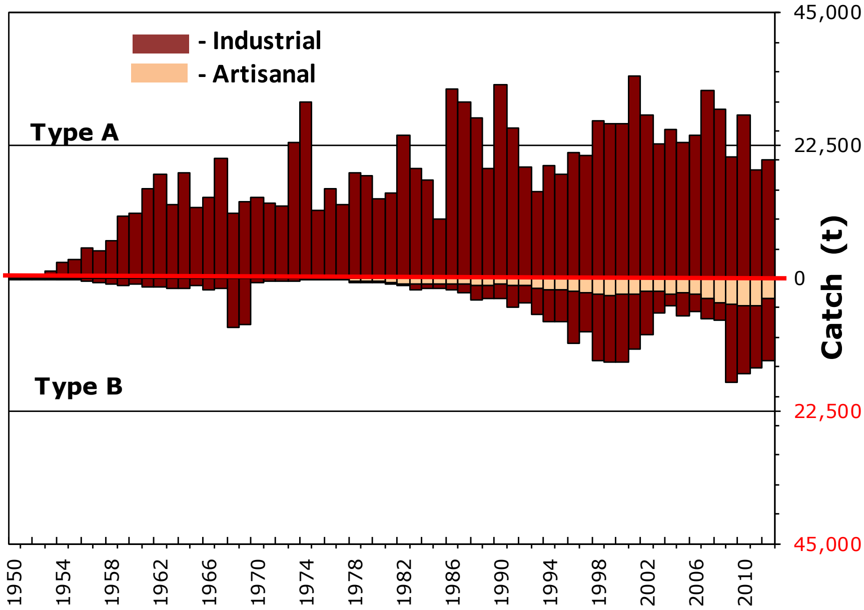


**Fig. 5**. Albacore: Uncertainty of annual catch estimates for albacore (1950–2012) (Data as of October 2013). Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken 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.

***Albacore – Effort trends***

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2011 and 2012 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 2011 and 2012 are provided in Fig. 7.

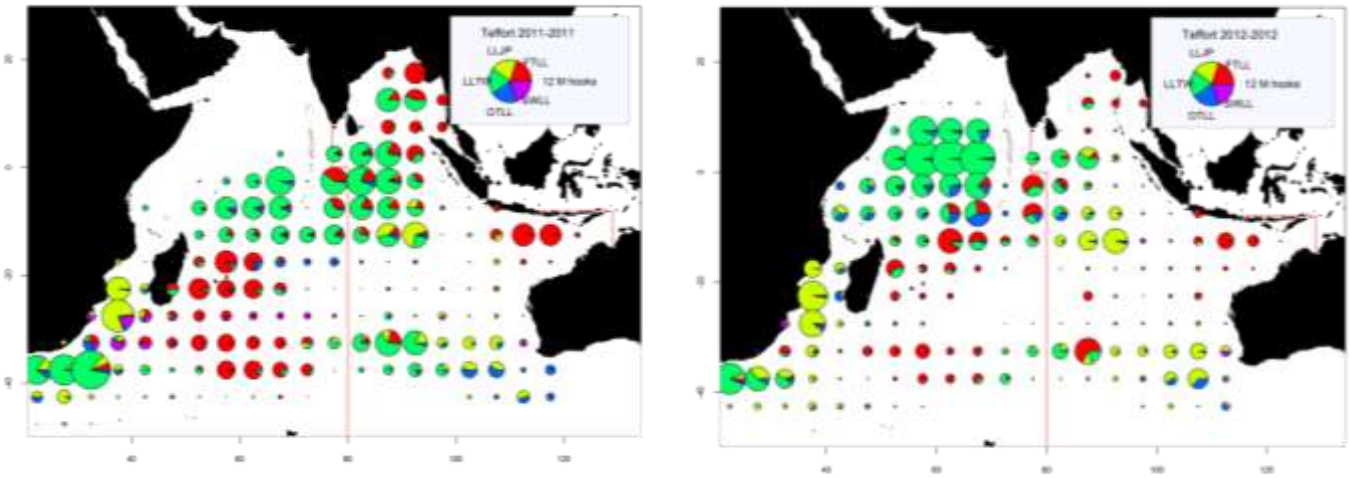

**Fig. 6.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (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)

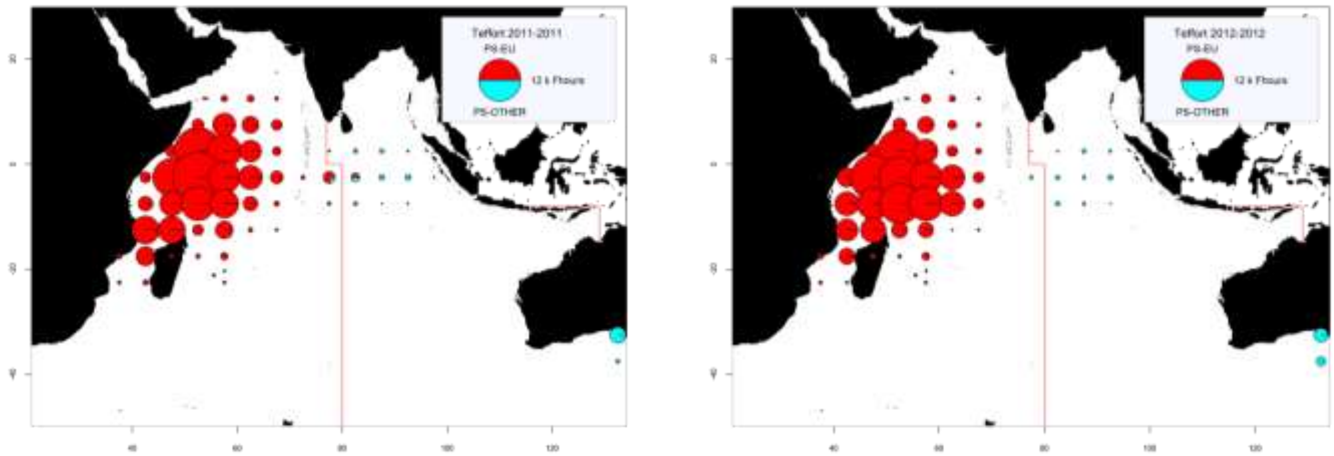

**Fig. 7.** Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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 1980–2012 is available. In general, the amount of catch for which size data for the species are available before 1980, across all fleets, 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) and the small-scale fisheries of Indonesia (1950-2012).
- the paucity of catch by area data available for some industrial fleets (Taiwan,China, NEI, India and Indonesia)

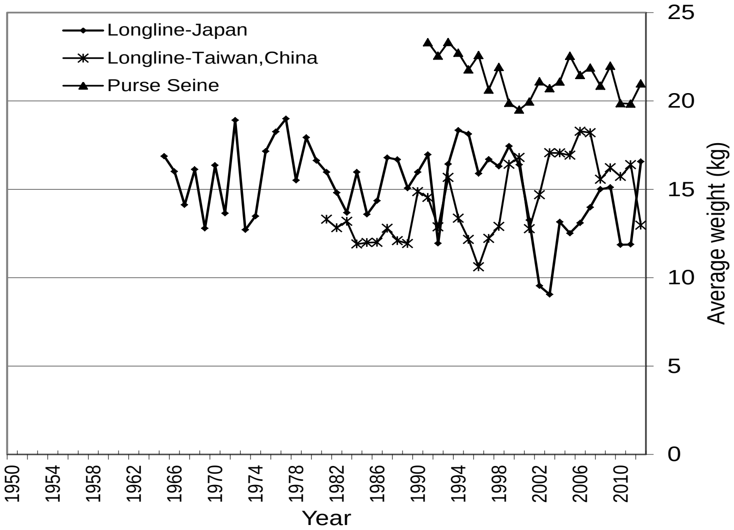


**Fig. 8.** Albacore: Average weight in kg of the catches of gillnet, longline–JPN, longline–TWN,CHN, purse seine and other gears from 1950 to 2012.

***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.

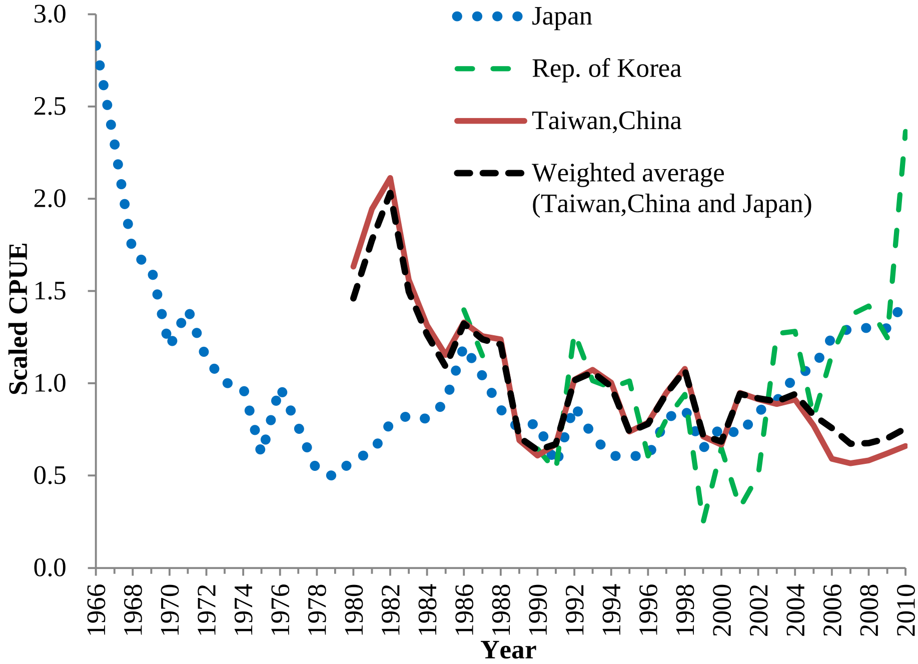


**Fig. 9.** Albacore: Comparison of the three CPUE series for longline fleets fishing for albacore in the IOTC area of competence, as well as the weight average of the Taiwan,China and Japan series. Series have been rescaled relative to their respective means from 1966–2010.

## 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)** |
|---|---|
| 2012 catch estimate | 33,960 t |
| Mean catch from 2008–2012 | 37,082 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

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

# 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 | | 2013 stock status[2] determination |
|---|---|---|---|
| Indian Ocean | Catch in 2012:<br>Average catch 2008–2012: | 115,793 t<br>107,603 t | |
| | MSY (1000 t):<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$ :<br>$SB_{2012}/SB_0$: | 132 t (98.5–207 t)[3]<br>0.42 (0.21–0.80)[3]<br>1.44 (0.87–2.22)[3]<br>0.40 (0.27–0.54)[3] | |

[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]The point estimate is the median of the plausible models investigated in the 2013 SS3 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.*** A new stock assessment was carried out in 2013. The 2013 stock assessment model results did not differ substantively from the previous (2010 and 2011) assessments; however, the final overall estimates of stock status differ somewhat due to the revision of the catch history and updated standardised CPUE indices. All the runs (except 2 extremes) carried out in 2013 indicate the stock is above a biomass level that would produce MSY in the long term (i.e. $SB_{2012}/SB_{MSY}$ > 1) and in all runs that current fishing mortality is below the MSY-based reference level (i.e. $F_{2012}/F_{MSY}$ < 1) (Table 1 and Fig. 1). The median value of MSY from the model runs investigated was 132,000 t with a range between 98,000 and 207,000 t. Current spawning stock biomass was estimated to be 40% (Table 1) of the unfished levels. Catches in 2012 (≈115,800 t) remain lower than the estimated MSY values from the 2013 stock assessments (Table 1). The average catch over the previous five years (2008–12; ≈107,600 t) also remains below the estimated MSY. In 2012 catch levels of bigeye tuna increased markedly (~24% over values in 2011), especially longline catches. On the weight of stock status evidence available, the bigeye tuna stock is therefore **not overfished**, and is **not subject to overfishing**.

***Outlook.*** Declines in longline effort since 2007, 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 based on all plausible model runs from SS3 in 2013 illustrates the levels of risk associated with varying catch levels over time and could be used to inform future management actions (Table 2).

The SS3 projections from the 2013 assessment show that there is a low risk of exceeding MSY-based reference points by 2015 and 2022 if catches are maintained at the current levels of 115,800 t (0% risk that $B_{2022}<B_{MSY}$ and 0% risk that $F_{2022}>F_{MSY}$) (Table 2). The following key points should be noted:

- The median value of Maximum Sustainable Yield (MSY) from the model runs investigated was 132,000 t with a range between 98,000 and 207,000 t (range expressed as the different runs of SS3 done in 2013 using steepness values of 0.7, 0.8 and 0.9; different natural mortality values; and catchability increase for longline CPUE) (see Table 1 for further description)). Current stock size is above $SB_{MSY}$ and predicted to increase on the short term. Catches at the level of 132,000 t have a low probability of reducing the stock below $SB_{MSY}$ in the short term (3–5 years) and medium term (10 years). Therefore, the annual catches of bigeye tuna should not exceed the median value of MSY. However, for lower productivity model options, catches at the median MSY level will reduce stock biomass over the long-term (10–15 years).

- If catch remains below the estimated MSY levels, 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 Resolution 13/104 *on interim target and limit reference points and a decision framework*, 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).

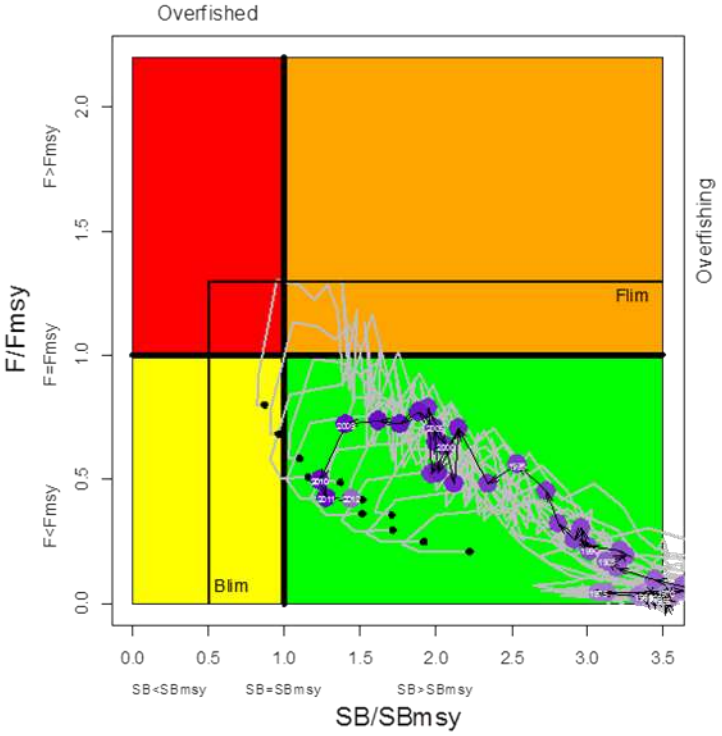



**Fig. 1. Bigeye tuna:** SS3 Aggregated Indian Ocean assessment Kobe plot. The Kobe plot presents the trajectories for the range of 12 plausible model options included in the formulation of the final management advice (grey lines with the black point representing the terminal year of 2012). The trajectory of the median of the 12 plausible model options (purple points) is also presented. The biomass ($B_{lim}$) and fishing mortality limit ($F_{lim}$) reference points are also presented.

**Table 2. Bigeye tuna:** 2013 SS3 Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of weighted distribution of models violating the MSY-based reference points for five constant catch projections (2012 catch level, ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years. Note: from the 2013 stock assessment using catch estimates at that time.

| **Reference point and projection timeframe** | **Alternative catch projections (relative to 2012) and weighted probability (%) scenarios that violate reference point** | | | | |
|---|---|---|---|---|---|
| | **100%** (115,800 t) | **110%** (127,400 t) | **120%** (139,000 t) | **130%** (150,500 t) | **140%** (162,100 t) |
| $SB_{2015} < SB_{MSY}$ | 0 | 0 | 0 | 0 | 0 |
| $F_{2015} > MSY$ | 0 | 0 | 0 | 8 | 17 |
| $SB_{2022} < SB_{MSY}$ | 0 | 0 | 8 | 17 | 25 |
| $F_{2022} > MSY$ | 0 | 0 | 8 | 17 | 25 |

**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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 13/10 *On interim target and limit reference points and a decision framework*
- Resolution 13/11 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.
- 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*

### 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.<br>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 and weight) | Maximum length: 200 cm FL; Maximum weight: 210 kg.<br>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 (70% in 2012) and purse seine (19% in 2012) fisheries, with the remaining 11% of the catch taken by other fisheries (Table 4). 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 by other fisheries are important.

Total annual catches have increased steadily since the start of the fishery, reaching the 100,000 t level in 1993 and peaking at over 160,000 t in 1999 (Fig. 2). Catches dropped since then to values between 130,000–150,000 t (2000–07), further dropping in recent years, to values under 90,000 t in recent years (2010–11), and increasing in 2012 to over 115,000 t. The Scientific Committee believes that the recent drop in catches could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean (Area A1, Table 5), which led to a marked drop in the levels of longline effort in the core fishing area of these species in 2010–11 (Table 5).

**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 (2003–2012), in tonnes (Data as of September 2013). Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery (refer to Fig. 2).

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| BB | 21 | 50 | 266 | 1,536 | 2,968 | 4,864 | 4,103 | 4,519 | 4,119 | 4,822 | 5,274 | 6,731 | 6,770 | 6,782 | 6,963 | 5,217 |
| FS | 0 | 0 | 0 | 2,341 | 4,823 | 6,216 | 7,915 | 4,097 | 8,484 | 6,406 | 5,672 | 9,646 | 5,301 | 3,792 | 6,222 | 7,180 |
| LS | 0 | 0 | 0 | 4,855 | 18,317 | 20,253 | 15,918 | 19,295 | 17,557 | 18,521 | 18,104 | 19,876 | 24,708 | 18,486 | 16,386 | 10,434 |
| LL | 6,488 | 21,979 | 30,270 | 42,887 | 62,311 | 71,273 | 85,203 | 90,621 | 75,863 | 72,932 | 74,170 | 51,591 | 51,553 | 32,252 | 35,794 | 65,655 |
| FL | 0 | 0 | 218 | 3,066 | 26,307 | 23,471 | 19,431 | 22,366 | 19,637 | 18,788 | 22,451 | 23,323 | 15,810 | 12,759 | 14,667 | 15,774 |
| LI | 43 | 294 | 658 | 2,384 | 4,278 | 5,560 | 5,037 | 5,595 | 4,735 | 5,372 | 5,898 | 7,323 | 7,231 | 7,796 | 7,692 | 5,583 |
| OT | 38 | 63 | 164 | 859 | 1,407 | 3,725 | 2,768 | 3,136 | 3,098 | 4,581 | 4,203 | 5,121 | 6,294 | 5,368 | 5,985 | 5,950 |
| **Total** | **6,589** | **22,387** | **31,577** | **57,930** | **120,411** | **135,362** | **140,377** | **149,629** | **133,493** | **131,422** | **135,772** | **123,611** | **117,667** | **87,235** | **93,709** | **115,793** |

**Gears:** Pole-and-Line (**BB**); Purse seine free-school (**FS**); Purse seine associated school (**LS**); Deep-freezing longline (**LL**); Fresh-tuna longline (**FL**); Line (handline, small longlines, gillnet & longline combine) (**LI**); Other gears nei (gillnet, trolling & other minor artisanal gears)(**OT**).

**TABLE 5. Bigeye tuna:** Best scientific estimates of the catches of bigeye tuna (*Thunnus obesus*) by area [as used for stock assessment in 2013] by decade (1950–2009) and year (2003–2012), in tonnes (Data as of September 2013). Catches by decade represent the average annual catch. The areas are presented in Fig. 4a.

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| A1 | 2,436 | 11,824 | 17,359 | 34,731 | 57,127 | 76,920 | 88,763 | 91,531 | 85,659 | 80,428 | 79,588 | 65,565 | 56,210 | 38,626 | 39,411 | 68,721 |
| A2 | 3,586 | 6,872 | 9,844 | 18,071 | 43,292 | 42,178 | 31,162 | 40,377 | 33,543 | 40,150 | 48,055 | 48,918 | 53,948 | 41,316 | 47,113 | 38,540 |
| A3 | 199 | 2,614 | 2,876 | 2,679 | 15,033 | 12,040 | 16,318 | 13,298 | 10,100 | 5,533 | 4,007 | 4,570 | 3,716 | 4,447 | 4,711 | 4,967 |
| A0 | 368 | 1,077 | 1,499 | 2,448 | 4,960 | 4,224 | 4,134 | 4,423 | 4,189 | 5,311 | 4,121 | 4,559 | 3,794 | 2,846 | 2,473 | 3,565 |
| **Total** | **2,436** | **11,824** | **17,359** | **34,731** | **57,127** | **76,920** | **140,377** | **149,629** | **133,493** | **131,422** | **135,772** | **123,611** | **117,667** | **87,235** | **93,709** | **115,793** |

**Areas**: West Indian Ocean (**A1**); East Indian Ocean (**A2**); Southwest and Southeast Indian Ocean(**A3**); Other Areas(A0)

Bigeye tuna have been caught by industrial longline fleets since the early 1950's, but before 1970 they only represented an incidental catch. 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 becoming 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). With the exception of 2012, 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 between 2007 and 2011 decreased markedly (≈20,000 t), to values three times lower than those in 2003. Catches in 2012 are higher though still far from those in 2003. Large bigeye tuna (averaging just above 40 kg) are primarily caught by longlines, in particular deep longline vessels.

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 skipjack tuna and yellowfin 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 flagged to EU countries and the Seychelles take the majority of purse seine caught bigeye tuna in the Indian Ocean (Fig. 3). Purse seine vessels mainly take small juvenile bigeye tuna (averaging around 5 kg) whereas longliner vessels catch much larger and heavier fish; and while purse seiner vessels take lower tonnages of bigeye tuna compared to longline vessels, they take larger numbers of individual fish.

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 (A2 in Fig. 4 and Table 5). 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 as fresh product. This fleet started its operation in the mid 1970's. 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 (Figs. 3, 5).

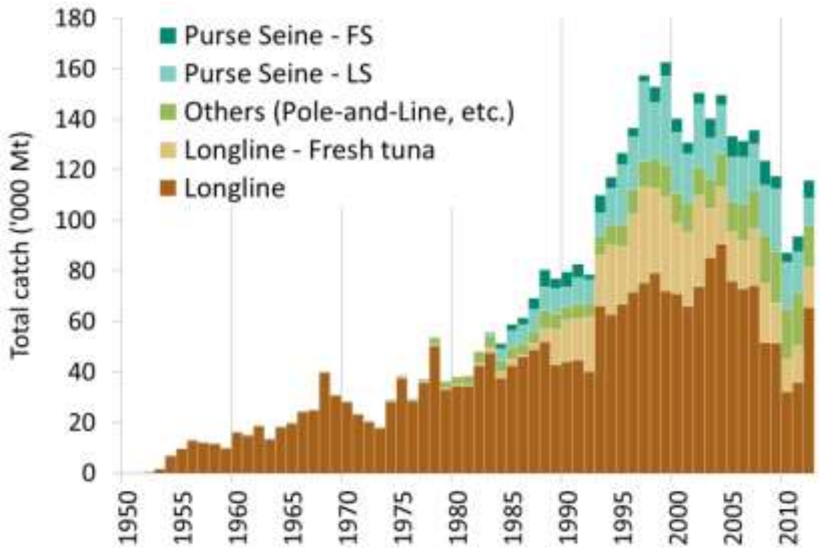



**Fig. 2. Bigeye tuna:** Annual catches of bigeye tuna by gear (1950–2012) (Data as of September 2013). Gears: Purse seine free-school (FS); Purse seine associated school (LS); Deep-freezing longline (LL); Fresh-tuna longline (FL); Other gears nei (Pole-and-Line, handline, small longlines, gillnet, trolling & other minor artisanal gears) (OT).

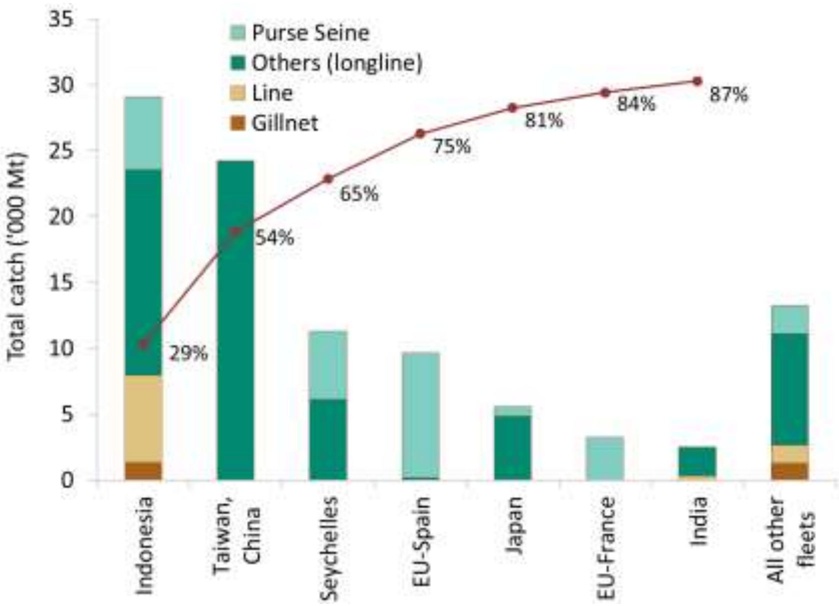



**Fig. 3. Bigeye tuna:** average catches in the Indian Ocean over the period 2009–12, by country (Data as of September 2013). Countries are ordered from left to right, according to the magnitude of catches of bigeye tuna reported. The red line indicates the (cumulative) proportion of catches of bigeye tuna for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

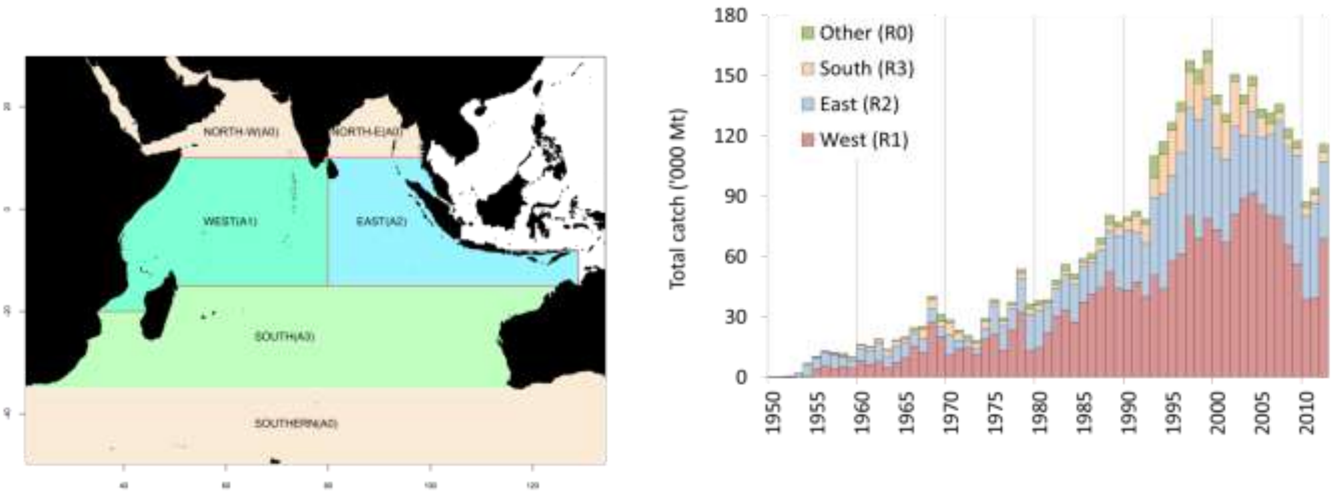



**Fig. 4a–b. Bigeye tuna:** Catches of bigeye tuna by area by year estimated for the WPTT (1950–2012) (Data as of September 2013). Catches outside the areas presented in the Map were assigned to the closest neighbouring area for the assessment. Areas: West Indian Ocean (A1); East Indian Ocean (A2); Southwest and Southeast Indian Ocean (A3); Other Areas (A0).

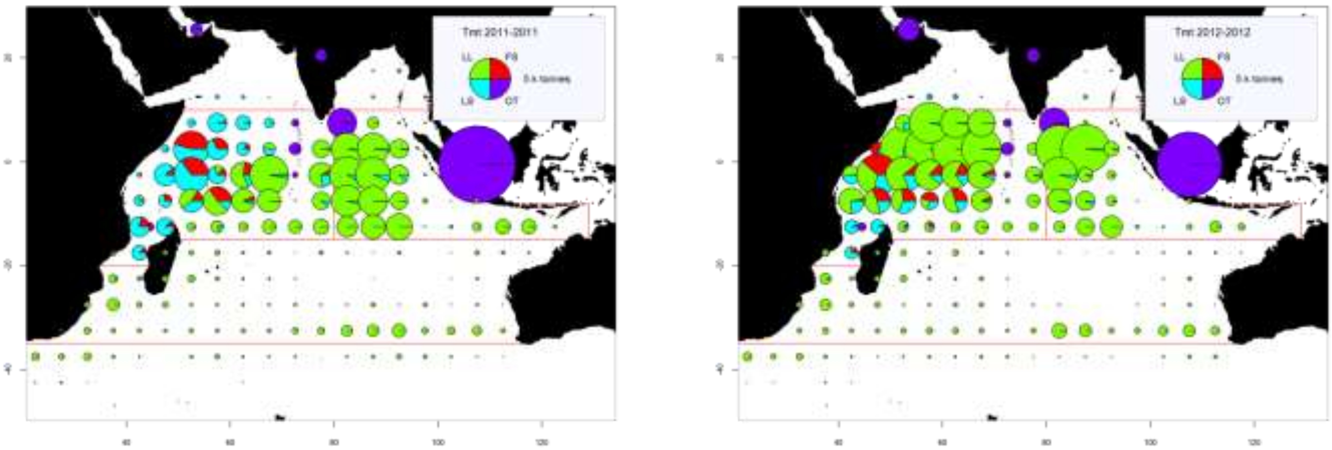


**Fig. 5. Bigeye tuna:** Time-area catches (total combined in tonnes) of bigeye tuna estimated for 2011 (left) and 2012 (right) by gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), and other fleets (**OT**), including pole-and-line, drifting gillnets, and various coastal fisheries. Data as of September 2013. 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. 6); but are less certain for non-reporting industrial purse seiners and longliners (NEI) and for other industrial fisheries (e.g. longliners of India). Catches are also uncertain for some artisanal fisheries including the pole-and-line fishery in the Maldives, the gillnet fisheries of Iran (before 2012) and Pakistan, the gillnet and longline combination fishery in Sri Lanka and the artisanal fisheries in Indonesia, Comoros (before 2011) and Madagascar.

**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:** The catch history for bigeye tuna changed following reviews of the catches of Indonesia, Sri Lanka, and, to a lesser extent, other fisheries (EU,France, India, Pakistan). Overall, the best estimates of catch for the bigeye tuna are higher in 2013 than those used for the WPTT in 2012, with marked increases to the catches since the early 1990s. More details about the reviews are provided in paper IOTC–2013–WPTT15–07 Rev_1.

**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 (Fig. 6), 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.
- incomplete data for the driftnet fisheries of Iran and Pakistan and the gillnet/longline fishery of Sri Lanka, especially in recent years.

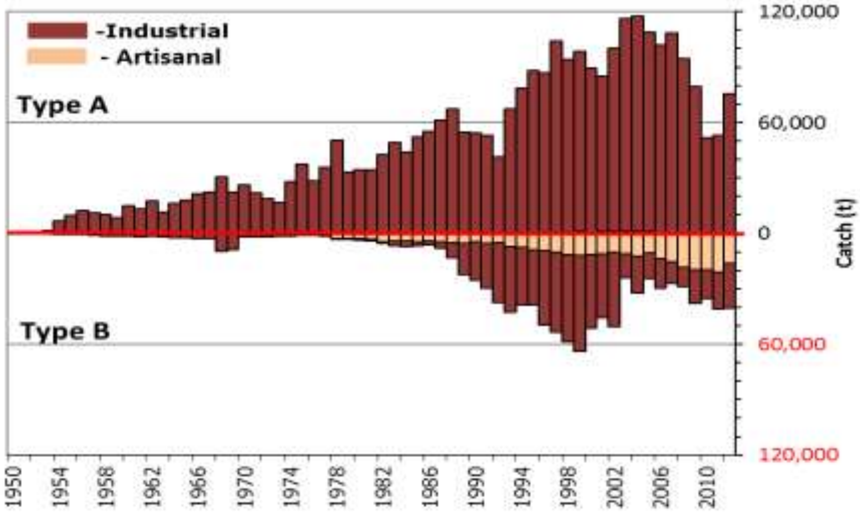



**Fig. 6. Bigeye tuna:** Uncertainty of annual catch estimates for bigeye tuna (Data as of September 2013). Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat). 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.

***Bigeye tuna – Effort trends***

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2011 and 2012 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 2011 and 2012 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 2011 and 2012 are provided in Fig. 9.

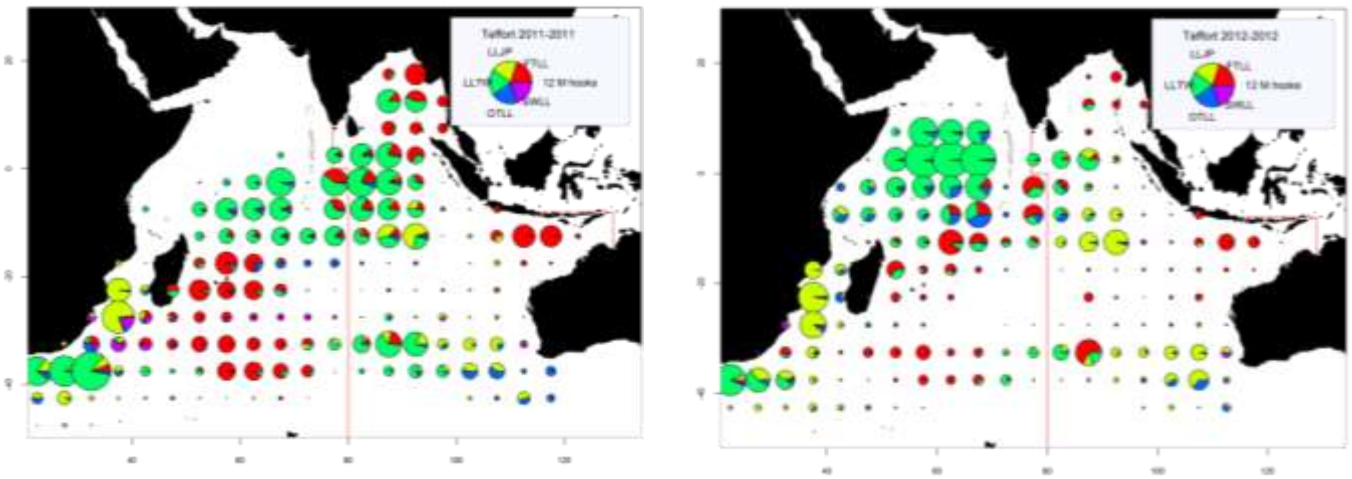


**Fig. 7.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (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)

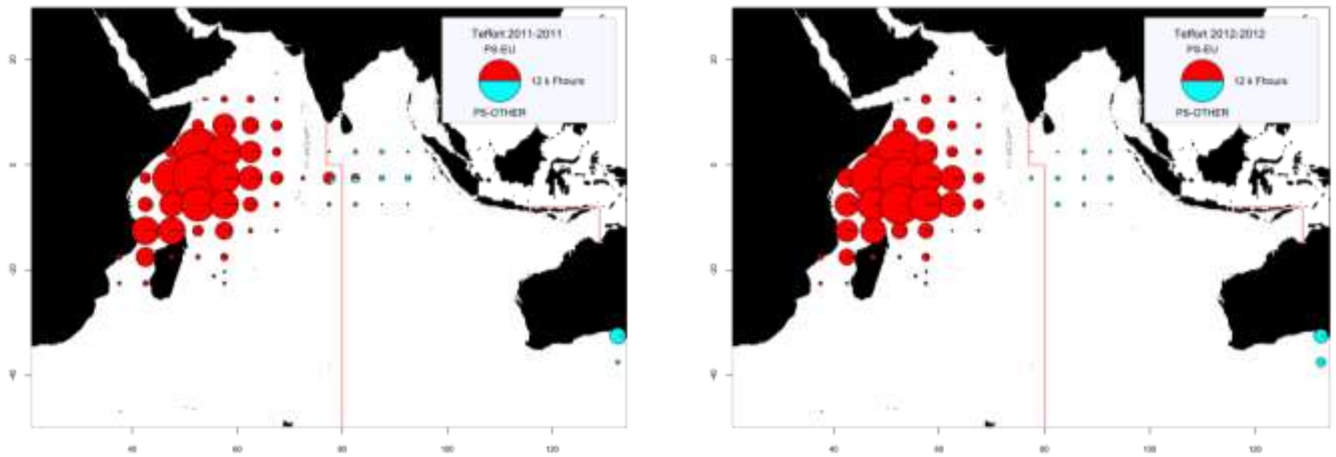


**Fig. 8.** Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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)

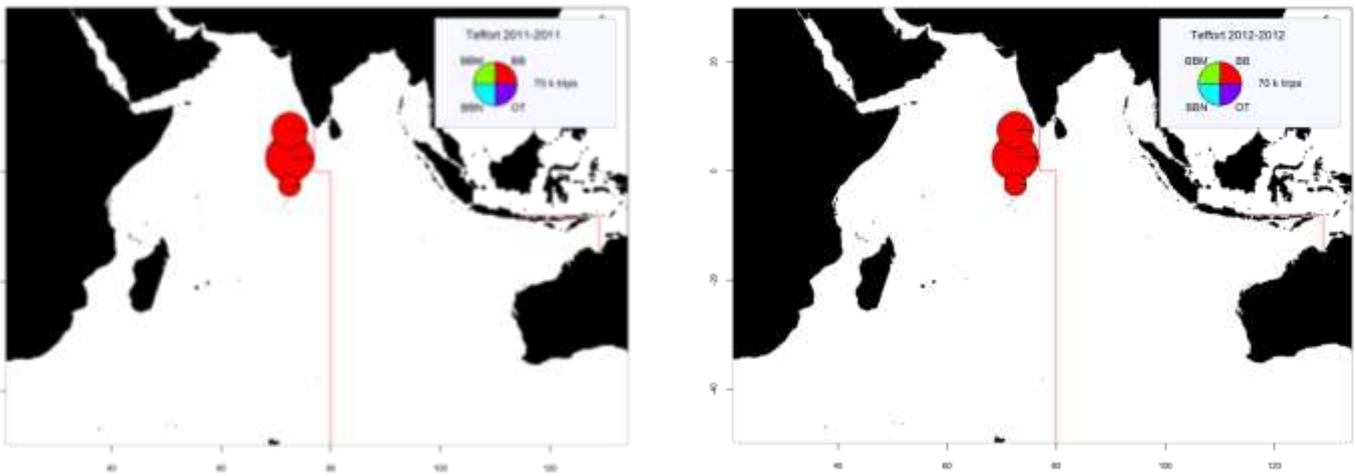


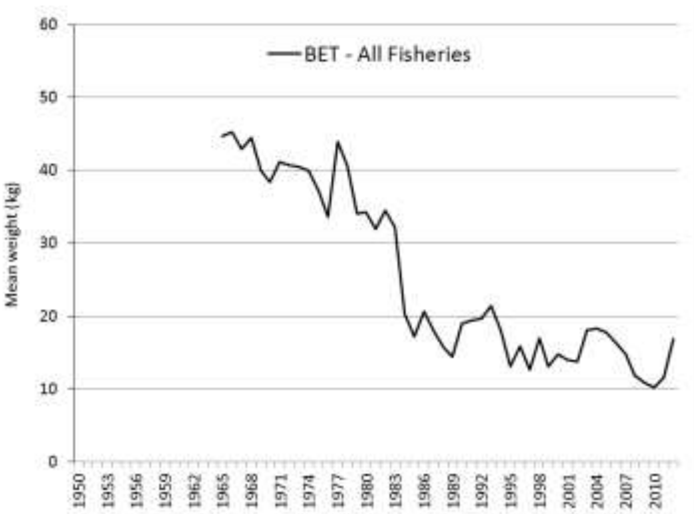
**Fig. 9.** Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): 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 and Taiwan,China longline) (Fig. 10).

**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)



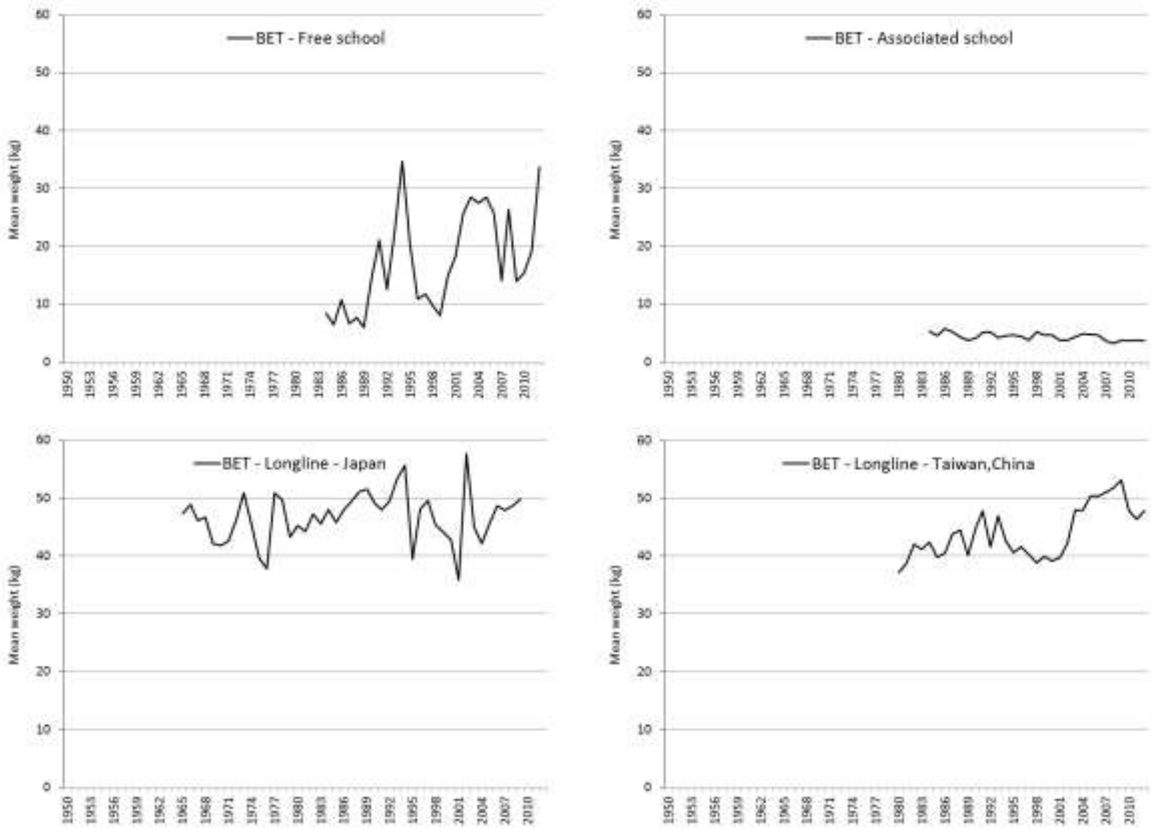



**Fig. 10. Bigeye tuna:** Changes in average weight (kg) of bigeye tuna from 1950 to 2012 – all fisheries combined (top) and by main fleet (Data as of September 2013).

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

The CPUE series presented at the WPTT15 meeting in 2013 are listed below. However, only the Japanese longline CPUE index (quarterly) for the whole Indian Ocean (1960–2012) (Fig. 11) was utilised for the final stock assessment model runs and in the development of management advice, noting that the Japanese series from the tropical areas and the Indian Ocean as a whole, showed very similar trends.

- Rep. of Korea data (1977–2012): Series (core area and whole Indian Ocean) from document IOTC–2013–WPTT15–24.
- Japan data (1960–2012): Series (whole Indian Ocean, tropical area, temperate area) from document IOTC–2013–WPTT15–25.
- Taiwan,China data (1980–2012): Series (whole Indian Ocean, tropical area, temperate area) from document IOTC–2013–WPTT15–26.

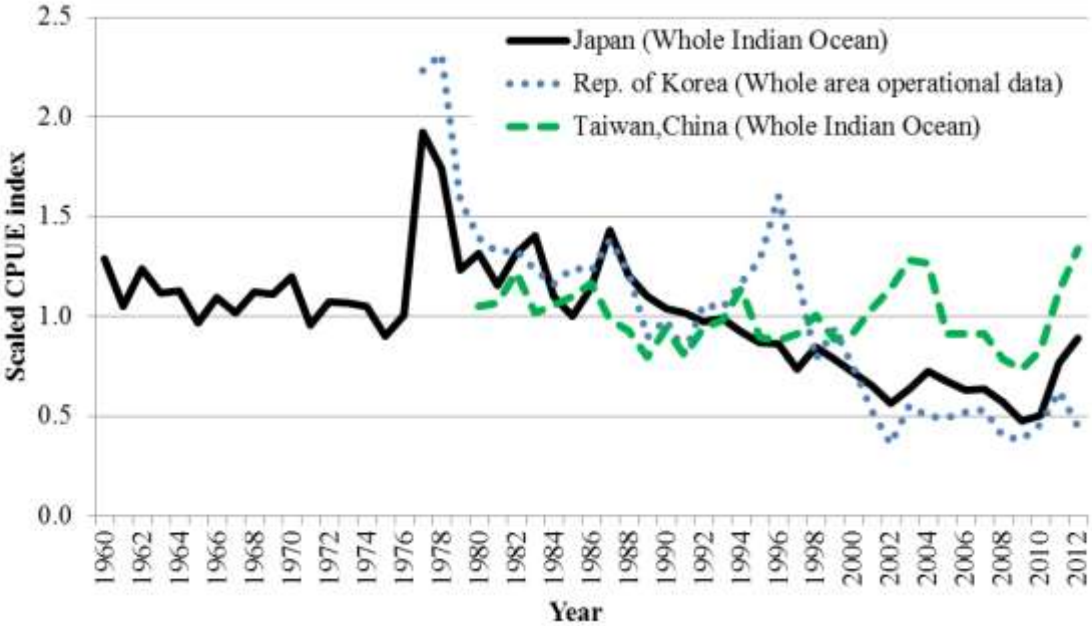



**Fig. 11. Bigeye tuna:** Standardised CPUE series for the longline fleets of Japan, Rep. of Korea and Taiwan,China for the whole Indian Ocean (1960–2012). The quarterly series for the Japanese longline fleet was used in the final 2013 stock assessment runs used for management advice.

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. 12). The remaining were tagged during small-scale projects, and by other institutions with the support of the IOTC Secretariat, in the Maldives, India, and in the south west and the eastern Indian Ocean. To date, 5,789 specimens (16.1%) have been recovered and reported to the IOTC Secretariat. These tags were mainly reported from the purse seine fleets operating in the Indian Ocean (90.9%), while 5.2% were recovered from longline vessels.

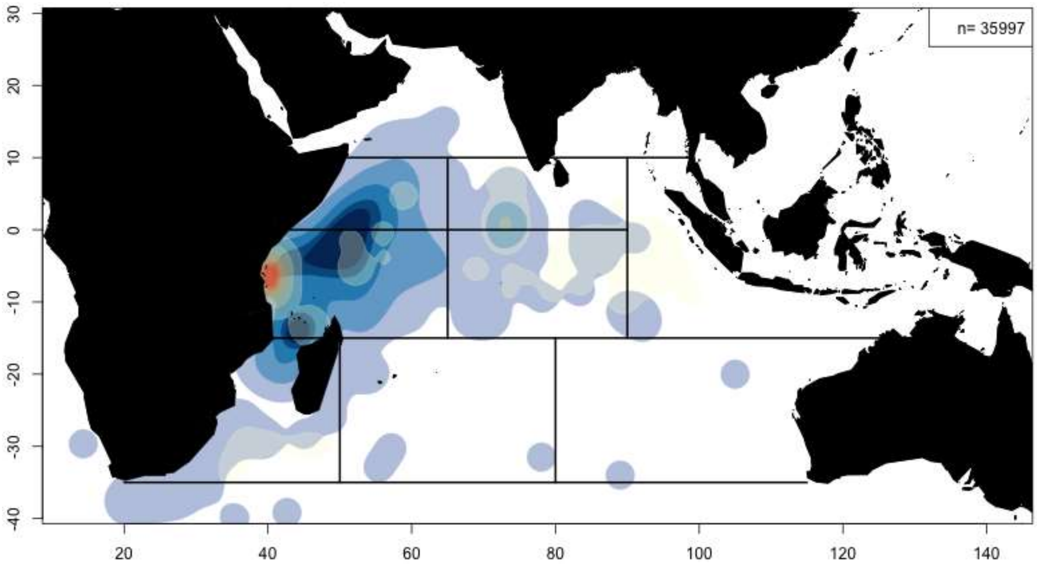
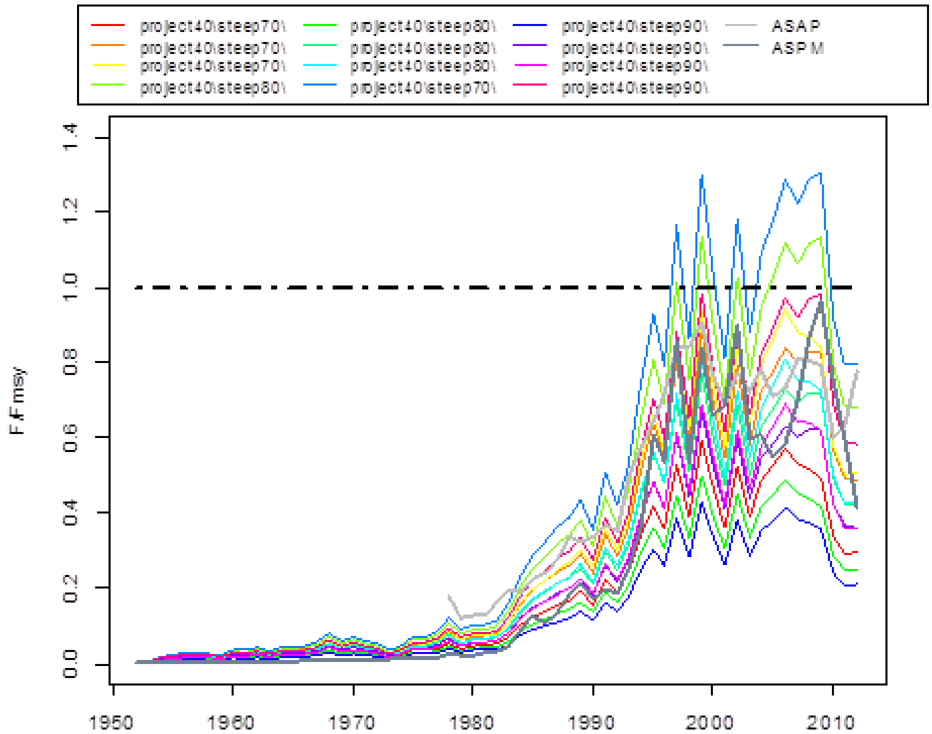



**Fig. 12.** Bigeye tuna: Densities of releases (in red) and recoveries (in blue) (Data as of September 2012).

**STOCK ASSESSMENT**

A range of quantitative modelling methods (ASAP, ASPM and SS3) were applied to bigeye tuna in 2013. Management advice for bigeye tuna is based on the range of results from the SS3 models. The SS3 results were preferred to the other assessment platforms (ASPM and ASAP) because a more comprehensive range of model options were investigated and a range of diagnostics indicated that the models represented a reasonable fit to the main datasets. The range of plausible SS3 model options was considered to adequately represent the range of uncertainty in the assessment. Integrating across all outcomes, the 2013 stock assessment model results did not differ substantively from the previous (2010 and 2011) assessments or amongst the models applied, although, the final overall estimates of stock status differ somewhat due to the revision of the catch history, new information, and updated standardised CPUE indices.

All the runs (except 2 extremes) carried out in 2013 indicate that the stock is above a biomass level that would produce MSY in the long term (i.e. $SB_{2012}/SB_{MSY} > 1$) and in all runs that current fishing mortality is below the MSY-based reference level (i.e. $F_{2012}/F_{MSY} < 1$). This is illustrated in Fig. 13, which shows the time trajectories in $F/F_{MSY}$ and $B/B_{MSY}$ across the range of model results applied to characterise uncertainty in stock status.



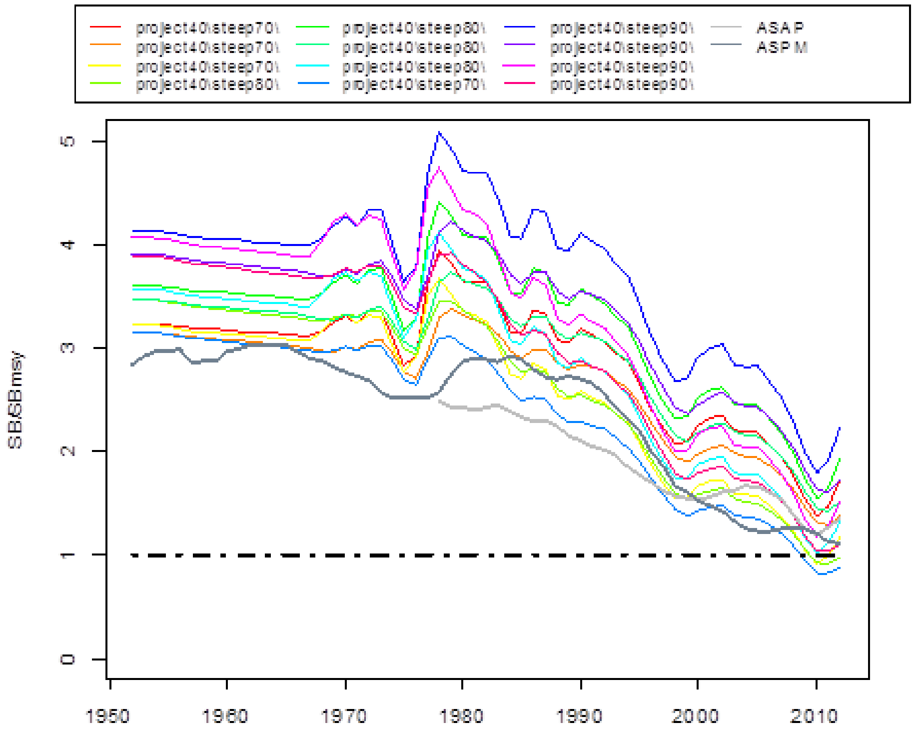



**Fig. 13. Bigeye tuna:** Ranges of $F/F_{MSY}$ (top) and $B/B_{MSY}$ (bottom) over time, indicating the range of uncertainty in stock assessment outcomes from the stock assessment models used in 2013 (SS3). ASAP and ASPM base cases are presented for comparative purposes.

Key assessment results for the 2013 SS3 stock assessment are shown in Tables 1, 2 and 6; Fig. 1.

**Table 6. Bigeye tuna:** Key management quantities from the SS3 assessment, for the aggregate Indian Ocean.

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2012 catch estimate | 115,793 t |
| Mean catch from 2008–2012 | 107,603 t |
| MSY [plausible range] | 132,000 [98,000–207,000] |
| Data period used in assessment | 1952–2012 |
| $F_{2012}/F_{MSY}$ [plausible range] | 0.42 [0.21–0.80] |
| $B_{2012}/B_{MSY}$ | n.a. |
| $SB_{2012}/SB_{MSY}$ [plausible range] | 1.44 [0.87–2.22] |
| $B_{2012}/B_{1952}$ | n.a. |
| $SB_{2012}/SB_{1952}$ [plausible range] | 0.40 [0.27–0.54] |
| $B_{2012}/B_{2012, F=0}$ | n.a. |
| $SB_{2012}/SB_{2012, F=0}$ | 0.40 [0.27–0.54] |

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Froese R, Pauly DE (2009) *FishBase*, version 02/2009, FishBase Consortium, <www.fishbase.org>
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. Skipjack tuna:** Status of skipjack tuna (*Katsuwonus pelamis*) in the Indian Ocean

| Area[1] | Indicators | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 314,537 t<br>400,980 t | |
| | MSY (1000 t):<br>$F_{2011}/F_{MSY}$:<br>$SB_{2011}/SB_{MSY}$:<br>$SB_{2011}/SB_0$: | 478 t (359–598 t)<br>0.80 (0.68–0.92)<br>1.20 (1.01–1.40)<br>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) | | |
| Stock not subject to overfishing ($C_{year}$/MSY≤ 1) | | |

### INDIAN OCEAN STOCK – MANAGEMENT ADVICE

***Stock status.*** No new stock assessment was carried out for skipjack tuna in 2013. Previous 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). Total catch has continued to decline with 314,537 t landed in 2012, in comparison to 384,537 t in 2011. Based on the stock assessment carried out in 2012, the stock was considered to be **not overfished** and **not subject to overfishing** (Table 1).

***Outlook.*** The recent declines in catches are thought to be caused by a recent decrease in purse seine effort as well as 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 and purse seine catch and CPUE, which may be due to the combined effects of the fishery and environmental factors affecting recruitment or catchability. Catches in 2010 (424,013 t), 2011 (384,537 t) and 2012 (314,537 t) as well as the average level of catches of 2008–2012 (400,980 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 2008–2012 was 400,980 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 and purse seine fishery, suggest that the situation of the stock should be closely monitored with a new stock assessment to be carried out in 2014.

- 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 Resolution 132/10 *on interim target and limit reference points and a decision framework*, 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 spawning stock biomass, at the current catch levels, will be below the limit reference point of $0.4*SB_{MSY}$ in 3 or 10 years.

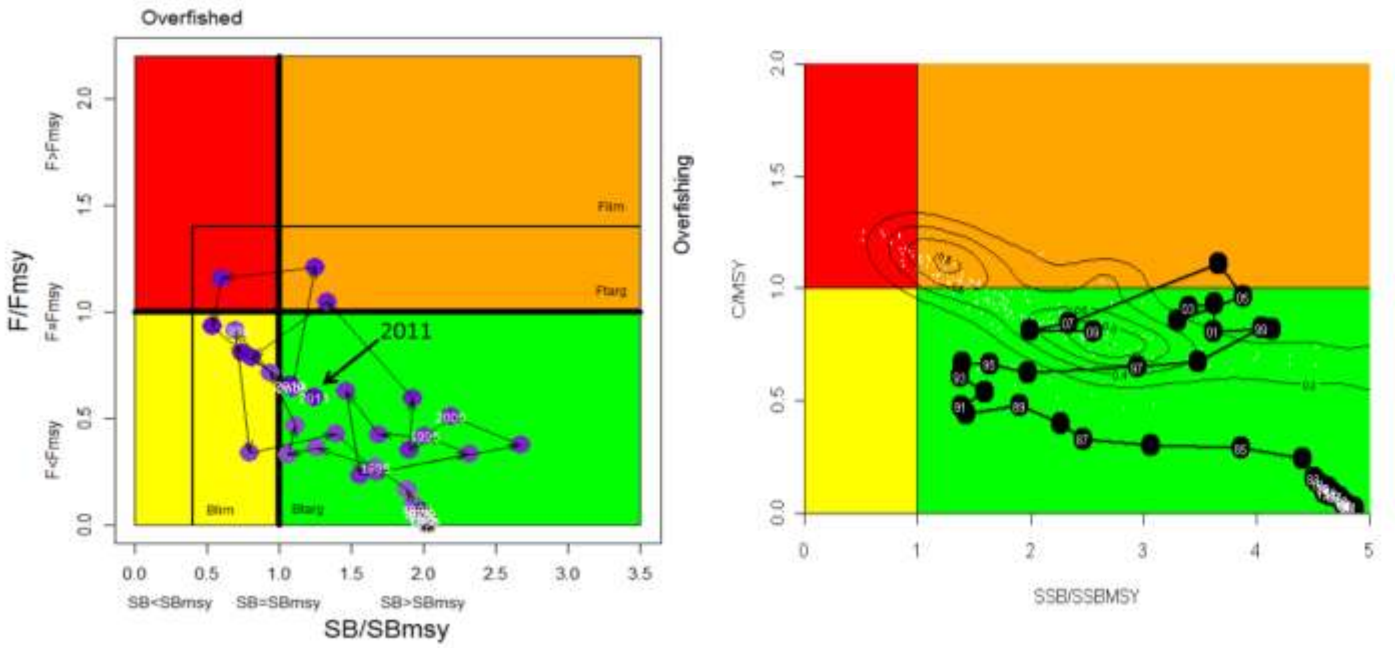



**Fig. 1. Skipjack tuna:** 2012 SS3 Indian Ocean assessment Kobe plot (left; mean values of the weighted models used in the analysis in 2012). Circles indicate the trajectory of the point estimates for the SB ratio and $F/F_{MSY}$ ratio for each year 1950–2011. 2011 SS3 Aggregated Indian Ocean assessment 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 |
| $C_{2020} > MSY$ | <1 | <1 | 31 | 45 | 72 |

(proxy for $F_{2009}/F_{MSY}$)

## 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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 13/10 *On interim target and limit reference points and a decision framework*
- Resolution 13/11 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.
- 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*

### 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.<br>Size: females and males 41–43 cm.<br>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.<br>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 tuna 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 purse seine vessels in the early 1980s, and skipjack tuna became one of the most important commercial tuna species in the Indian Ocean. Annual catches peaked at over 600,000 t in 2006 (Tables 4, 5; Fig. 2). Though preliminary, the catch levels estimated for 2012, at around 315,000 t, represent the lowest catches recorded since 1998.

The increase in skipjack tuna catches by purse seine vessels (Fig. 2) is due to the development of a fishery in association with Fish Aggregating Devices (FADs) (Table 4). In recent years, over 90% of the skipjack tuna caught by purse seine vessels is taken from around FADs (Table 4; Fig. 2). Catches by purse seine vessels 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 by purse seine vessels 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 2007 coincided with a similar decline in the catches by Maldivian baitboats (pole-and-line).

**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 (2003–2012), in tonnes (Data as of September 2013). Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery (refer to Fig. 2).

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| BB | 10,007 | 15,148 | 24,684 | 41,705 | 77,079 | 109,081 | 114,060 | 111,833 | 138,652 | 147,428 | 106,605 | 98,923 | 75,199 | 82,971 | 68,886 | 67,573 |
| FS | 0 | 0 | 41 | 15,253 | 30,598 | 25,868 | 30,975 | 18,516 | 43,166 | 34,930 | 24,199 | 16,274 | 10,433 | 8,774 | 9,000 | 2,984 |
| LS | 0 | 0 | 125 | 34,472 | 124,032 | 163,656 | 179,930 | 137,282 | 168,018 | 211,509 | 120,951 | 128,448 | 148,135 | 144,097 | 123,056 | 80,989 |
| OT | 4,999 | 11,712 | 21,952 | 38,281 | 87,731 | 174,498 | 155,952 | 187,840 | 185,989 | 217,275 | 203,428 | 202,986 | 201,415 | 188,172 | 183,594 | 162,990 |
| **Total** | **15,006** | **26,860** | **46,801** | **129,712** | **319,440** | **473,102** | **480,916** | **455,470** | **535,825** | **611,143** | **455,183** | **446,631** | **435,182** | **424,013** | **384,537** | **314,537** |

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

**Table 5. Skipjack tuna:** Best scientific estimates of the catches of skipjack tuna (*Katsuwonus pelamis*) by area [as used for the assessment] by decade (1950–2009) and year (2003–2012), in tonnes (Data as of September 2013). Catches by decade represent the average annual catch. The areas are present in Fig. 4a.

| Areas/ Regions | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| R1 | 4,524 | 9,951 | 19,291 | 34,587 | 80,757 | 115,572 | 110,103 | 119,042 | 94,897 | 104,270 | 127,329 | 148,270 | 150,091 | 154,588 | 155,333 | 124,950 |
| R2 | 10,483 | 16,910 | 27,511 | 95,126 | 238,683 | 357,530 | 370,814 | 336,428 | 440,928 | 506,873 | 327,853 | 298,361 | 285,091 | 269,426 | 229,205 | 189,586 |
| **Total** | **15,006** | **26,860** | **46,801** | **129,712** | **319,440** | **473,102** | **480,916** | **455,470** | **535,825** | **611,143** | **455,183** | **446,631** | **435,182** | **424,013** | **384,537** | **314,537** |

**Areas**: East Indian Ocean plus Maldives (**R1**); West Indian Ocean excluding Maldives (**R2**)

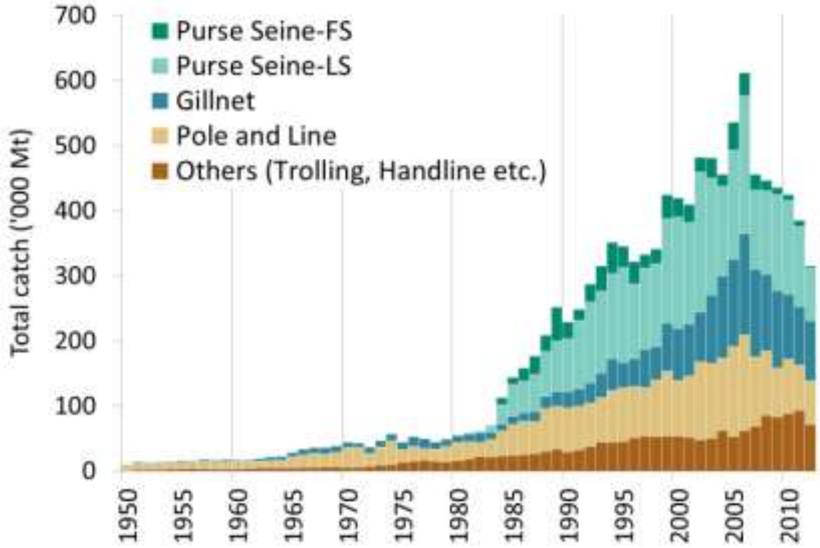



**Fig. 2. Skipjack tuna:** Annual catches of skipjack tuna by gear (1950–2012) (Data as of September 2013).

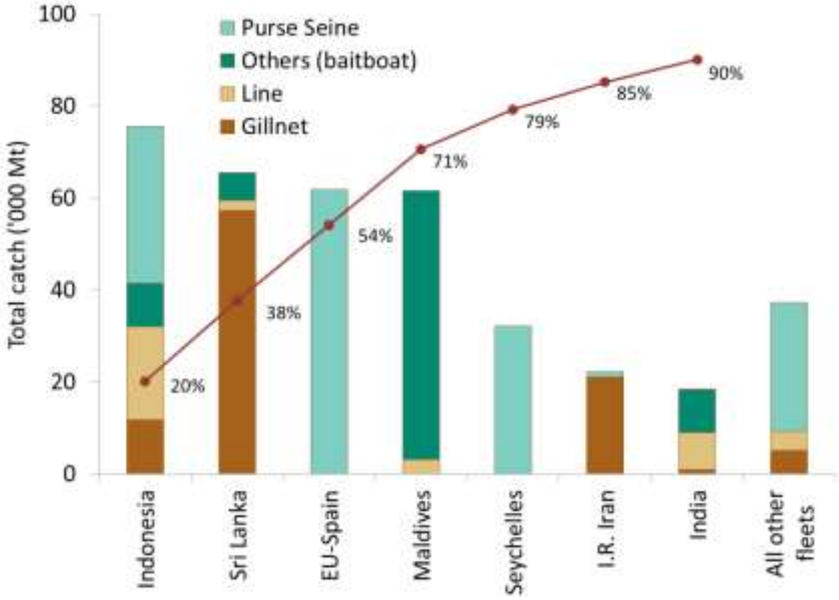



**Fig. 3**. **Skipjack tuna:** average catches in the Indian Ocean over the period 2009–12, by country (Data as of September 2013). Countries are ordered from left to right, according to the importance of catches of skipjack reported. The red line indicates the (cumulative) proportion of catches of skipjack for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

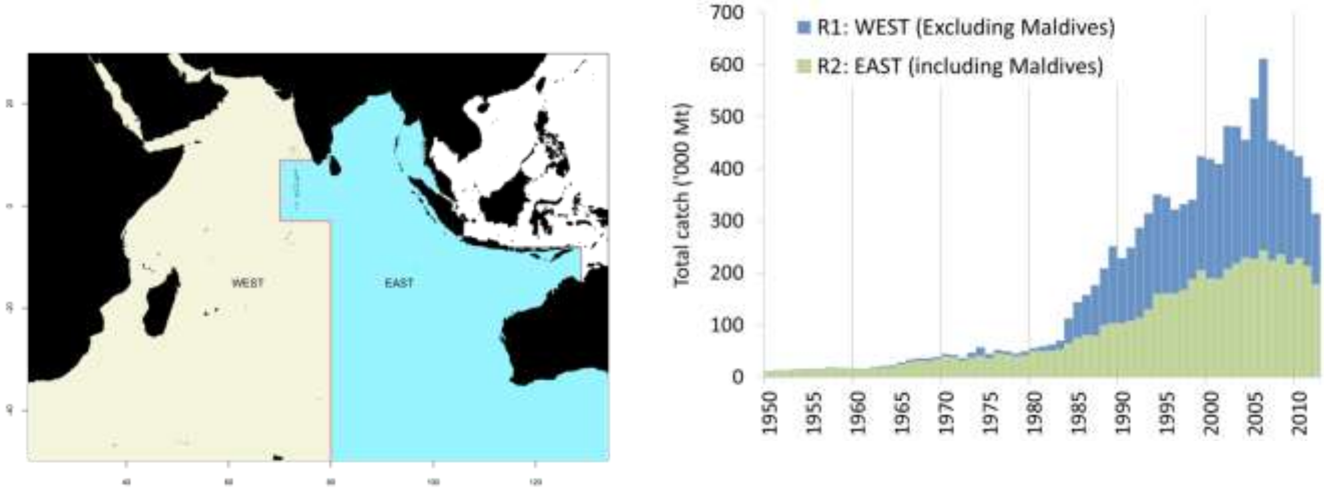



**Fig. 4a–b. Skipjack tuna:** Catches of skipjack tuna by area by year estimated for the WPTT (1950–2012) (Data as

of September 2013). Areas: East Indian Ocean plus Maldives (R1); West Indian Ocean excluding Maldives (R2).

The Maldivian fishery 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 80% 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 (≈140,000 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 and just 58% of the total catches of tropical tunas. In 2011 and 2012 Maldives reported high catches of yellowfin tuna following the development of handline fisheries for yellowfin tuna in the Maldives (Fig. 3).

Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean (Fig. 3), including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of I.R. 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 I.R. Iran and Sri Lanka (Figs. 4, 5) 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 (Table 4, Figs. 5, 6). Since 2007 (Table 5) 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 seine fleets, as well as those using driftnets from I.R. Iran (Figs. 4, 5) and Pakistan; and the drop in the catches of skipjack tuna by Maldives baitboats following the introduction of handlines to target large specimens of yellowfin tuna.

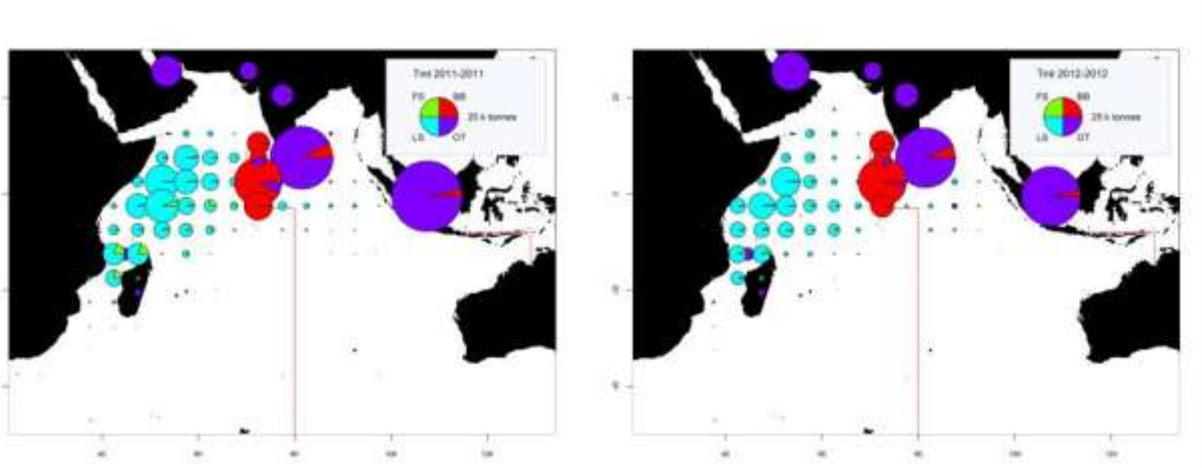


**Fig. 5. Skipjack tuna:** Time-area catches (total combined in tonnes) of skipjack tuna estimated for 2011 (left) and 2012 (right) by gear (Data as of September 2013). Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (BB), and other fleets (**OT**), including longline, drifting gillnets, and various coastal fisheries. 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** are generally well known for the industrial fisheries but are less certain for many artisanal fisheries (Fig. 6), 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.

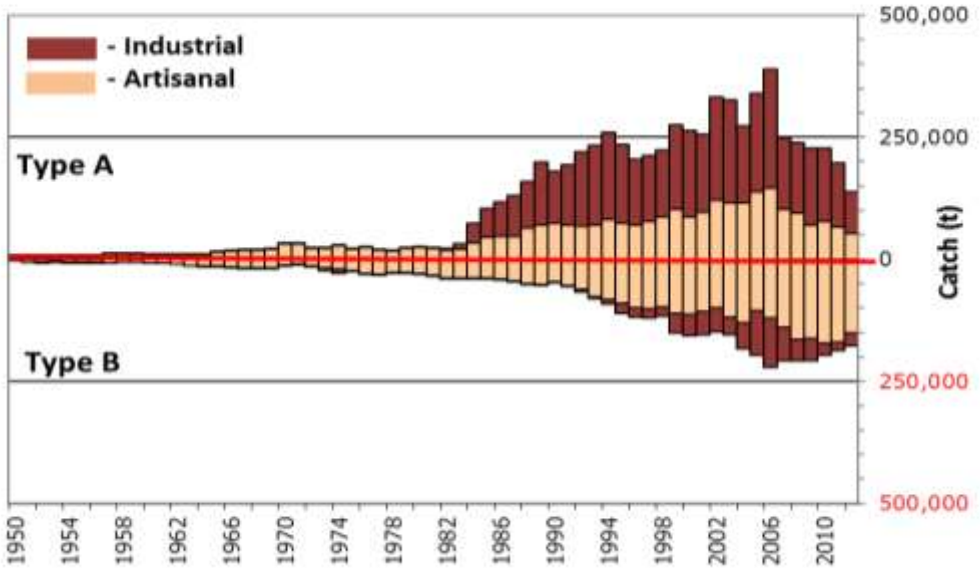



**Fig. 6. Skipjack tuna:** Uncertainty of annual catch estimates for skipjack tuna (Data as of September 2013). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by 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** are believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seine vessels flagged to 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 2012. However, the IOTC Secretariat used new information compiled during 2012–13 to rebuild the catch series for the coastal fisheries operated in some countries, in particular Indonesia 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. More details about these reviews can be found in paper IOTC–2013–WPTT15–07 Rev_1.

**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:

- insufficient data available for the gillnet fisheries of I.R. 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 and Madagascar.

***Skipjack tuna – Effort trends***

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2011 and 2012 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 2011 and 2012 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 2011 and 2012 are provided in Fig. 9.

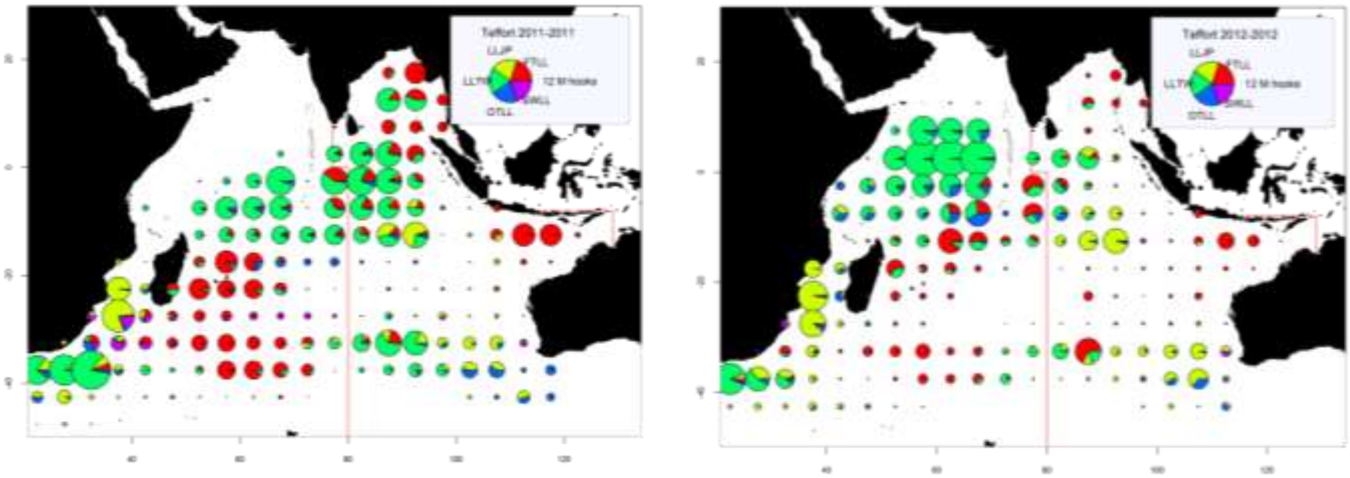


**Fig. 7.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (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)

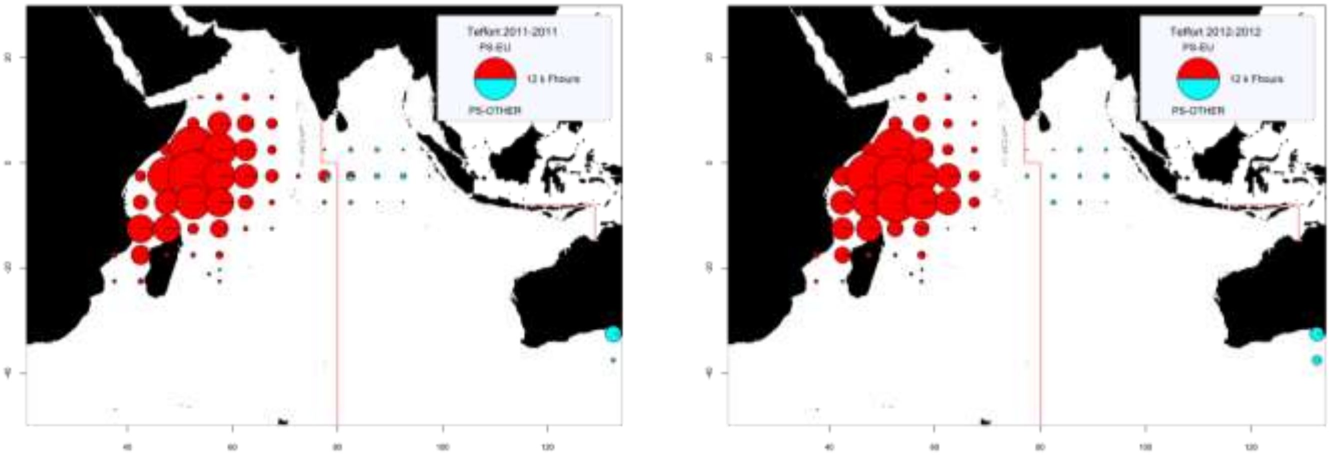


**Fig. 8.** Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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)

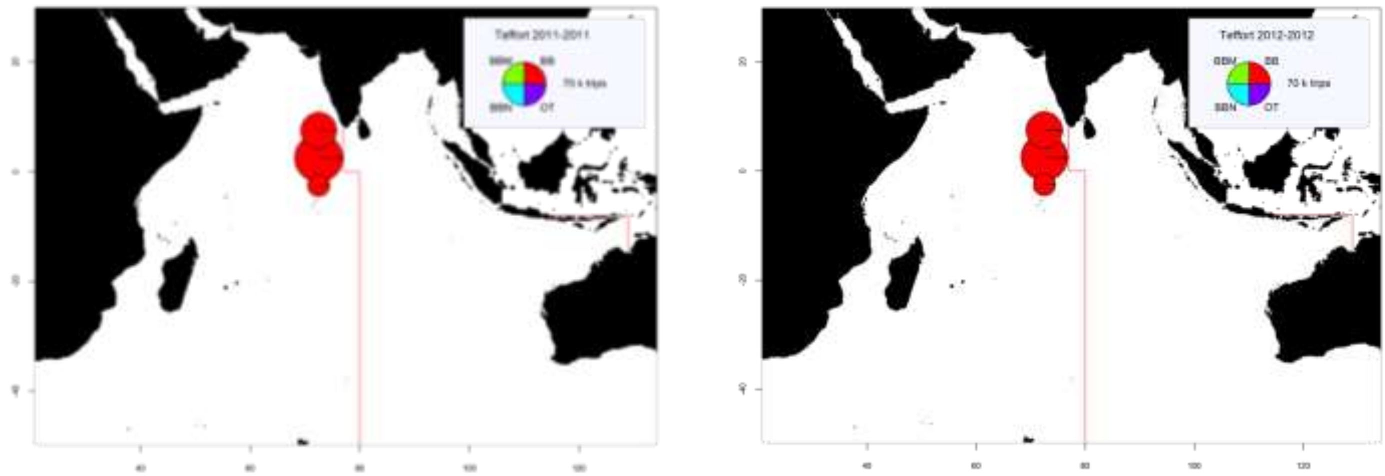
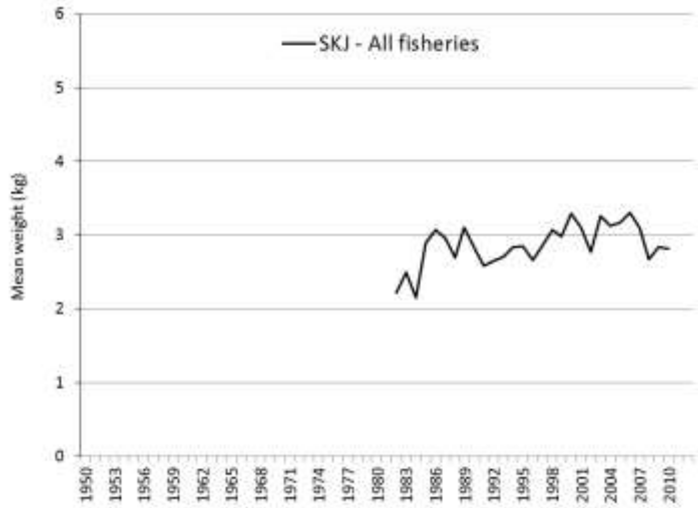


**Fig. 9.** Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): 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: 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 (Fig. 10) and are incomplete for most artisanal fisheries thereinafter, namely hand lines, troll lines and many gillnet fisheries (Indonesia).

**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).



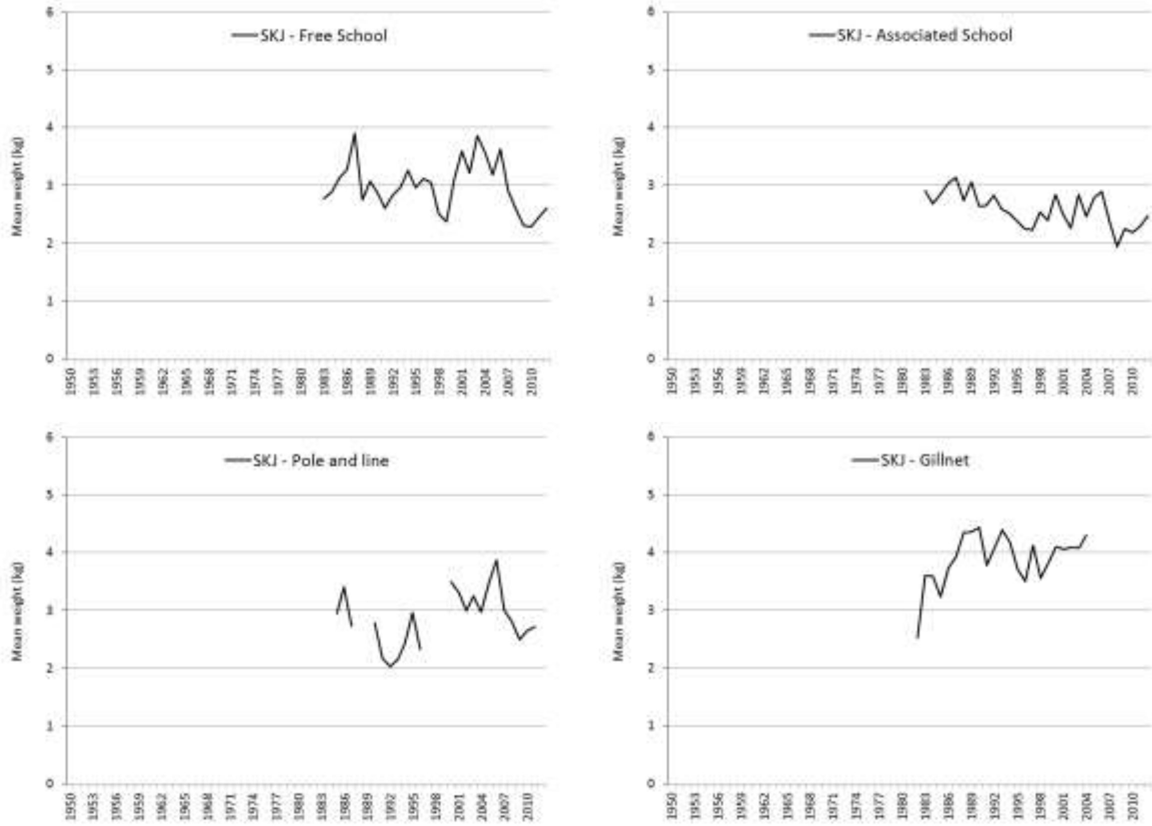



**Fig. 10. Skipjack tuna:** Changes in average weight (kg) of skipjack tuna from 1950 to 2012 – all fisheries combined (top) and by main fleet (Data as of September 2013).

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

The CPUE series presented at the WPTT15 meeting in 2013 are provided in Fig. 11, and should be used in the scheduled 2014 stock assessment for skipjack tuna. The standardised Maldivian CPUE series (2004–11) has declined from the peak in 2006. Further work is required to improve the standardisation of this series before the next stock assessment. The data currently available for CPUE standardisation include: improved vessel logbook data; new live bait fishery logbook data; and anchored FAD (aFAD) data that are potentially informative about "hyperstability" conditions that may be caused by fishing on aFADs.

The following points should be noted:

- The vessel effect could be examined to assess if the single day effect is primarily for certain vessels that could be excluded from the dataset;
- The fuel price could affect the catch rates if it excludes vessels from reaching high skipjack tuna density fishing grounds;

The targeted effort for skipjack tuna should be specifically determined to obtain information on the proportion of the days that boats switch targeting between handline and pole-and-line in any given trip. Other factors that may affect the CPUE is the availability of bait that may influence the catch rate, and the distance the vessels are going over time to catch skipjack.

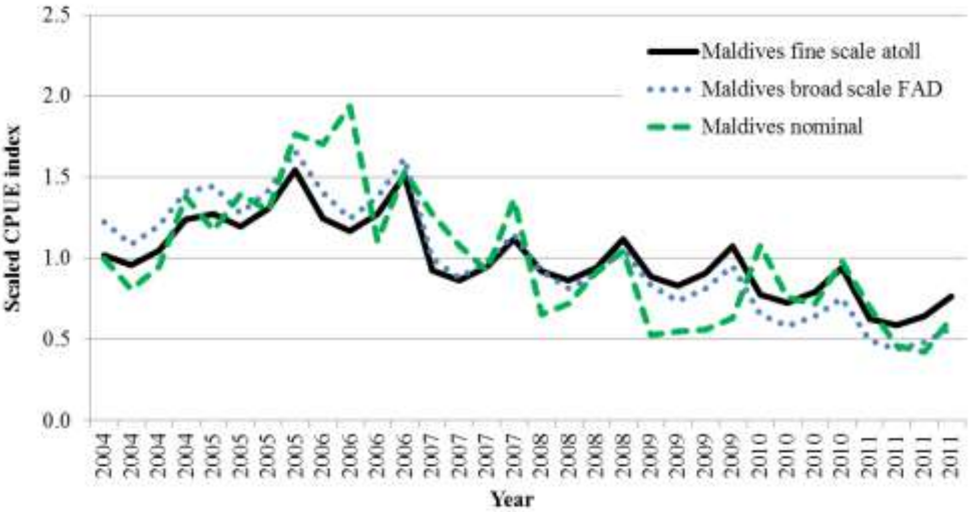



**Fig. 11. Skipjack tuna:** Maldives quarterly pole-and-line CPUE series for skipjack tuna from 2004–11, using fine scale atoll data, broad scale FAD data, as well as the nominal CPUE series for comparison.

***Skipjack tuna – Tagging data***

A total of 101,212 skipjack tuna (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. 12). 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, 17,688 specimens (17.5%), have been recovered and reported to the IOTC Secretariat. Around 69.5% of the recoveries were from the purse seine fleets operating from the Seychelles, and around 28.9% 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.

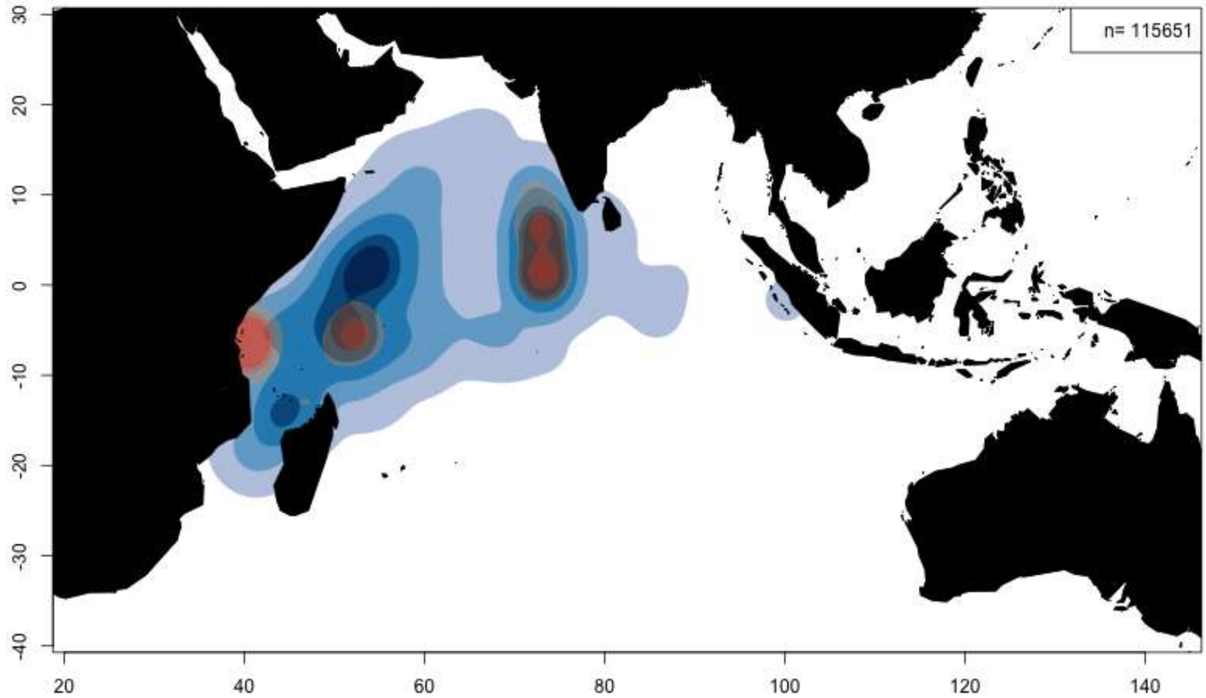



**Fig. 12**. **Skipjack tuna:** Densities of releases (in red) and recoveries (in blue) (Data as of September 2012).

### STOCK ASSESSMENT

As no new stock assessment was carried out in 2013, the advice on the status of skipjack tuna in 2013 is based on the models using an integrated statistical assessment method from 2012 (see IOTC–2012–WPTT14–R) and current catch and effort trends presented at the current meeting.

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. A summary of the key management quantities is provided in Table 6.

**Table 6. Skipjack tuna:** Key management quantities from the 2012 SS3 assessment, for the aggregate Indian Ocean

| Management Quantity | Aggregate Indian Ocean |
|---|---|
| 2012 catch estimate | 314,537 t |
| Mean catch from 2008–2012 | 400,980 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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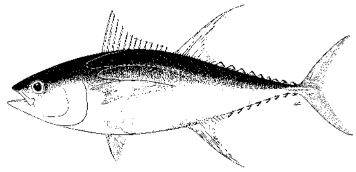
# Appendix XII
# Executive Summary: Yellowfin Tuna

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 | | | 2013 stock status determination |
|---|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 368,663 t<br>317,505 t | | |
| | | Multifan[2] | ASPM[3] | |
| | MSY (1000 t): | | | |
| | $F_{curr}/F_{MSY}$: | 344 t (290–453 t) | 320 (283–358 t) | |
| | $SB_{curr}/SB_{MSY}$: | 0.69 (0.59–0.90) | 0.61 (0.31–0.91) | |
| | $SB_{curr}/SB_0$ : | 1.24 (0.91–1.40) | 1.35 (0.96–1.74) | |
| | | 0.38 (0.28–0.38) | - | |

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2] most recent years data 2010
[3] most recent years data 2011

| 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 new stock assessment was carried out for yellowfin tuna in 2013. Previous stock assessment model results (2012) did 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 **not subject to overfishing** ($F_{2010}$<$F_{MSY}$) (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. Total catch has continued to increase with 368,663 t landed in 2012, a value over previous MSY estimates (344,000 t; Table 1), in comparison to 327,490 t in 2011 and 300,000 t in 2010. However, catch rates have improved in the purse seine fishery while remaining stable for the Japanese longline fleet. Therefore it is difficult to know whether the stock is moving towards a state of being subject to overfishing. If the provisional catch estimate for 2013 confirms the increasing trend, it may be necessary to carry out a new stock assessment in 2014.

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). The management advice in 2012 indicated that 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. Catches have exceeded this level in 2011 and 2012.
- 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 is similar to MFCL estimates, the ASPM recruitment trend is estimated to be at a lower level without any declining trend.

- Provisional reference points: Noting that the Commission in 2012 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, 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).*** 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 (300,000 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.

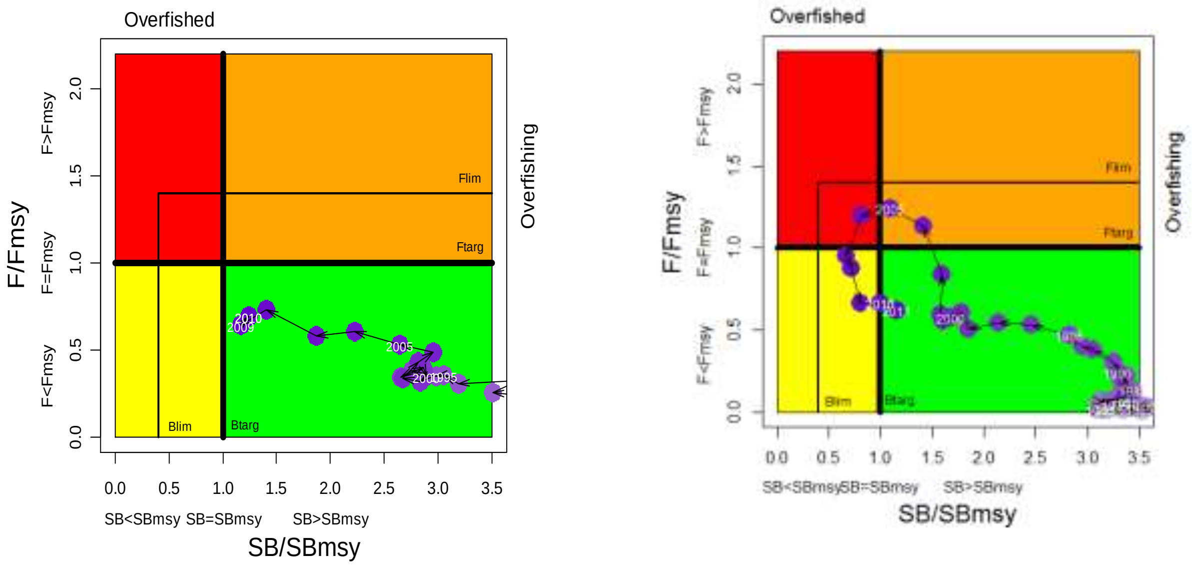



**Fig. 1.** Yellowfin tuna: MULTIFAN-CL Indian Ocean yellowfin tuna stock assessment Kobe plot. Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1972–2010 for a steepness value of 0.8. The left panel is output obtained from the base case run in MFCL. 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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 13/10 *On interim target and limit reference points and a decision framework*
- Resolution 13/11 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.

- 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*

**FISHERIES INDICATORS**

***Yellowfin tuna: General***

Yellowfin tuna *(Thunnus albacares)* 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.<br>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.<br>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.<br>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 2012 are shown in Tables 4, 5; Figs. 2, 3, 4, and 5. 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 (Table 4; Fig. 2) 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 longline vessels and, to a lesser extent, gillnet vessels. 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. 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 525,000 t) and average annual catch for the period at around 480,000 t. Yellowfin tuna catches dropped markedly after 2006, with the lowest catches recorded in 2009. Catch levels in 2012 are estimated to be at around 370,000 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 (2003–2012), in tonnes (Data as of September 2013). Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery (refer to Fig. 2).

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1950s** | **1960s** | **1970s** | **1980s** | **1990s** | **2000s** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| FS | - | - | 18 | 31,561 | 64,974 | 89,377 | 136,881 | 168,392 | 123,998 | 85,044 | 53,526 | 74,985 | 36,049 | 32,135 | 36,453 | 64,593 |
| LS | - | - | 17 | 17,610 | 56,275 | 61,719 | 87,015 | 59,655 | 69,878 | 74,612 | 43,778 | 41,546 | 51,351 | 73,383 | 76,659 | 66,166 |
| LL | 21,990 | 41,250 | 29,493 | 34,090 | 71,557 | 70,227 | 70,225 | 99,768 | 130,993 | 88,365 | 65,490 | 39,354 | 36,552 | 37,073 | 33,957 | 40,756 |
| LF | - | - | 615 | 4,286 | 47,571 | 34,150 | 31,162 | 32,938 | 35,949 | 31,752 | 33,302 | 34,342 | 23,125 | 21,501 | 21,267 | 23,366 |
| BB | 2,111 | 2,318 | 5,810 | 8,295 | 12,805 | 16,061 | 17,277 | 15,876 | 16,734 | 18,017 | 16,268 | 18,326 | 16,819 | 14,105 | 14,016 | 15,386 |
| GI | 1,572 | 4,116 | 7,838 | 11,899 | 39,421 | 49,388 | 53,769 | 74,160 | 61,257 | 62,601 | 43,412 | 48,011 | 42,822 | 50,772 | 50,448 | 59,902 |
| HD | 728 | 1,779 | 4,772 | 11,488 | 26,073 | 42,737 | 43,768 | 52,447 | 47,288 | 40,898 | 40,961 | 41,163 | 37,160 | 43,398 | 66,347 | 70,797 |
| TR | 1,102 | 1,981 | 4,335 | 6,946 | 11,628 | 16,124 | 12,979 | 20,929 | 16,793 | 18,235 | 19,715 | 18,814 | 16,822 | 19,968 | 20,424 | 21,444 |
| OT | 80 | 193 | 453 | 1,844 | 3,318 | 5,055 | 4,012 | 4,631 | 4,220 | 5,294 | 5,897 | 7,060 | 7,071 | 7,665 | 7,919 | 6,253 |
| **Total** | **27,583** | **51,637** | **53,351** | **128,019** | **333,622** | **384,838** | **457,089** | **528,797** | **507,111** | **424,819** | **322,349** | **323,602** | **267,771** | **300,000** | **327,490** | **368,663** |

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

**TABLE 5. Yellowfin tuna:** Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by area by decade (1950–2009) and year (2003–2012), in tonnes (Data as of September 2013). Catches by decade represent the average annual catch. The areas are presented in Fig. 4a.

| Area / Region | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1950s** | **1960s** | **1970s** | **1980s** | **1990s** | **2000s** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| R1 | 2,146 | 4,715 | 6,951 | 16,783 | 74,549 | 86,730 | 82,305 | 125,641 | 129,465 | 108,572 | 80,564 | 74,481 | 59,642 | 65,334 | 77,905 | 89,020 |
| R2 | 11,226 | 23,066 | 21,208 | 71,695 | 138,278 | 180,825 | 262,313 | 271,608 | 248,766 | 199,399 | 128,041 | 137,320 | 104,423 | 124,456 | 146,643 | 178,394 |
| R3 | 844 | 7,516 | 5,892 | 9,592 | 23,974 | 24,750 | 22,968 | 27,389 | 25,591 | 24,770 | 24,617 | 21,297 | 20,063 | 19,565 | 20,159 | 19,365 |
| R4 | 917 | 1,785 | 1,415 | 1,257 | 8,298 | 6,244 | 10,032 | 9,079 | 7,121 | 4,485 | 1,682 | 1,755 | 1,438 | 1,981 | 1,123 | 3,087 |
| R5 | 11,253 | 13,226 | 16,074 | 22,606 | 67,947 | 61,369 | 54,882 | 69,154 | 65,387 | 67,863 | 62,446 | 57,492 | 66,764 | 62,458 | 57,007 | 57,978 |
| R0 (North) | 1,195 | 1,305 | 1,796 | 6,053 | 20,533 | 24,896 | 24,554 | 25,898 | 30,730 | 19,726 | 24,996 | 31,253 | 15,433 | 26,196 | 24,639 | 20,817 |
| R0 (Other) | 1 | 24 | 15 | 32 | 43 | 24 | 34 | 29 | 51 | 5 | 2 | 5 | 7 | 10 | 13 | 2 |
| **Total** | **27,583** | **51,637** | **53,351** | **128,019** | **333,622** | **384,838** | **457,089** | **528,797** | **507,111** | **424,819** | **322,349** | **323,602** | **267,771** | **300,000** | **327,490** | **368,663** |

**Areas**: Arabian Sea (**R1**); Off Somalia (**R2**); Mozambique Channel (**R3**); South Indian Ocean (**R4**); East Indian Ocean (**R5**); Bay of Bengal (**R0(North)**); Other Area (**R0(Other)**)

Although some Japanese purse seine vessels have fished in the Indian Ocean since 1977, the purse seine (Fig. 2) 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; Figs. 2, 3 and 5). The fishery on floating objects (FADs), catches large numbers of small yellowfin tuna in association with skipjack tuna and juvenile bigeye tuna, and a fishery on free swimming schools, 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; Fig. 2) started in the early 1950's and expanded rapidly over throughout the Indian Ocean. Longline vessels mainly catch large fish, from 80 to 160 cm FL, although smaller fish in the size range 60 cm – 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 130,000 t. The second highest catches of yellowfin tuna by longline vessels were recorded in 2005 (≈165,000 t). As was the case for the purse seine fleets, since 2005 longline catches have declined with current catches estimated to be at around 60,000 t, representing a two-fold decrease from the catches taken in 2005. The Scientific Committee 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 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; Fig. 2). 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 50,000 t. During the years 2004 and then in 2012 the catches by artisanal gears attained its maximum over the time series, peaking at 165,000 t and 170,000 t, respectively.

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 seine vessels currently take the bulk of the yellowfin tuna catch, mostly from the western Indian Ocean, around Seychelles (Tables 4, 5; Fig. 5; Off Somalia (R2) and Mozambique Channel (R3) (Figs. 4, 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 longline vessels have reported higher than normal catches in the tropical western Indian Ocean during this period.

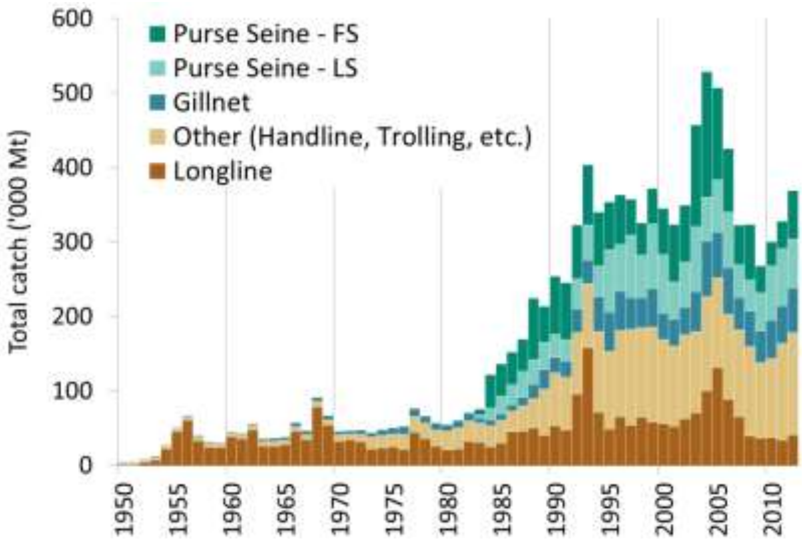



**Fig. 2. Yellowfin tuna:** Catches of yellowfin tuna by gear by year estimated for the WPTT (1950–2012) (Data as of September 2013). Purse seine free-school (FS); Purse seine associated school (LS).

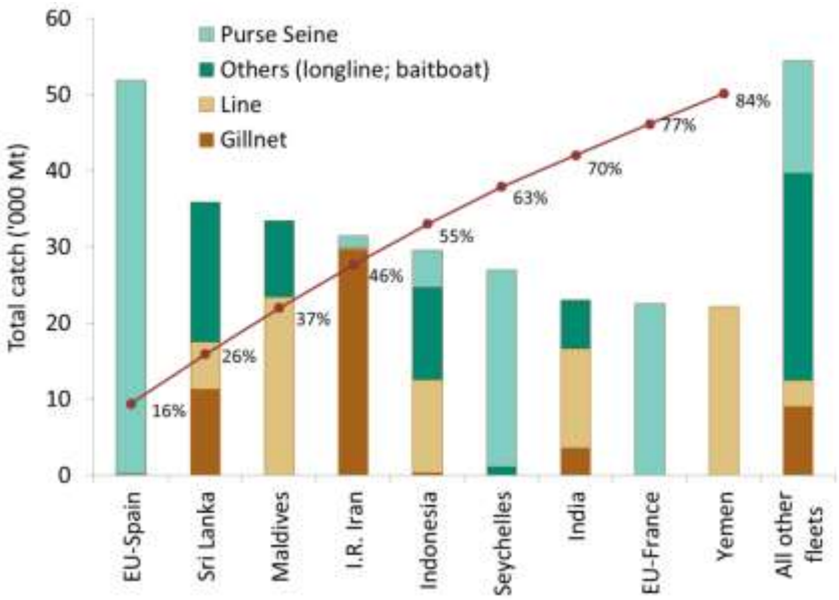
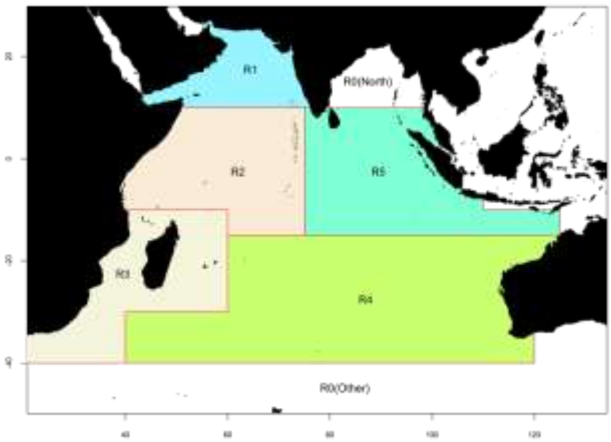



**Fig. 3. Yellowfin tuna:** average catches in the Indian Ocean over the period 2009–12, by country (Data as of September 2013). Countries are ordered from left to right, according to the importance of catches of yellowfin reported. The red line indicates the (cumulative) proportion of catches of yellowfin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.



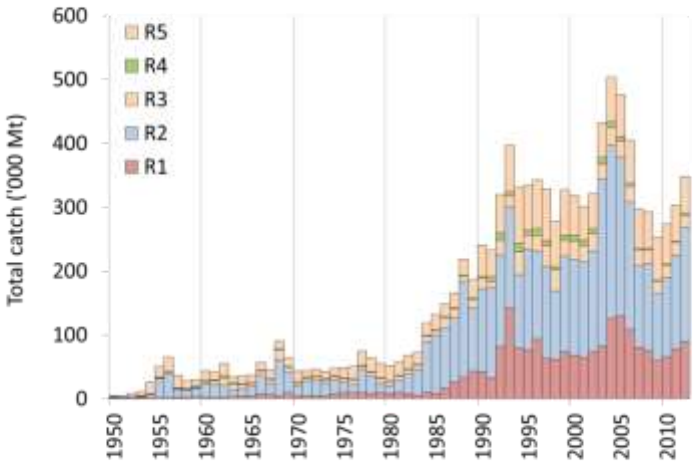




**Fig. 4a–b. Yellowfin tuna:** Catches of yellowfin tuna by area by year estimated for the WPTT (1950–2012) (Data as of September 2013). Catches in areas R0 were assigned to the closest neighbouring area for the assessment. Areas: Arabian Sea (R1); Off Somalia (R2); Mozambique Channel (R3); South Indian Ocean (R4); East Indian Ocean (R5); Bay of Bengal (R0(North)); Other Area (R0(Other)).

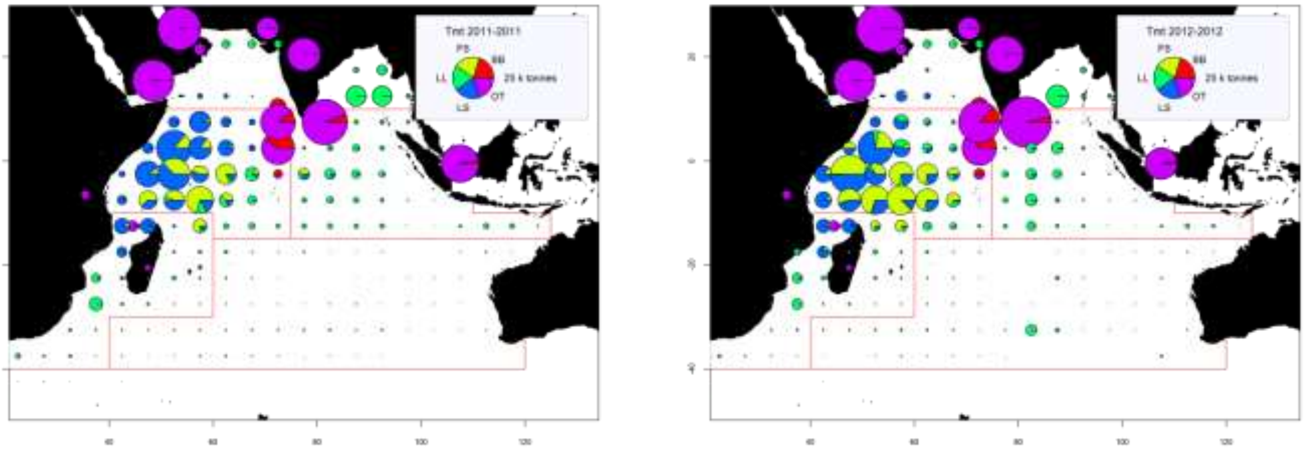


Fig. 5a–b. Yellowfin tuna: Time-area catches (total combined in tonnes) of yellowfin tuna estimated for 2011 and 2012, by type of gear (Data as of September 2013). Longline (LL), Purse seine free-schools (FS), Purse seine associated-schools (LS), pole-and-line (BB), and other fleets (OT), including drifting gillnets, and various coastal fisheries. 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.

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 (Figs. 4, 5). 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. Longline effort levels in the western tropical area have increased in 2012, as a consequence of increased security in the region.

***Yellowfin tuna – uncertainty of catches***

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

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

**Discard levels** are believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–2007.

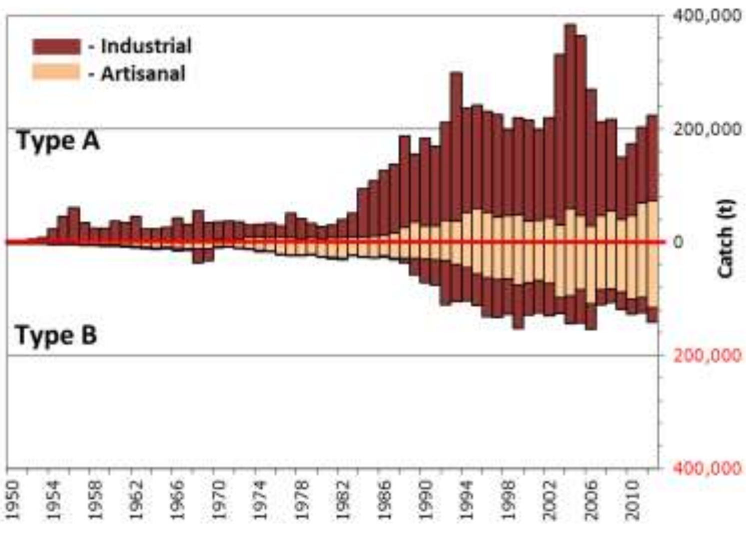



**Fig. 6. Yellowfin tuna:** Uncertainty of annual catch estimates for yellowfin tuna (Data as of September 2013). Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC

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 2012–13 to rebuild the catch series for the coastal fisheries operated in some countries, in particular Pakistan, Indonesia, Sri Lanka, and India. In general, the new catches of yellowfin tuna estimated by the IOTC Secretariat are slightly higher than those used in the past by the WPTT. More details about these reviews can be found in paper IOTC–2013–WPTT15–07 Rev_1.

**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
- insufficient data 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, and Madagascar.

***Yellowfin tuna: Effort trends***

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2011 and 2012 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 2011 and 2012 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 2011 and 2012 are provided in Fig. 9.

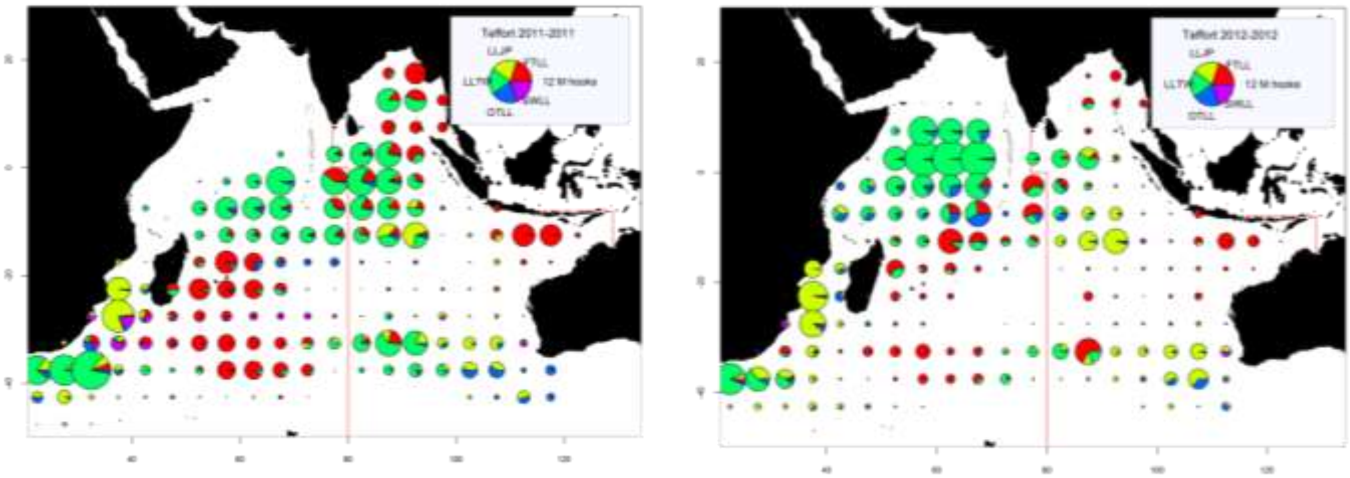


**Fig. 7.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (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)

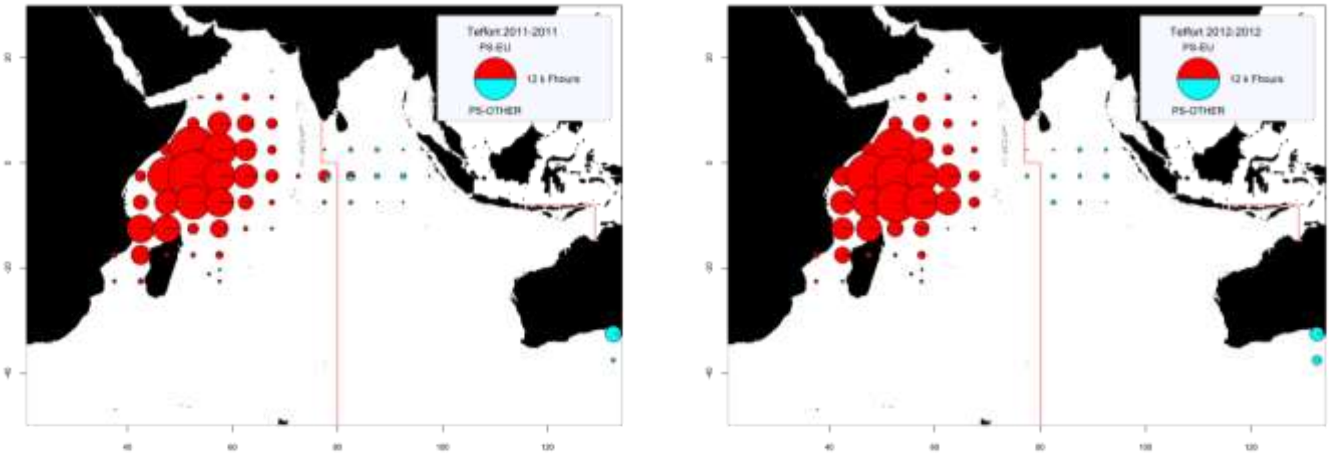



**Fig. 8.** Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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)

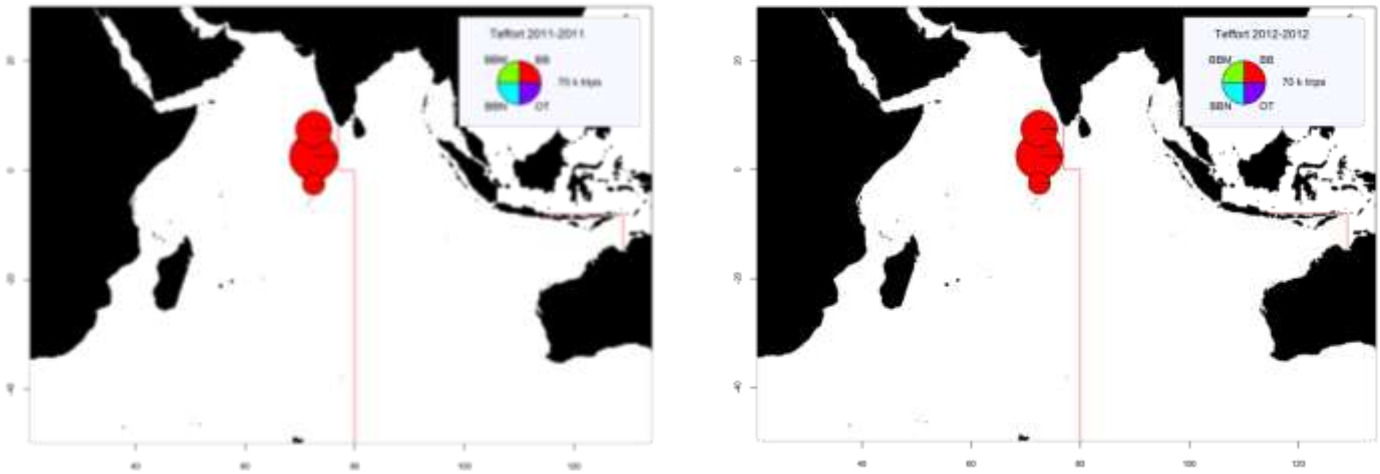



**Fig. 9.** Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): 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 Japan longline fleet (LL regions 2–5) and for the Taiwan,China longline fleet (LL region 1) to be used in the stock assessment. Standardised longline CPUE indices for the Taiwan,China fleet were available for 1979–2008. The GLM analysis used to standardise the Japan 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 Japan CPUE indices for region 2 in the most recent year (2010) and no CPUE indices are available for region 1 for 2009–10.

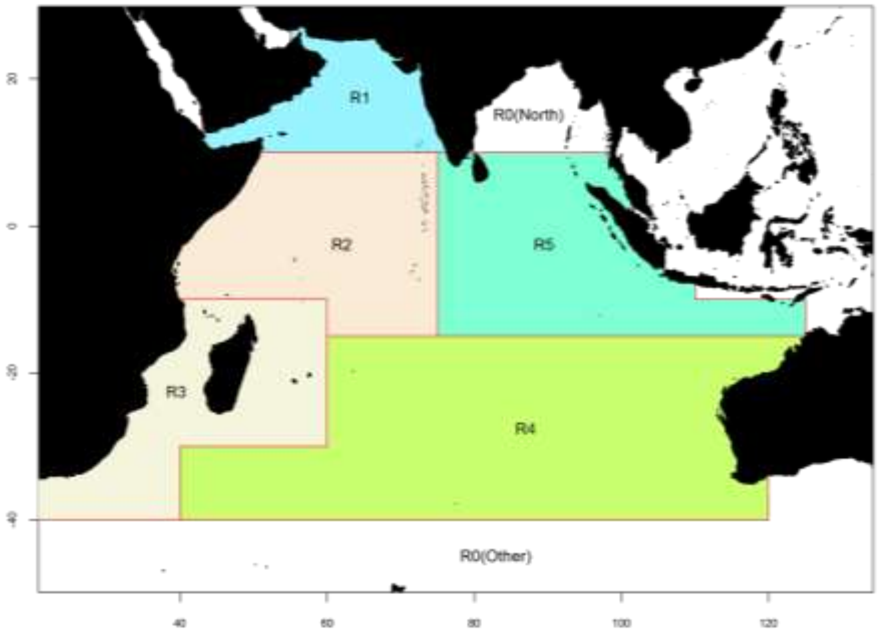



**Fig. 10**. Spatial stratification of the Indian Ocean for the MFCL assessment model carried out in 2012.

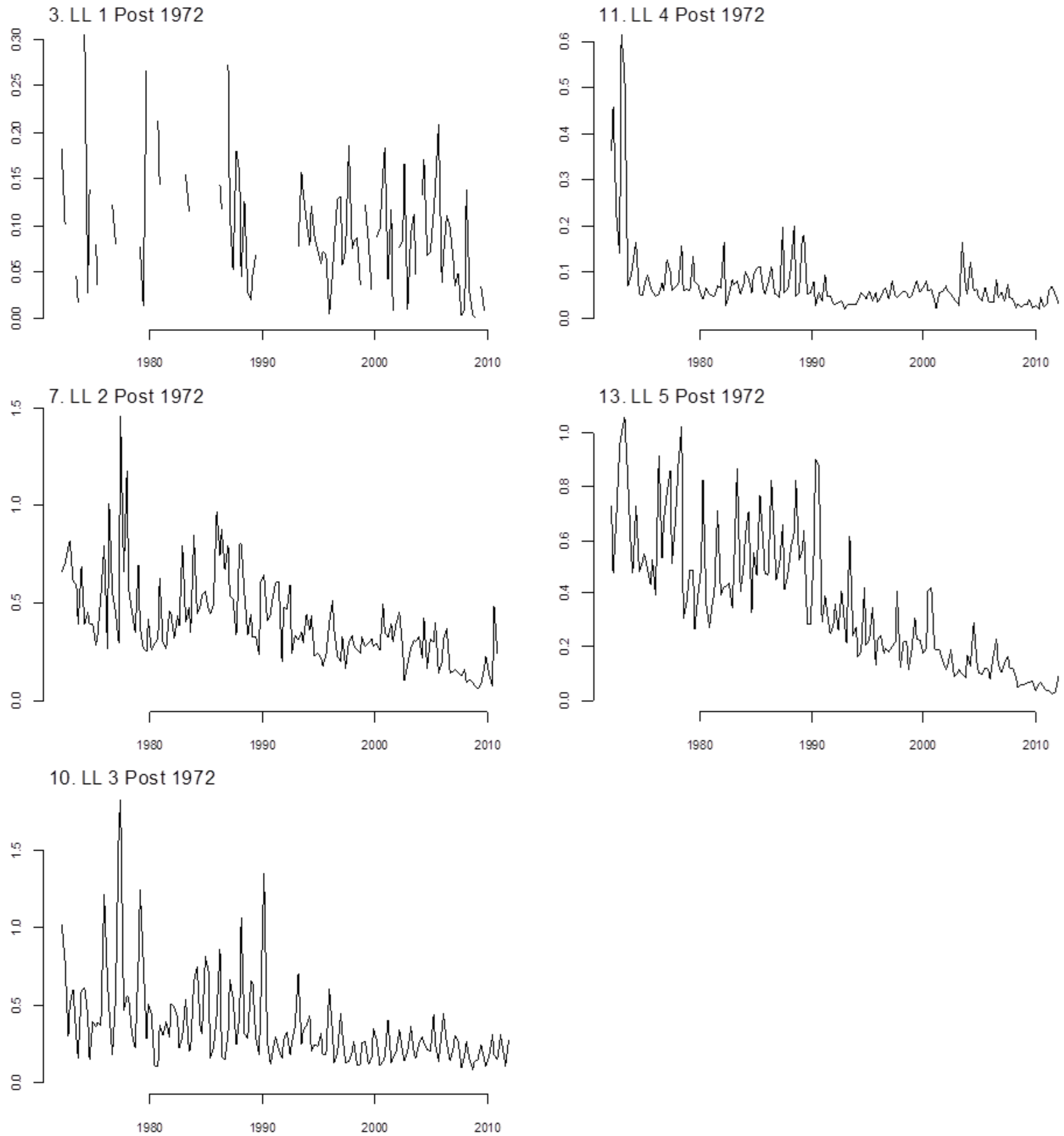



**Fig. 11. Yellowfin tuna:** Quarterly GLM standardised catch-per-unit-effort (CPUE) for the principal longline fisheries (LL 1 to 5) scaled by the respective region scalars.

For the longline fisheries (LL fisheries in regions 1–5; Fig. 10, CPUE indices analysed in 2013, were derived using generalised linear models (GLM) from the Japanese longline fleet (LL regions 2–5) and for the Taiwan,China longline fleet (LL region 1) to be used in the stock assessment in subsequent years for the stock assessment

The standardised CPUE trend estimated in 2013, for the Taiwan,China longline fleet (Fig. 12) is in contrast to the consistent negative trend displayed by the Japanese series (Fig. 13). The difference in the series between Taiwan,China and the Japan/Rep. of Korea standardised CPUE series, were questioned as it would seem intuitive that the trend should have decreased when catches increased significantly at the advent of the purse seine fishery. Scientists from these fleets need to resolve this by meeting inter-sessionally to assess why this may be occurring.

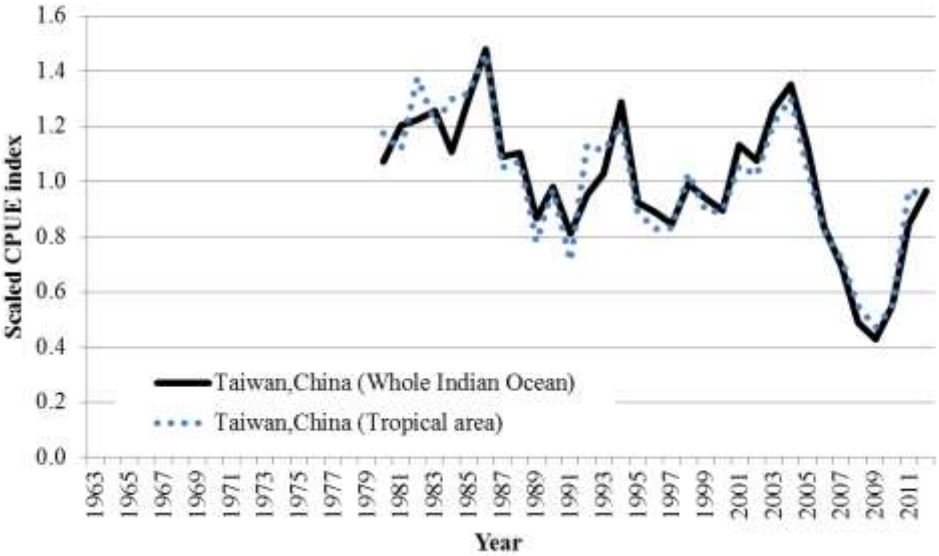



**Fig. 12. Yellowfin tuna:** Comparison of the two standardised longline CPUE series for Taiwan,China. Series have been rescaled relative to their respective means from 1963–2012.

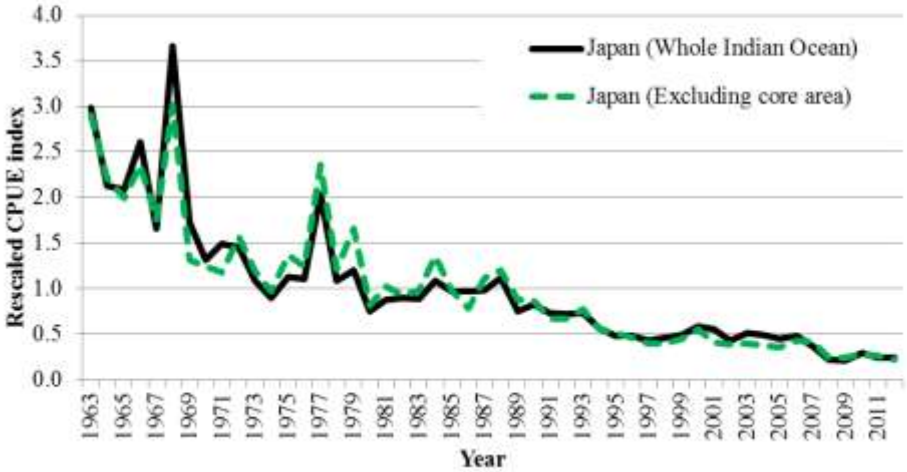
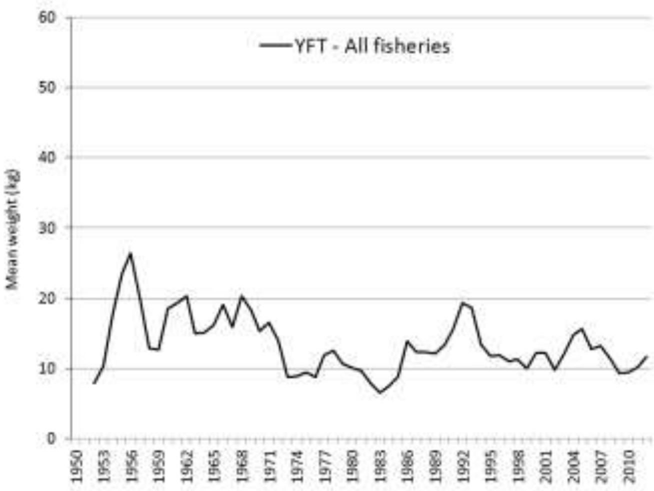



**Fig. 13. Yellowfin tuna:** Comparison of the two standardised longline CPUE series (with and without Region 2) for Japan. Series have been rescaled relative to their respective means from 1963–2012.

***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 (Fig. 14) 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.



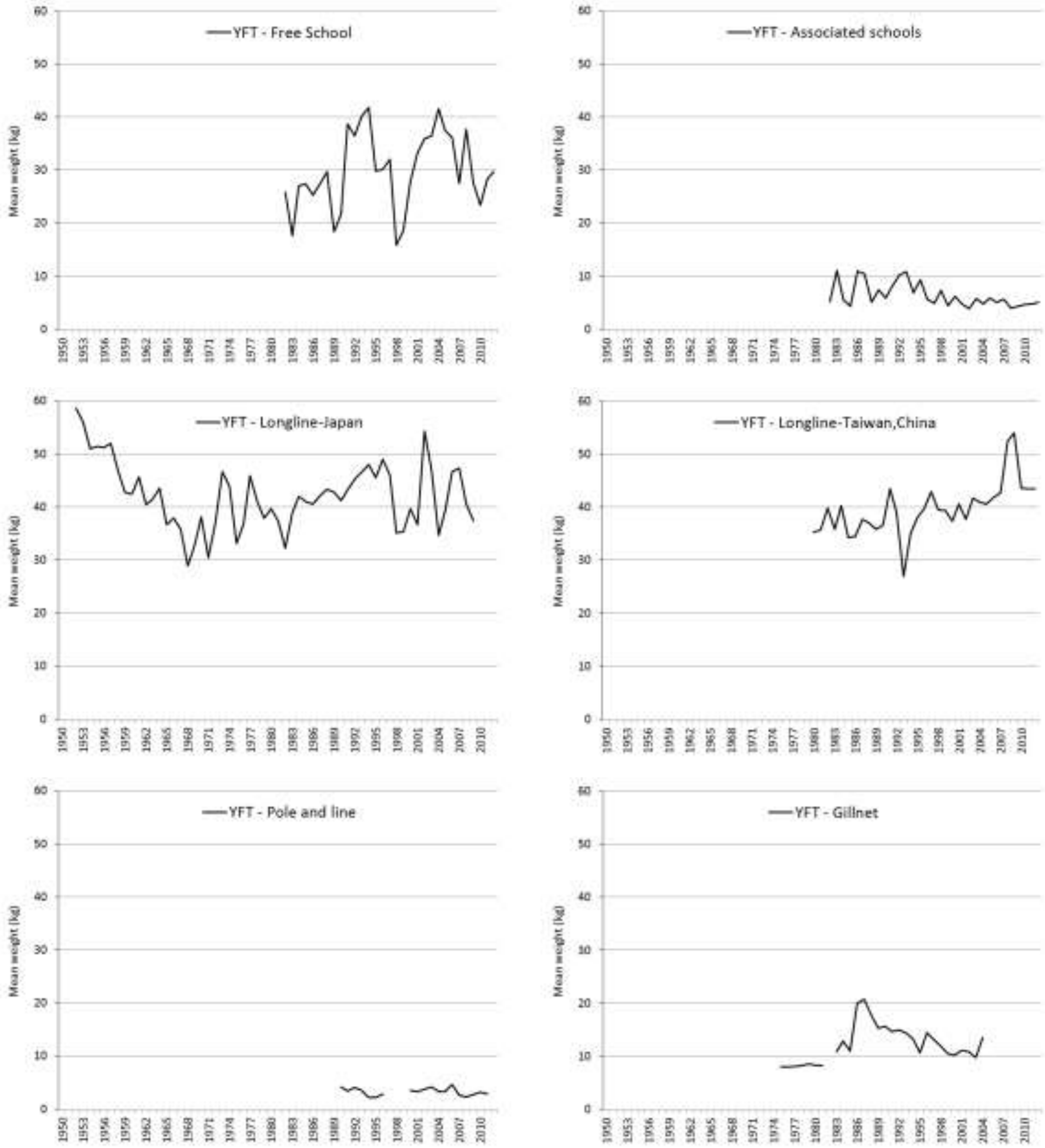



**Fig. 14. Yellowfin tuna:** Changes in average weight (kg) of yellowfin tuna from 1950 to 2012 – all fisheries combined (top) and by main fleet (Data as of September 2013).

**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. 15). 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, 10,834 specimens (17.1%), have been recovered and reported to the IOTC Secretariat. More than 85.9% of these recoveries we made by the purse seine fleets operating in the Indian Ocean, while around 9.1% 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 yellowfin tuna to the databases, or which 151 were recovered, mainly from the Maldives.

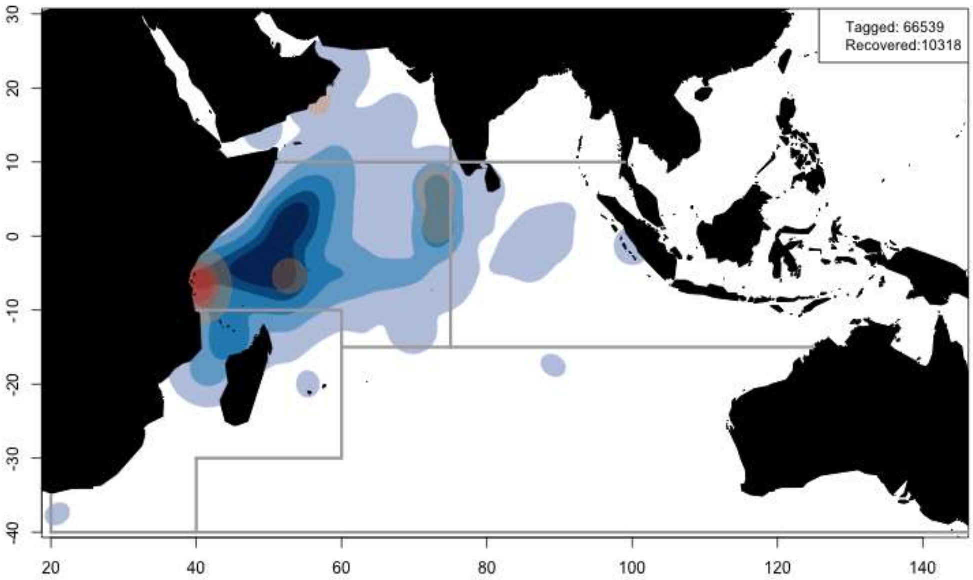



**Fig. 15. Yellowfin tuna:** Densities of releases (in red) and recoveries (in blue). The red line represents the stock assessment areas (Data as of September 2012).

**STOCK ASSESSMENT**

As no formal stock assessment was carried out in 2013, the management advice for yellowfin tuna was 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), the ASPM based case using steepness of 0.9, and current catch and effort trends presented at the current meeting. 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.

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.

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** |
|---|---|
| 2012 catch estimate | 368,663 t |
| Mean catch from 2008–2012 | 317,505 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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 26,184 t<br>24,545 t | (green) |
| | MSY (4 models):<br>$F_{2009}/F_{MSY}$ (4 models):<br>$SB_{2009}/SB_{MSY}$ (4 models):<br>$SB_{2009}/SB_0$ (4 models): | 29,900–34,200 t<br>0.50–0.63<br>1.07–1.59<br>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 ($SB_{year}/SB_{MSY}\geq 1$) |
|---|---|---|
| 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.*** 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. The most recent catch estimate of 26,184 t in 2012 indicate that the stock status is unlikely to have changed. Thus, the stock remains not overfished and not subject to overfishing. However, recent revisions to the catch history for swordfish make it timely for a new stock assessment to be undertaken in 2014.

***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 2013 agreed to Resolution 13/10*on interim target and limit reference points and a decision framework*, 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 |

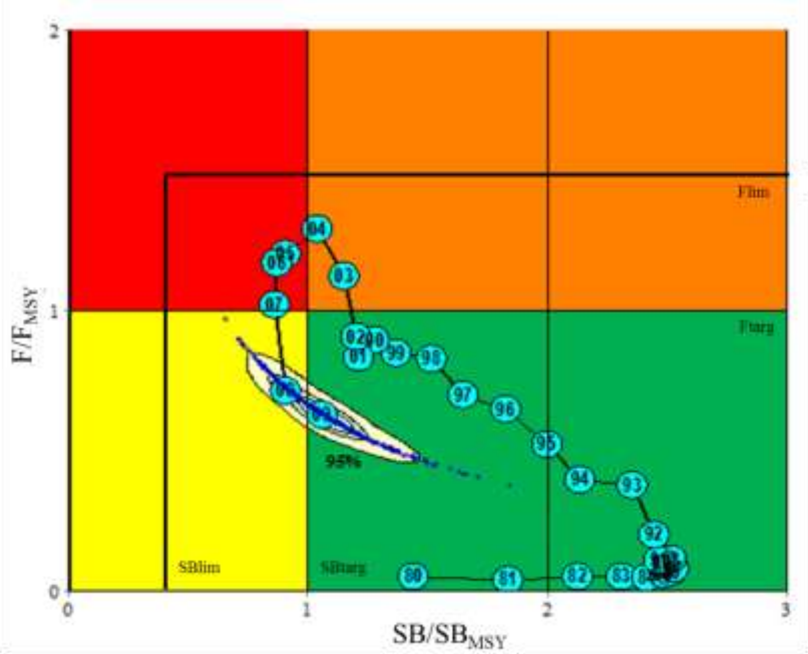



**Fig. 1.** Swordfish: ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2010. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference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

# 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 | | 2013 stock status determination |
|---|---|---|---|
| Southwest Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 6,662 t<br>6,808 t | |
| | MSY (3 models):<br>$F_{2009}/F_{MSY}$ (3 models):<br>$SB_{2009}/SB_{MSY}$ (3 models):<br>$SB_{2009}/SB_0$ (3 models): | 7,100 t–9,400 t<br>0.64–1.19<br>0.73–1.44<br>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 ($SB_{year}/SB_{MSY}$≥ 1) |
|---|---|---|
| Stock subject to overfishing ($F_{year}/F_{MSY}$> 1) | | |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 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 is not a separate genetic stock. However this region has been subject to localised depletion over 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 8,099 t, which equals 121.3% 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 2013 are less than 34% for $F_{MSY}$ and less than 32% for $B_{MSY}$ (Table 4). Despite the fact that the total estimated catch in 2011 was 6,663 t, and 6,662 t in 2012, lower that the recommended level set by the SC in 2011 (6,678 t), the resource remains **not subject to overfishing** but **overfished**, as no further estimate of biomass is available.

***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 8,099 t caught in this region in 2010. 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 $B_{MSY}$.
- total estimated catch in 2011 was 6,663 t, and 6,662 t in 2012, lower that the recommended level set by the SC in 2011 (6,678 t).
- 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 2013 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, 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%** (3,960 t) | **80%** (5,280 t) | **100%** (6,600 t) | **120%** (7,920 t) | **140%** (9,240 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. Swordfish is also subject to the following non species-specific Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- Resolution 11/04 *on a regional observer scheme*
- 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*

### FISHERIES INDICATORS

***Swordfish: 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.

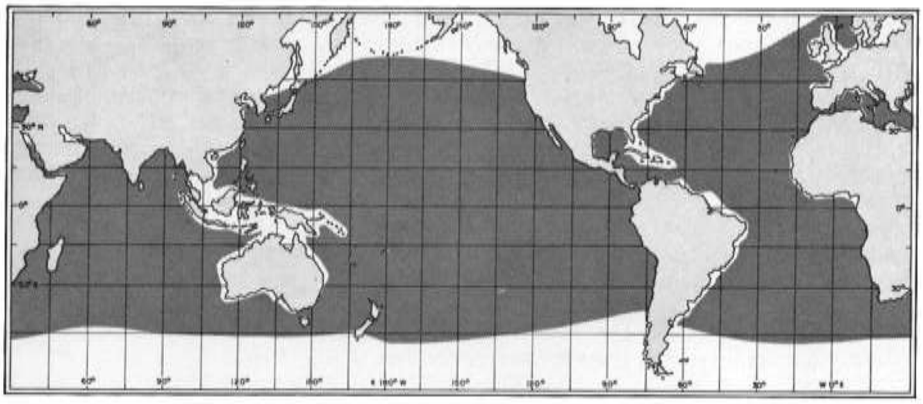


**Fig. 2.** Swordfish: The worldwide distribution of swordfish (Source: Nakamura 1984)

**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<br>**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.<br>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).<br>L-W relationships for the Indian Ocean are: females TW=0.00002409*LJFL^2.86630,<br>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***

Around 90% of swordfish are caught mainly using drifting longlines, on longline fisheries directed to tunas (Table 6, LL) or swordfish (Table 6, ELL), while the remaining the catches are taken by other fisheries, in particular drifting gillnets. 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 (Fig. 3). Swordfish were mainly a bycatch of industrial longline fisheries before the early 1990's with catches slightly increasing from 1950 to 1990 proportionally to the increase in the catches of target species (tropical and temperate tunas).

The catches of swordfish markedly increased after 1990, from around 9,000 t in 1991 to a peak of 38,000 t in 1998 and 41,000 t in 2004. The change in target species from tunas to swordfish by part of the fleet of Taiwan,China along with the development of longline fisheries in Australia, Reunion island, Seychelles and Mauritius and the arrival of longline fleets from the Atlantic Ocean (Portugal, Spain, the UK and other fleets operating under various flags), all targeting swordfish, are the main reasons for this significant increase.

Since 2004, annual catches have declined steadily (Fig. 3), largely due to the continued decline in the number of active Taiwan,China longliners in the Indian Ocean. 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. 2). Catches of swordfish of up to 6,000 t have been recorded in recent years for a fleet of deep-freezing and fresh tuna longliners operating under flags of non-reporting countries (NEI). The catches have been low since 2006, at just over 1,000 t (Fig. 4).

Swordfish is mostly exploited in the western Indian Ocean (Fig. 5), in waters off Somalia, and in the southwest Indian Ocean. Other important fisheries operate in waters off Sri Lanka, Western Australia and Indonesia. In recent years (Fig. 3) the catches of swordfish in the western tropical Indian Ocean have dropped considerably (Table 7), especially in areas off Somalia, Kenya and Tanzania, from around 25,000 t in 2005 to 15,000 t in 2008, and falling to the lowest levels of around 9,000 t in 2011. The drop in catches is the consequence of a drop in fishing effort in the area by longline fisheries, due to either piracy or decreased fish abundance, or a combination of both.

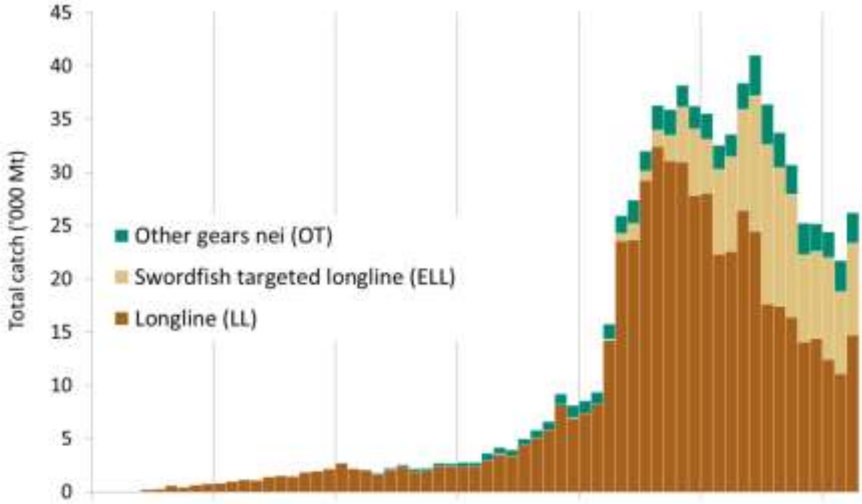



**Fig. 3** Swordfish: Catches of swordfish by gear and year recorded in the IOTC Database (1950–2012) (Data as of October 2013).

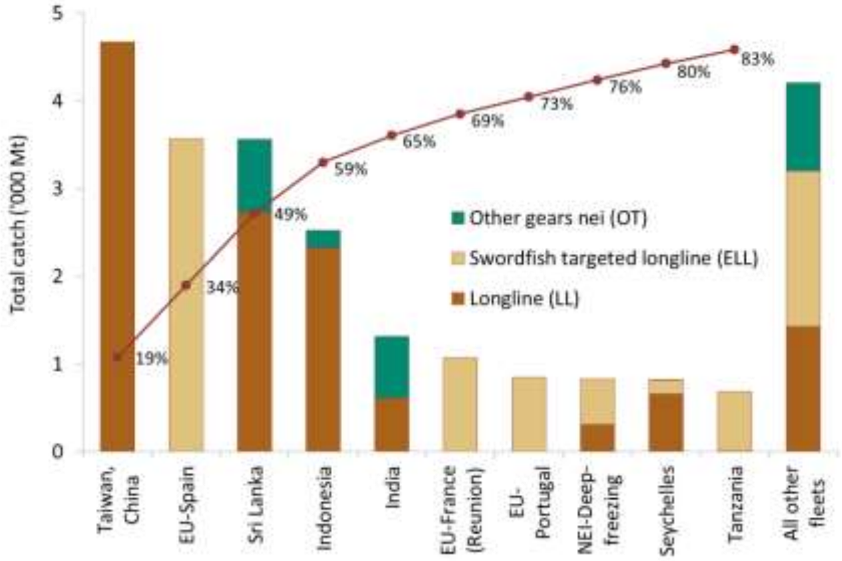



**Fig. 4**. **Swordfish**: average catches in the Indian Ocean over the period 2009–12, by country. Countries are ordered from left to right, according to the importance of catches of swordfish reported. The red line indicates the (cumulative) proportion of catches of swordfish for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

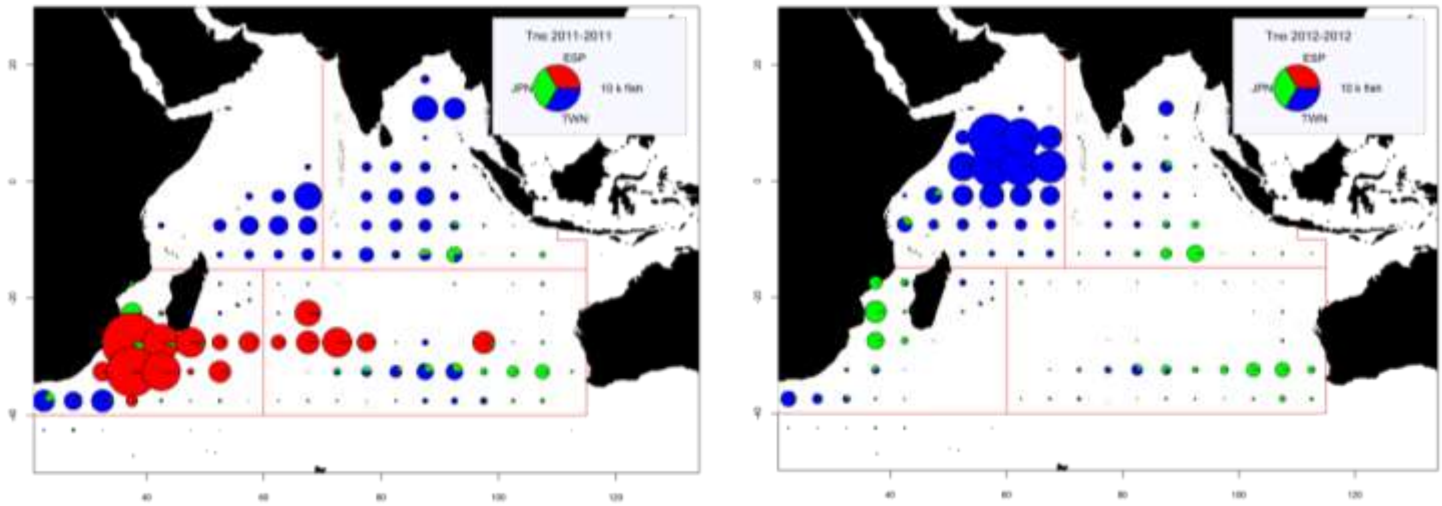


**Fig. 5a–b. Swordfish**: Time-area catches (total combined in tonnes) of swordfish as reported for the longline fleets of Japan (JPN), Taiwan,China (TWN), and EU-Spain (ESP), the latter directed at swordfish, for 2011 and 2012 (excluding EU-Spain). Red lines represent the boundaries of the areas used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

**TABLE 6**. **Swordfish**: Best scientific estimates of the catches of swordfish by type of fishery for the period 1950–2012 (in metric tons). Data as of October 2013.

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| ELL | 0 | 0 | 0 | 9 | 1,847 | 10,417 | 10,700 | 13,415 | 15,625 | 13,630 | 12,011 | 8,581 | 8,262 | 9,708 | 7,742 | 8,604 |
| LL | 282 | 1,425 | 2,141 | 4,524 | 22,934 | 19,977 | 25,224 | 23,819 | 16,977 | 16,843 | 15,949 | 13,699 | 14,336 | 12,292 | 11,113 | 14,771 |
| OT | 37 | 39 | 180 | 655 | 1,774 | 2,841 | 2,483 | 3,769 | 3,793 | 3,253 | 2,758 | 2,970 | 2,577 | 2,433 | 2,828 | 2,809 |
| **Total** | **320** | **1,464** | **2,320** | **5,188** | **26,556** | **33,235** | **38,407** | **41,003** | **36,395** | **33,726** | **30,718** | **25,250** | **25,175** | **24,433** | **21,683** | **26,184** |

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

**TABLE 7**. **Swordfish**: Best scientific estimates of the catches of swordfish by fishing area for the period 1950–2012 (in metric tons). Data as of October 2013.

| Area | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| NW | 100 | 545 | 776 | 1,887 | 8,303 | 10,587 | 15,737 | 13,635 | 13,133 | 11,529 | 8,869 | 6,566 | 4,785 | 2,843 | 2,672 | 7,961 |
| SW | 14 | 256 | 406 | 607 | 8,624 | 7,643 | 4,129 | 6,295 | 9,753 | 8,940 | 7,366 | 6,186 | 6,429 | 8,099 | 6,663 | 6,662 |
| NE | 168 | 451 | 755 | 2,206 | 6,799 | 9,274 | 9,871 | 11,470 | 7,748 | 9,272 | 9,250 | 8,956 | 10,809 | 10,037 | 9,589 | 8,770 |
| SE | 37 | 204 | 308 | 347 | 2,741 | 5,713 | 8,648 | 9,570 | 5,747 | 3,980 | 5,219 | 3,539 | 3,147 | 3,444 | 2,754 | 2,790 |
| OT | 0 | 8 | 75 | 142 | 89 | 19 | 22 | 33 | 15 | 5 | 14 | 5 | 5 | 11 | 7 | 3 |
| **Total** | **319** | **1,464** | **2,320** | **5,188** | **26,556** | **33,236** | **38,407** | **41,003** | **36,396** | **33,726** | **30,718** | **25,252** | **25,175** | **24,434** | **21,685** | **26,186** |

**Areas**: Northwest Indian Ocean (**NW**); Southwest Indian Ocean (**SW**); Northeast Indian Ocean (**NE**); Southeast Indian Ocean (**SE**); Southern Indian Ocean (**OT**)
***Note: differences in the total catches in table 6 and 7 are due to rounding errors.***

### *Uncertainty of time–area catches*

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

- **Drifting gillnet fishery of Pakistan**: For the first time Iran has 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 around 2% or less 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 between 5% to 10% 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 around 5% or less 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 (representing around 4% of the total catches of swordfish in the Indian Ocean).
- **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.
- **Changes to the catch series**: There have been changes to the catches of swordfish since the WPB meeting in 2012. Most changes that have been made to the data series since the last WPB are relatively small increases to the nominal catch as a result of reallocation of catch reported as other billfish species or as aggregated species groups reported by Sri Lanka, I.R. Iran, and Pakistan to a lesser extent. These changes, however, did not lead to very significant changes in the total catch estimates.

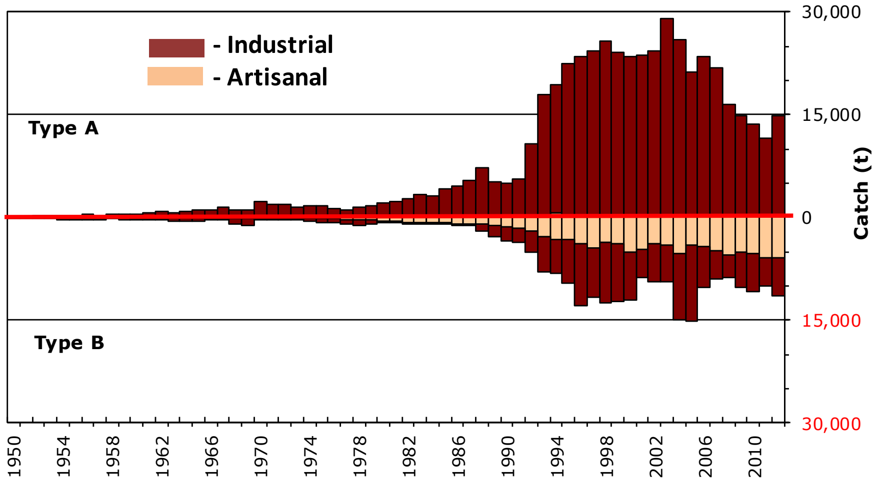



**Fig. 6. Swordfish**: Uncertainty of annual catch estimates for swordfish (Data as of October 2013).

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.

***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** 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 length frequency data recorded for longliners of Japan and Taiwan,China, for which average weights of swordfish derived from length frequency data and catch-and-effort data are very different.
- 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.

***Swordfish: Effort trends***

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2011 and 2012 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 2011 and 2012 are provided in Fig. 8.

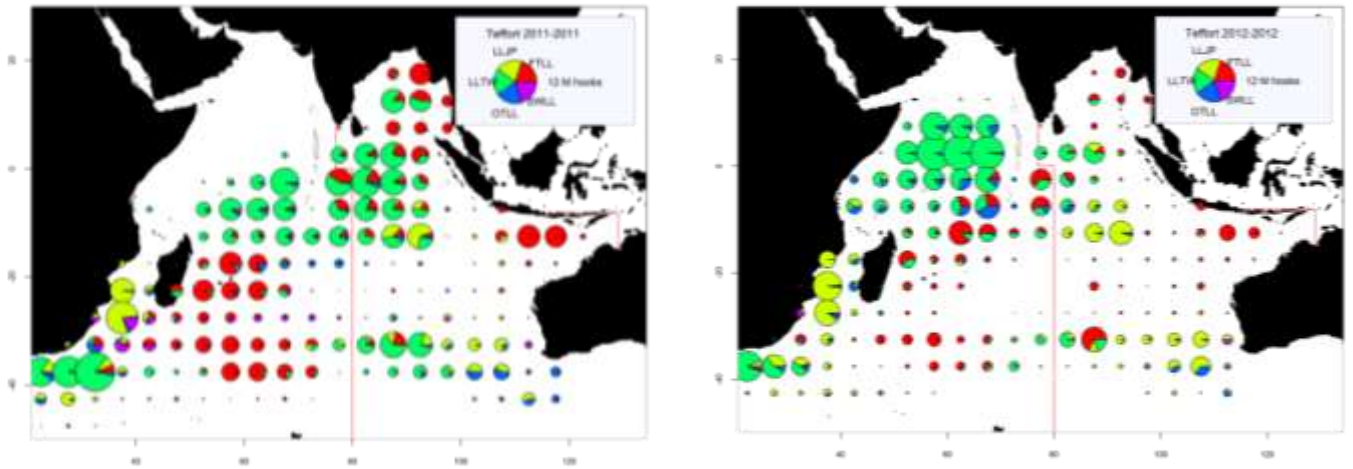


**Fig. 7.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (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)

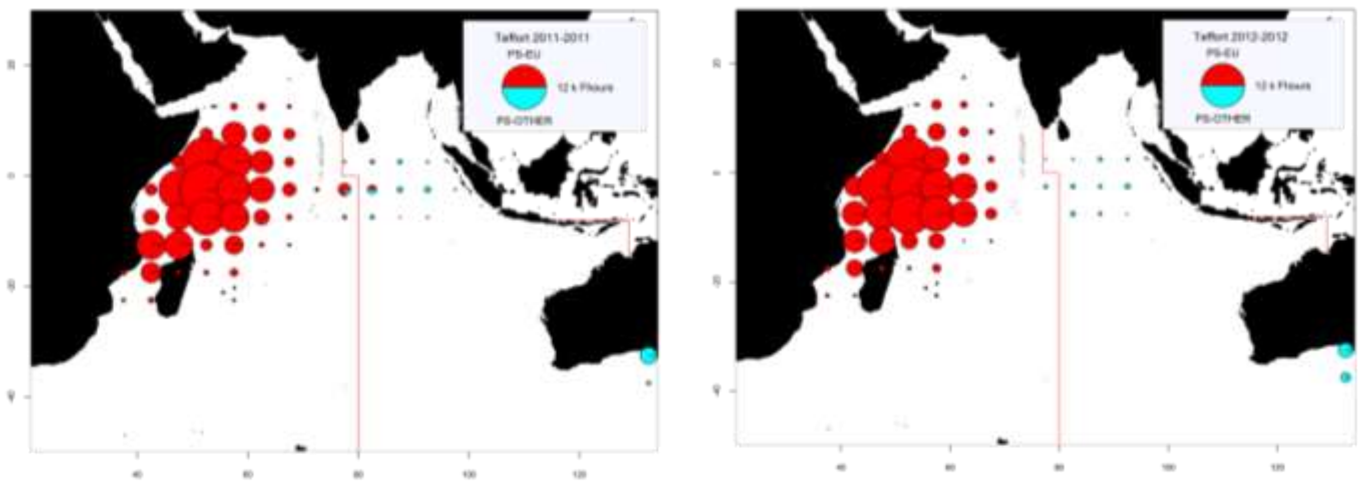


**Fig. 8.** Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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. 9 and 10), 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).

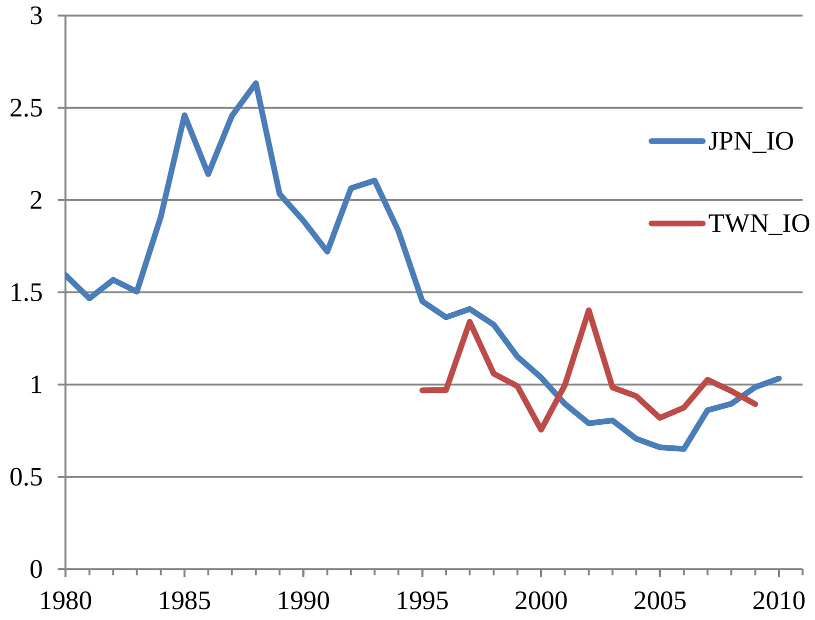
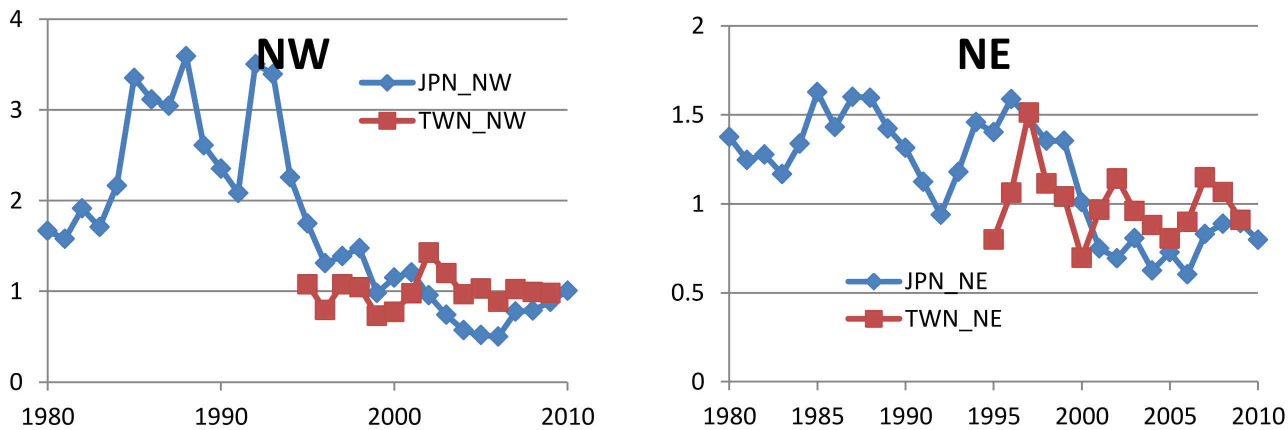



**Fig. 9.** Swordfish: Aggregate Indian Ocean CPUE series for swordfish. Series have been rescaled relative to their respective means from 1995–2010



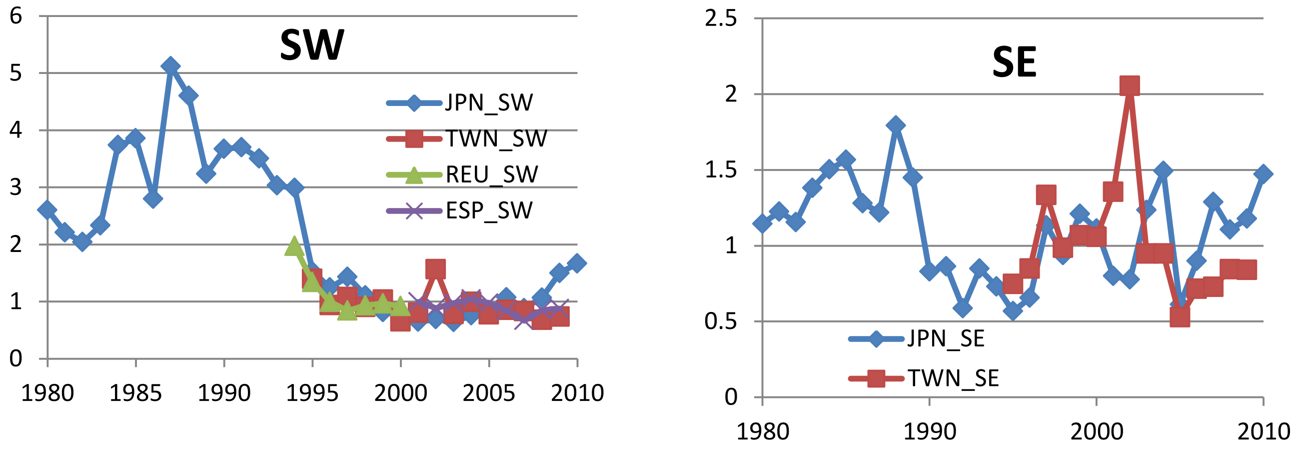



**Fig. 10.** Swordfish: CPUE series for Indian Ocean swordfish assessments by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods). NW – north-west; SW – south-west; NE – north-east; SE – south-east Indian Ocean.

## 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 focused 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 50$^{th}$ (5$^{th}$–95$^{th}$) 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 |
|---|---|---|
| 2012 catch estimate | 26,184 t | 6,662 t |
| Mean catch from 2008–2012 | 24,545 t | 6,808 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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 8,315 t<br>9,417 t | **Uncertain** |
| | MSY (range):<br>$F_{2011}/F_{MSY}$ (range):<br>$B_{2011}/B_{MSY}$ (range):<br>$B_{2011}/B_{1950}$ (range): | 8,605 (6,278–11,793)<br>1.03 (0.15–2.19)<br>1.17 (0.75–1.55)<br>0.58 (0.38–0.78) | |

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

| **Colour key** | Stock overfished($B_{year}/B_{MSY} < 1$) | Stock not overfished ($B_{year}/B_{MSY} \geq 1$) |
|---|---|---|
| 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.*** Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished and close to optimum fishing levels (Table 1). However, as this is the first time that the WPB used such a method on marlin species, further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken before the WPB uses it to determine stock status. Thus, the stock status remains **uncertain**. Nonetheless in using the SRA method for comparative purposes with other stocks, the WPB considers that the use of the target reference points may be possible for the approach. The stock appears to show an increase in catch rates which is a cause of concern, indicating that fishing mortality levels may be becoming too high (Fig. 1). 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 concern. Research emphasis on developing possible CPUE indicators and further exploration of stock assessment approaches for data poor fisheries are warranted. Given the limited data being reported for coastal gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps.

***Outlook.*** Total catch for black marlin in recent years has continued to increase to a total of 8,315 t in 2012 (10,421 in 2011). The following key points should be noted:

- Maximum Sustainable Yield estimate for the whole Indian Ocean is between 6,278 and 11,793 t.
- improvement in data collection and reporting, particularly for coastal gillnet and sports fisheries, is required to further assess the stock.
- research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are warranted.

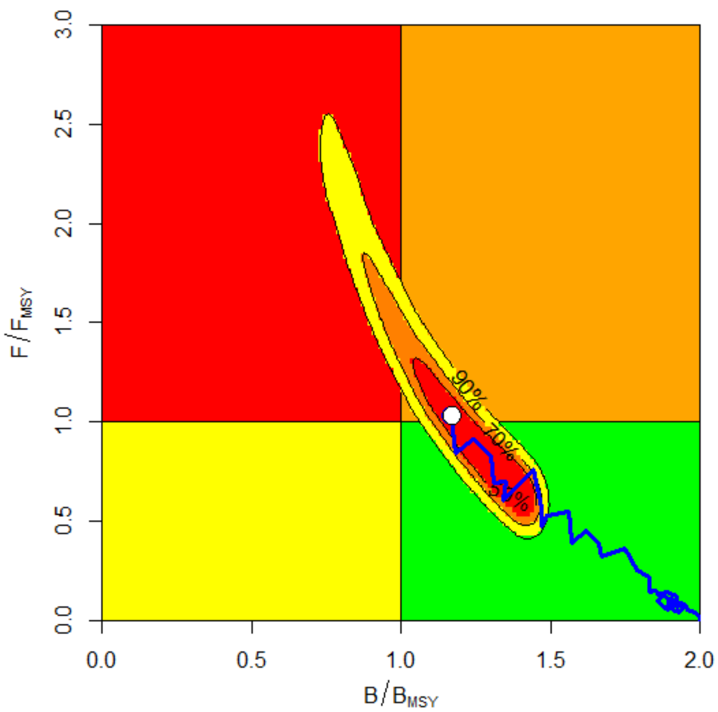



**Fig. 1**. Black marlin: Stock reduction analysis aggregated Indian Ocean assessment Kobe plots for black marlin (95% confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the total biomass (B) ratio and F ratio for each year 1950–2011.

## 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 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- Resolution 11/04 *on a regional observer scheme*
- 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*

### FISHERIES INDICATORS

***Black marlin: General***

Black marlin (*Makaira indica*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans (Fig. 2). 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.

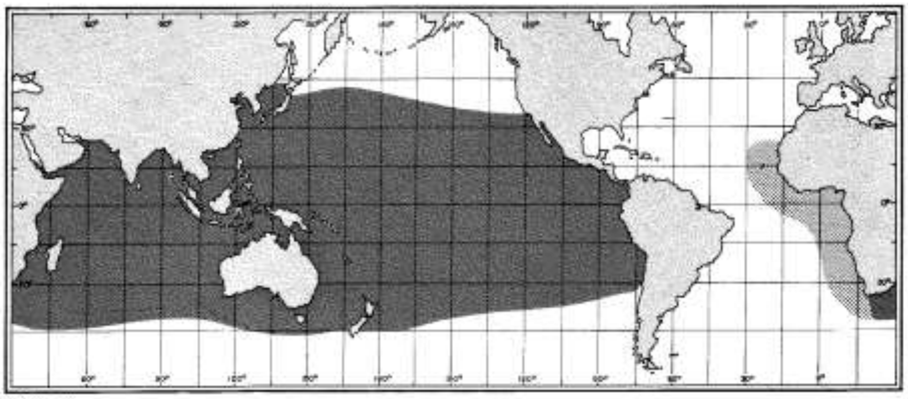


**Fig. 2.** Black marlin: The worldwide distribution of black marlin (Source: Nakamura 1984)

**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<br>**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℃. 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.<br>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.<br>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.<br>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.<br>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 (19%) and gillnets (59%) with remaining catches taken by troll and hand lines (Table 3, Fig. 3). Black marlin are not targeted by industrial fisheries, but is 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 (2010–12) the fleets of Sri Lanka (longline and gillnet), Indonesia (troll and hand lines) and India (gillnet and troll) account for around 74% of the catch of black marlin (Fig. 4). Catches of black marlin have increased steadily since the 1990s, from around 2,800 t in 1991 to over 10,400 t in 2011. Current annual catches are estimated at between 8,000 t to 10,000 t (Table 3).

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. 5).

The catches of black marlin in Sri Lanka have risen steadily since the mid-1990's as a result of the development of the fishery using a combination of drifting gillnets and longlines, from around 1,000 t in the early 1990s to over 4,500 t in 2011. In recent years (2009–11) India has reported higher catches of black marlin for its fisheries, amounting to around 1,000 t to 2,000 t, largely from increases in catches from gillnet and troll.

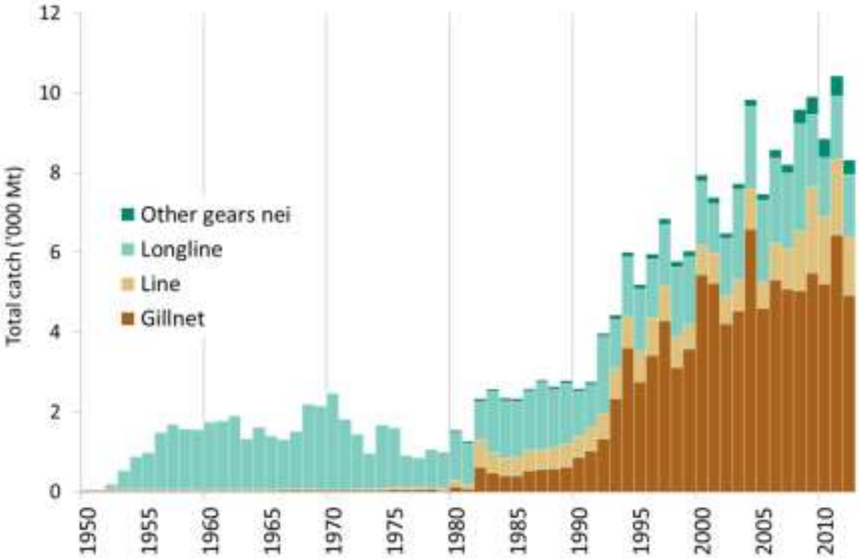



**Fig. 3.** Black marlin: Catches of black marlin by gear and year recorded in the IOTC Database (1950–2012) (Data as of October 2013).

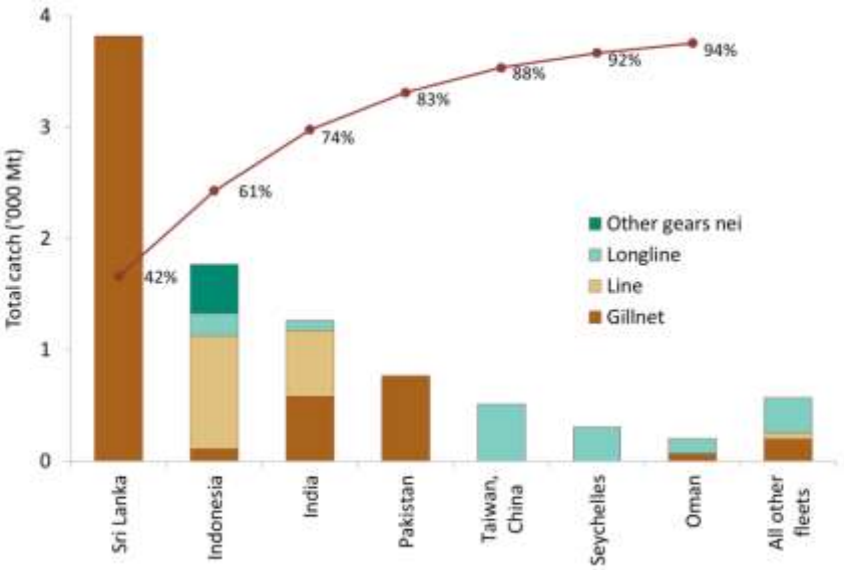



**Fig. 4.** Black marlin: Average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of black marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

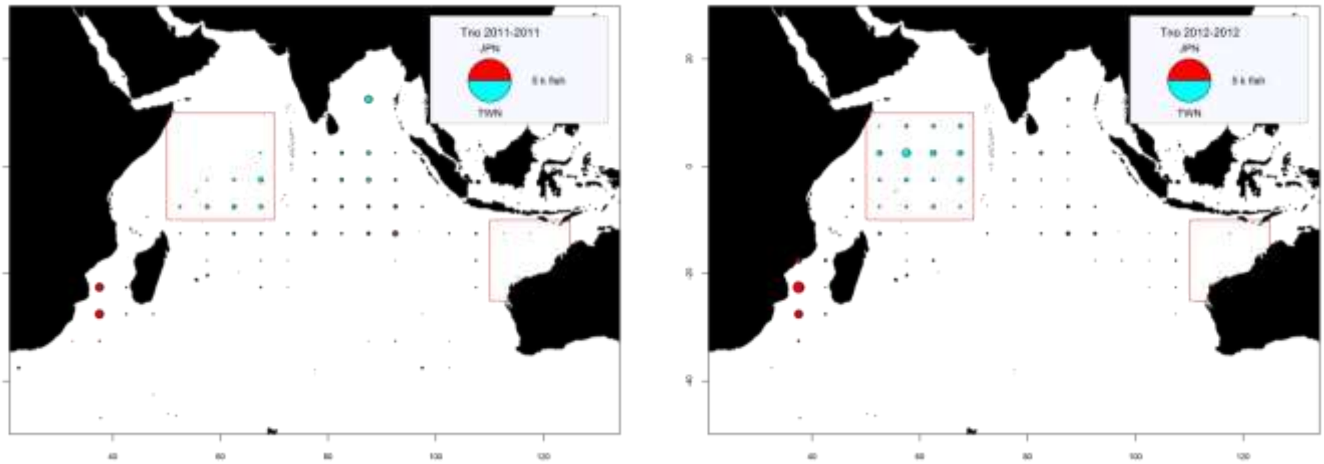


**Fig. 5a–b.** Black marlin: Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2011 and 2012 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

**TABLE 2.** Black marlin: Best scientific estimates of the catches of black marlin by type of fishery for the period 1950–2012 (in metric tons) (Data as of October 2013).

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| LL | 846 | 1,633 | 1,287 | 1,370 | 1,486 | 1,920 | 2,277 | 2,075 | 2,057 | 2,123 | 1,879 | 2,704 | 1,803 | 1,498 | 1,598 | 1,562 |
| GN | 26 | 31 | 44 | 438 | 2,631 | 5,152 | 4,533 | 6,581 | 4,601 | 5,319 | 5,081 | 5,041 | 5,488 | 5,214 | 6,436 | 4,924 |
| HL | 24 | 27 | 42 | 446 | 727 | 1,020 | 775 | 1,008 | 652 | 913 | 1,018 | 1,479 | 2,159 | 1,669 | 1,891 | 1,477 |
| OT | 0 | 0 | 4 | 65 | 112 | 216 | 142 | 170 | 155 | 216 | 218 | 370 | 452 | 472 | 496 | 353 |
| **Total** | **896** | **1,692** | **1,377** | **2,319** | **4,955** | **8,308** | **7,727** | **9,834** | **7,465** | **8,572** | **8,196** | **9,594** | **9,903** | **8,852** | **10,421** | **8,315** |

**Fisheries:** Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

***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 (by species) also contribute to the uncertainties of the information available to the Secretariat.

Retained catches are uncertain for some fisheries (Fig. 6), 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.
- **Discards** are unknown for most industrial fisheries, mainly longliners. 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.
- **Changes to the catch series**: There have been relatively large changes to catches of black marlin since the WPB meeting in 2012, mostly as a result of revisions to catches estimates for Sri Lanka. Catches of marlins (by species) in Sri Lanka have frequently been misidentified, making catches in previous years highly uncertain and subject to sharp fluctuations between years. Estimates of black marlins have subsequently been revised by IOTC from around 1,000 t to over 4,000 t in the last decade in response to

inconsistencies identified in the reported data; with most of the increase the result of reallocation of catch previously reported as blue marlin.

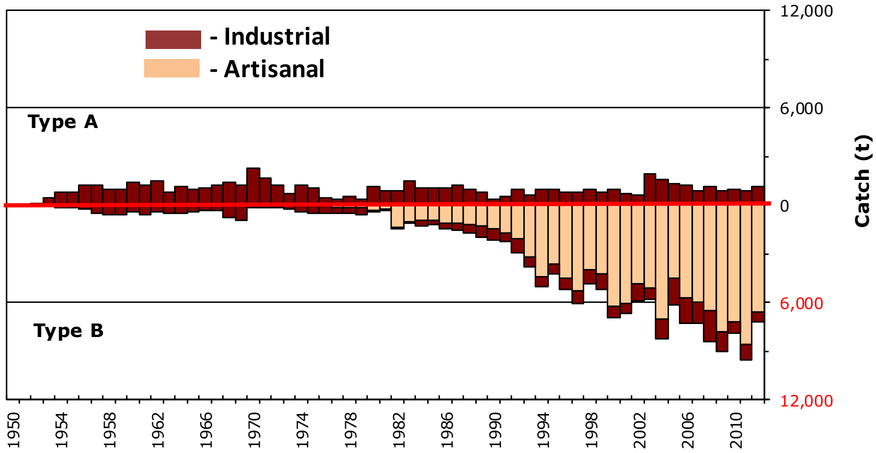
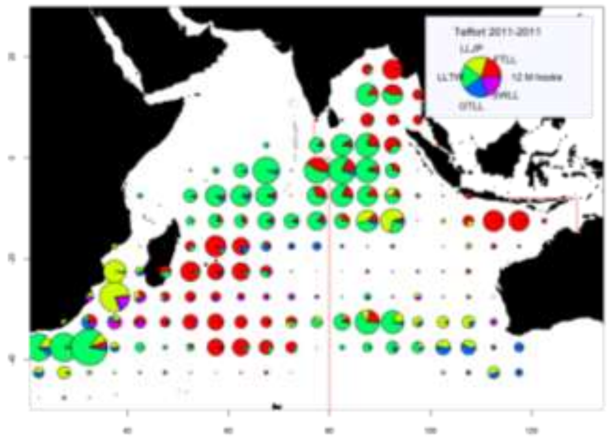



**Fig. 6**. Black marlin: Uncertainty of annual catch estimates for black marlin (Data as of October 2013). Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by 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 2011 and 2012 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 2011 and 2012are provided in Fig. 9.



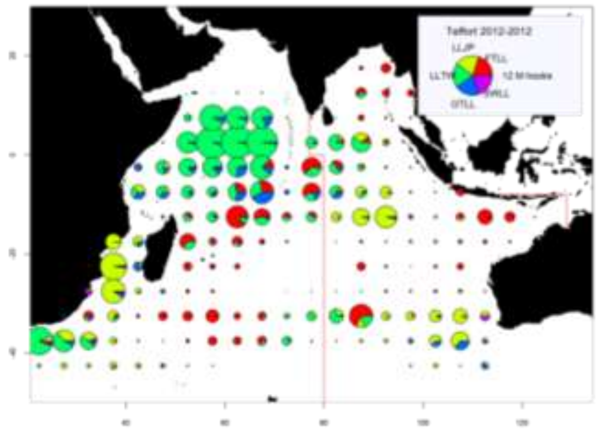


**Fig. 8.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of Ocotber 2013).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (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)

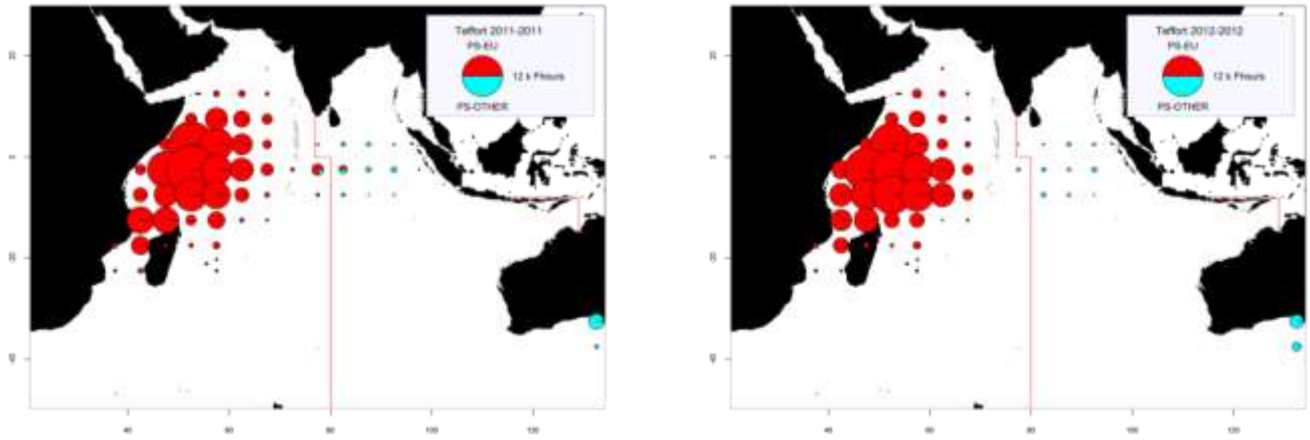



**Fig. 9.** Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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. 10) 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.

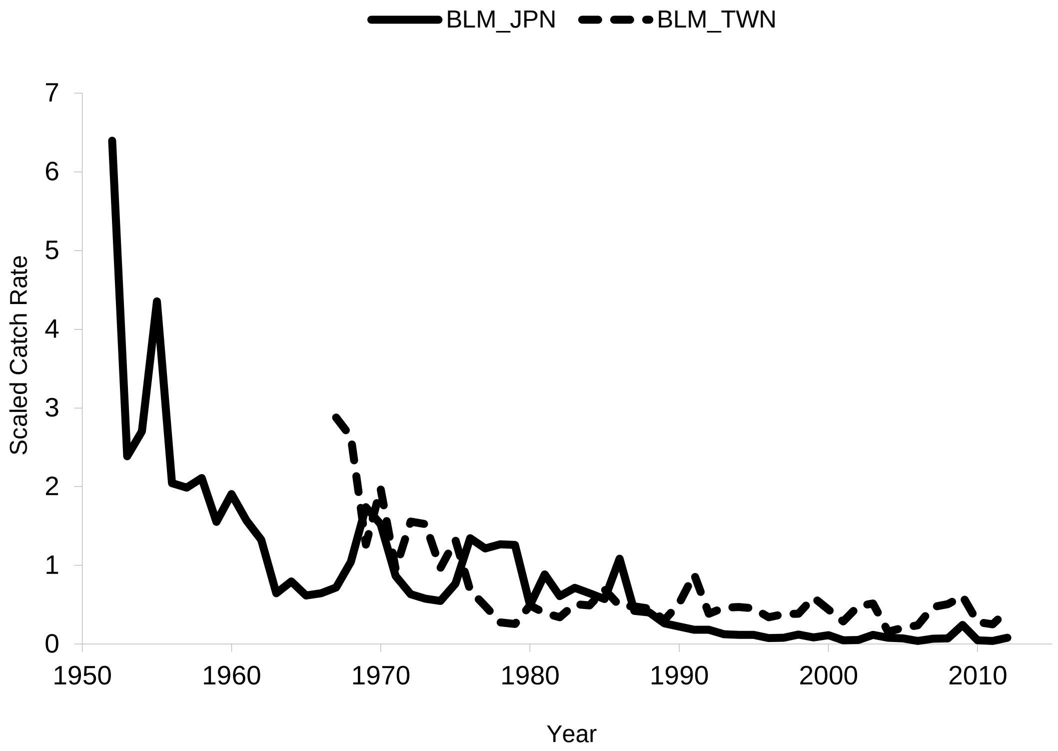



**Fig. 10.** Black marlin: Standardised catch rates of black marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

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)***

**Fish size:** 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. 11).

**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.

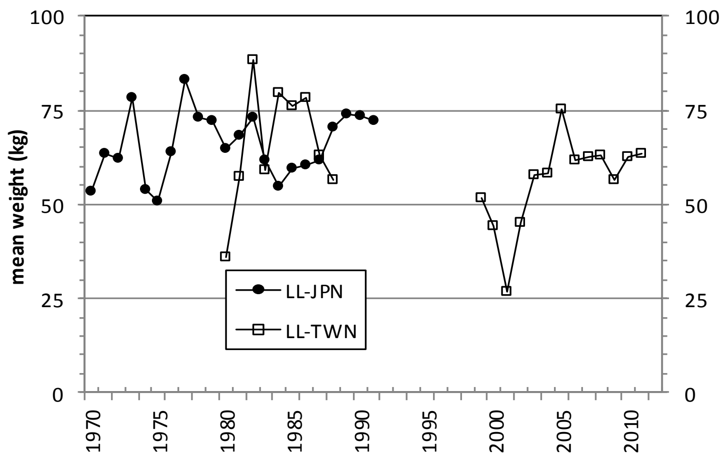



**Fig. 11**. Black marlin: Average weight of black marlin (kg) estimated from the size samples available for longliners of Japan (JPN:1970–2012) and Taiwan,China (TWN:1980–2012). Note: Average weights are shown only for years in which 300 or more specimens were sampled for length.

## STOCK ASSESSMENT

Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished and close to optimum fishing levels (Tables 1, 3). However, as this is the first time that the WPB used such a method on marlin species, further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken before the WPB uses it to determine stock status. Thus, the stock status remains **uncertain**. Nonetheless in using the SRA method for comparative purposes with other stocks, the WPB considers that the use of the target reference points may be possible for the approach. The stock appears to show an increase in catch rates which is a cause of concern, indicating that fishing mortality levels may be becoming too high (Fig. 1). 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 concern. Research emphasis on developing possible CPUE indicators and further exploration of stock assessment approaches for data poor fisheries are warranted. Given the limited data being reported for coastal gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps.

**TABLE 3.** Black marlin (*Makaira indica*) stock status summary

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2012 catch estimate | 8,315 t |
| Mean catch from 2008–2012 | 9,417 t |
| MSY (80% CI) | 8,605 (6,278–11,793) |
| Data period used in assessment | 1950–2011 |
| $F_{2012}/F_{MSY}$ (80% CI) | 1.17 (0.15–2.19) |
| $B_{2012}/B_{MSY}$ (80% CI) | 1.03 (0.75–1.55) |
| $SB_{2012}/SB_{MSY}$ | – |
| $B_{2012}/B_{1950}$ (80% CI) | – |
| $SB_{2012}/SB_{1950}$ | – |
| $B_{2012}/B_{1950,\ F=0}$ | – |

| | |
|---|---|
| $SB_{2012}/SB_{1950,\ F=0}$ | – |

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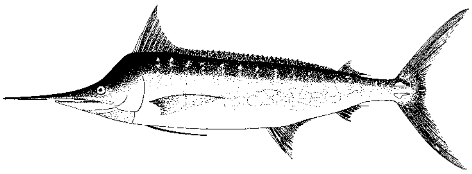
# APPENDIX XV
# EXECUTIVE SUMMARY: BLUE MARLIN

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** | | **2013 stock status determination** |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 13,885 t<br>10,640 t | |
| | MSY (range):<br>$F_{2011}/F_{MSY}$ (range):<br>$B_{2011}/B_{MSY}$ (range):<br>$B_{2011}/B_{1950}$ (range): | 11,690 (8,023–12,400)<br>0.85 (0.63–1.45)<br>0.98 (0.57–1.18)<br>0.48 (na) | |

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

| **Colour key** | Stock overfished($B_{year}/B_{MSY}$< 1) | Stock not overfished ($B_{year}/B_{MSY}$≥ 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 standardised longline CPUE series indicate a decline in abundance in the early 1980s, followed by a constant or slightly increasing abundance over the last 20 years. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicates the stock is currently being exploited at sustainable levels and that the stock is at the optimal biomass level. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method, Stock reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicates that the stock was most likely subject to overfishing in the recent past. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **not overfished** and **not subject to overfishing** (Table 1; Fig. 1). However, the uncertainty in the data available for assessment purposes and the CPUE series suggests that the advice should be interpreted with caution as the stock may still be in an overfished state (biomass less than $B_{MSY}$) (Table 1; Fig. 1). Given the recent declining effort trend, and a clear rebuilding trajectory (Fig. 1), fishing effort is not considered an immediate concern. Research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are still warranted. Given the limited data being reported for gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps.

***Outlook.*** Total catch and effort for blue marlin in recent years has continued to increase to a total of 13,885 t in 2012 (9,919 in 2011). The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is between 8,023–12,400 t.
- improvement in data collection and reporting is required to further assess the stock.
- research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are warranted.

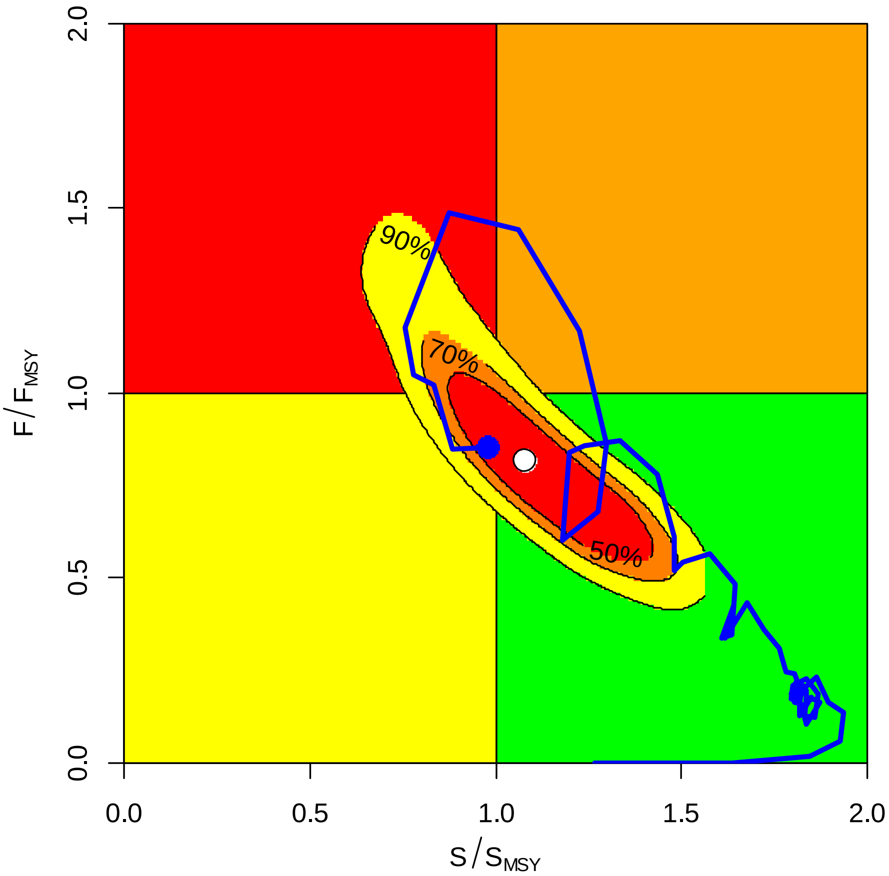



**Fig. 1.** Blue marlin: ASPIC Aggregated Indian Ocean assessment Kobe plot for blue marlin (90% bootstrap confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio (shown as S) and F ratio for each year 1950–2011.

## SUPPORTING INFORMATION

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

### CONSERVATION AND MANAGEMENT MEASURES

Blue marlin (*Makaira nigricans*) 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 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- Resolution 11/04 *on a regional observer scheme*
- 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*

### FISHERIES INDICATORS

#### *Blue marlin: General*

Blue marlin (*Makaira nigricans*) is a large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans (Fig. 2). Table 2 outlines some key life history parameters relevant for management.

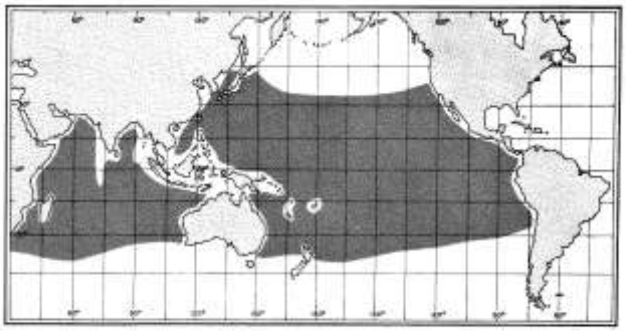


**Fig. 2.** Blue marlin: The worldwide distribution of blue marlin (Source: Nakamura 1984).

**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℃); 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.<br>**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.<br>L-W relationships for the Indian Ocean are: females TW=0.00000026*LJFL^3.59846<br>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 (66%) and gillnets (33%) with remaining catches recorded taken by troll and hand lines (Table 3, Fig. 3). Blue marlins are considered to be a bycatch of industrial and artisanal fisheries. The catches of blue marlin are typically higher than those of black marlin and striped marlin combined.

In recent years (2010–12), the fleets of Taiwan,China (longline), Indonesia (longline and handline), I.R. Iran (gillnet) Sri Lanka (longline gillnet) accounted for around 75% of the total catch of blue marlin (Fig. 4). The distribution of blue marlin catches has changed since the 1980’s with most of the catch now taken in the western areas of the Indian Ocean (Fig. 5).

Catch trends for blue marlin are variable; however, this may reflect the level of reporting. The catches of blue marlin recorded taken by drifting longlines were more or less stable until the mid-80’s, at around 3,000–4,000 t, and have steadily increased since then to between 6,000–8,000 t. The largest catches reported by longlines were recorded in 1998 (~13,000 t). Catches taken by drifting longlines have been recorded by Taiwan,China and Japan fleets and, recently, Indonesia, India, Sri Lanka and several NEI fleets (Fig. 4). In recent years, the deep-freezing longliners from Taiwan,China and Japan 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. 5).

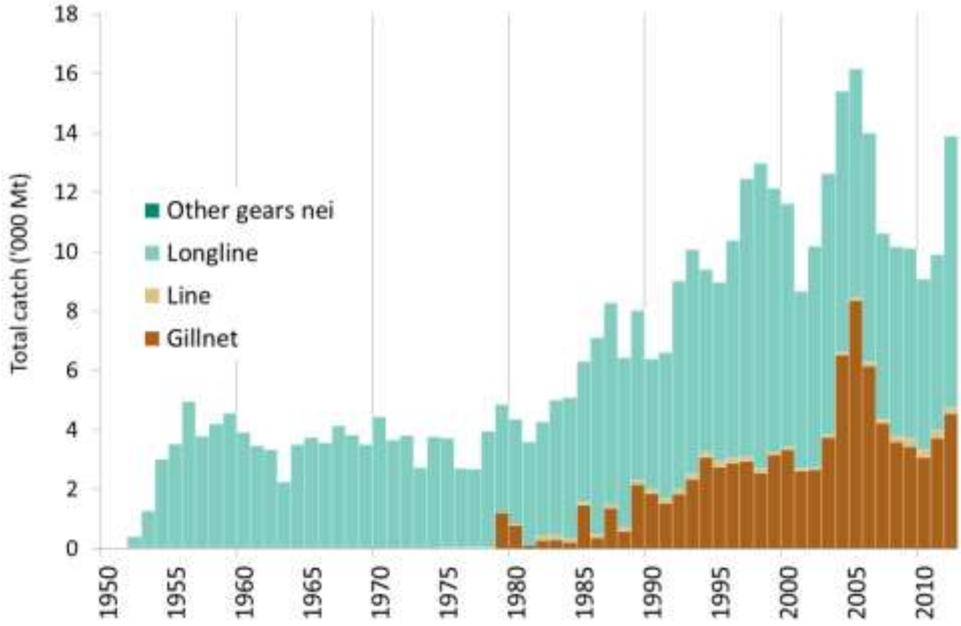



**Fig. 3.** Blue marlin: Catches of blue marlin by gear and year recorded in the IOTC Database (1950–2012) (Data as of October 2013).

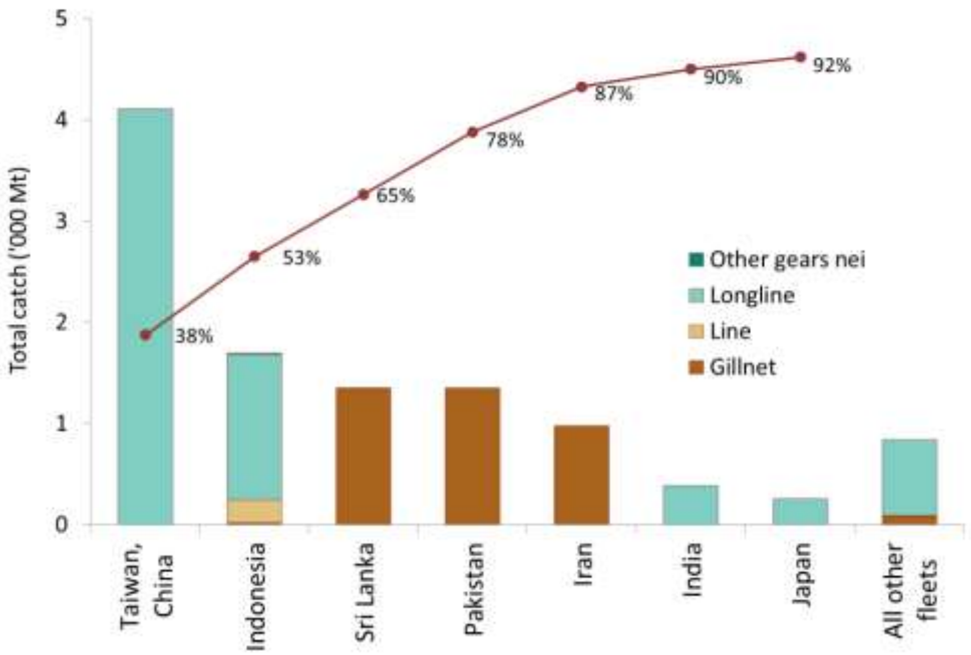



**Fig. 4.** Blue marlin: average catches in the Indian Ocean over the period 2009–12, by country. Countries are ordered from left to right, according to the importance of catches of blue marlin reported. The red line indicates the (cumulative) proportion of catches of blue marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

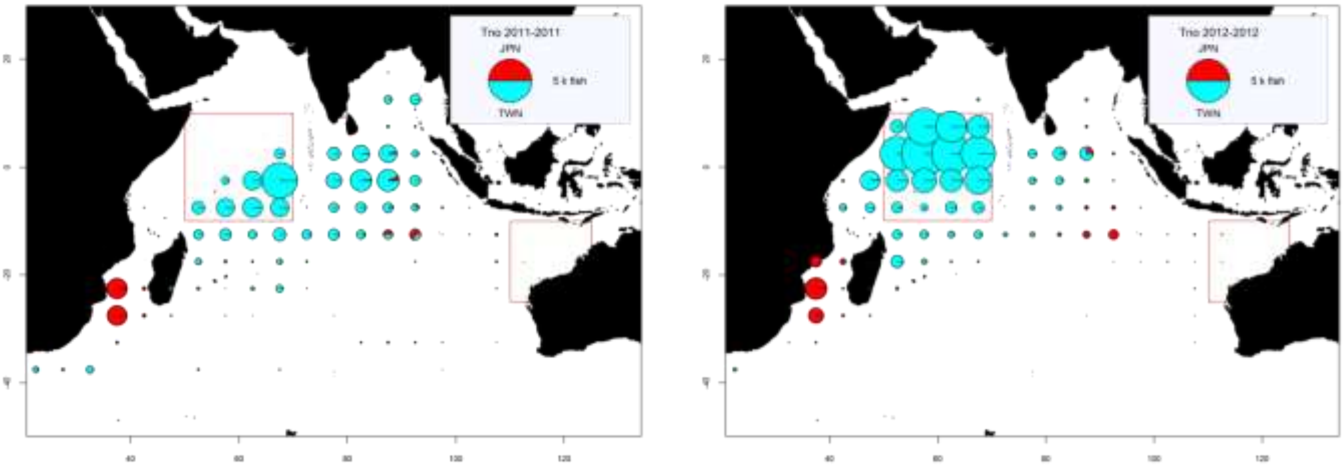


**Fig. 5a–b.** Blue marlin: Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2011 and 2012 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

**TABLE 3**: Blue marlin: Best scientific estimates of the catches of blue marlin by type of fishery for the period 1950–2012 (in metric tons) (Data as of October 2013).

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| LL | 2,563 | 3,515 | 3,489 | 4,977 | 7,197 | 7,368 | 8,786 | 8,794 | 7,714 | 7,727 | 6,264 | 6,367 | 6,433 | 5,730 | 5,921 | 9,141 |
| GN | 1 | 2 | 124 | 761 | 2,489 | 4,464 | 3,752 | 6,508 | 8,367 | 6,155 | 4,228 | 3,599 | 3,440 | 3,063 | 3,716 | 4,546 |
| HL | 5 | 9 | 17 | 105 | 149 | 120 | 81 | 95 | 85 | 121 | 122 | 201 | 250 | 271 | 265 | 187 |
| OT | 0 | 0 | 0 | 2 | 4 | 7 | 5 | 5 | 5 | 7 | 7 | 12 | 15 | 15 | 16 | 11 |
| **Total** | **2,570** | **3,526** | **3,630** | **5,844** | **9,840** | **11,960** | **12,624** | **15,401** | **16,171** | **14,009** | **10,621** | **10,179** | **10,138** | **9,080** | **9,919** | **13,885** |

**Fisheries:** Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

### *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 (by species) also contribute to the uncertainties of the information available to the IOTC Secretariat.

Retained catches are poorly known for most fisheries (Fig. 6) due to:

- catch reports often refer to total catches of all three marlin species combined or as an aggregate of all billfish species; 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 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.
- **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.
- **Changes to the catch series**: There have been relatively large changes to the catches of blue marlin since the WPB meeting in 2012 mainly for the mid-2000s. Catches for I.R. Iran and Pakistan have been revised upwards following improvements by IOTC in the disaggregation by species of catches reported as (aggregated) billfish catches; some of the catches for Sri Lanka have been reassigned as black marlin in response to large fluctuations in the reported catch estimates due to misidentification of the two species.

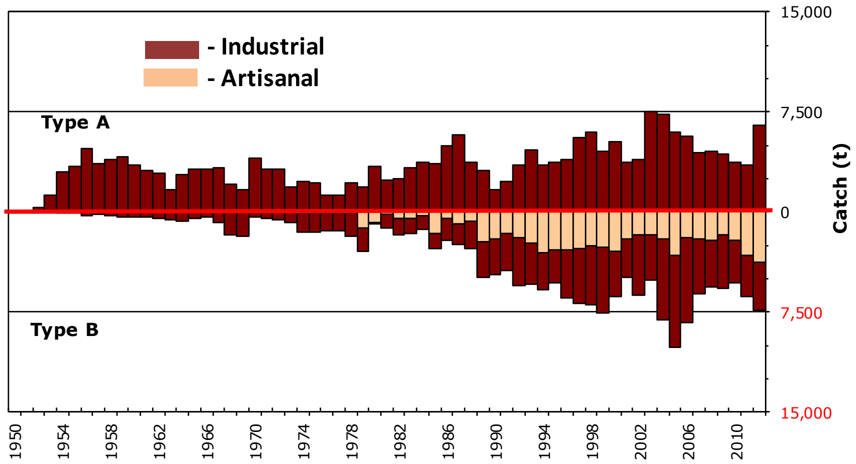



**Fig. 6**. Blue marlin: Uncertainty of annual catch estimates for blue marlin (Data as of October 2013). Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by 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.

### *Blue marlin: Effort trends*

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2011 and 2012 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 2011 and 2012 are provided in Fig. 8.

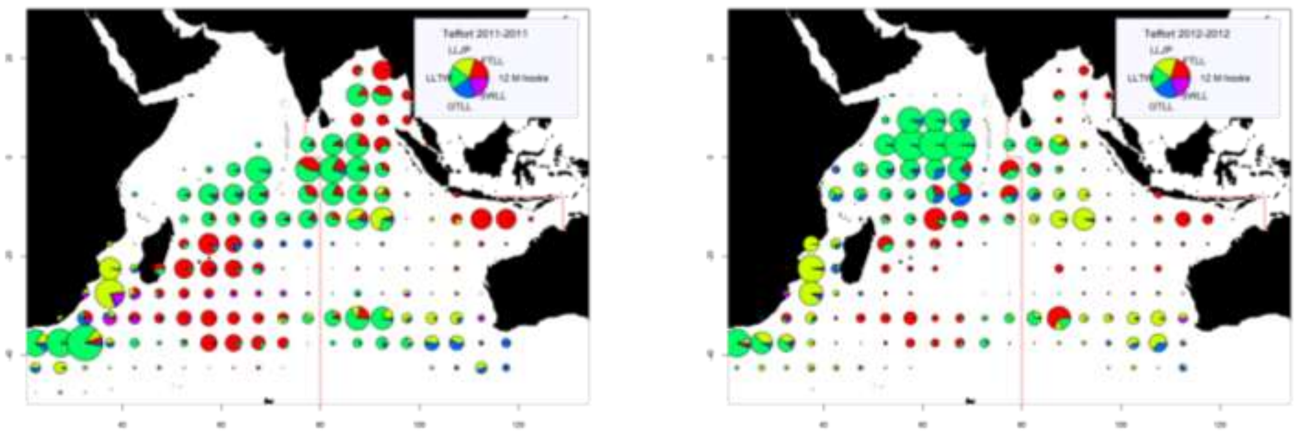


**Fig. 7.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (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)

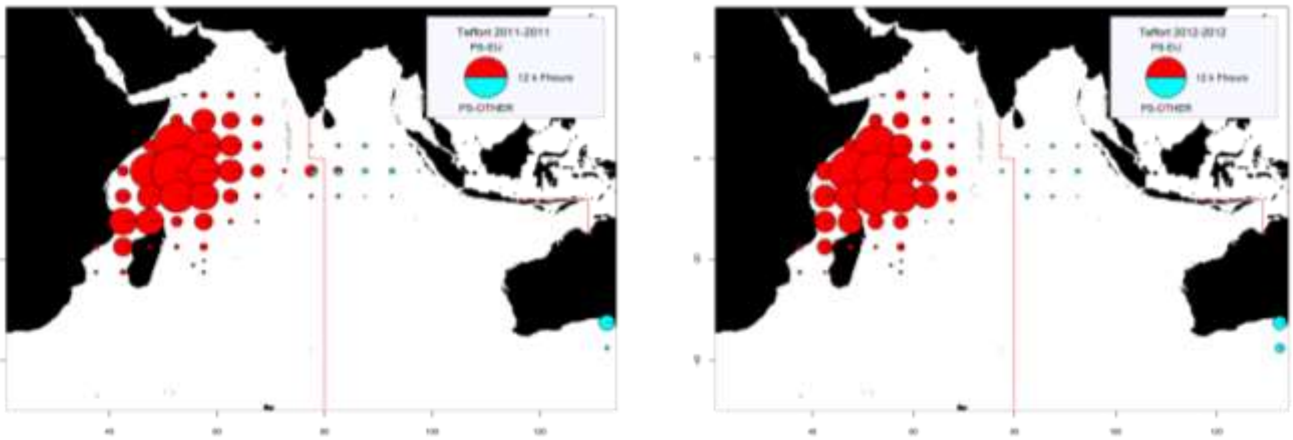


**Fig. 8.** Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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)

***Blue marlin: Catch–per–unit–effort (CPUE) trends***

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. 9). The catches and CPUE series estimated for blue marlin were very similar between the longline fleets of Japan and Taiwan,China, although there were two peaks in the Taiwan,China data series. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

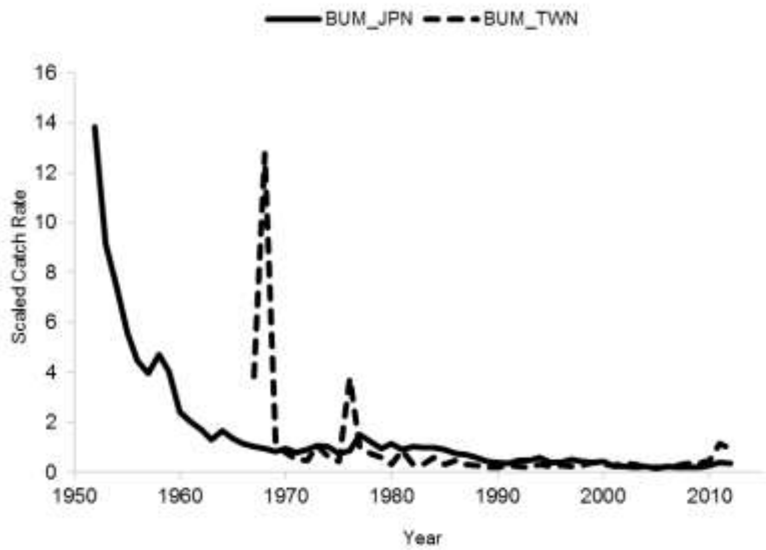



**Fig. 9.** Blue marlin: Standardised catch rates of blue marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Of the blue marlin CPUE series available for assessment purposes, the Japan and Taiwan,China CPUE series (Fig. 10) were used in the stock assessment model for 2013.

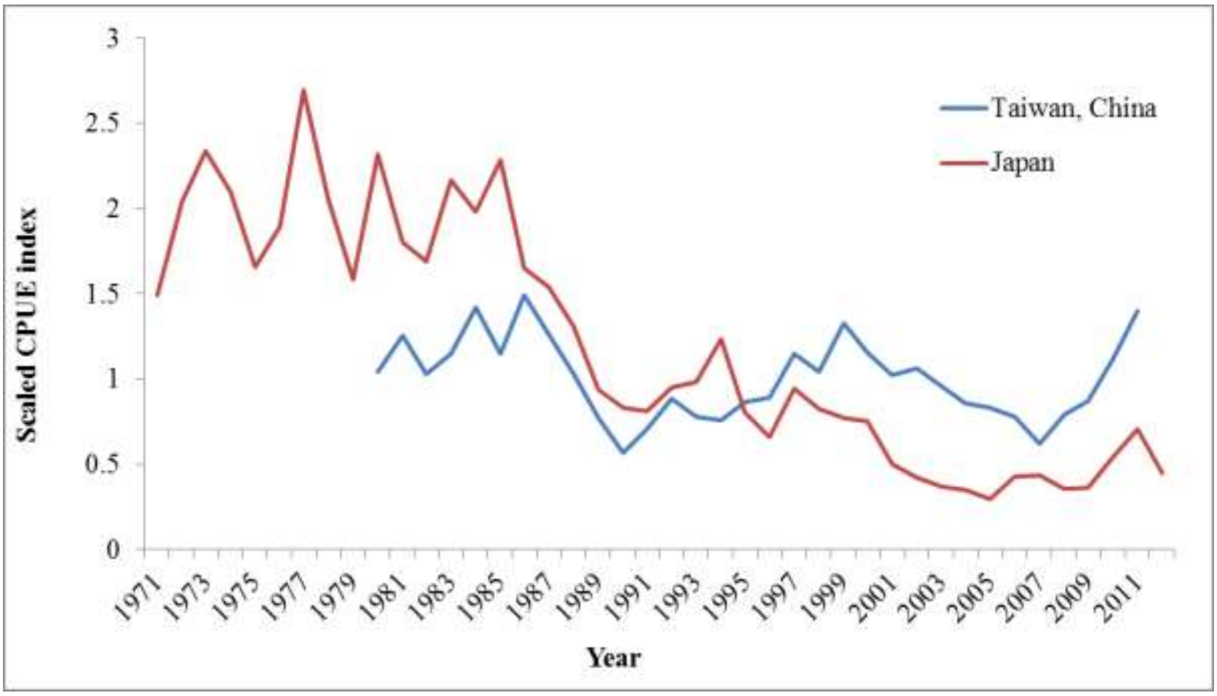



**Fig. 10.** Blue marlin: Comparison of the CPUE series for the longline fleets of Japan and Taiwan,China. Scaling was carried out using the average of the overlapped years.

Both Japan and Taiwan,China should undertake a historical review of their longline data and to document the changes in fleet dynamics for presentation and 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.

***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 (Fig. 11). 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.

**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.

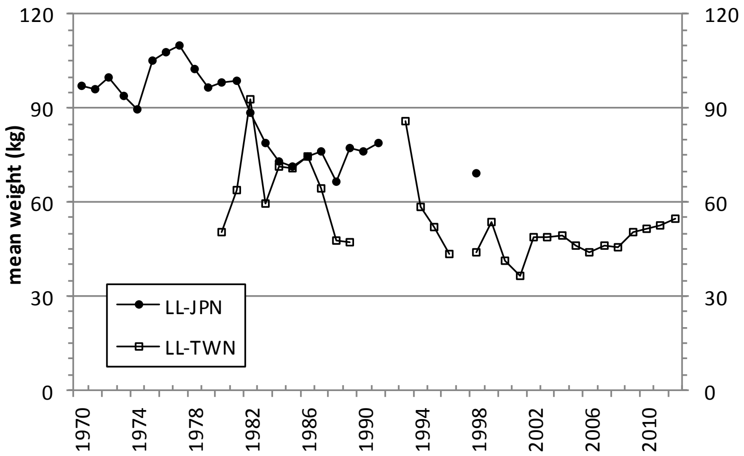



**Fig. 11.** Blue marlin: Average weight of blue marlin (kg) estimated from the size samples available for longliners of Japan (1970–2012) and Taiwan,China (1980–2012). Note: Average weights are shown only for years in which 300 or more specimens were sampled for length.

## STOCK ASSESSMENT

A range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Stock Reduction Analysis) were applied to the blue marlin in 2013. The models explored did not perform well as far as the residual diagnostics, or other were concerned, denoting high uncertainties. However, these models showed similar stock trajectories, and based on the weight-of-evidence approach, the WPB agreed to use the results from the ASPIC model for stock status advice. Further work needs to be conducted in future years to improve these assessments.

The standardised longline CPUE series indicate a decline in abundance in the early 1980s, followed by a constant or slightly increasing abundance over the last 20 years. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicates the stock is currently being exploited at sustainable levels and that the stock is at the optimal biomass level. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method, Stock reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicates that the stock was most likely subject to overfishing in the recent past. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **not overfished** and **not subject to overfishing** (Table 1; Fig. 1). However, the uncertainty in the data available for assessment purposes and the CPUE series suggests that the advice should be interpreted with caution as the stock may still be in an overfished state (biomass less than $B_{MSY}$) (Table 1; Fig. 1). Given the recent declining effort trend, and a clear rebuilding trajectory (Fig. 1), fishing effort is not considered an immediate concern. Research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are still warranted. Given the limited data being reported for gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps.

**TABLE 4.** Blue marlin: Blue marlin (*Makaira nigricans*) stock status summary

| Management Quantity | Aggregate Indian Ocean |
|---|---|
| 2012 catch estimate | 13,885 t |
| Mean catch from 2008–2012 | 10,640 t |
| MSY (80% CI) | 9,524 (6,004–15,105) |
| Data period used in assessment | 1950–2011 |
| $F_{2011}/F_{MSY}$ (80% CI) | 1.05 (0.63–1.47) |
| $B_{2011}/B_{MSY}$ (80% CI) | 1.03 (0.03–2.31) |
| $SB_{2011}/SB_{MSY}$ | – |
| $B_{2011}/B_{1950}$ (80% CI) | 0.59 (0.02–1.16) |
| $SB_{2011}/SB_{1950}$ | – |
| $B_{2011}/B_{1950,\ F=0}$ | – |
| $SB_{2011}/SB_{1950,\ F=0}$ | – |

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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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 4,833 t<br>3,011 t | |
| | MSY (range):<br>$F_{2011}/F_{MSY}$ (range):<br>$B_{2011}/B_{MSY}$ (range):<br>$B_{2011}/B_0$ (range): | 4,408 (3,539–4,578)<br>1.28 (0.95–1.92)<br>0.416 (0.2–0.42)<br>0.18 | |

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

| **Colour key** | Stock overfished($B_{year}/B_{MSY} < 1$) | Stock not overfished ($B_{year}/B_{MSY} \geq 1$) |
|---|---|---|
| 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.*** The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicates the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method, Stock Reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicates that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the $B_{MSY}$ level and shows little signs of rebuilding despite the declining effort trend. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **overfished** and **subject to overfishing** (Table 1; Fig. 1).

***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 2013 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. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is 4,408 t (3,539–4,578). However, the biomass is well below the $B_{MSY}$ reference point and fishing mortality is in excess of $F_{MSY}$ at recent catch levels, of around 2,500 t.
- improvement in data collection and reporting is required to further assess the stock.
- research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are warranted.

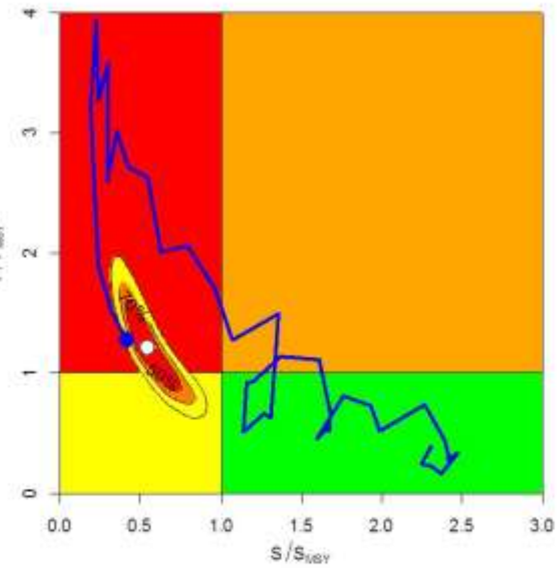


**Fig. 1**. Striped marlin: ASPIC Aggregated Indian Ocean assessment Kobe plots for striped marlin (90% bootstrap confidence surfaces shown around 2011 estimate – white dot). Blue line indicates the trajectory of the point estimates for the total biomass (B) ratio (shown as S) and F ratio for each year 1950–2011. Note: The MSY is close to the upper limit of the confidence intervals, as the bootstrap mean and ASPIC mean results are slightly different.

## 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 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- Resolution 11/04 *on a regional observer scheme*
- 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*

### FISHERIES INDICATORS

***Striped marlin: General***

Striped marlin (*Tetrapturus audax*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans (Fig. 2). 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.

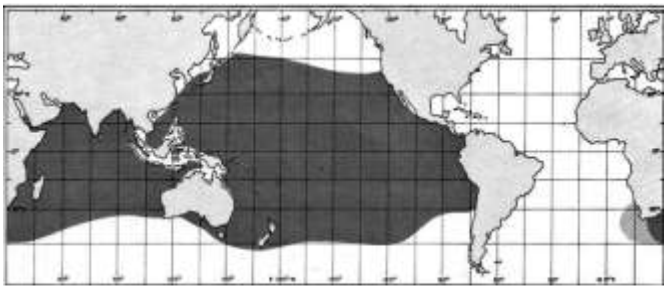

**Fig. 2.** Striped marlin: The worldwide distribution of striped marlin (Source: Nakamura, 1984)

**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 (0-10°S), 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.<br>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.<br>L-W relationships for the Indian Ocean are: females TW=0.00000009*LJFL**3.76598<br>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, which in previous years have accounted for as much as 98% of the catch. The remaining catches are recorded by gillnets and troll lines (Table 3, Fig. 3). Striped marlin are generally considered to be a bycatch of industrial fisheries. Catch trends for striped marlin are variable, ranging from 2000 t to 8000 t per year (Fig. 4); however, this may reflect the level of reporting. Similarly, catches reported by drifting longlines are highly variable, with recent falls since 2009 largely due to declining catches reported by Taiwan,China, deep-freezing and fresh-tuna longliners.

Catches under drifting longlines have been recorded by Taiwan,China, Japan, Rep. of Korea fleets and, recently, Indonesia and several NEI fleets. 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-50s and the late-80s 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 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. 5). 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. 6).

Discards are believed 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 the I.R of Iran, as this species has no commercial value in this country.

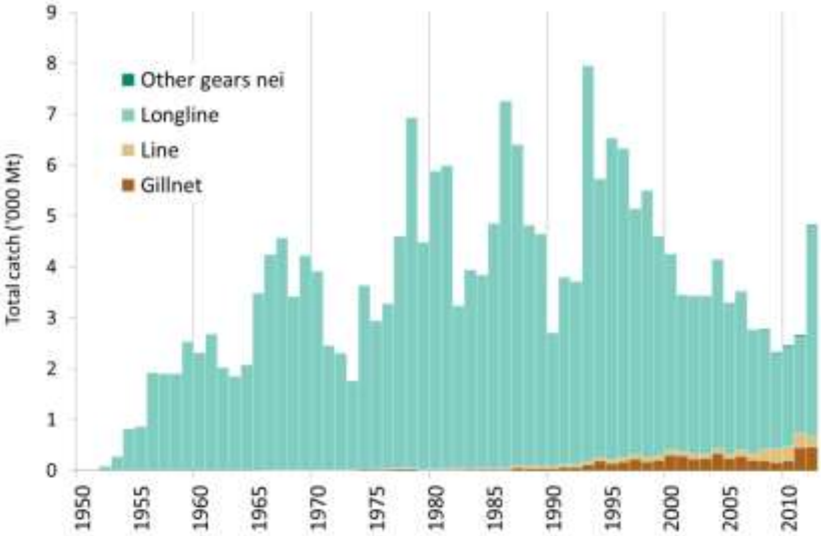


**Fig. 3. Striped marlin**: Catches of Striped marlin by gear and year recorded in the IOTC Database (1950–2012) (Data as of October 2013).

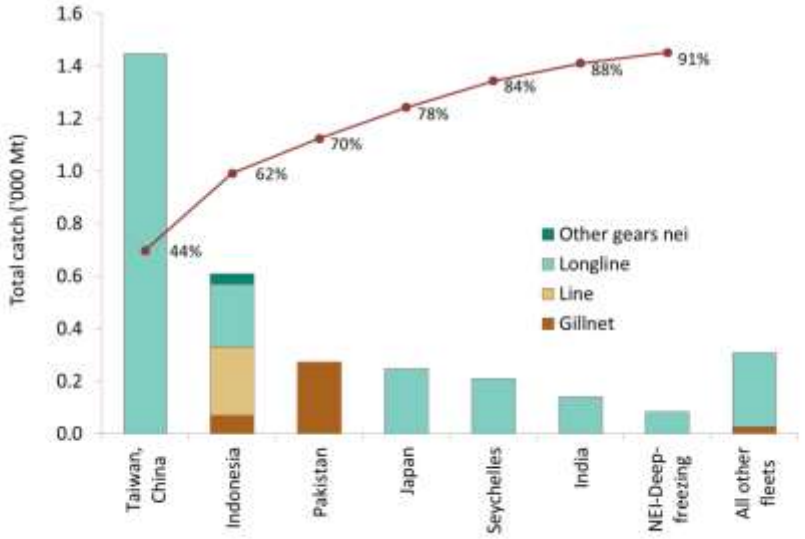


**Fig. 4. Striped marlin**: Average catches in the Indian Ocean over the period 2009–11, by country. Countries are ordered from left to right, according to the importance of catches of striped marlin reported. The red line indicates the (cumulative) proportion of catches of striped marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

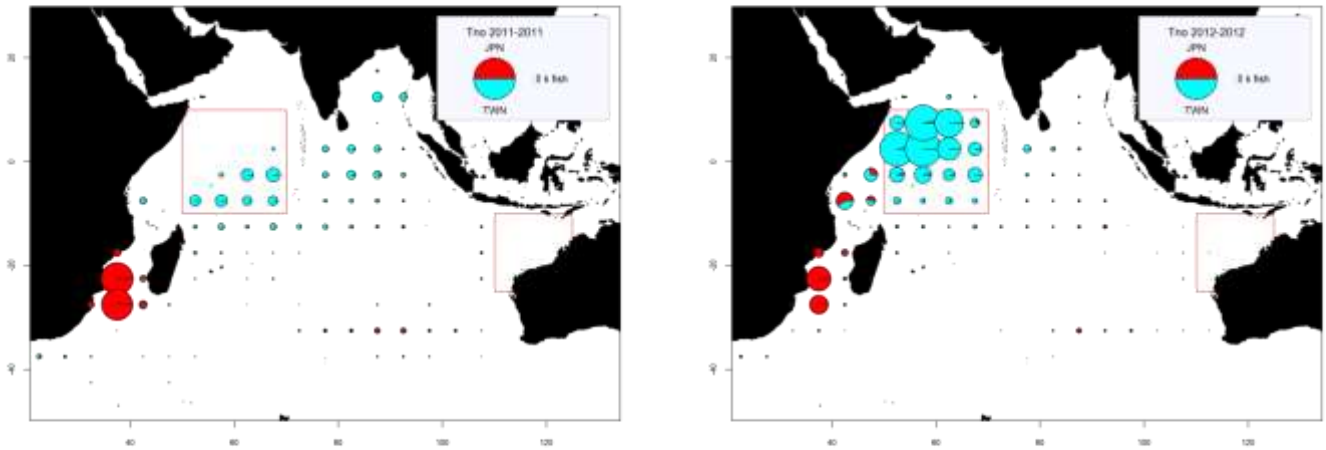

**Fig. 5a–b.** Striped marlin: Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2011 and 2012 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

**TABLE 3.** Striped marlin: Best scientific estimates of the catches of striped marlin by type of fishery for the period 1950–2012 (in metric tons). Data as of October 2013.

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| LL | 1,024 | 3,077 | 3,607 | 5,033 | 4,990 | 2,956 | 3,122 | 3,112 | 3,713 | 2,976 | 3,087 | 2,435 | 2,327 | 1,854 | 1,940 | 1,867 |
| GN | 5 | 8 | 16 | 22 | 139 | 245 | 225 | 237 | 331 | 235 | 280 | 198 | 196 | 163 | 188 | 450 |
| HL | 3 | 5 | 10 | 32 | 69 | 130 | 80 | 84 | 102 | 92 | 129 | 134 | 223 | 272 | 284 | 297 |
| OT | 0 | 0 | 0 | 6 | 10 | 19 | 12 | 13 | 15 | 14 | 19 | 19 | 33 | 40 | 42 | 44 |
| **Total** | **1,032** | **3,090** | **3,634** | **5,093** | **5,208** | **3,350** | **3,440** | **3,445** | **4,161** | **3,317** | **3,516** | **2,786** | **2,779** | **2,329** | **2,454** | **2,658** |

**Fisheries:** Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

### *Uncertainty of time–area catches*

Retained catches are reasonably well known (Fig. 6) although they remain uncertain for some 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.

- **Discards** 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.

- **Changes to the catch series:** Relatively minor revisions have been made to catches of striped marlin, which have been largely unchanged by reviews of the data series for Iran, Pakistan, Indonesia, Sri Lanka and Indonesia which have been used to adjust the catches of the other billfish species.

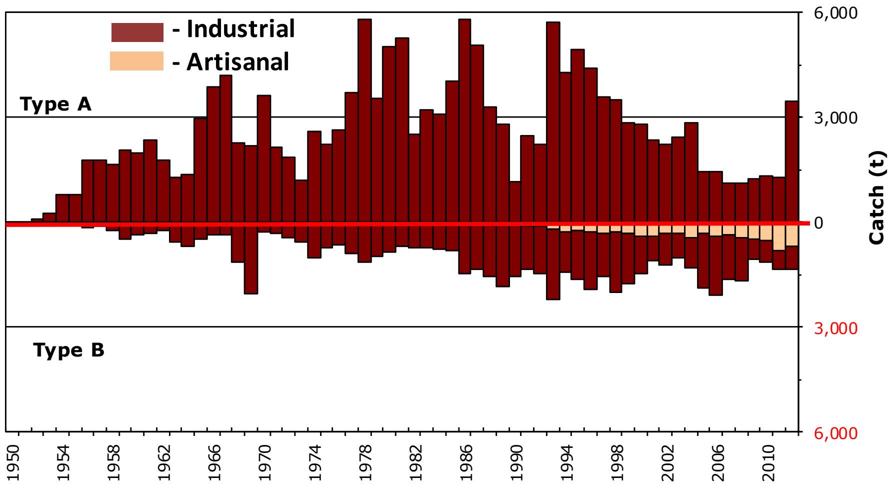


**Fig. 6**. Striped marlin: Uncertainty of annual catch estimates for striped marlin (Data as of October 2013). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by 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 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 2011are provided in Fig. 8.

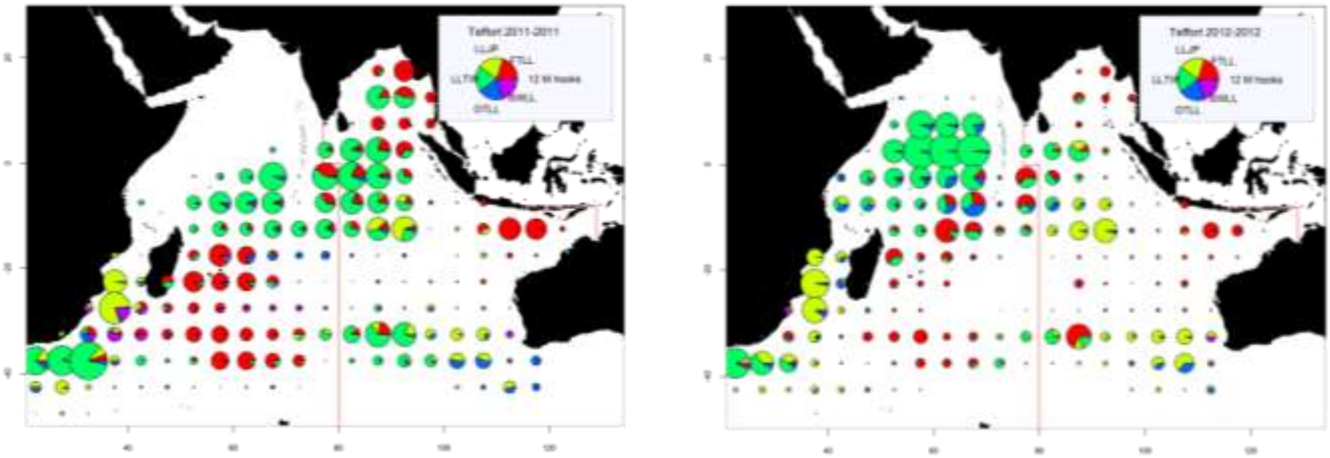

**Fig. 7.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012(right) (Data as of October 2013)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): 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)

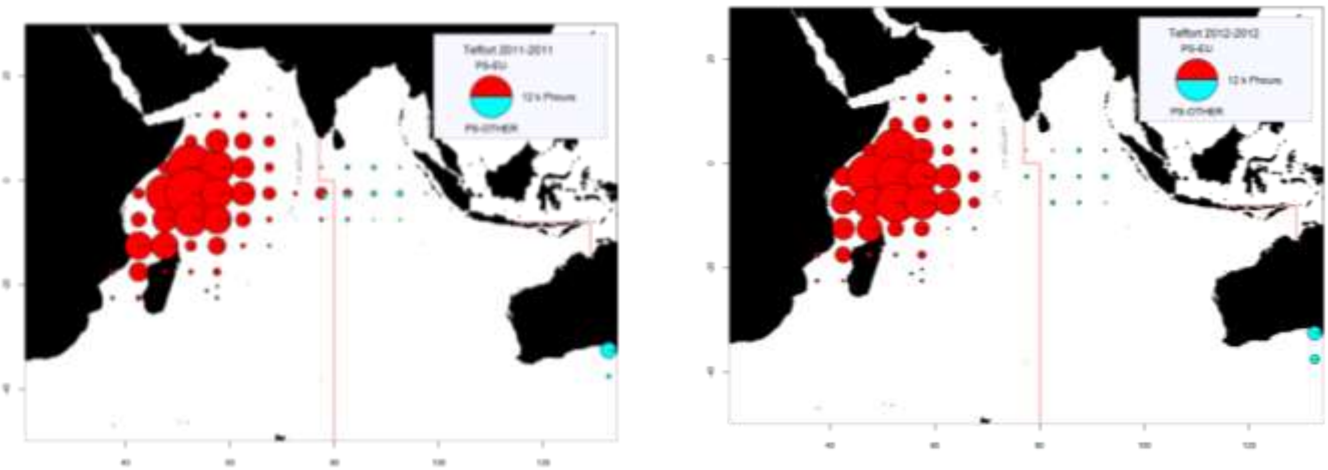

**Fig. 8.** Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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*

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. 9).

The catches and CPUE series estimated for striped marlin were very similar between the longline fleets of Japan and Taiwan,China although there were two peaks in the Taiwan,China data series. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

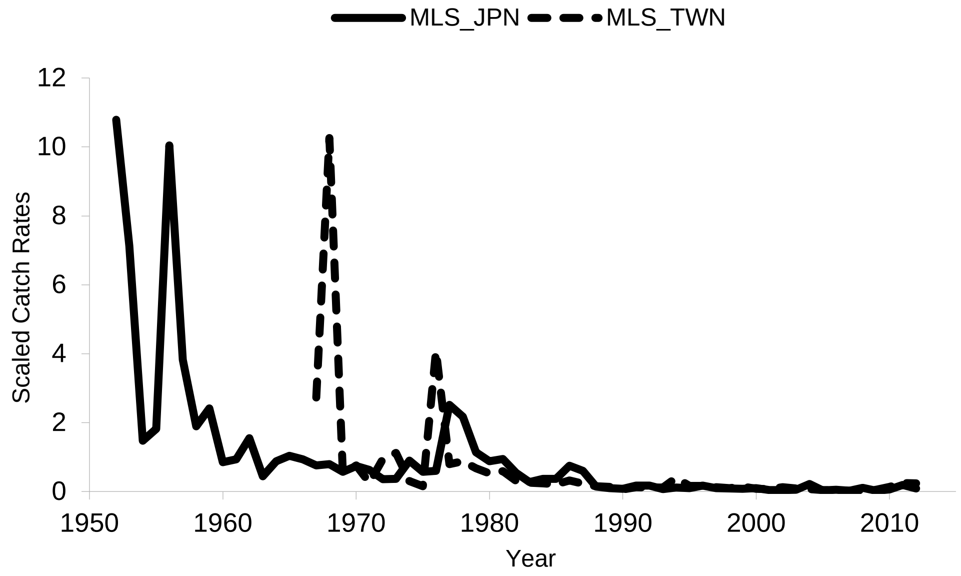


**Fig. 9.** Striped marlin: Standardised catch rates of striped marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Both Japan and Taiwan,China should undertake a historical review of their longline data and to document the changes in fleet dynamics for presentation and 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.

Of the striped marlin CPUE series available for assessment purposes, the separate Japan and Taiwan,China series were used in the stock assessment model for 2013 (Fig. 10).

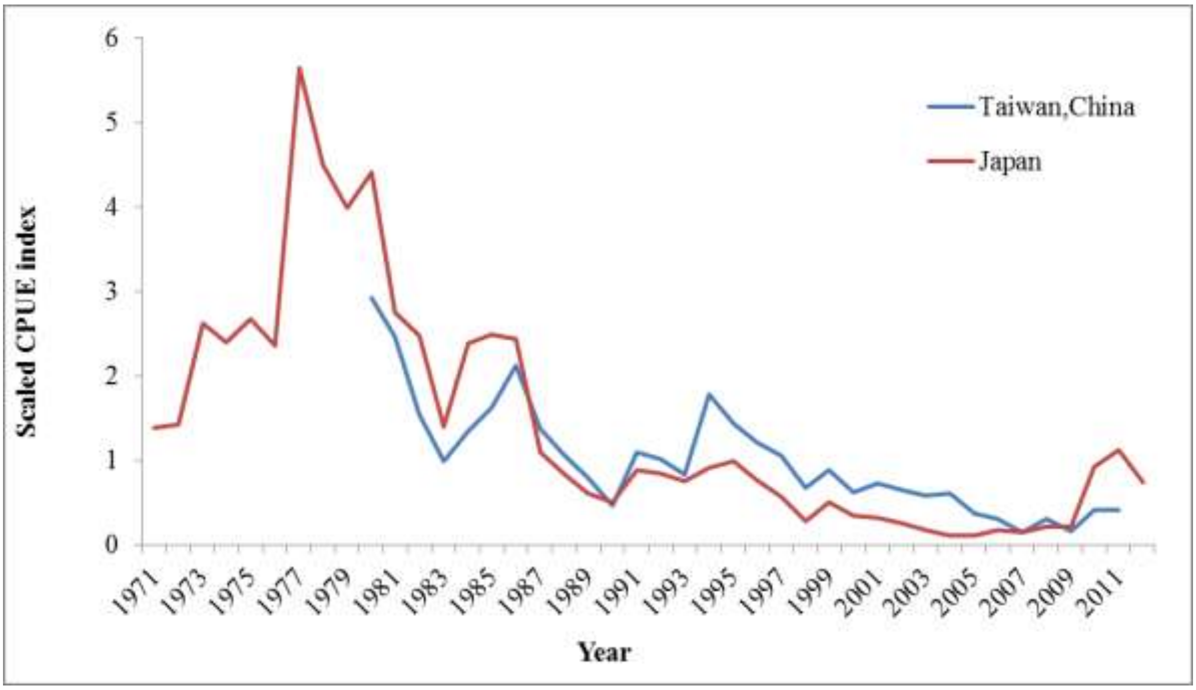


**Fig. 10.** Striped marlin: Comparison of the CPUE series for the longline fleets of Japan and Taiwan,China. Scaling was carried out using the average of the overlapped years.

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

***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 (Fig. 11). 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.

**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.

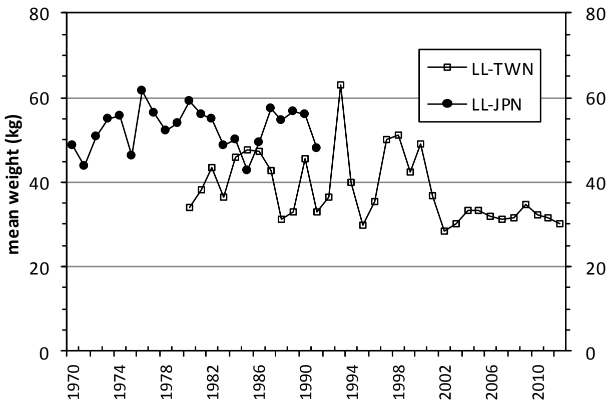


**Fig. 11.** Striped marlin: Average weight of striped marlin (kg) estimated from the size samples available for longliners of Japan (1970–2012) and Taiwan,China (1980–2012). Note: Average weights are shown only for years in which 300 or more specimens were sampled for length.

## STOCK ASSESSMENT

A range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Stock Reduction Analysis) were applied to the striped marlin in 2013. The models explored did not perform well as far as the residual diagnostics, or other were concerned, denoting high uncertainties. However, these models showed similar stock trajectories, and based on the weight-of-evidence approach, the WPB agreed to use the results from the ASPIC model for stock status advice. Further work needs to be conducted in future years to improve these assessments.

The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicates the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method, Stock Reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicates that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the $B_{MSY}$ level and shows little signs of rebuilding despite the declining effort trend. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **overfished** and **subject to overfishing** (Table 1, 4; Fig. 1).

**TABLE 4.** Striped marlin (*Tetrapturus audax*) stock status summary

| Management Quantity | Aggregate Indian Ocean |
|---|---|
| 2012 catch estimate | 4,833 t |
| Mean catch from 2007–2011 | 3,011 t |
| MSY (80% CI) | 4,408 (3,539–4,578) |
| Data period used in assessment | 1950–2011 |
| $F_{2011}/F_{MSY}$ (80% CI) | 1.28 (0.95–1.92) |
| $B_{2011}/B_{MSY}$ (80% CI) | 0.416 (0.2–0.42) |
| $SB_{2011}/SB_{MSY}$ | – |
| $B_{2011}/B_{1950}$ (80% CI) | 0.18 (n.a.) |
| $SB_{2011}/SB_{1950}$ | – |

| | |
|---|---|
| $B_{2011}/B_{1950, F=0}$ | – |
| $SB_{2011}/SB_{1950, F=0}$ | – |

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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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 28,449t<br>26,283t | **Uncertain** |
| | MSY (range):<br>$F_{2012}/F_{MSY}$ (range):<br>$SB_{2012}/SB_{MSY}$ (range):<br>$SB_{2012}/SB_0$ (range): | unknown<br>unknown<br>unknown<br>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 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. A data poor approach was pursued by the WPB in 2013, though results were considered preliminary and require further sensitivity analysis. 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. Given the limited data being reported for coastal gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps. Records of stock extirpation in the Gulf should also be examined to examine the degree of localised depletion in Indian Ocean coastal areas.

***Outlook.*** The estimated increase in coastal gillnet 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 further reviewed.
- improvement in data collection and reporting, particularly for coastal gillnet and sports fisheries, is required to further assess the stock.
- research emphasis on improving indicators and further 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 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- Resolution 11/04 *on a regional observer scheme*
- 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*

## 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 (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.

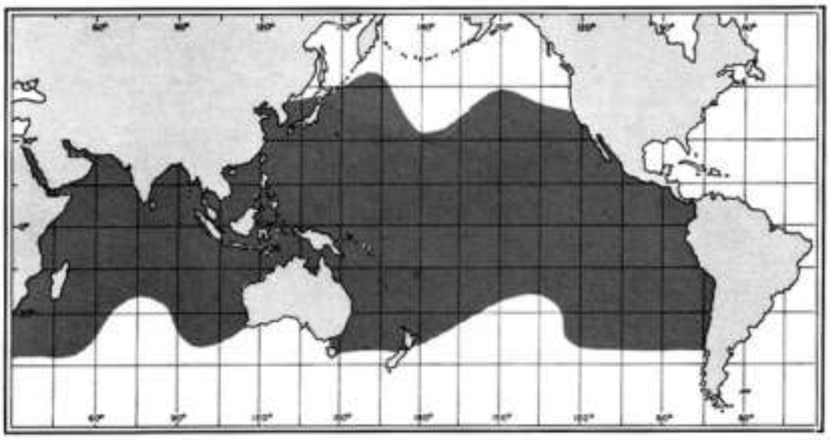

**Fig. 1. Indo-Pacific sailfish**: The worldwide distribution of Indo-Pacific sailfish (Source: Nakamura, 1984)

**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.<br>**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.<br>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.<br>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.<br>Females: 300 cm LJFL, 50+ kg total weight; Males: 200 cm LJFL, 40+ kg total weight in the Indian Ocean.<br>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 kg 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 caught mainly under gillnets (79%) with remaining catches recorded by troll and hand lines (17%), longlines (4%) or other gears (Table 2, Fig. 3). The average annual catch over recent years is estimated at over 28,000 t. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea (India, I.R. Iran, Pakistan and Sri Lanka). Smaller catches are reported for line fishers in Comoros and Mauritius and by Indonesia longliners. This species is also a popular catch for sport fisheries (e.g. Kenya, Mauritius, Seychelles).

Catches of Indo-Pacific sailfish greatly increased since the mid-1990's (from around 5,000 t in the early 1990s to almost 29,000 t in 2011). The increases are largely due to the development of a gillnet/longline fishery in Sri Lanka (Fig. 4) and, especially, the extension in the area of operation of Iranian gillnet vessels to areas beyond the EEZ of I.R. Iran. In the case of Iranian gillnets (Fig. 5), catches have increased from less than 1,000 t in the early 1990's to over 9,800 t in 2012.

Catches of Indo-Pacific sailfish under drifting longlines (Table 3) and other gears have also increased – to a lesser extent than catches from gillnet – from around 1,500 t to over 2,500 t 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).

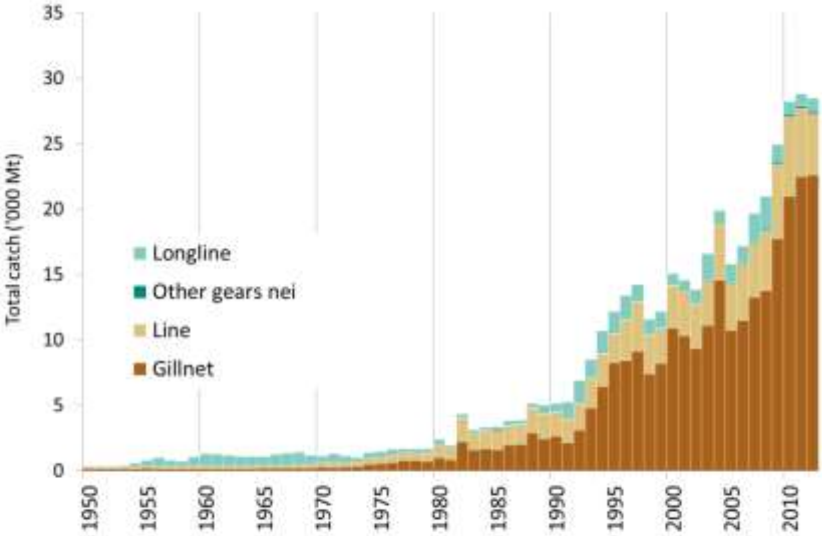


**Fig. 2. Indo-Pacific sailfish**. Catches of Indo-pacific sailfish by gear and year recorded in the IOTC Database (1950–2012) (Data as of October 2013).

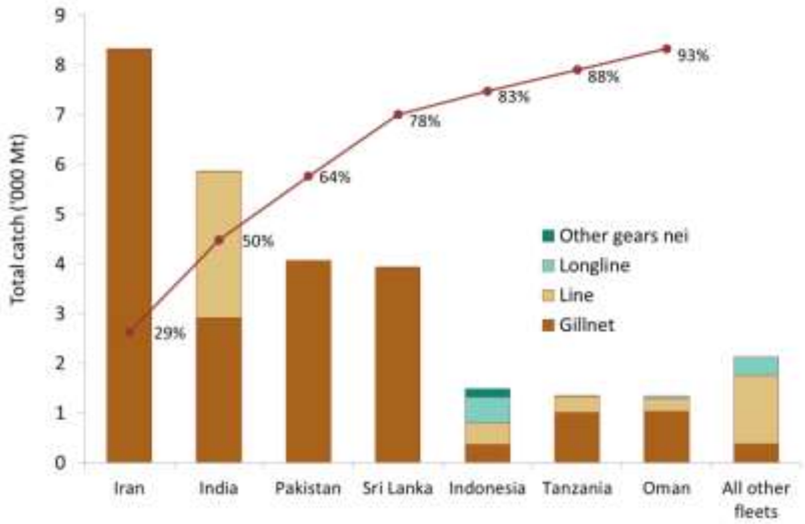


**Fig. 3. Indo-Pacific sailfish**: Average catches in the Indian Ocean over the period 2009–12, by country. Countries are ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of Indo-Pacific sailfish for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

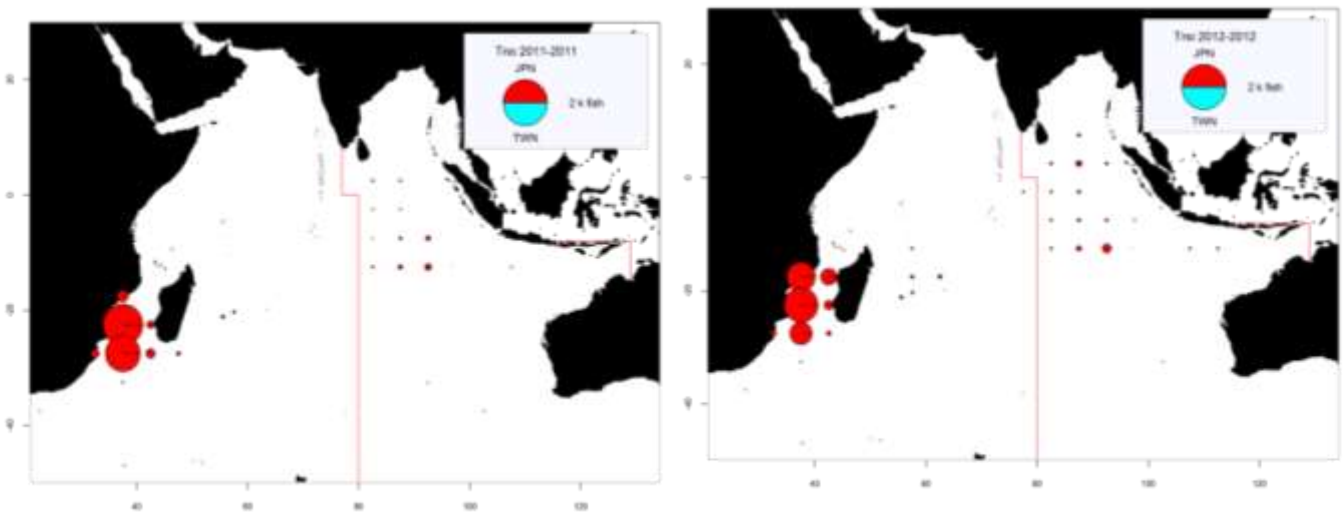

**Fig. 4a-b. Indo-Pacific sailfish**: Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) for 2011 and 2012 by fleet.

**TABLE 2. Indo-Pacific sailfish**: Best scientific estimates of the catches of Indo-Pacific sailfish by type of fishery for the period 1950–2012 (in metric tons). Data as of October 2013.

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| LL | 299 | 819 | 446 | 338 | 1,412 | 1,470 | 2,025 | 960 | 1,440 | 1,405 | 2,227 | 2,532 | 1,307 | 1,000 | 941 | 1,010 |
| GN | 165 | 181 | 507 | 1,809 | 6,047 | 12,313 | 11,095 | 14,564 | 10,718 | 11,471 | 13,266 | 13,758 | 17,708 | 20,974 | 22,494 | 22,596 |
| HL | 171 | 213 | 456 | 1,430 | 2,499 | 3,982 | 3,402 | 4,269 | 3,574 | 4,220 | 4,073 | 4,549 | 5,749 | 6,071 | 5,207 | 4,712 |
| OT | 0 | 0 | 3 | 44 | 42 | 81 | 52 | 63 | 57 | 80 | 81 | 149 | 168 | 175 | 184 | 131 |
| **Total** | **634** | **1,212** | **1,411** | **3,620** | **10,000** | **17,847** | **16,574** | **19,856** | **15,789** | **17,177** | **19,646** | **20,988** | **24,931** | **28,219** | **28,826** | **28,449** |

**Fisheries:** Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

### *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.
- **Discards** are unknown for most industrial fisheries, mainly longliners (for which they are presumed to be moderate-high).

**Changes to the catch series**: Catches of sailfish since the WPB meeting in 2012 have been revised downwards, in particular around the mid-2000s. The changes mostly affect catch estimates for I.R. Iran, which have been reduced following improvements in the estimation of catch-by-species (specifically, the disaggregation of reported catches of sailfish that likely refer to a combination of billfish species).

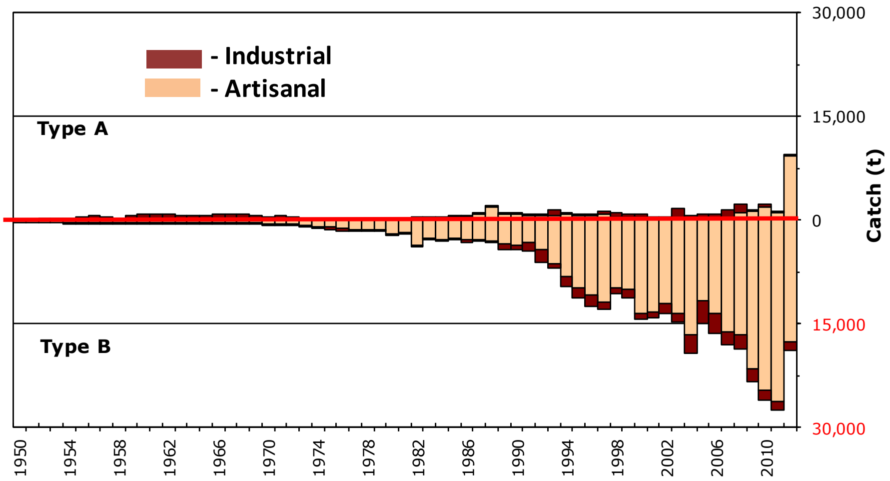


**Fig. 5**. Indo-Pacific sailfish: Uncertainty of annual catch estimates for Indo-Pacific sailfish. (Data as of October 2013). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (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 in 2011 and 2012 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 2011 and 2012 are provided in Fig. 7.

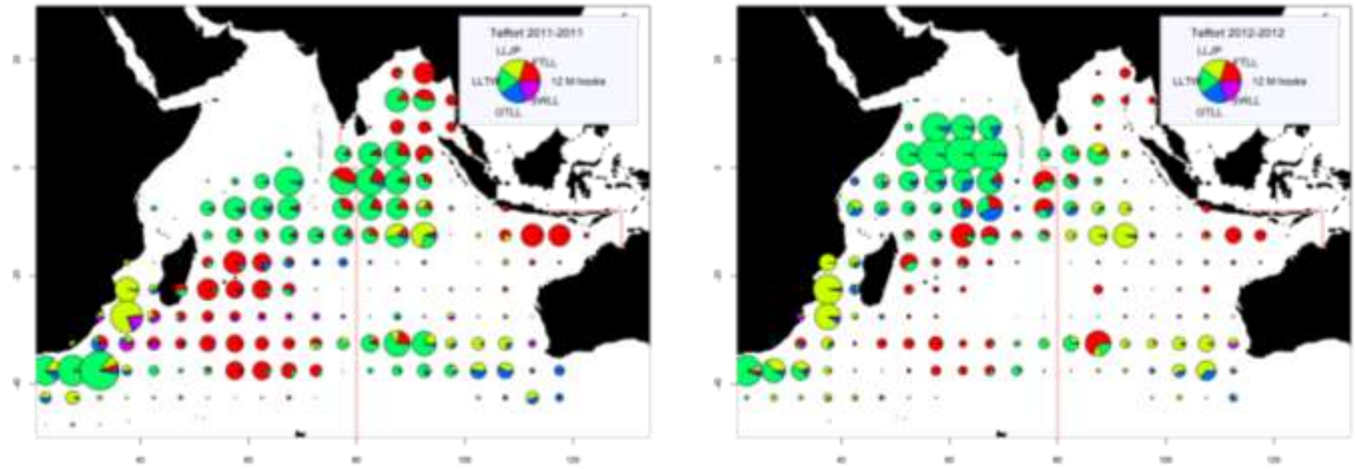


**Fig. 6.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (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)

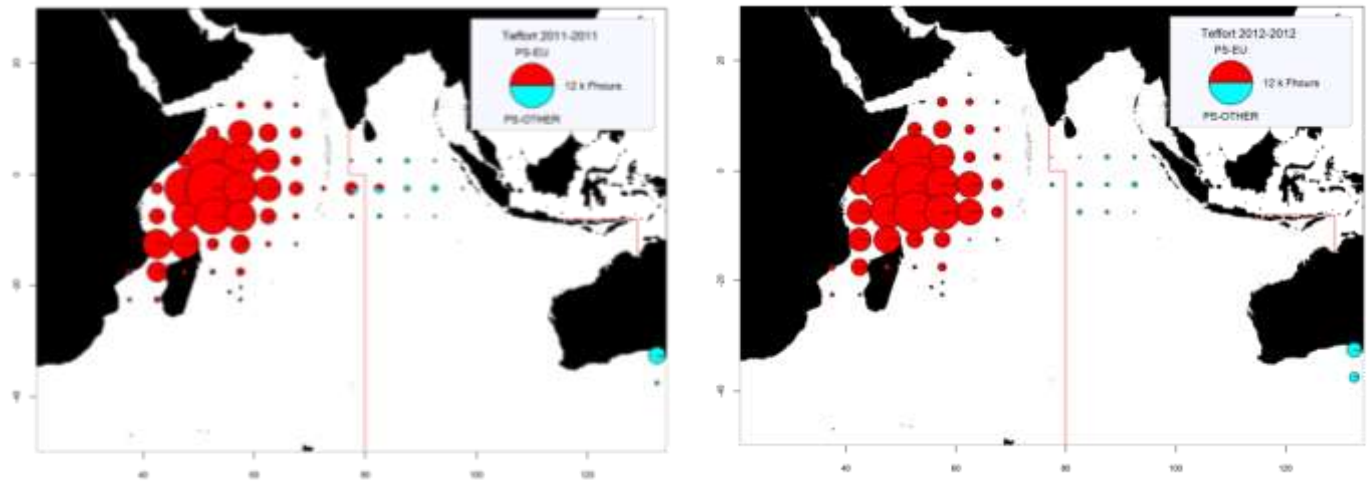


**Fig. 7.** Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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*

Currently there is insufficient data to develop a CPUE series for Indo-Pacific sailfish caught in the IOTC area of competence. 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. 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.

### 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 (Table 4). 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. The IOTC Secretariat should contact U.A.E. to obtain any information regarding its sailfish fishery in the Gulf, as the most recent information submitted to the WPB some time ago suggested that the fishery may be collapsing. Any new information received should be submitted to the next WPB meeting as part of a general review of sailfish fisheries in the Indian Ocean.

**TABLE 3.** Indo-Pacific sailfish (*Istiophorus platypterus*) stock status summary

| Management Quantity | Aggregate Indian Ocean |
|---|---|
| 2012 catch estimate | 28,449 t |
| Mean catch from 2008–2012 | 26,283 t |
| MSY (80% CI) | unknown |
| Data period used in assessment | – |
| $F_{2012}/F_{MSY}$ (80% CI) | – |
| $B_{2012}/B_{MSY}$ (80% CI) | – |
| $SB_{2012}/SB_{MSY}$ | – |
| $B_{2012}/B_0$ (80% CI) | – |
| $SB_{2012}/SB_0$ | – |
| $B_{2012}/B_{0,\ F=0}$ | – |
| $SB_{2012}/SB_{0,\ F=0}$ | – |

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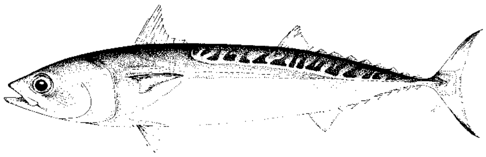
Ndegwa S, Herrera M (2011) Kenyan Sports Fishing Sailfish Catches. IOTC–2011–WPB09–09

# 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** | | **2013 stock status determination** |
|---|---|---|---|
| Indian Ocean | Catch 2012:<br>Average catch 2008–2012: | 8,862 t<br>8,468 t | |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | unknown<br>unknown<br>unknown<br>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 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 that this increase may have had 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 (*Auxis rochei*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- 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*

**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.<br>**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 coastal purse seiners. The catch estimates for bullet tuna were derived from very small amounts of information and are therefore highly uncertain[3].

**TABLE 3.** Bullet tuna: Best scientific estimates of the catches of bullet tuna by type of fishery for the period 1950–2012 (in metric tonnes) (Data as of October 2013)

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Purse seine | 0 | 2 | 28 | 278 | 552 | 646 | 612 | 603 | 562 | 635 | 548 | 935 | 1,051 | 1,372 | 638 | 606 |
| Gillnet | 41 | 153 | 296 | 531 | 1,222 | 1,722 | 1,525 | 1,699 | 1,501 | 1,840 | 1,623 | 2,293 | 2,577 | 3,346 | 2,699 | 2,856 |
| Line | 113 | 193 | 325 | 393 | 780 | 1,182 | 1,034 | 1,004 | 999 | 1,152 | 1,113 | 1,881 | 2,178 | 2,903 | 1,165 | 1,245 |
| Other | 5 | 13 | 44 | 242 | 755 | 1,278 | 775 | 1,239 | 882 | 1,390 | 1,745 | 1,769 | 2,000 | 2,746 | 3,922 | 4,155 |
| **Total** | **159** | **362** | **693** | **1,444** | **3,309** | **4,828** | **3,947** | **4,545** | **3,943** | **5,016** | **5,028** | **6,878** | **7,807** | **10,367** | **8,425** | **8,862** |

Estimated catches of bullet tuna reached around 2,000 t in the early 1990's, increasing markedly in the following years to reach a peak in 1997 at around 4,900 t. The catches decreased slightly in the following years and remained around 4,000 t until the mid-2000's. Since then, catches of bullet tuna have increased to over 8,000 t in recent years, with the highest catch of 10,400 t recorded in 2010 (Table 3; Fig. 1).

[3] 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.

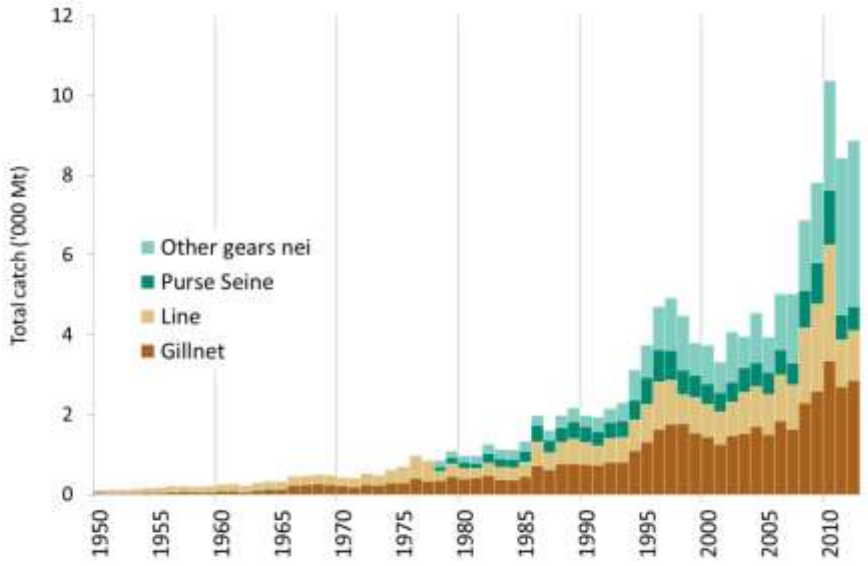



**Fig. 1.** Bullet tuna: Annual catches of bullet tuna by gear recorded in the IOTC Database (1950–2012) (Data as of October 2013).

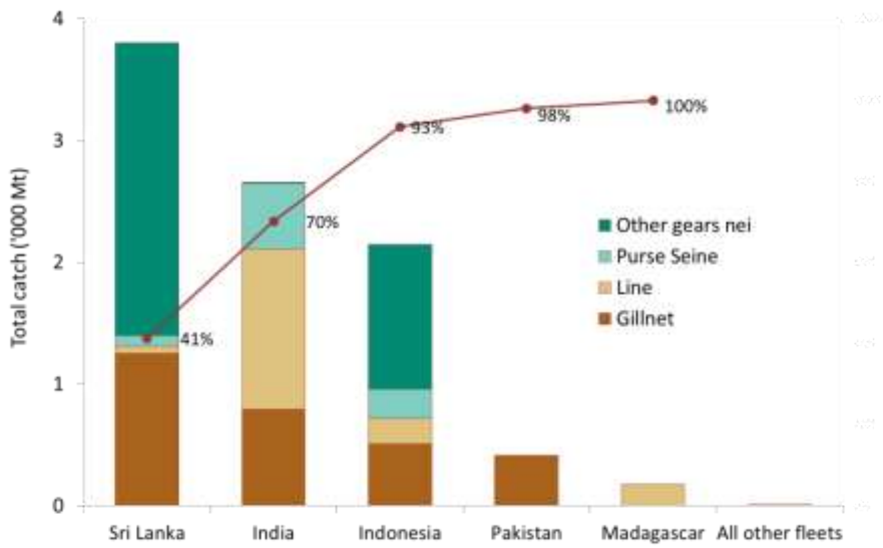



**Fig. 2.** Bullet tuna: average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of bullet tuna reported. The red line indicates the (cumulative) proportion of catches of bullet tuna for the countries concerned, over the total combined catches of bullet tuna reported from all countries and fisheries (Data as of October 2013).

In recent years the catches of bullet tuna estimated for the fisheries of India, Sri Lanka and Indonesia have represented over 90% of the total catches of this species from all fisheries in the Indian Ocean (Fig. 2).

***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.
- 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 2012, with catches more than doubling over the entire time series, following major reviews of catch time series for Indonesia, India, and Sri Lanka.

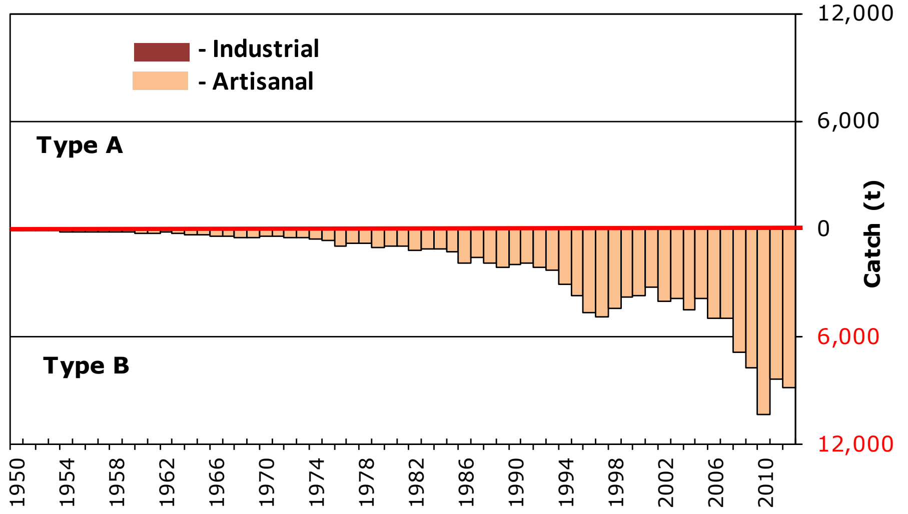



**Fig. 3.** Bullet tuna: Uncertainty of annual catch estimates for bullet tuna (1950–2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by 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 (Data as of October 2013).

***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. 4).

**TABLE. 4**. Bullet tuna: Availability of catches and effort series, by fishery and year (1970–2012) . Note that no catches and effort are available at all for 1950–78.

| Gear-Fleet | Years with catch-and-effort data (70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10) |
|---|---|
| PSS-Indonesia | 86 |
| GILL-India | 79 |
| GILL-Indonesia | 84–85 |
| GILL-Sri Lanka | 85–91, 94–04 |
| LINE-India | 79 |
| LINE-Indonesia | 85 |
| LINE-Sri Lanka | 86 |
| LINE-Yemen | 03–06 |
| OTHR-Indonesia | 84–85, 87 |
| OTHR-Sri Lanka | 91, 94–04 |

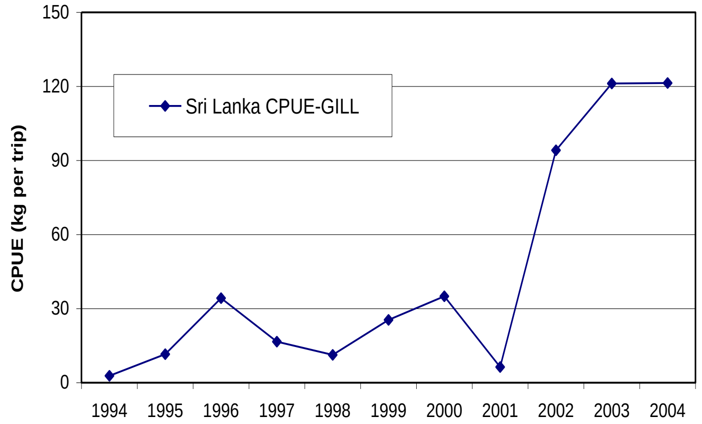
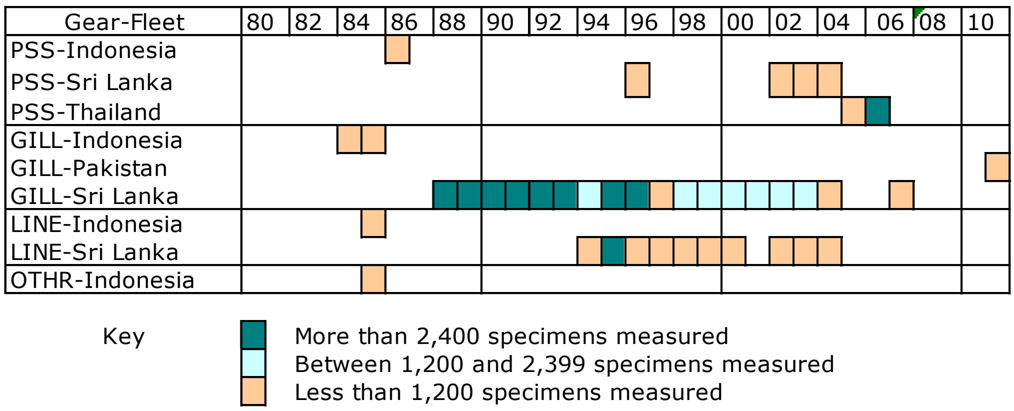



**Fig. 4.** Bullet tuna: Nominal CPUE series for the gillnet fishery of Sri Lanka derived from the available catches and effort data (1994–2004)

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

- Length frequency data for the bullet tuna is only available for some Sri Lanka fisheries and periods. These fisheries catch bullet tuna ranging between 15 and 35 cm.
- 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 (Fig. 6)
- Sex ratio data have not been provided to the Secretariat by CPCs.

**TABLE. 5.** Bullet tuna: Availability of length frequency data, by fishery and year (1980–2012)[4]. Note that no length frequency data are available for the period 1950–83




[4] 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

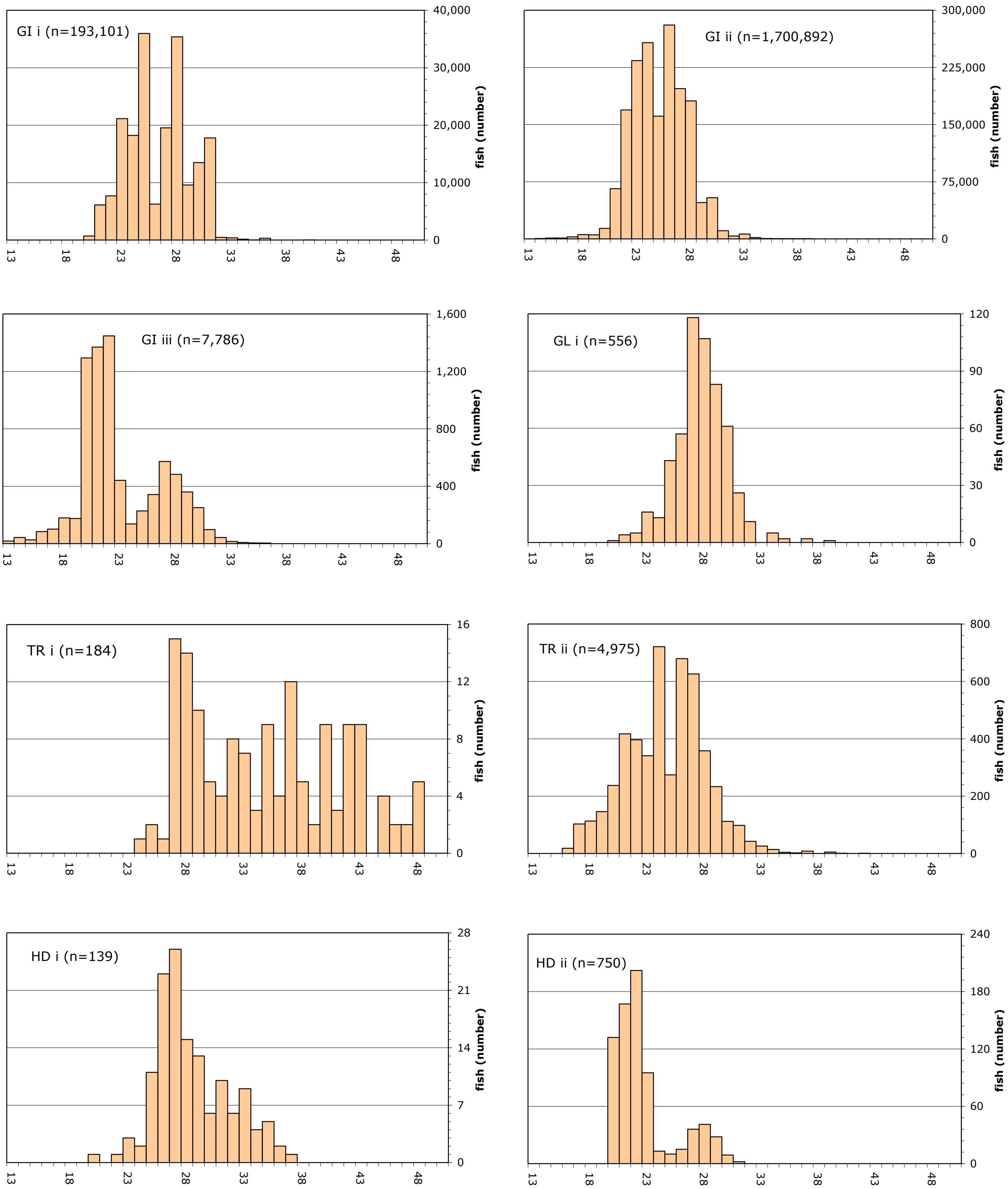



**Fig. 6.** Bullet tuna: Length frequency distributions (total amount of fish measured by 1cm length class by decade) derived from the data available at the IOTC Secretariat for selected fisheries and periods. GI: Gillnet fisheries: i. Sri Lanka 1980–89, ii. Sri Lanka 1990-99, iii. Sri Lanka 2000–06. 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

## 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 6).

**TABLE 6.** Bullet tuna (*Auxis rochei*) stock status summary

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2012 catch estimate | 8,862 t |
| Mean catch from 2008–2012 | 8,468 t |
| MSY (80% CI) | unknown |
| Data period used in assessment | – |
| $F_{2012}/F_{MSY}$ (80% CI) | – |
| $B_{2012}/B_{MSY}$ (80% CI) | – |
| $SB_{2012}/SB_{MSY}$ | – |
| $B_{2012}/B_0$ (80% CI) | – |
| $SB_{2012}/SB_0$ | – |
| $B_{2012}/B_{0,\ F=0}$ | – |
| $SB_{2012}/SB_{0,\ F=0}$ | – |

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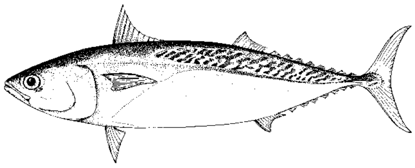
Kahraman A, Göktürk D, Bozkurt ER, Akayl T, Karakulak FS (2010) Some reproductive aspects of female bullet tuna, Auxis rochei (Risso), from the Turkish Mediterranean coasts. African J Biotech 9(40): 6813-6818

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** | | **2013 stock status determination** |
|---|---|---|---|
| Indian Ocean | Catch[2] 2012:<br>Average catch[2] 2008–2012: | 83,029t<br>90,221t | |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | unknown<br>unknown<br>unknown<br>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 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 that this increase may have had 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 (*Auxis thazard*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*

- 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*

**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.<br>**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, handlines and trolling, and pole-and-lines (Table 3; Fig. 1). This species is also an important bycatch (byproduct) for industrial purse seiners and is the target of some ring net fisheries (recorded as purse seine in Table 3). The catch estimates for frigate tuna were derived from very small amounts of information and are therefore highly uncertain[5] (Fig. 3).

**TABLE 3.** Frigate tuna: Best scientific estimates of the catches of frigate tuna by type of fishery for the period 1950–2012 (in metric tonnes) (Data as of October 2013).

| **Fishery** | **By decade (average)** | | | | | | **By year (last ten years)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1950s** | **1960s** | **1970s** | **1980s** | **1990s** | **2000s** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Purse seine | 0 | 13 | 931 | 4,835 | 7,449 | 9,811 | 10,135 | 10,331 | 10,093 | 10,983 | 9,649 | 10,054 | 9,498 | 12,038 | 11,235 | 10,105 |
| Gillnet | 479 | 1,234 | 2,848 | 6,973 | 14,508 | 19,718 | 18,660 | 19,250 | 18,316 | 21,521 | 21,941 | 25,218 | 23,452 | 30,872 | 30,095 | 30,027 |
| Line | 1,270 | 2,413 | 4,421 | 7,423 | 13,751 | 26,043 | 22,750 | 25,692 | 22,587 | 25,987 | 27,864 | 33,651 | 34,037 | 37,801 | 38,145 | 28,897 |
| Other | 1,441 | 2,007 | 2,349 | 3,683 | 9,279 | 13,239 | 12,238 | 12,229 | 12,204 | 11,997 | 13,725 | 16,531 | 17,887 | 18,535 | 19,027 | 13,999 |
| **Total** | **3,190** | **5,668** | **10,548** | **22,914** | **44,988** | **68,812** | **63,783** | **67,502** | **63,201** | **70,488** | **73,179** | **85,454** | **84,873** | **99,246** | **98,501** | **83,029** |

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 30,000 t in the mid 1980's and over 60,000 t by the 2000's. Catches increased substantially from the mid-2000's reaching around 100,000 t in 2010 (Table 3; Fig. 2). The catches of frigate tuna have been higher

[5] 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.

in the east since the late 1990's, with three quarters of total catches of frigate tuna taken in the eastern Indian Ocean in recent years.

Following several major reviews of artisanal fisheries in 2012–13 by the IOTC Secretariat – in particular for Indonesia, Sri Lanka and India – catches of frigate have been increased for all years from the 1950s onwards (on average by around 10%-30%), compared to previous estimates published by IOTC.

In recent years (2010-2012), the countries attributed with the highest catches are Indonesia (60%), India (14%), Sri Lanka (11%) and Iran (7%) (Table 3; Fig. 2).

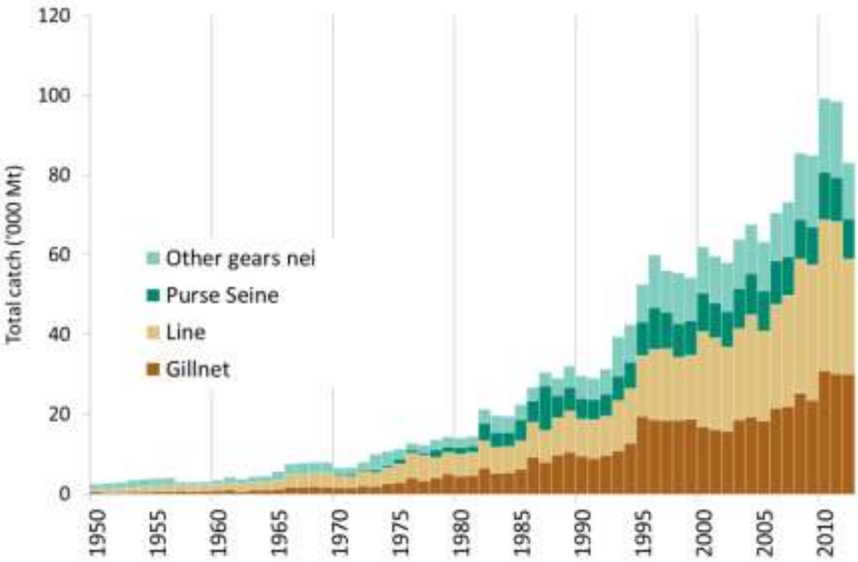



**Fig. 1. Frigate tuna**: Annual catches of frigate tuna by gear recorded in the IOTC Database (1950–2012) (Data as of October 2013).

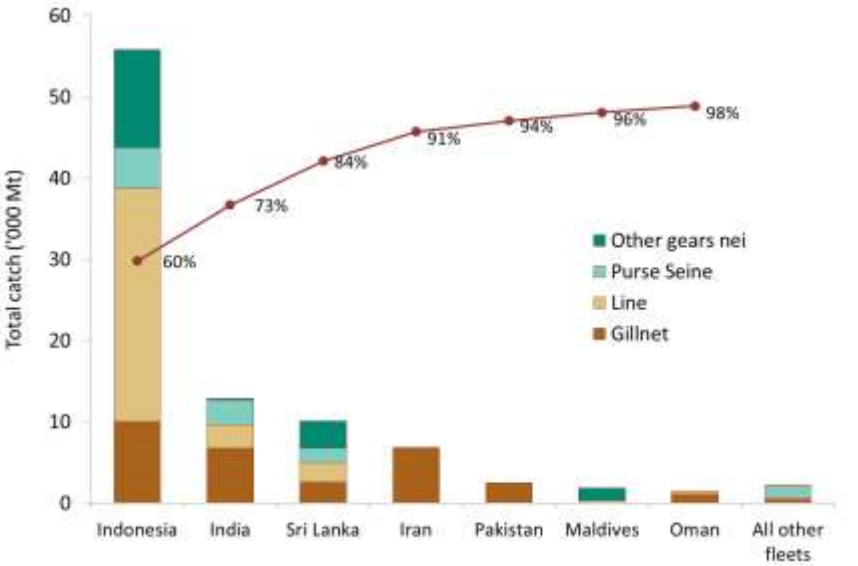



**Fig. 2**. **Frigate tuna**: average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of frigate tuna reported. The red line indicates the (cumulative) proportion of catches of frigate tuna for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

***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. In the past, the IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004, by gear and species. However, in a recent review it was indicated that the catches of frigate tuna had been underestimated by

Indonesia. While the new catches estimated for frigate tuna in Indonesia remain uncertain, representing around 60% of the total catches of this species in the Indian Ocean in recent years (2010–12), the new estimates are considered more reliable.

- Artisanal fisheries of India and Sri Lanka: Although these countries report catches of frigate tuna until recently, the catches have not been reported by gear. The catches of both countries were also reviewed and assigned by gear on the basis of official reports and information from various other alternative sources. The new catches estimated for Sri Lanka are as much as three times higher than previous estimates. In recent years, the combined catches of frigate tuna for both countries have represented 25% of the total catches of this species in the Indian Ocean.
- Artisanal fisheries of Myanmar (and Somalia): None of these countries have 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 mislabeling, with all catches assigned as 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.
- 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 changed substantially since the WPNT meeting in 2012, following major reviews of catch time series for Indonesia, India, and Sri Lanka.

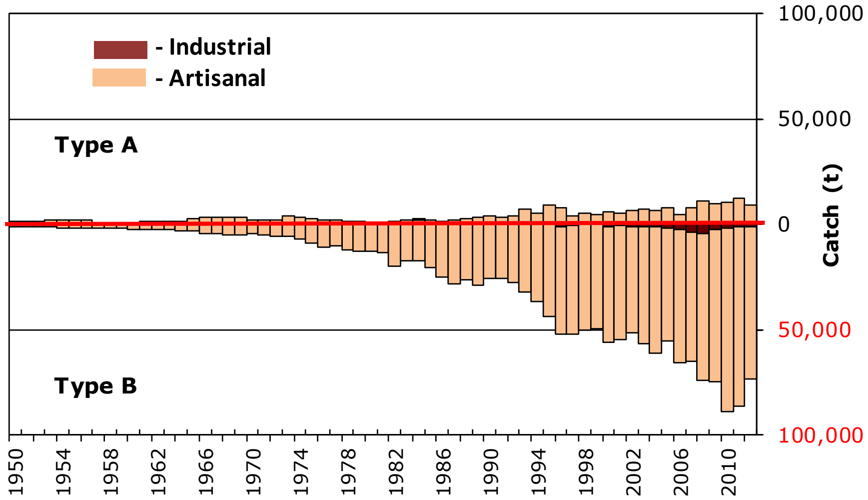



**Fig. 3**. Frigate tuna: Uncertainty of annual catch estimates for frigate tuna (1950–2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species 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 (Data as of October 2013).

***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.

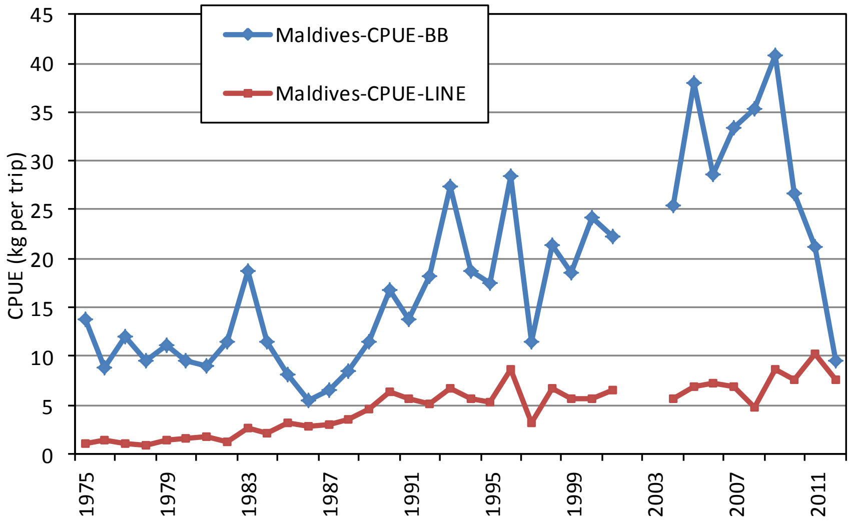
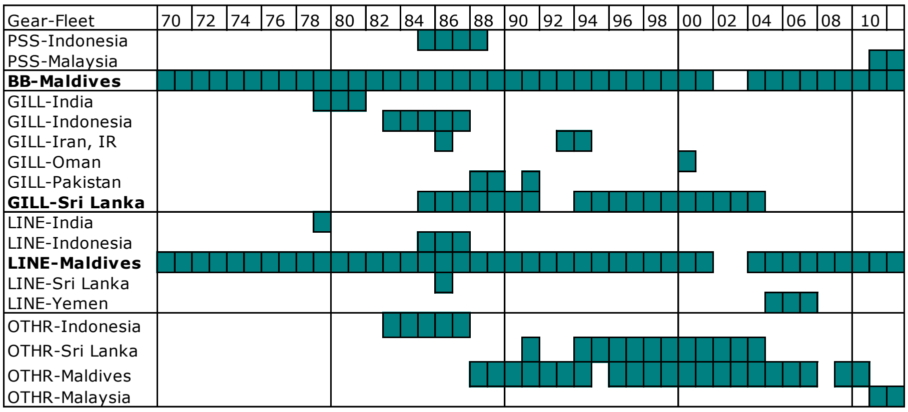



**Fig. 4.** Frigate tuna: Nominal CPUE series for the baitboat (BB using mechanied boats) and line (LINE, including handlines and trolling using mechanized boats) fisheries of Maldives derived from the available catches and effort data (1975–2012)

**TABLE 4.** Frigate tuna: Availability of catches and effort series, by fishery and year (1970–2012)[6]. Note that no catches and effort are available for the period 1950–69 in the IOTC Secretariat databases

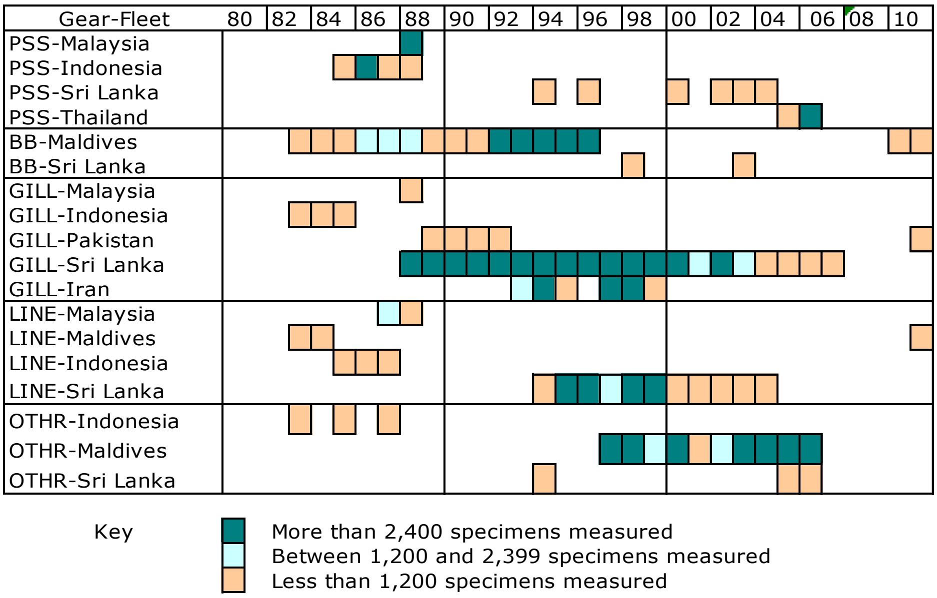



***Frigate tuna – Fish size or age trends (e.g. by length, weight, sex and/or maturity)***

- 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

[6] 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:** Frigate tuna: Availability of length frequency data, by fishery and year (1980–2012)[7]. 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).
- Catch-at-Size(Age) data are not available for the frigate tuna due to the paucity of size data available from most fleets (Table 5) 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.

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[7] 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

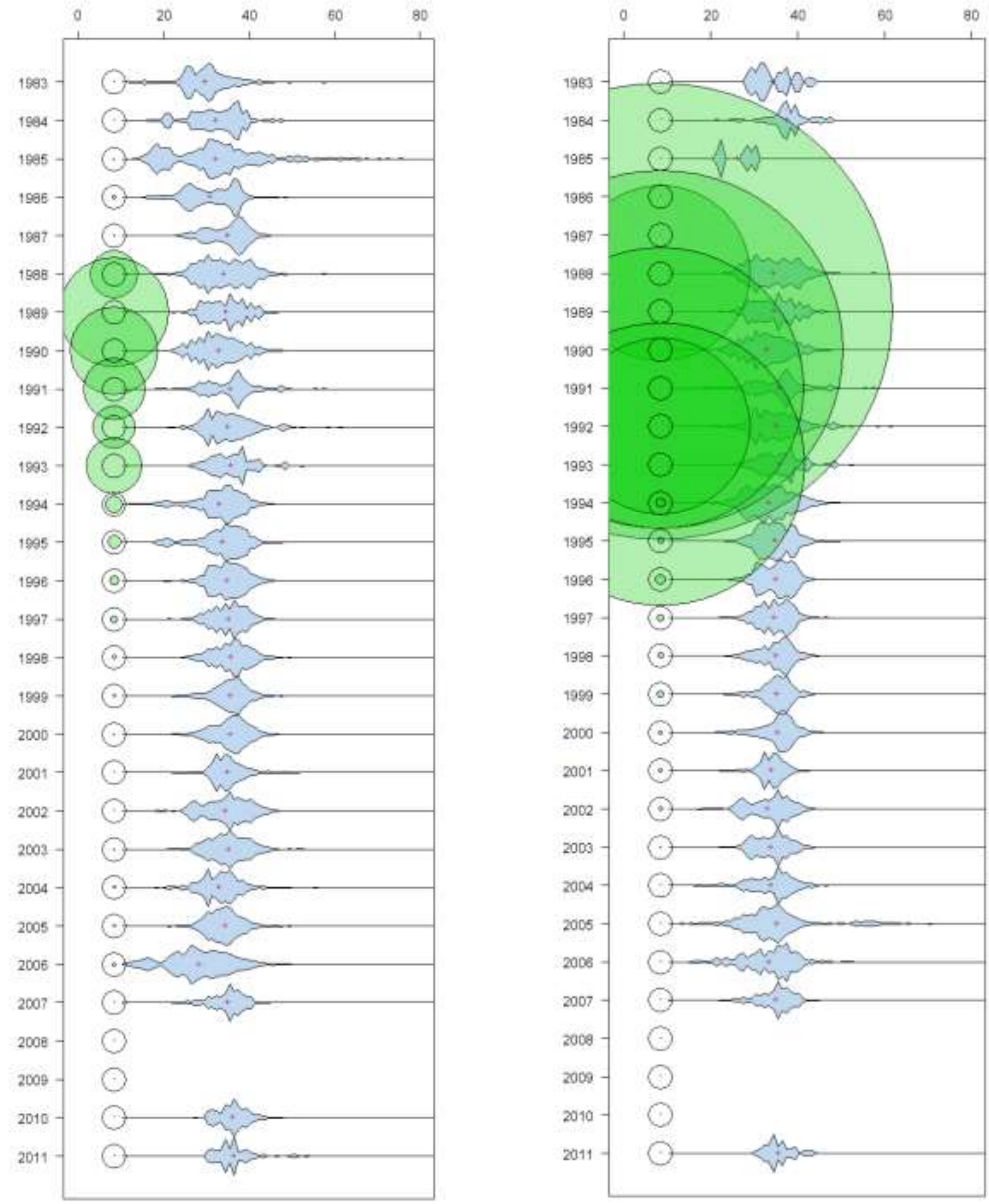


**Fig. 5.** Frigate tuna: Length frequency distributions (total amount of fish measured by 1cm length class) derived from the data available at the IOTC Secretariat for selected fisheries, by gear and year. The black outline circles (to the left of each chart) indicate the minimum sampling standard set by IOTC of one fish per metric tonne; the green proportional circles indicate the relative sampling coverage in each year (i.e., circles with areas greater than the minimum sampling standard indicate relatively high sampling coverage in a given year).

## 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).

**TABLE 6.** Frigate tuna (*Auxis thazard*) stock status summary

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2012 catch estimate | 83,029t |
| Mean catch from 2008–2012 | 90,221 t |
| MSY (80% CI) | unknown |
| Data period used in assessment | – |
| $F_{2012}/F_{MSY}$ (80% CI) | – |
| $B_{2012}/B_{MSY}$ (80% CI) | – |
| $SB_{2012}/SB_{MSY}$ | – |
| $B_{2012}/B_0$ (80% CI) | – |
| $SB_{2012}/SB_0$ | – |
| $B_{2012}/B_{0,\ F=0}$ | – |
| $SB_{2012}/SB_{0,\ F=0}$ | – |

## LITERATURE CITED

Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, <www.fishbase.org>.

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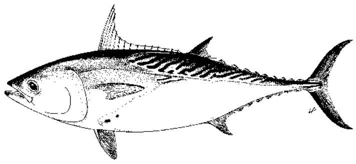
# APPENDIX XX
# EXECUTIVE SUMMARY: KAWAKAWA

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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch[2] 2012:<br>Average catch[2] 2008–2012: | 152,391t<br>147,951t | |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$B_{2012}/B_{MSY}$:<br>$SB_{2012}/SB_0$: | 126,000–132,000 t<br>0.9–1.06<br>1.09–1.17<br>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. Preliminary analysis using a stock-reduction analysis (SRA) approach indicates that the stock in near optimal levels of $F_{MSY}$, or exceeding these targets, although stock biomass remains above the level that would produce MSY ($B_{MSY}$). Due to the quality of the data being used, the simplistic approach used here, and the rapid increase in kawakawa catch in recent years, some measures need to be taken to slow the increase in catches in the IO Region, despite the stock status remaining classified as **uncertain** (Table 1). A separate analysis done on a sub-population (north-west Indian Ocean region) indicated that that stock may be experiencing overfishing, although spawning biomass is likely to be above the level to produce MSY. However, further analysis of the CPUE data should be undertaken in preparation for the next WPNT meeting so that more traditional approaches for assessing stock status are used. Due to a lack of fishery data for several gears, only data poor assessment approaches can currently be used. 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 resource, and the stock is likely to currently be fully exploited. 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 estimated to be between 120,000 and 132,000 t.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock using more traditional stock assessment techniques.
- Given the rapid increase in kawakawa catch in recent years, some measures need to be taken to slow the increase in catches in the Indian Ocean.

### SUPPORTING INFORMATION

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

**CONSERVATION AND MANAGEMENT MEASURES**

Kawakawa (*Euthynnus affinis*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- 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*

**FISHERIES INDICATORS**

***Kawakawa: General***

Kawakawa (*Euthynnus affinis*) 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.<br>**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, handlines and trolling (Table 3; Fig. 1); and may be also an important bycatch of the industrial purse seiners. The catch estimates for kawakawa were derived from very small amounts of information and are therefore highly uncertain[8] (Fig. 2).

[8] 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.

**TABLE 3.** Best scientific estimates of the catches of kawakawa by type of fishery for the period 1950–2012 (in metric tonnes) (Data as of October 2013).

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Purse seine | 100 | 385 | 2,446 | 11,679 | 23,749 | 34,647 | 30,038 | 32,429 | 33,154 | 38,970 | 39,424 | 41,854 | 44,419 | 42,599 | 42,229 | 40,882 |
| Gillnet | 2,179 | 4,098 | 9,205 | 16,695 | 29,793 | 50,312 | 44,060 | 45,762 | 46,000 | 52,600 | 55,404 | 66,121 | 63,539 | 57,997 | 69,471 | 75,007 |
| Line | 2,102 | 3,642 | 7,164 | 11,320 | 16,741 | 22,445 | 19,316 | 22,782 | 20,797 | 22,109 | 23,410 | 29,113 | 29,286 | 29,506 | 30,743 | 27,420 |
| Other | 295 | 719 | 1,357 | 2,690 | 5,132 | 7,853 | 6,594 | 7,555 | 7,618 | 7,954 | 9,639 | 9,830 | 10,266 | 10,484 | 9,908 | 9,082 |
| **Total** | **4,676** | **8,844** | **20,172** | **42,383** | **75,415** | **115,257** | **100,008** | **108,529** | **107,569** | **121,634** | **127,877** | **146,918** | **147,510** | **140,585** | **152,351** | **152,391** |

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 markedly from around 20,000 t in the mid-1970’s to reach the 40,000 t mark in the mid-1980’s and 152,000 t in 2012, the highest catch ever recorded for this species in the Indian Ocean. In recent years the majority of the catches of kawakawa have been taken in the East Indian Ocean. In recent years (2010–12), the countries attributed with the highest catches are Indonesia (25%), India (21%), Iran (14%), Pakistan (9%) and Malaysia (7%) (Fig. 2).

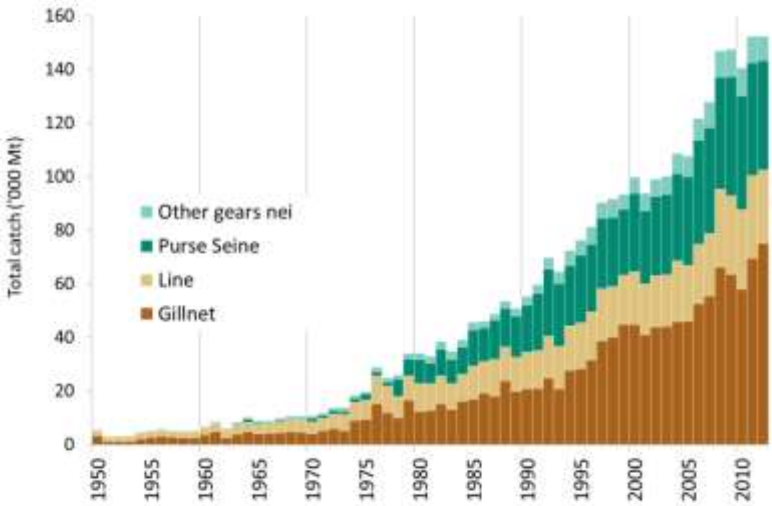



**Fig. 1.** Kawakawa: Annual catches by gear recorded in the IOTC database (1950–2012) (Data as of October 2013).

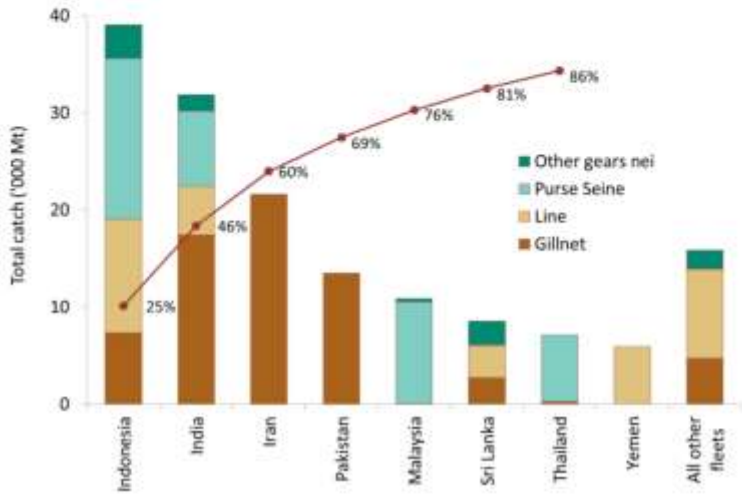



**Fig. 2.** Kawakawa: Average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of kawakawa reported. The red line indicates the (cumulative) proportion of catches of kawakawa for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

***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. In the past, the IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004, by gear and species. However, in a recent review it was indicated that the catches of kawakawa had been overestimated by Indonesia. While the new catches estimated for the kawakawa in Indonesia remain uncertain, representing around 25% (38% in the past) of the total catches of this species in the Indian Ocean in recent years (2010–12), the new figures are considered more reliable than those previously recorded in the IOTC database.
- Artisanal fisheries of India: Although India reports catches of kawakawa they are not always reported by gear. The catches of kawakawa in India were also reviewed and assigned by gear on the basis of official reports and information from various other alternative sources. The catches of kawakawa in India have represented 21% (17% in the past) 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 European Union 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 European Union recently reported discard levels of kawakawa for its purse seine fleet, for 2003–07, estimated using observer data.
- Changes to the catch series: While the overall change to the total catch of kawakawa has not changed substantially for recent years since the WPNT meeting in 2012, there have been large revisions to the catch estimates for individual countries and breakdown by gear; specifically a decrease to catches estimated for Indonesia, and increases to the catch series for Sri Lanka, Pakistan, and India following reviews of the data by the IOTC Secretariat in 2012 and 2013.

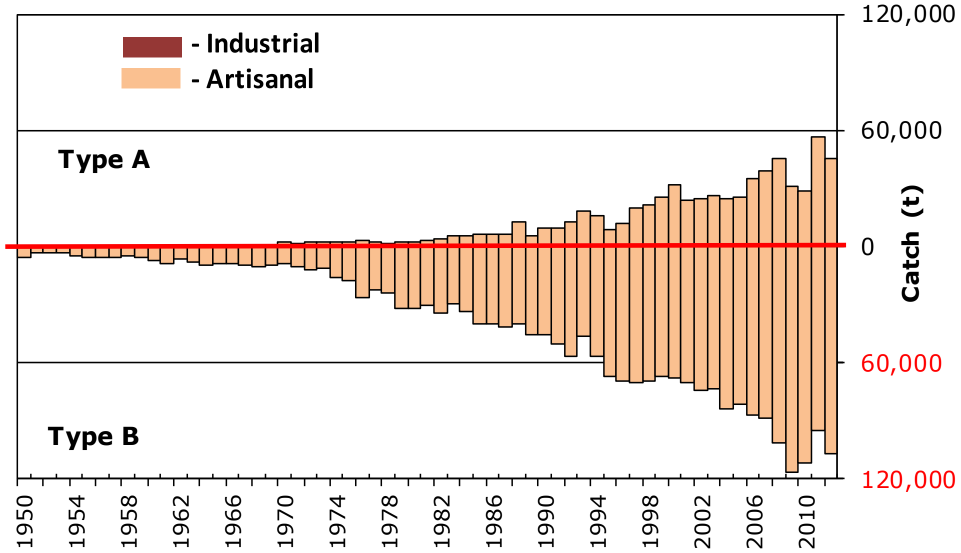



**Fig. 3.** Kawakawa: Uncertainty of annual catch estimates for kawakawa (1950–2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the 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 (Data as of October 2013).

***Kawakawa – Effort trends***

Effort trends are unknown for kawakawa in the Indian Ocean.

*Kawakawa – Catch–per–unit–effort (CPUE) trends*

Standardised CPUE series were developed for some fisheries in 2013 (see IOTC–2013–WPNT03–R). 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.

Kawakawa catch in Oman is less than 2.5%/yr on average for the Indian Ocean which may not be representative of the entire Indian Ocean stock. CPCs are therefore encouraged to collect catch and effort data to compute CPUEs in their respective fisheries (Fig. 5).

**TABLE 4.** Kawakawa: Availability of catches and effort series, by fishery and year (1970–2012)[9]. Note that no catch and effort data are available for the period 1950–69 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-France** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ |  |  |  |  |  |  |  |  |  |
| BB-Indonesia |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **BB-Maldives** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **LL-Portugal** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ |  |  |  |  |
| GILL-Indonesia |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| GILL-India |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| GILL-Iran, IR |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ |  |  |  |  |  |  | ■ | ■ | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| GILL-Malaysia |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ |
| GILL-Oman |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ |  |  |  |  |  |  |  |  |  |  |  |  |
| GILL-Pakistan |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| GILL-Sri Lanka |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  |  |  |  |  |  |  |
| GILL-Thailand |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| LINE-EC-France |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  |  |  |  |
| LINE-UK-OT |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ |  |  |  | ■ |  | ■ | ■ | ■ | ■ | ■ |
| LINE-Indonesia |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| LINE-India |  |  |  |  |  |  |  |  |  | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| LINE-Sri Lanka |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| LINE-Maldives | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| LINE-Malaysia |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| LINE-Seychelles |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| LINE-Yemen |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ |  |  |  |  |  |
| LINE-South Africa |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| OTHR-Sri Lanka |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  |  |  |  |  |  |  |
| OTHR-Indonesia |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| OTHR-Malaysia |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ |
| OTHR-Maldives |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |  |  |

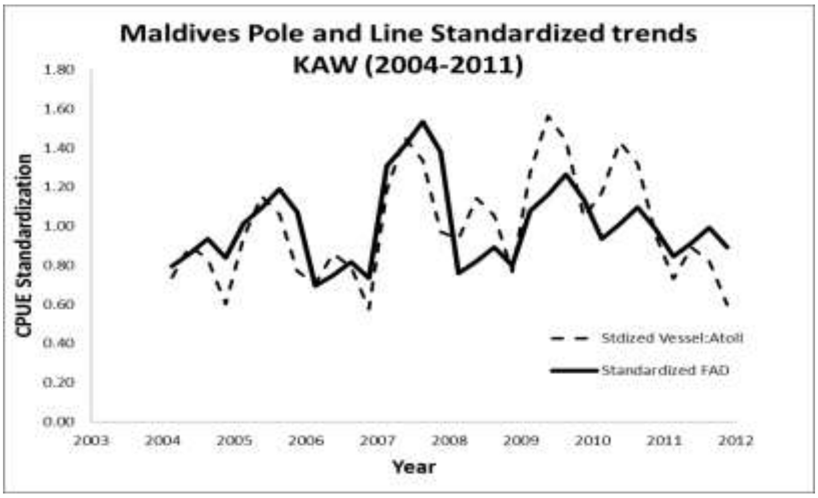



**Fig. 4.** Kawakawa: Maldives pole-and-line standardized index of abundance (CPUE) using two models (standardised by vessel and atoll; and standardised by FADs), from 2004–2011.

[9] 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

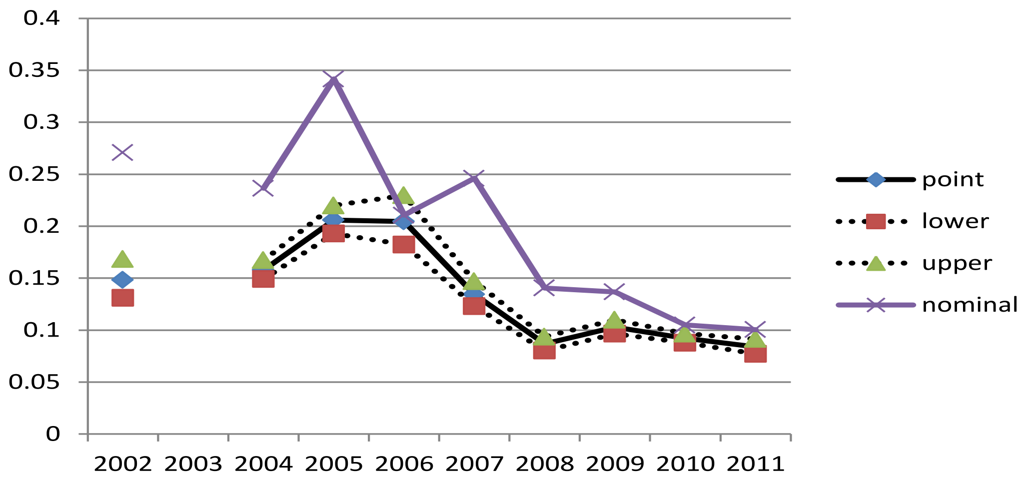
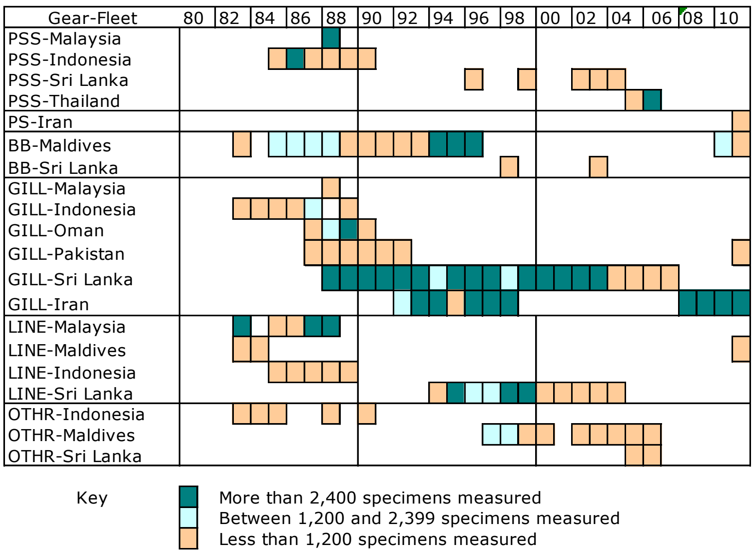



**Fig. 5**. Kawakawa: Sultanate of Oman gillnet standardized index of abundance (CPUE), its 95% confidence intervals and nominal CPUE, from 2002–11.

***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-Size(age) 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. 5.
- 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 (1980–2012)[10]. Note that no length frequency data are available for the period 1950–82




[10] 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

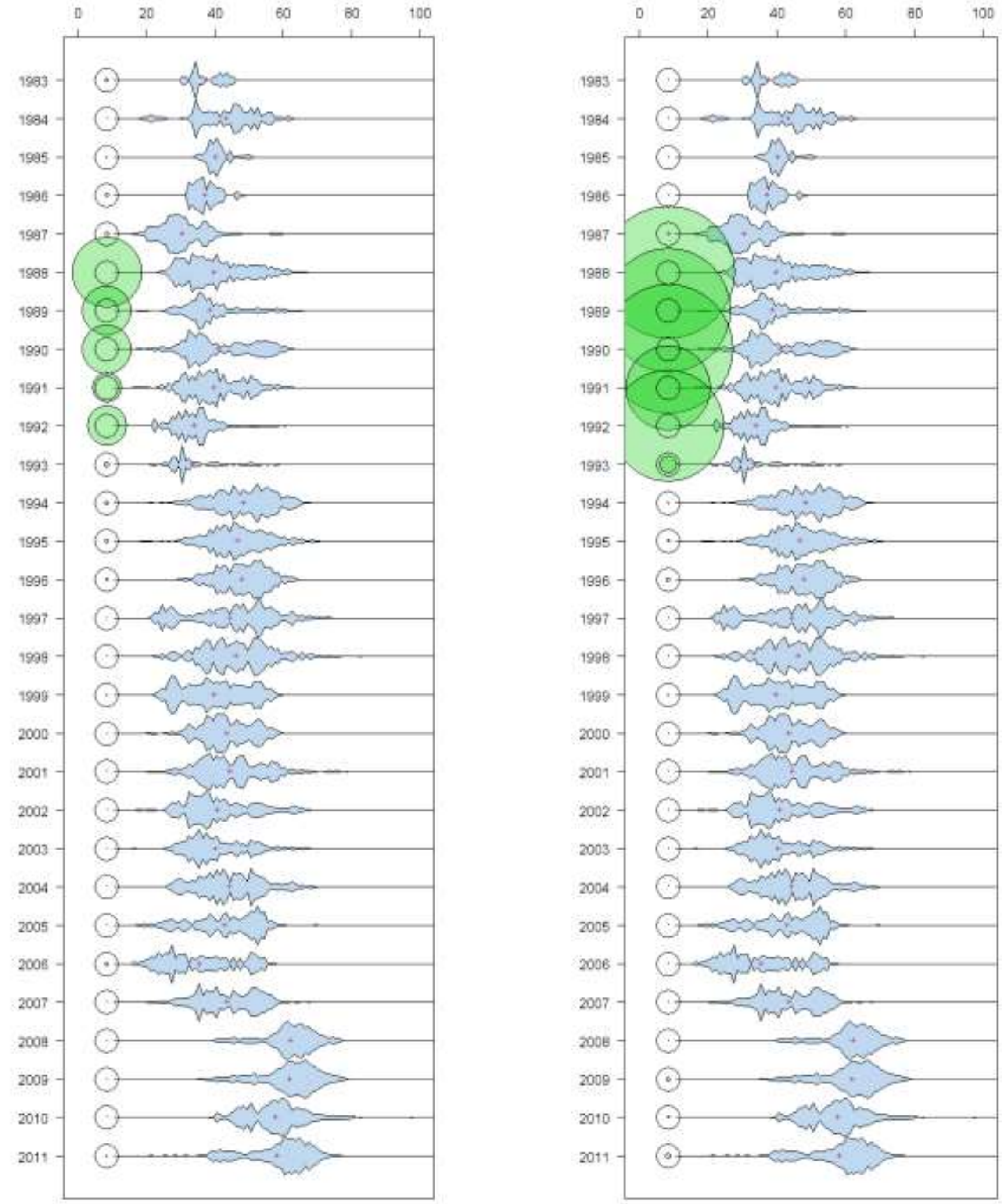



**Fig. 5.** Kawakawa: Length frequency distributions (total amount of fish measured by 1cm length class) derived from the data available at the IOTC Secretariat for selected fisheries and periods, by gear and year. The black outline circles (to the left of each chart) indicate the minimum sampling standard set by IOTC of one fish per metric tonne; the green proportional circles indicate the relative sampling coverage in each year (i.e., circles with areas greater than the minimum sampling standard indicate relatively high sampling coverage in a given year).

**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 fisheries, 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).

**TABLE 6.** Kawakawa (*Euthynnus affinis*) stock status summary

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2012 catch estimate | 152,391 t |
| Mean catch from 2008–2012 | 147,951 t |
| MSY (80% CI) | 126,000–132,000 t |
| Data period used in assessment | 1950–2011 |
| $F_{2011}/F_{MSY}$ (80% CI) | 0.9–1.06 |
| $B_{2011}/B_{MSY}$ (80% CI) | 1.09–1.17 |
| $SB_{2011}/SB_{MSY}$ | – |
| $B_{2011}/B_0$ (80% CI) | – |
| $SB_{2011}/SB_0$ | – |
| $B_{2011}/B_{0, F=0}$ | – |
| $SB_{2011}/SB_{0, F=0}$ | – |

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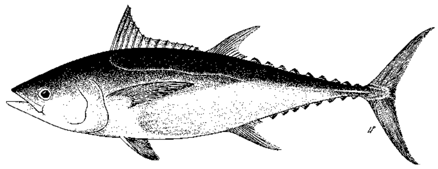
Kaymaram F, Darvishi M (2012) Growth and mortality parameters of *Euthynnus affinis* in the northern part of the Persian Gulf and Oman Sea. IOTC–2012–WPNT02–14 Rev_1

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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch[2] 2012:<br>Average catch[2] 2008–2012: | 155,603 t<br>133,890 t | (orange) |
| | MSY:<br>$F_{2011}/F_{MSY}$:<br>$B_{2011}/B_{MSY}$:<br>$SB_{2011}/SB_0$: | 110,000–123,000 t<br>1.11–1.77<br>1.11–1.25<br>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($F_{year}/F_{MSY}> 1$) | (red) | (orange) |
| Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$) | (yellow) | (green) |
| Not assessed/Uncertain | (grey) | |

### INDIAN OCEAN STOCK – MANAGEMENT ADVICE

***Stock status.*** There remains considerable uncertainty about stock structure and about the total catches in the Indian Ocean. Stock Reduction Analysis techniques indicate that the stock is being exploited at rates that exceed $F_{MSY}$ in recent years. Whether a four quadrant stock structure of catches in the Indian Ocean or a one stock assumption is used in the analysis, the conclusions remain the same. 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. More traditional methods of stock assessment need to be conducted by developing indices of abundance using catch and effort series from I.R. Iran and Indonesia. Given estimated values of current biomass are above the estimated abundance to produce $B_{MSY}$ in 2011, and that fishing mortality has exceeded $F_{MSY}$ values in recent years, the stock is considered to be **not overfished**, but **subject to overfishing** (Table 1).

***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. 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 is likely being exceeded in recent years.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock status, primarily abundance index series from I.R. Iran, Oman and Indonesia.

## SUPPORTING INFORMATION

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

### CONSERVATION AND MANAGEMENT MEASURES

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

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- 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*

### 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.<br>**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[11]. 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 gradually from the mid 1950's to the year 2000 when over 90,000 t were landed. Catches then declined until 2005 (67,600 t). Since 2005, catch have increased continually with the highest catches ever recorded at around 165,100 t, landed in 2011.

In recent years (2010–12), the countries attributed with the highest catches of longtail tuna are Iran (49%) and Indonesia (15%) and Pakistan (9%), and to a lesser extent, Malaysia, India, Oman and Thailand (23%) (Table3; Fig. 2). In particular, Iran has reported large increases in the catch of longtail tuna since 2008. 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.

[11] 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.

**TABLE 3.** Longtail tuna: Best scientific estimates of the catches of longtail tuna by type of fishery for the period 1950–2012 (in metric tonnes) (Data as of October 2013)

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1950s** | **1960s** | **1970s** | **1980s** | **1990s** | **2000s** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Purse seine | 44 | 204 | 1,092 | 4,833 | 8,984 | 11,505 | 11,585 | 9,319 | 7,714 | 11,138 | 15,456 | 11,329 | 13,381 | 9,697 | 20,591 | 21,765 |
| Gillnet | 2,593 | 5,849 | 8,964 | 24,808 | 39,081 | 57,846 | 54,510 | 45,981 | 43,133 | 51,455 | 59,699 | 67,332 | 83,142 | 101,057 | 120,406 | 112,429 |
| Line | 909 | 1,160 | 2,530 | 5,084 | 7,217 | 14,094 | 11,510 | 14,093 | 14,219 | 16,519 | 17,667 | 15,332 | 15,679 | 16,629 | 17,897 | 17,427 |
| Other | 0 | 0 | 125 | 1,091 | 1,987 | 3,241 | 2,384 | 2,823 | 2,516 | 3,132 | 4,057 | 4,932 | 4,777 | 5,466 | 6,201 | 3,981 |
| **Total** | **3,546** | **7,213** | **12,711** | **35,814** | **57,269** | **86,686** | **79,989** | **72,216** | **67,582** | **82,244** | **96,879** | **98,924** | **116,980** | **132,849** | **165,096** | **155,603** |

The size of longtail tuna taken by IOTC fisheries typically ranges between 20 and 100 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 longtail tuna of small size (20–45cm) while the main gillnet fisheries operating in the Arabian Sea (Iran and Pakistan) catch larger specimens (50–100cm).

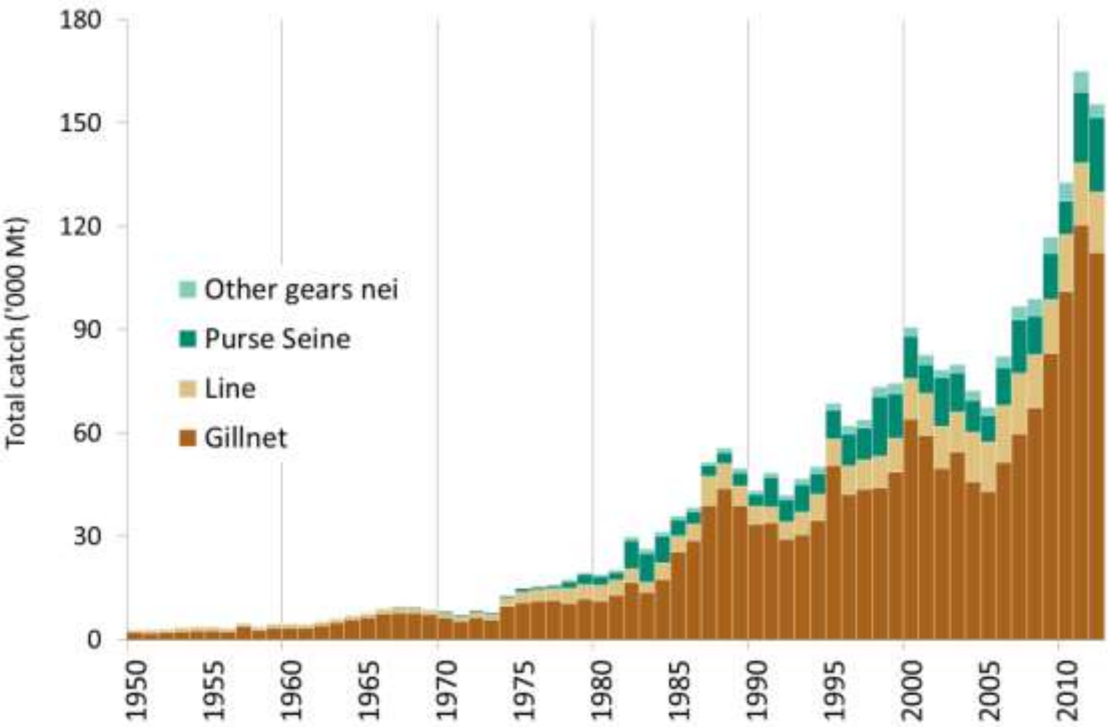



**Fig. 1.** Longtail tuna: Annual catches of longtail tuna by gear recorded in the IOTC Database (1950–2012) (Data as of October 2013).

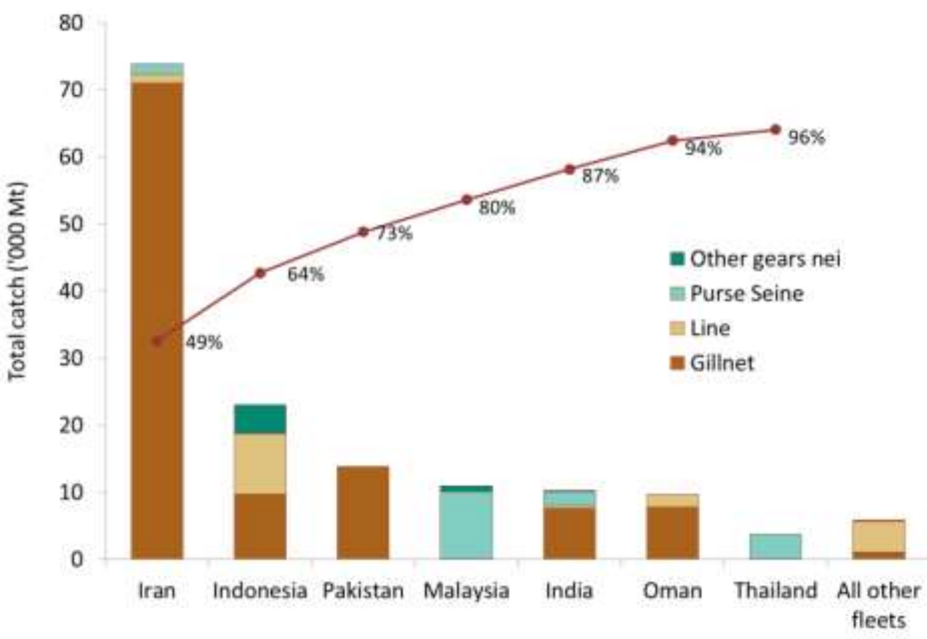


**Fig. 2.** Longtail tuna: Average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of longtail reported. The red line indicates the (cumulative) proportion of catches of longtail tuna for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

### *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. In the past, the IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004 by gear and species. However, in a recent review of the data (2012) it was identified that the catches of longtail tuna had been overestimated by Indonesia. While the new catches estimated for longtail tuna in Indonesia remain uncertain, representing around 15% (30% in the past) of the total catches of this species in the Indian Ocean in recent years (2010–12), the new figures are considered more reliable than those existing in the past.
- 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 assign the catches reported by Oman by gear. The catches of India were also reviewed in 2012 and assigned by gear on the basis of official reports and information from various alternative sources. The catches of longtail tuna from Oman and India represented 13% of the total catches of this species in recent years (2010–12).
- 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 for years before 2012. The catches estimated for the longtail tuna represent 7% of the total catches of this species, across all years and fleets, 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 been significant changes to the catches of longtail tuna since the WPNT meeting in 2012, following major reviews of catch time series for Indonesia, India, and Sri Lanka.

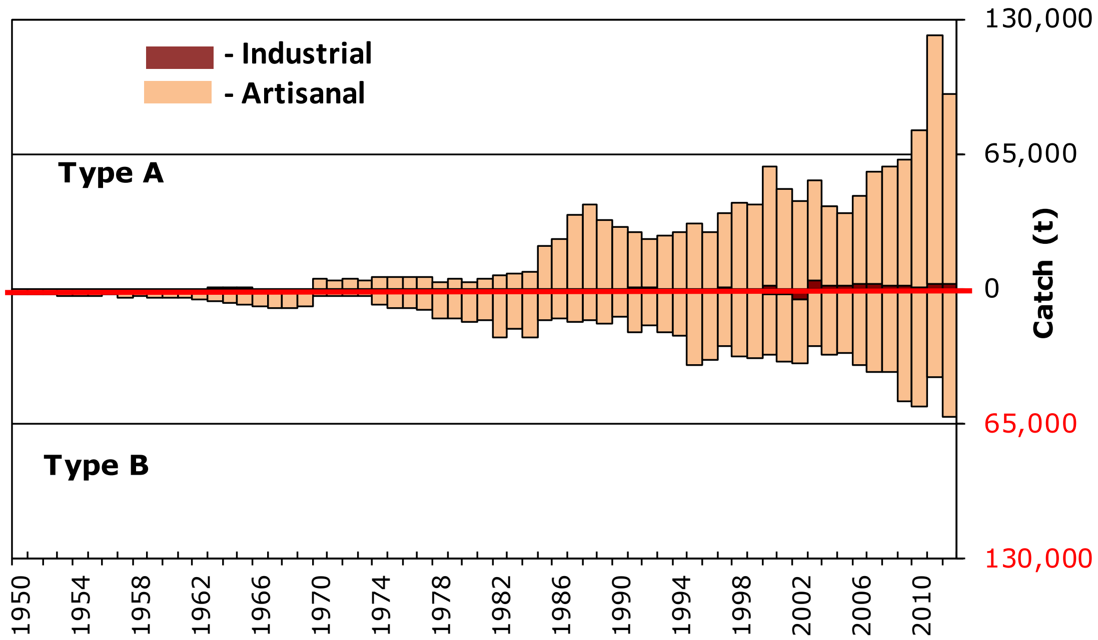



**Fig. 3**. Uncertainty of annual catch estimates for longtail tuna (1950–2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC 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 (Data as of October 2013)

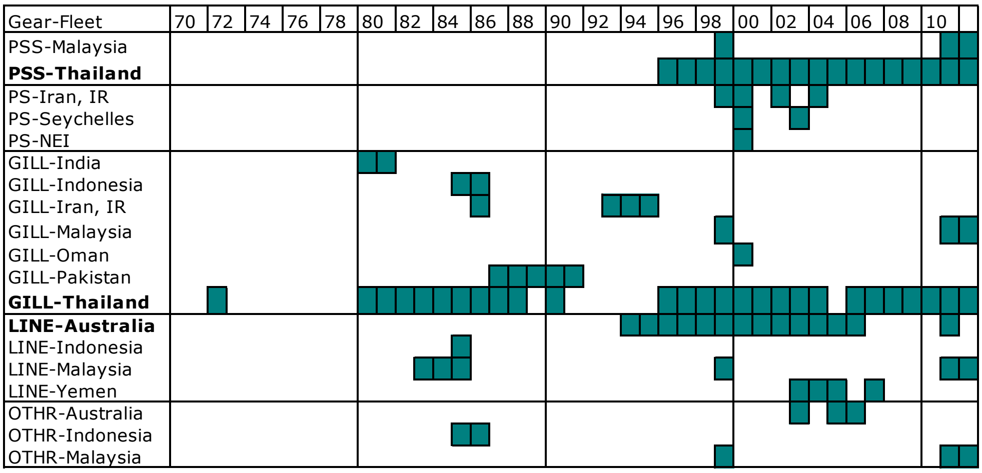
### *Longtail tuna – Effort trends*

Effort trends are unknown for longtail tuna in the Indian Ocean.

### *Longtail tuna – Catch–per–unit–effort (CPUE) trends*

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 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 (1970–2012)[12]. Note that no catch and effort data are available for the period 1950–1971 in the IOTC Secretariat databases



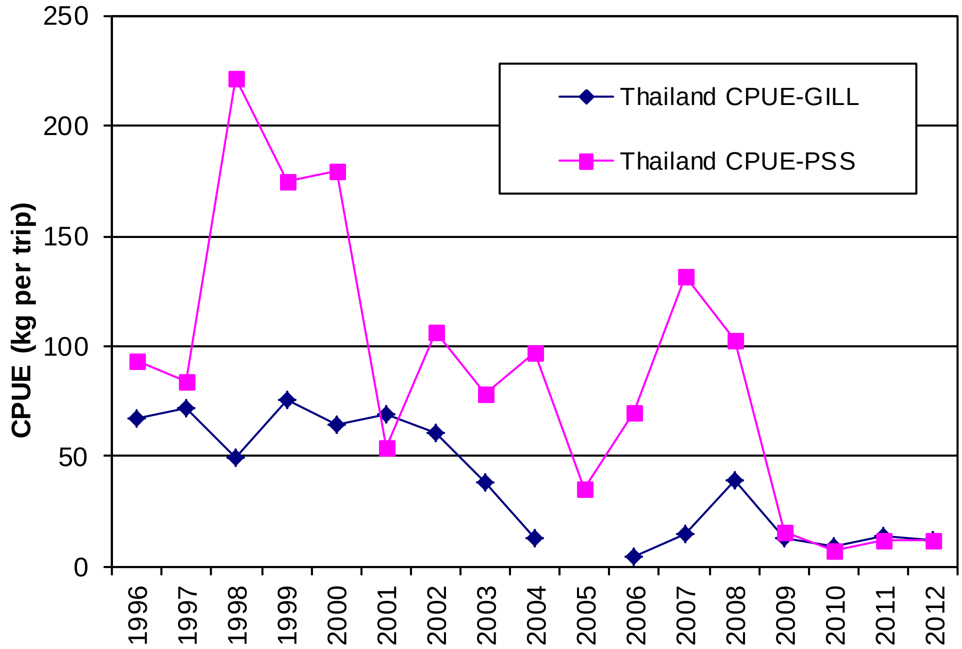




**Fig. 4.** Longtail tuna: Nominal CPUE series for the gillnet (GILL) and coastal purse seine (PSS) fisheries of Thailand derived from the available catches and effort data (1996–2012)

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

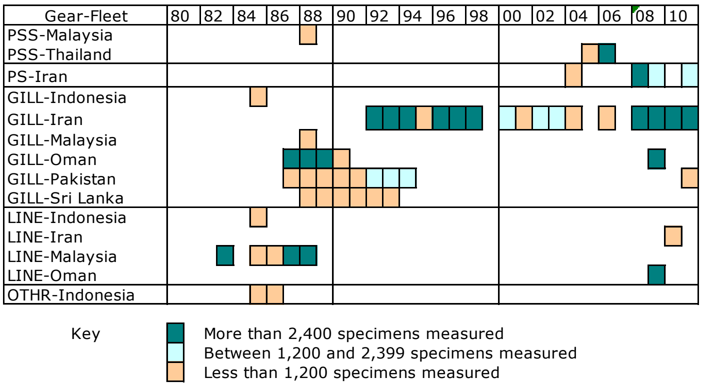
- The size of longtail tuna taken by the Indian Ocean fisheries typically ranges between 15–120 cm depending on the type of gear used, season and location. The fisheries operating in the Andaman Sea (coastal purse seines and troll lines) tend to catch longtail tuna of small size (20–45cm) while the drifting gillnet fisheries operating in the Arabian Sea catch larger specimens (50–100cm).
- 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-

[12] 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.

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.

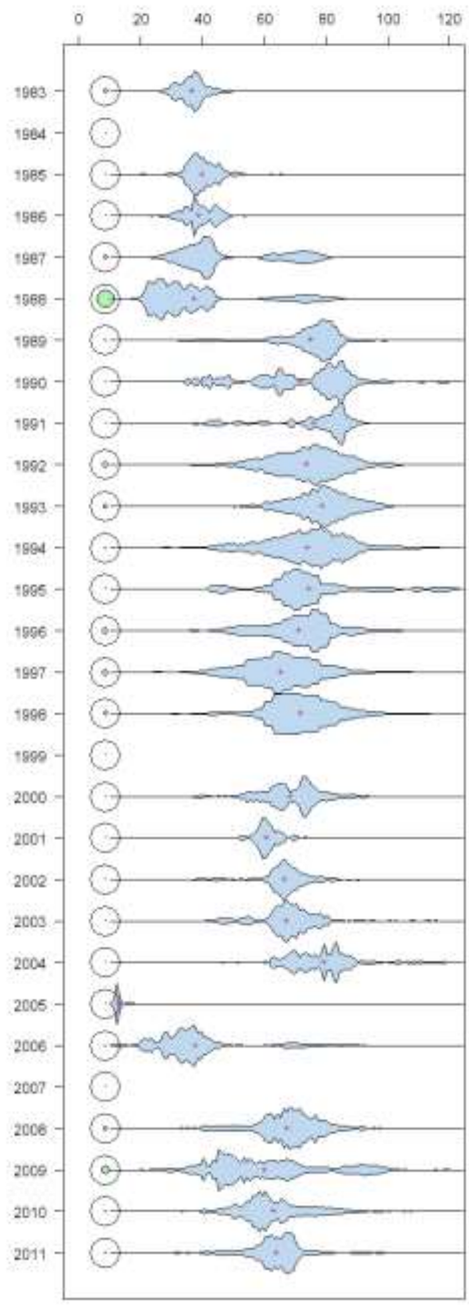
- Catch-at-Size(Age) tables are not available for the longtail tuna due to the paucity of size data available from most fleets and the uncertain status of the catches for this species (Table 5). Length distributions derived from the data available for some selected fisheries are shown in Fig. 5.
- Sex ratio data have not been provided to the Secretariat by CPCs.

**TABLE 5.** Longtail tuna: Availability of length frequency data, by fishery and year (1980–2012)[13]. Note that no catch and effort data are available for the period 1950–1982 in the IOTC Secretariat databases




[13] 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

LOT (All samples): size (in cm)



LOT (Gillnet samples): size (in cm)

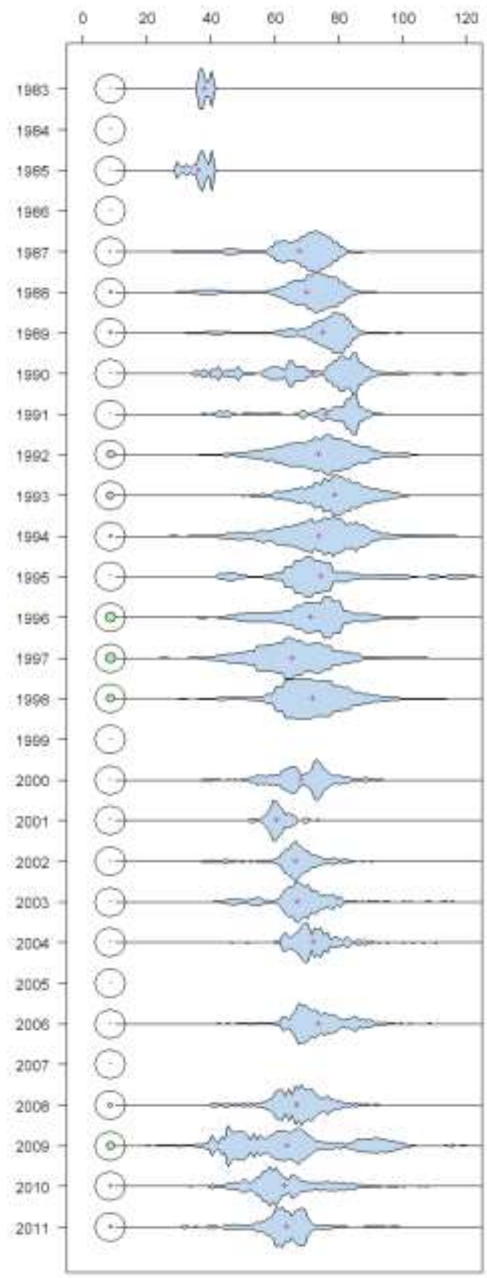


**Fig. 5:** Longtail tuna: Length frequency distributions (total amount of fish measured by 1cm length class) derived from the data available at the IOTC Secretariat for selected fisheries, by gear and year. The black outline circles (to the left of each chart) indicate the minimum sampling standard set by IOTC of one fish per metric tonne; the green proportional circles indicate the relative sampling coverage in each year (i.e., circles with areas greater than the minimum sampling standard indicate relatively high sampling coverage in a given year).

### 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).

**TABLE 6.** Longtail tuna (*Thunnus tonggol*) stock status summary

| Management Quantity | Aggregate Indian Ocean |
|---|---|
| 2012 catch estimate | 155,603 t |
| Mean catch from 2008–2012 | 133,890 t |
| MSY (80% CI) | 110,000–123,000 t |
| Data period used in assessment | 1950–2011 |
| $F_{2011}/F_{MSY}$ (80% CI) | 1.11–1.77 |
| $B_{2011}/B_{MSY}$ (80% CI) | 1.11–1.25 |
| $SB_{2011}/SB_{MSY}$ | – |
| $B_{2011}/B_0$ (80% CI) | – |
| $SB_{2011}/SB_0$ | – |
| $B_{2011}/B_{0,\ F=0}$ | – |
| $SB_{2011}/SB_{0,\ F=0}$ | – |

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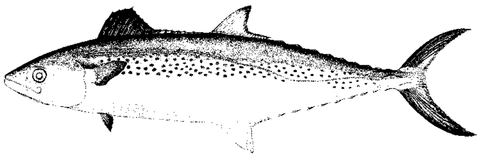
Griffiths S, Pepperell J, Tonks M, Sawynok W, Olyott L, Tickell S, Zischke M, Lynne J, Burgess J, Jones E, Joyner D, Makepeace C, Moyle K (2010b) Biology, fisheries and status of longtail tuna (*Thunnus tonggol*),with special reference to recreational fisheries in Australian waters. FRDC Final Report 2008/058, 101 pp

Kaymaram F, Darvishi M., Parafkandeh F, Ghasemi S,Talebzadeh SA (2011) Population dynamic parameters of *Thunnus tonggol* in the north of the Persian Gulf and Oman Sea. IOTC–2011–WPNT01–18

# 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** | | **2013 stock status determination** |
|---|---|---|---|
| Indian Ocean | Catch[2] 2012:<br>Average catch[2] 2008–2012: | 46,234 t<br>47,245 t | |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | unknown<br>unknown<br>unknown<br>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 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 that this increase may have had 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 (*Scomberomorus guttatus*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- 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*

## 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.<br>**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[14] is mostly caught by artisanal 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[15] (Fig. 1).

[14] Hereinafter referred to as king mackerel

[15] 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 non-reporting fisheries for which catches had to be estimated.

**TABLE 3.** Indo-Pacific king mackerel: Best scientific estimates of the catches of Indo-Pacific king mackerel by type of fishery for the period 1950–2012 (in metric tonnes) (Data as of October 2013).

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Purse seine | 0 | 0 | 35 | 589 | 781 | 930 | 857 | 788 | 693 | 704 | 1,068 | 1,276 | 1,610 | 1,129 | 1,262 | 1,266 |
| Gillnet | 4,213 | 6,748 | 13,533 | 16,559 | 21,255 | 23,066 | 21,008 | 21,846 | 18,054 | 20,249 | 26,173 | 31,969 | 31,744 | 26,113 | 28,408 | 28,865 |
| Line | 404 | 500 | 1,184 | 1,880 | 2,286 | 2,610 | 2,219 | 2,347 | 2,116 | 2,085 | 3,031 | 3,638 | 3,949 | 3,201 | 3,452 | 3,380 |
| Other | 13 | 21 | 48 | 3,879 | 5,110 | 9,319 | 7,743 | 8,195 | 7,873 | 8,127 | 10,627 | 12,193 | 15,768 | 11,642 | 12,633 | 12,723 |
| **Total** | **4,630** | **7,269** | **14,801** | **22,907** | **29,433** | **35,924** | **31,826** | **33,176** | **28,736** | **31,164** | **40,900** | **49,076** | **53,072** | **42,086** | **45,756** | **46,234** |

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 1960's, reaching around 14,000 t in the early 1970's and over 30,000 t since the mid-1990's. Catches have increased steadily since then until 1998, when catches of around 40,000 t were recorded. From 1999 catches of Indo-Pacific king mackerel have declined to around 28,000, and from 2000 to 2005 catches remained stable at around 30,000 t per year. Since 2005 catches have increased substantially, reaching 53,000 t in 2009, before declining marginally to around 45,000 t.

In recent years (2010–12), the countries attributed with the highest catches are India (40%) and Indonesia (27%) and, to a lesser extent, Myanmar and Iran (19%) (Fig. 2). Catches of king mackerel have been higher in the eastern Indian Ocean recent years.

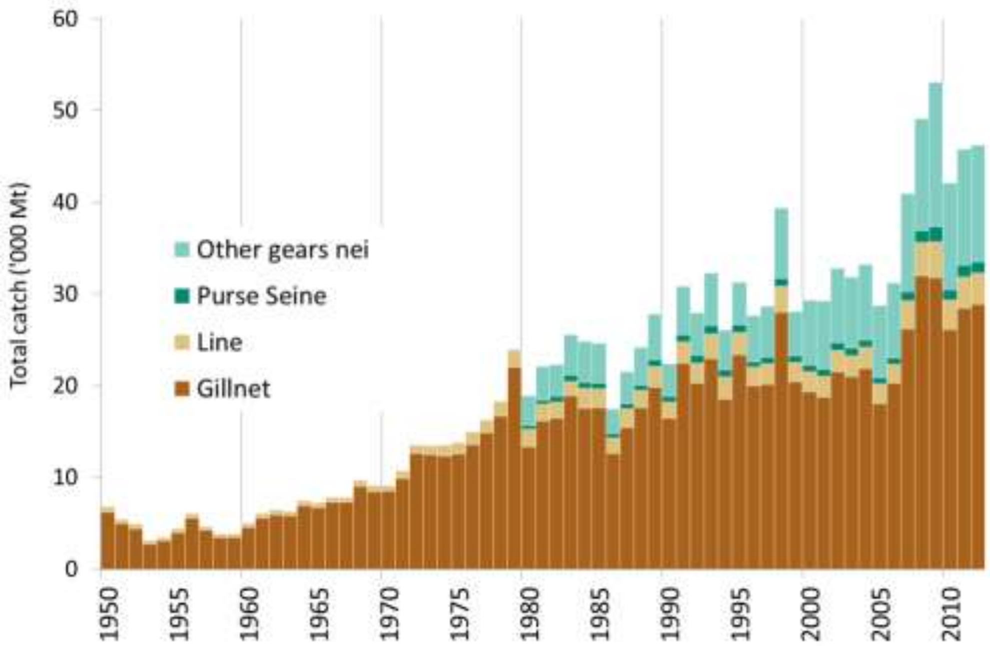



**Fig. 1.** Indo-Pacific king mackerel: Annual catches of Indo-Pacific king mackerel by gear recorded in the IOTC database (1950–2012) (Data as of October 2013)

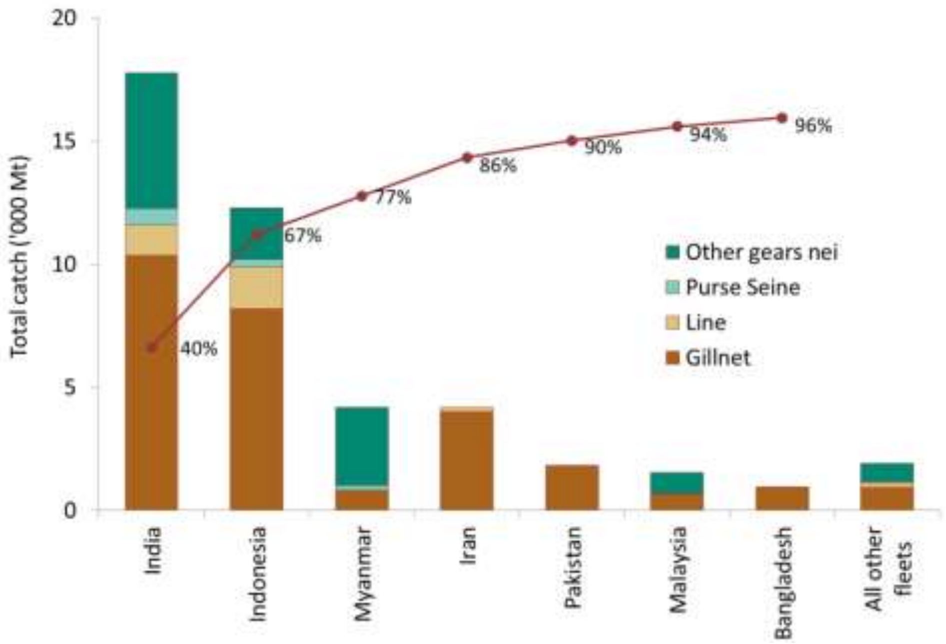



**Fig. 2. Indo-Pacific king mackerel**: average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of Indo-Pacific king mackerel reported. The red line indicates the (cumulative) proportion of catches of Indo-Pacific king mackerel for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

***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 been relatively minor revisions to the catch series of Indo-Pacific king mackerel since the WPNT in 2012, following reviews of the artisanal catch series of Indonesia, India and Sri Lanka.  The largest revisions affect catches estimated for the mid-1990s and mid-2000s, with catches revised downwards by around 10%–20%.

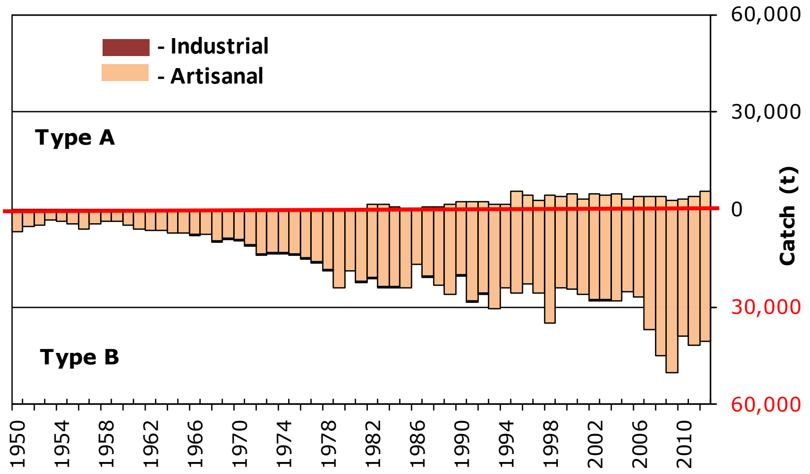



**Fig. 3.** Indo-Pacific king mackerel: Uncertainty of annual catch estimates for Indo-Pacific king mackerel (1950–2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (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 (Data as of October 2013).

### *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 refer to very short periods (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 (1970–2012)[16]. Note that no catches and effort are available for the period 1950–85 at the IOTC Secretariat

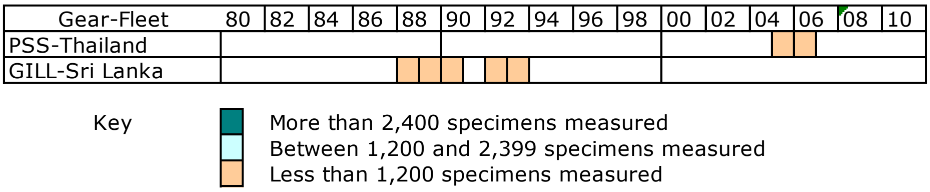
| Gear-Fleet | 70 | 72 | 74 | 76 | 78 | 80 | 82 | 84 | 86 | 88 | 90 | 92 | 94 | 96 | 98 | 00 | 02 | 04 | 06 | 08 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PSS-Indonesia | | | | | | | | | ■ | | | | | | | | | | | | | |
| LINE-South Africa | | | | | | | | | | | | | | | | | | ■ | | | | |
| 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.

[16] 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 (1980–2012)[17]. 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).

**TABLE 6.** Indo-Pacific king mackerel (*Scomberomorus guttatus*) stock status summary

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2012 catch estimate | 46,244 t |
| Mean catch from 2008–2012 | 47,245 t |
| MSY (80% CI) | unknown |
| Data period used in assessment | – |
| $F_{2012}/F_{MSY}$ (80% CI) | – |
| $B_{2012}/B_{MSY}$ (80% CI) | – |
| $SB_{2012}/SB_{MSY}$ | – |
| $B_{2012}/B_{0}$ (80% CI) | – |
| $SB_{2012}/SB_{0}$ | – |
| $B_{2012}/B_{0,\ F=0}$ | – |
| $SB_{2012}/SB_{0,\ F=0}$ | – |

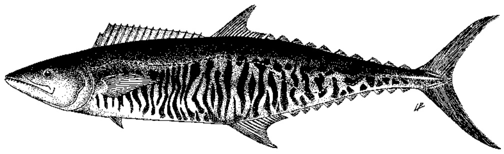
## Literature Cited

Froese R, Pauly DE (2009) FishBase, version 02/2009, FishBase Consortium, www.fishbase.org

[17] 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** | | **2013 stock status determination** |
|---|---|---|---|
| Indian Ocean | Catch[2] 2012:<br>Average catch[2] 2008–2012: | 136,301 t<br>133,692 t | |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | unknown<br>unknown<br>unknown<br>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 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 that this increase may have had 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

Narrow-barred Spanish mackerel (*Scomberomorus commerson*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 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*
- 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*

**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<br>**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 1950–2012 (in metric tonnes) (Data as of October 2013)

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Purse seine | 0 | 0 | 284 | 2,352 | 4,136 | 5,435 | 4,692 | 4,692 | 4,563 | 4,695 | 7,326 | 5,918 | 6,654 | 8,358 | 8,916 | 9,023 |
| Gillnet | 8,680 | 16,862 | 29,732 | 51,762 | 60,008 | 64,079 | 63,079 | 63,079 | 61,991 | 53,776 | 65,162 | 69,226 | 73,119 | 69,190 | 75,109 | 81,234 |
| Line | 2,581 | 3,300 | 7,106 | 14,464 | 14,741 | 18,767 | 17,365 | 17,365 | 17,397 | 16,950 | 19,272 | 20,047 | 22,536 | 23,579 | 23,869 | 25,577 |
| Other | 57 | 96 | 468 | 5,614 | 9,739 | 20,995 | 18,285 | 18,285 | 19,528 | 18,327 | 23,309 | 24,271 | 23,652 | 27,933 | 25,589 | 27,821 |
| **Total** | **11,318** | **20,258** | **37,590** | **74,191** | **88,624** | **109,276** | **103,422** | **103,422** | **103,479** | **93,747** | **115,069** | **119,462** | **125,962** | **129,060** | **133,483** | **143,655** |

The catch estimates for narrow-barred Spanish mackerel were derived from very small amounts of information and are therefore highly uncertain[18]. 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. 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 143,700 t. Narrow-barred Spanish mackerel is caught in both Indian Ocean basins, with higher catches recorded in the west.

In recent years (2008–12), the countries attributed with the highest catches of narrow-barred Spanish mackerel are Indonesia (29%) and India (23%) and, to a lesser extent, Iran, Myanmar, Pakistan, and the UAE (27%) (Fig. 2).

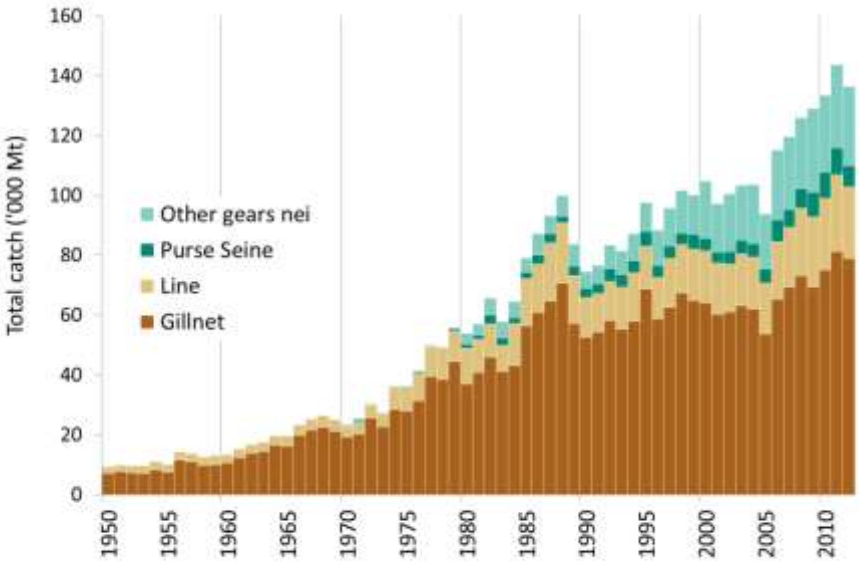



**Fig. 1. Narrow-barred Spanish mackerel**: Annual catches of narrow-barred Spanish mackerel by gear recorded in the IOTC database (1950–2012) (Data as of October 2013).

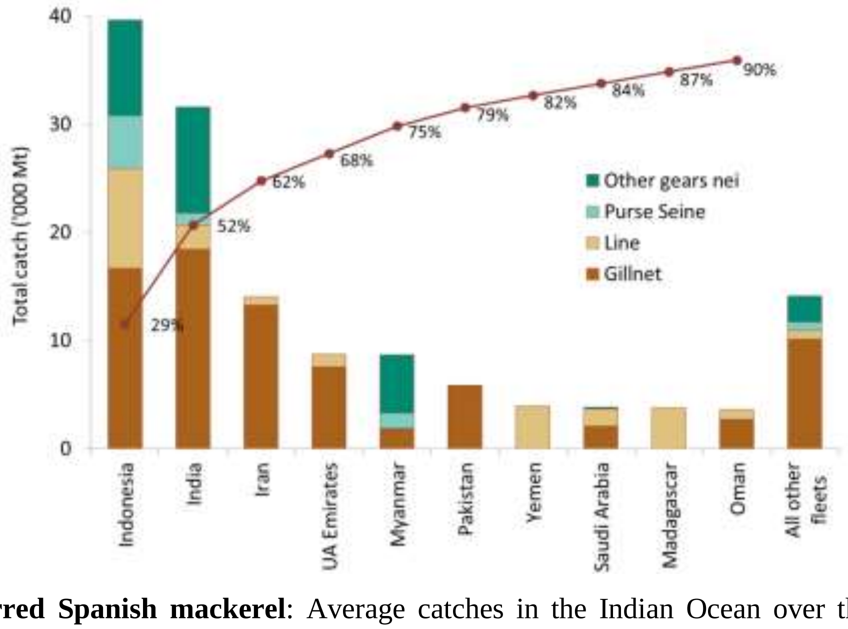



**Fig. 2. Narrow-barred Spanish mackerel**: Average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of narrow-barred Spanish mackerel reported. The red line indicates the (cumulative) proportion of catches narrow-barred Spanish mackerel for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

[18] 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 non-reporting fisheries for which catches had to be estimated

### *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 Spanish mackerel by gear, including catches by gear for the years 2005–08 and 2007–08, respectively. In the past, the IOTC Secretariat used the catches reported in recent years to break the aggregates for previous years, by gear and species. However, in a recent review the catches of narrow-barred Spanish mackerel were reassigned by gear using other sources. The catches of narrow-barred Spanish mackerel estimated for this component represent around 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 2012 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 tunas and tuna-like species had been combined under this name (the review used data from various sources including a reconstruction of the total marine fisheries catches of Madagascar (1950–2008), undertaken by the Sea Around Us Project). The new catches estimated are thought to be very uncertain.
- Artisanal fisheries of Somalia: Catch levels are unknown.
- Other artisanal fisheries 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. In addition, Thailand 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 Spanish mackerel. This mislabelling is thought to have little impact in the case of the 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 2012. The catch series estimated for the WPNT in 2013 show lower catches of narrow-barred Spanish mackerel between the mid-1990's and early 2000's, following a review of the catch series in India.

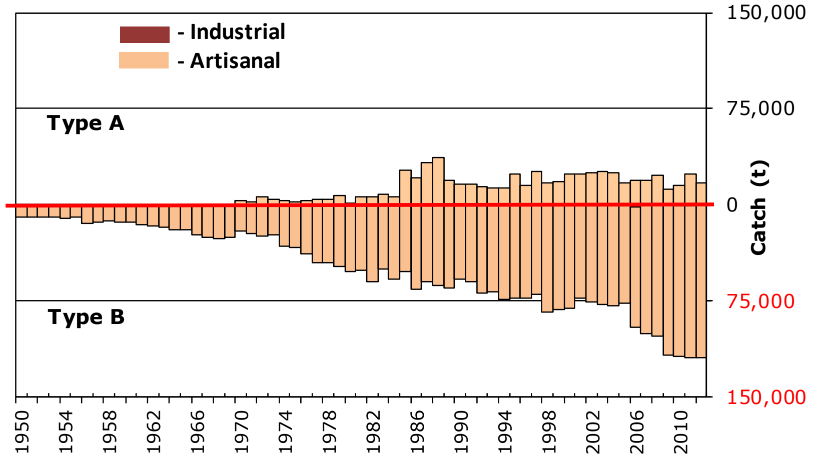



**Fig. 3. Narrow-barred Spanish mackerel**: Uncertainty of annual catch estimates for narrow-barred Spanish mackerel (1950–2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or 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 (Data as of October 2013)

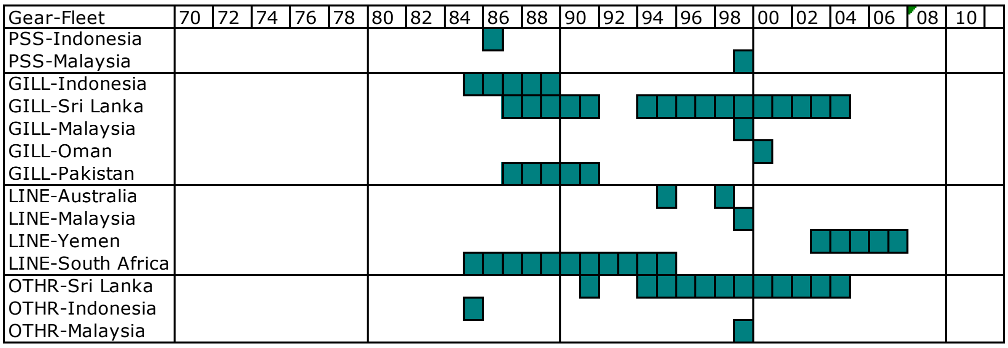
### *Narrow-barred Spanish mackerel – Effort trends*

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 (1970–2012)[19]. Note that no catches and effort are available for the period 1950–84 and 2008–12



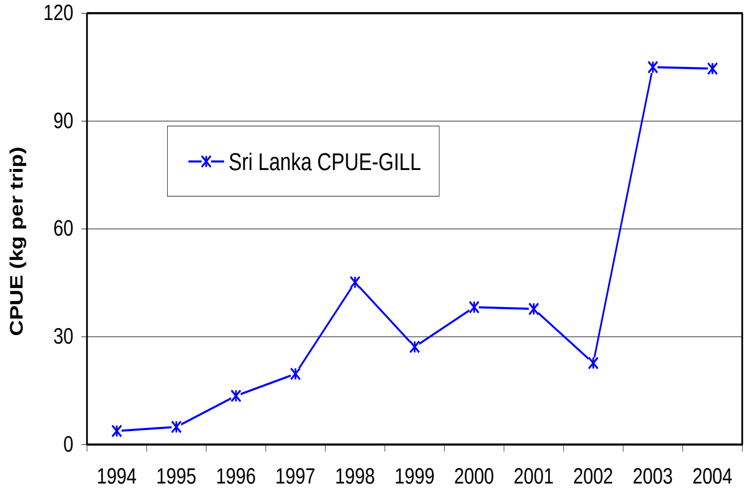




**Fig. 4. Narrow-barred Spanish mackerel:** Nominal CPUE series for the gillnet fishery of Sri Lanka derived from the available catches and effort data (1994–2004)

### *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.

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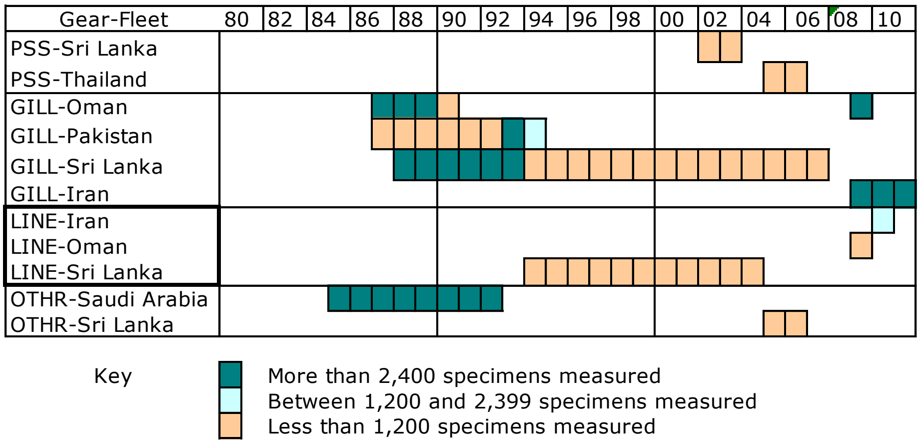
[19] Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, when available catches and effort may not be available throughout the year existing only for short periods

**TABLE 5. 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



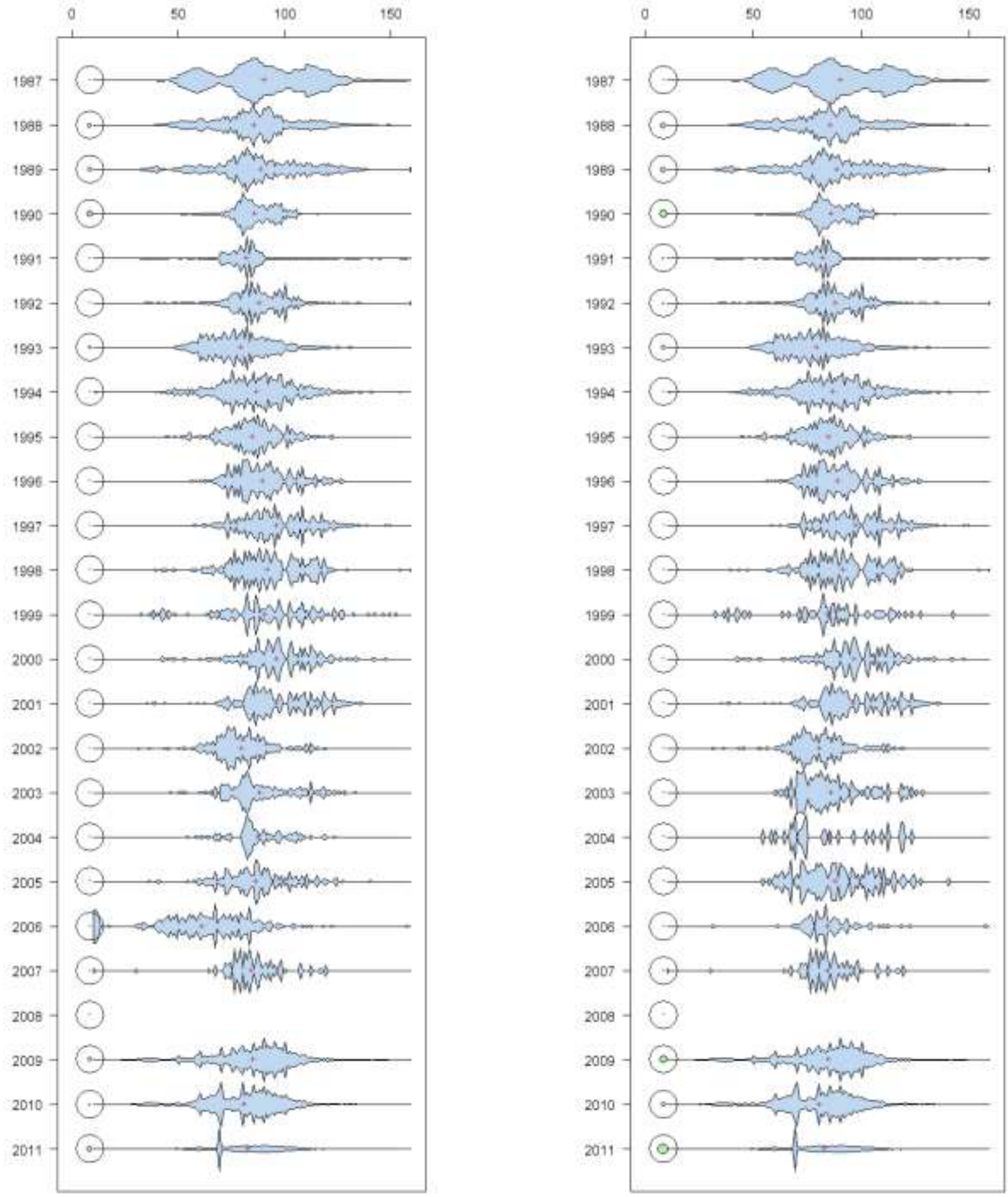



**Fig. 5. Narrow-barred Spanish mackerel**: Length frequency distributions (total amount of fish measured by 1cm length class) derived from the data available at the IOTC Secretariat for selected fisheries and periods, by gear and year. The black outline circles (to the left of each chart) indicate the minimum sampling standard set by IOTC of one fish per metric tonne; the green proportional circles indicate the relative sampling coverage in each year (i.e., circles with areas greater than the minimum sampling standard indicate relatively high sampling coverage in a given year).

**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).

**TABLE 6. Narrow-barred Spanish mackerel** (*Scomberomorus commerson*) stock status summary

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2012 catch estimate | 136,301 t |
| Mean catch from 2008–2012 | 133,692 t |
| MSY (80% CI) | unknown |
| Data period used in assessment | – |
| $F_{2012}/F_{MSY}$ (80% CI) | – |
| $B_{2012}/B_{MSY}$ (80% CI) | – |
| $SB_{2012}/SB_{MSY}$ | – |
| $B_{2012}/B_0$ (80% CI) | – |
| $SB_{2012}/SB_0$ | – |
| $B_{2012}/B_{0,\ F=0}$ | – |
| $SB_{2012}/SB_{0,\ F=0}$ | – |

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McPherson GR (1989) North-eastern Australian mackerel (*Scomberomorus*) fishery. In: Chavez EA, Ed). Proceedings of the workshop Australia-Mexico on marine sciences, Quintana Roo, Mexico, 6-17 July 1989. Quintana Roo, Mexico. pp. 341-348

## 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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Reported catch 2012:<br>Not elsewhere included (nei) sharks:<br>Average reported catch 2008–2012:<br>Not elsewhere included (nei) sharks: | 21,901 t<br>42,793 t<br>24,204 t<br>48,708 t | Uncertain |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | unknown<br>unknown<br>unknown<br>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[20] | | |
|---|---|---|---|---|
| | | 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 ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Blue sharks received a medium vulnerability ranking (No. 10) in the ERA rank for longline gear because it was estimated as one of the most productive shark species, but was also characterised by the second highest susceptibility to longline gear. Blue shark was estimated as not being susceptible thus not vulnerable to purse seine gear. 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. Therefore stock status remains **uncertain** (Table 1).

***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

[20] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

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 should 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.
- Noting that current reported catches (probably largely underestimated) are estimated at an average ~ 24,204 t over the last five years, ~ 21,901 t in 2012, 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 13/03 *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 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- 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 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.

*Extracts from Resolutions 13/03, 13/06, 11/04 and 05/05*

**RESOLUTION 13/03 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 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES**

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures**.**

**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 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 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.

**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.<br>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 4–6 years for males and 5–7 years for females.<br>Size: not available for the Indian Ocean. In the Atlantic 182–218 cm TL 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 °N and 6 °S, pregnant females are present for most of the year.<br>• Fecundity: relatively high (25–50)<br>• Generation time: 8–10 years<br>• Gestation Period: 9–12 months<br>• Annual reproductive cycle |
| Size (length and weight) | Maximum size is around 380 cm FL.<br>New-born pups are around 40 to 51 cm TL.<br>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, Nakano & Stevens 2008, 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. 2011).

**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 |
| At vessel 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, Coelho et al. (2011), Coelho et al. (2013a).

### *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. Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, I.R. Iran and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Rep. of Korea, Indonesia, Mozambique, Malaysia, Oman, Seychelles, Mauritius, Philippines, UK-territories, Vanuatu). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 71% 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 2010 to 2012

| Catch | | 2010 | 2011 | 2012 |
|---|---|---|---|---|
| Most recent catch (reported) | Blue shark | 25,330 t | 26,361 t | 21,901 t |
| | nei-sharks | 51,581 t | 53,658 t | 42,793 t |
| Mean catch (reported) over the last 5 years (2008–2012) | Blue shark | | | 24,204 t |
| | nei-sharks | | | 48,708 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). Due to identification problems prior to 1994 this series was only analysed and presented since the period when species-specific identification became available.

The standardised CPUE of blue shark catches by the Portuguese longline fleet in the Indian Ocean show little variability between 1999–2012 (Fig. 2; Coelho et al. 2013b).

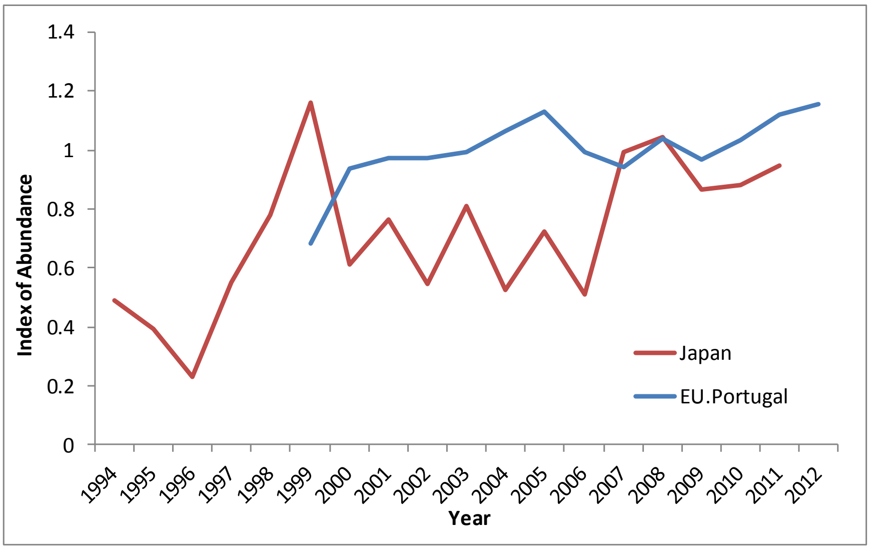


**Fig. 2**. Blue shark: Comparison of the blue shark standardised CPUE series for the longline fleets of Japan and EU,Portugal.

***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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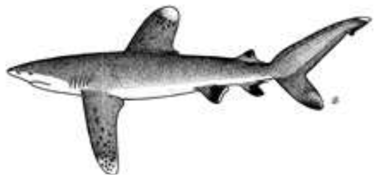
# APPENDIX XXV
# EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK

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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Reported catch 2012:<br>Not elsewhere included (nei) sharks:<br>Average reported catch 2008–2012:<br>Not elsewhere included (nei) sharks: | 412 t<br>42,793 t<br>292 t<br>48,708 t | Uncertain |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | unknown<br>unknown<br>unknown<br>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 | | |

**NOTE:** IOTC Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*, prohibits retention onboard, transhipping, landing or storing any part or whole carcass of oceanic whitetip sharks.

**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[21] | | |
|---|---|---|---|---|
| | | 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
CITES - In March 2013, CITES agreed to include oceanic whitetip shark to Appendix II to provide further protections prohibiting the international trade; which will become effective on September 14, 2014.

### 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 ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Oceanic whitetip shark received a high vulnerability ranking (No. 5) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, and was also characterised by a high susceptibility to longline gear. Oceanic whitetip shark was estimated as being the most vulnerable shark species to purse seine gear, as it was characterised as having a relatively low productive rate, and high susceptibility.

[21] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

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. Therefore stock status remains **uncertain** (Table 1).

***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 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 ~292 t over the last five years, ~412 t in 2012, 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 13/03 *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 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
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- 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.

| *Extracts from Resolutions 13/03, 13/06, 11/04 and 05/05* |
|---|

**RESOLUTION 13/03 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 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES**

Para. 3. CPCs shall to prohibit, as an interim pilot measure, to retain onboard, tranship, land or store any part or whole carcass of oceanic whitetip sharks with the exception of paragraph 7.

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.

**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 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 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.

## 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.<br>Area of overlap with IOTC management area = high. |
| Longevity | Maximum age observed was 17 years. |
| 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 placental 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.<br>• Fecundity: medium (<20 pups)<br>• Gestation Period: 12 months<br>• Generation time: 11 years<br>• 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: Bass et al. 1973, 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. Five CPCs have reported detailed data on shark landings (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Rep. of Korea, Indonesia, Mozambique, Malaysia, Oman, Seychelles, Mauritius, Philippines, UK-territories, Vanuatu). For CPCs having longline fisheries targeting swordfish that report catches of sharks by species (i.e. Australia, EU,Spain, EU,Portugal, United Kingdom, Madagascar, and South Africa), 0.9% of the catch of sharks by longliners, all targeting swordfish, were oceanic whitetip sharks, and for CPCs reporting gillnet data by species, I.R. Iran reported 3% of the catches of shark as oceanic whitetip sharks (drifting gillnet and longline combination fishery, where longline have usually been directed at sharks.

**TABLE 5.** Oceanic whitetip shark: Catch estimates for oceanic whitetip shark in the Indian Ocean for 2010 to 2012

| Catch | | 2010 | 2011 | 2012 |
|---|---|---|---|---|
| Most recent catch (reported) | Oceanic whitetip shark | 533 t | 251 t | 412 t |
| | nei-sharks | 51,581 t | 53,658 t | 42,793 t |
| Mean catch (reported) over the last 5 years (2008–2012) | Oceanic whitetip shark | | | 292 t |
| | nei-sharks | | | 48,708 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. A recent project estimated possible oceanic white tip shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al. 2013). This estimation was done using target species nominal catch IOTC database and assuming that target catches are declared correctly. The estimated figure by this study highlighted that the possible underestimation of oceanic white tip shark in IOTC database is considerable (i.e. the estimated catch is around 20 times higher than the declared in the IOTC database). Although this figure needs to be further investigated, it gives a global figure of possible underreporting level of oceanic white tip in the area.

***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.

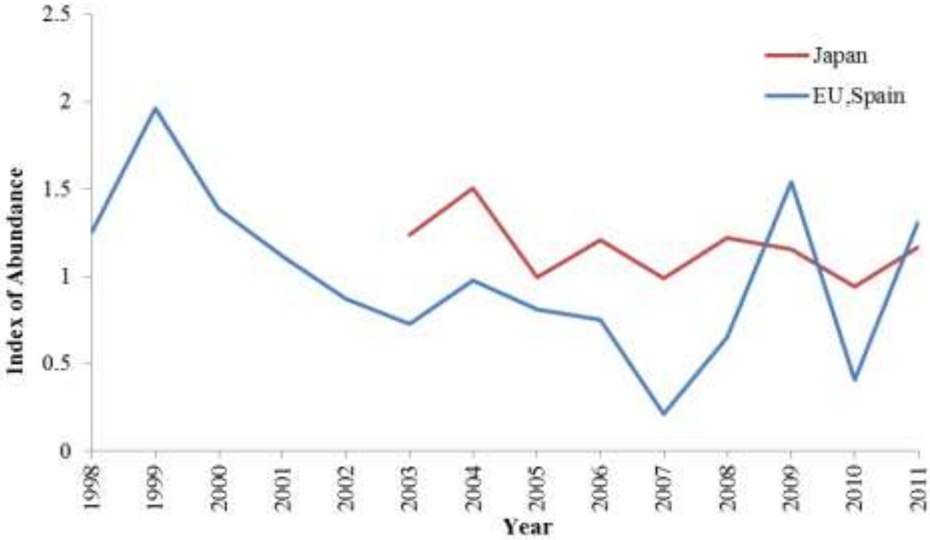


**Fig. 2.** Oceanic whitetip shark: Comparison of the oceanic whitetip shark standardised CPUE series for the longline fleets of Japan and EU,Spain

***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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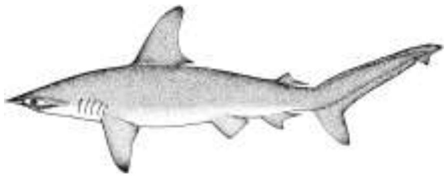
# APPENDIX XXVI
# EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK

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** | | **2013 stock status determination** |
|---|---|---|---|
| Indian Ocean | Reported catch 2012: | 80 t | Uncertain |
| | Not elsewhere included (nei) sharks: | 42,793 t | |
| | Average reported catch 2008–2012: | 74 t | |
| | Not elsewhere included (nei) sharks: | 48,708 t | |
| | MSY: | unknown | |
| | $F_{2012}/F_{MSY}$: | unknown | |
| | $SB_{2012}/SB_{MSY}$: | unknown | |
| | $SB_{2012}/SB_0$: | 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**[22] | | |
|---|---|---|---|---|
| | | **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). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Scalloped hammerhead shark received a low vulnerability ranking (No. 14) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, but was also characterised by a lower susceptibility to longline gear. Scalloped hammerhead shark was estimated as the sixth most vulnerable shark species in the ERA ranking for purse seine gear, but with lower levels of vulnerability compared to longline gear, because the susceptibility was lower for purse seine gear. 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. Therefore stock status remains **uncertain** (Table 1).

[22] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

***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.
- Noting that current reported catches (probably largely underestimated) are estimated at an average ~74 t over the last five years, ~80 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 13/03 *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 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on 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 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.

*Extracts from Resolutions 13/03, 13/06, 11/04 and 05/05*

**RESOLUTION 13/03 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 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES**

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures**.**

**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 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 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.

## 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. Their aggregating habit makes large schools highly vulnerable to fishing. Large CPUEs can be recorded even when stocks are severely depleted (Baum et al. 2007). An assessment of population rebound potential of 26 shark species in the Pacific Ocean ranked *Sphyrna lewini* as one of the species with the poorest ability to recover from increased mortality (Smith et al. 1998). 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)[23]

**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.<br>There is no information available on stock structure. |
| Growth and 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.<br>• Fecundity: medium (<31 pups)<br>• Generation time: 17–21 years<br>• Gestation Period: 9–10 months<br>• 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<br>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 or taken as an incidental bycatch by some semi-industrial, artisanal and recreational fisheries and often for 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 IUCN assessment for each of the major geographic regions where the scalloped hammerhead occurs (Baum et al. 2007), suggests a 64% decline in abundance over the study period, based largely on the observations by Dudley & Simpfendorfer (2006) which indicate that in the western Indian Ocean catch-per-unit-effort of *Sphyrna lewini* declined significantly from 1978–2003 in shark net catches off the beaches of Kwa-Zulu Natal, South Africa. It observed that *Sphyrna lewini* is captured throughout much of its range in the Indian Ocean, including illegal targeting of the species in several areas. Landings reported to FAO by Oman, surveys of landings sites in Oman and interviews with fishers also suggest that catches of *Sphyrna lewini* have declined substantially (IUCN 2007, Baum op. cit. 2007). The species faces heavy fishing pressure in the region, and similar declines in abundance are also inferred in other areas of its range. Papers presented at IOTC WPEB in 2013 show harvesting of scalloped hammerhead neonates and juvenile pups in the artisanal fisheries of both Kenya and Indonesia.

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.

[23] Map of distribution in the Indian Ocean is not correctly represent species distribution, which is much wider, including Madagascar, Seychelles – whole Mascarene shoals and islands chain (E. Romanov pers com) and to Maldives (Randall and Anderson 1993).

**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. Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Rep. of Korea, Indonesia, Malaysia, Oman, Seychelles, Mauritius, Philippines, UK-territories, Vanuatu).

**TABLE 5.** Catch estimates for scalloped hammerhead shark* in the Indian Ocean for 2010 to 2012

| Catch | | 2010 | 2011 | 2012 |
|---|---|---|---|---|
| Most recent catch (reported) | Scalloped hammerhead shark | 104 t | 90 t | 80 t |
| | nei-sharks | 51,581 t | 53,658 t | 42,793 t |
| Mean catch (reported) over the last 5 years (2008–2012) | Scalloped hammerhead shark | | | 74 t |
| | nei-sharks | | | 48,708 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 2012 two countries reported catches of scalloped hammerhead sharks in the IOTC region.

A recent project estimated possible hammerhead shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al 2013). The estimation was done using target species nominal catch from the IOTC database and assuming that target catches have been accurately declared. The estimated catch from this study highlighted that the possible underestimation of oceanic whitetip shark in the IOTC database is considerable (i.e. the estimated catch is around 80 times higher than the declared/report and contained in the IOTC database). Although this figure needs to be further investigated, it gives a global figure of the level of underreporting for oceanic whitetip in shark in the Indian Ocean.

***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
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# 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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Reported catch 2012:<br>Not elsewhere included (nei) sharks:<br>Average reported catch 2008–2012:<br>Not elsewhere included (nei) sharks: | 1,426 t<br>42,793 t<br>1,300 t<br>48,708 t | Uncertain |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | unknown<br>unknown<br>unknown<br>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.** Shortfin mako shark: IUCN threat status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean

| Common name | Scientific name | IUCN threat status[24] | | |
|---|---|---|---|---|
| | | 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 ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Shortfin mako sharks received the highest vulnerability ranking (No. 1) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and with a high susceptibility to longline gear. Shortfin mako shark was estimated as the third most vulnerable shark species in the ERA ranking for purse seine gear, but with lower levels of vulnerability compared to longline gear, because the susceptibility was lower for purse seine gear. 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

[24] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

offspring (<25 pups every two or three years), the shortfin mako shark is vulnerable to overfishing. Therefore stock status remains **uncertain** (Table 1).

***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.
- 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 ~1,300 t over the last five years, ~1,426 t in 2012, 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 13/03 *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 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on 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 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.

*Extracts from Resolutions 13/03, 13/06, 11/04 and 05/05*

**RESOLUTION 13/03 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 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF**

**SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES**

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures**.**

**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 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 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.

## 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℃. 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.<br>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.<br>• Fecundity: medium (<25 pups)<br>• Generation time: 23 years<br>• Gestation Period: 15–18 months<br>• 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 $TW=0.349*10\text{-}4 * FL^{2.76544}$.<br>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.

Preliminary estimations of at-vessel haulback mortality showed that 56% of the shortfin mako shark specimens captured in longline fisheries targeting swordfish in the Indian Ocean are dead at the time of haulback (Table 4). The effects of size on the mortality rates have not been studied in the Indian Ocean, but were substantial in the Atlantic Ocean with larger specimens having higher changes of surviving until being landed (at-haulback) (Coelho et al. 2012).

**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 |
| At-vessel mortality | unknown | 13 to 56 % | 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. Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Indonesia, Japan, Rep. of Korea, Malaysia, Mozambique, Oman, Seychelles, Mauritius, Philippines, UK-territories, Vanuatu). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 11.4% 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 2010 to 2012.

| **Catch** | | **2010** | **2011** | **2012** |
|---|---|---|---|---|
| Most recent catch (report) | Shortfin mako shark | 1,386 t | 1,489 t | 1,426 t |
| | nei-sharks | 51,581 t | 53,658 t | 42,793 t |
| Mean catch (reported) over the last 5 years (2008–2012) | Shortfin mako shark | | | 1,300 t |
| | nei-sharks | | | 48,708 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 2012, ten 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 standardised CPUE series of shortfin mako catches by the Portuguese longline fleet in the Indian Ocean showed some significant variability between 1999–2012, but no noticeable trends (Fig. 2; Coelho et al 2013).

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.

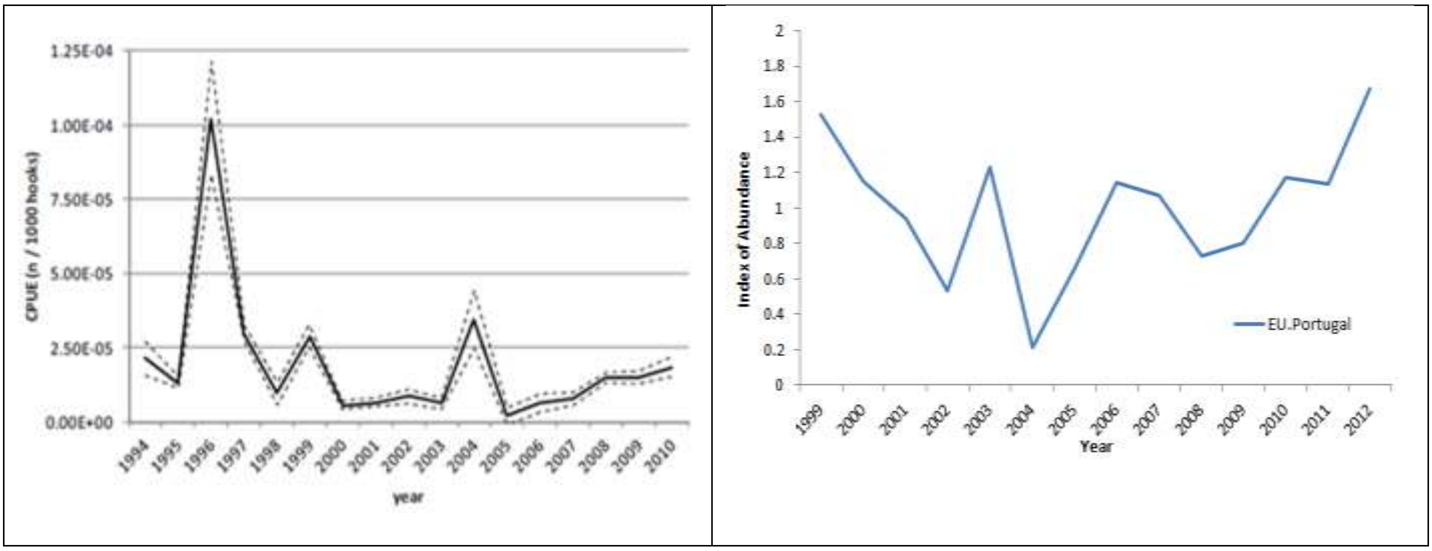


**Fig. 2.** Shortfin mako shark: Standardised longline CPUE series for shortfin mako shark in the Indian Ocean for the Japanese fleet (1994–2010) (left) and the EU,Portugal fleets (1999–2012) (right).

***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
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## 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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Reported catch 2012: | 4,177 t | Uncertain |
| | Not elsewhere included (nei) sharks: | 42,793 t | |
| | Average reported catch 2008–2012: | 3,443 t | |
| | Not elsewhere included (nei) sharks: | 48,708 t | |
| | MSY: | unknown | |
| | $F_{2012}/F_{MSY}$: | unknown | |
| | $SB_{2012}/SB_{MSY}$: | unknown | |
| | $SB_{2012}/SB_0$: | 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.** Silky shark: IUCN threat status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean

| Common name | Scientific name | IUCN threat status[25] | | |
|---|---|---|---|---|
| | | 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 ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Silky shark received a high vulnerability ranking (No. 4) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, and with a high susceptibility to longline gear. Silky shark was estimated as the second most vulnerable shark species in the ERA ranking for purse seine gear, due to its low productivity and high susceptibility for purse seine gear. 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. Therefore stock status remains **uncertain** (Table 1).

***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

[25] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

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.
- Noting that current reported catches (probably largely underestimated) are estimated at an average ~3,443 t over the last five years, ~ 4,177 t in 2012, 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 13/03 *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 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on 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 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.

*Extracts from Resolutions 13/03, 13/06, 11/04 and 05/05*

**RESOLUTION 13/03 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 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES**

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.

**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 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 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.

## 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 can reach 350 cm long. In the Pacific area it was estimated to be around 25 years. 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 Indian Ocean it has been estimated to be around 15 years for females and 13 years for males. 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.<br>Size: 215 cm TL for females; 207 cm TL for males in the Eastern Indian Ocean. 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.<br>• Fecundity: medium (<20 pups)<br>• Generation time: 11–16 years<br>• Gestation period: 12 months<br>• Reproductive cycle is biennial |
| Size (length and weight) | Maximum size is around 350 cm long FL.<br>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.<br>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, Compagno & Niem 1998, Smith et al. 1998, Mejuto et al. 2005, Matsunaga 2007, Romanov & Romanova 2009, Hall et al. 2012

***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 nominal catches for silky shark reported to the IOTC Secretariat are highly uncertain as is their utility in terms of minimum catch estimates (Table 5). Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Indonesia, Japan, Rep. of Korea, Malaysia, Mozambique, Oman, Philippines, Seychelles, Mauritius, UK-territories, Vanuatu). For CPCs reporting longline data by species (i.e. Australia, EU (Spain, Portugal), United Kingdom and South Africa), 0.1% of the catch of sharks by longliners, all targeting swordfish, were silky sharks, and for CPCs reporting gillnet data by species, I.R. Iran 25% and Sri Lanka 11% of the catches of shark were silky sharks.

**TABLE 5.** Silky shark: Catch estimates for silky shark in the Indian Ocean for 2010 to 2012.

| **Catch** | | **2010** | **2011** | **2012** |
|---|---|---|---|---|
| Most recent catch (reported) | Silky shark | 5,141 t | 4,490 t | 4,177 t |
| | nei-sharks | 51,581 t | 53,658 t | 42,793 t |
| Mean catch (reported) over the last 5 years (2008–2012) | Silky shark | | | 3,443 t |
| | nei-sharks | | | 48,708 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 2012, six countries reported catches of silky sharks in the IOTC region.

A recent project estimated possible silky shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al 2013). The estimation was done using target species nominal catch from the IOTC database and assuming that target catches have been accurately declared. The estimated catch from this study highlighted that the possible underestimation of silky shark in the IOTC database is considerable (i.e. the estimated catch is around 10 times higher than the declared/report and contained in the IOTC database). Another study estimated the amount of silky shark entanglement in the nets underneath FADs is much higher than previously thought, in a range between 480,000 and 960,000 individuals per year, assuming a presence of between 3,750 and 7,500 active FADs (Filmater et al. 2013). The authors also acknowledged that solutions exist to mitigate the problem excluding meshed materials in the subsurface structure of the FAD as the European purse seine fleet is being implementing currently and it is agreed by IOTC Commission with the Resolution 13/08 *Procedures on a fish aggregating devices*

*(FADs) management plan*, including more detailed specifications of catch reporting from fad sets, and the development of improved FAD designs to reduce the incidence of entanglement of non-target species.

***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

# 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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Reported catch 2012:<br>Not elsewhere included (nei) sharks:<br>Average reported catch 2008–2012:<br>Not elsewhere included (nei) sharks: | 465 t<br>42,793 t<br>98 t<br>48,708 t | **Uncertain** |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | unknown<br>unknown<br>unknown<br>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[26] | | |
|---|---|---|---|---|
| | | **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 carcass 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 ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Bigeye thresher shark received a high vulnerability ranking (No. 2) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and highly susceptible to longline gear. Despite its low productivity, bigeye thresher shark has a low vulnerability ranking to purse seine gear due to its low susceptibility for this particular gear. 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

[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).

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. Therefore stock status remains **uncertain** (Table 1).

***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 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 ~98 t over the last five years, ~465 t in 2012, 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 13/03 *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 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- 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.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on 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 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 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.

*Extracts from Resolutions 13/03, 13/06, 12/09, 11/04 and 05/05*

**RESOLUTION 13/03 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 30$^{th}$ of the following year on an aggregated basis.

**RESOLUTION 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES**

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.

**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.

**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 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 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.

## 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.

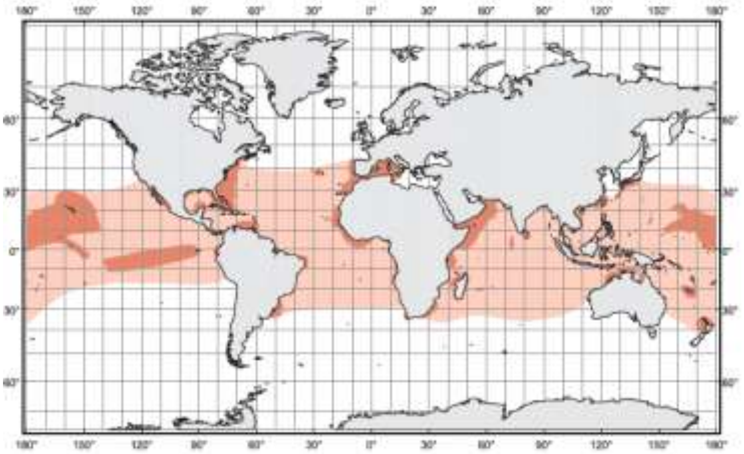

**Fig. 1.** Bigeye thresher shark: The worldwide distribution of the bigeye thresher shark (source: FAO)

**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).<br>Size: Males mature at 270–300 cm total length (TL) and females at 332-355 cm TL.<br>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.<br>• Fecundity: very low (2–4)<br>• Generation time: around 15 years (due to oophagy)<br>• Gestation Period: 12 months<br>• Reproductive cycle: unknown<br>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.<br>New-born pups are around 64–140 cm TL.<br>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). Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Indonesia, Japan, Rep. of Korea, Malaysia, Mozambique, Oman, Philippines, Seychelles, Mauritius, UK-territories, Vanuatu).

**TABLE 5.** Bigeye thresher shark: Catch estimates for bigeye thresher shark in the Indian Ocean for 2010 to 2012.

| Catch | | 2010 | 2011 | 2012 |
|---|---|---|---|---|
| Most recent catch (reported) | bigeye thresher | 8 t | 5 t | 465 t |
| | nei-sharks | 51,581 t | 53,658 t | 42,793 t |
| Mean catch (reported) over the last 5 years (2008–2012) | bigeye thresher | | | 98 t |
| | nei-sharks | | | 48,708 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 2012, 1 country reported catches of bigeye thresher sharks in the IOTC area of competence.

A recent project estimated possible thresher shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al 2013). The estimation was done using target species nominal catch from the IOTC database and assuming that target catches have been accurately declared. The estimated catch from this study highlighted that the possible underestimation of thresher shark in the IOTC database is considerable (i.e. the estimated catch is around 70 times higher than the declared/report and contained in the IOTC database).

### *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
iotc ctoi

# 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 | | 2013 stock status determination |
|---|---|---|---|
| Indian Ocean | Reported catch 2012:<br>Not elsewhere included (nei) sharks:<br>Average reported catch 2008–2012:<br>Not elsewhere included (nei) sharks: | 328 t<br>42,793 t<br>76 t<br>48,708 t | **Uncertain** |
| | MSY:<br>$F_{2012}/F_{MSY}$:<br>$SB_{2012}/SB_{MSY}$:<br>$SB_{2012}/SB_0$: | unknown<br>unknown<br>unknown<br>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[28] | | |
|---|---|---|---|---|
| | | 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 carcass of thresher sharks of all the species of the family Alopiidae[29].

### 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 ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Pelagic thresher shark received a high vulnerability ranking (No. 3) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and with a high susceptibility to longline gear. Despite its low productivity, pelagic thresher shark has a low vulnerability ranking to purse seine gear due to its low susceptibility for this particular gear. 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

[28] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
[29] 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).

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. Therefore stock status remains **uncertain** (Table 1).

***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 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 an average ~76 t over the last five years ~328 t in 2012, 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 13/03 *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 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- 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.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on 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 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 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.

*Extracts from Resolutions 13/03, 13/06, 12/09, 11/04 and 05/05*

**RESOLUTION 13/03 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 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES**

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.

**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.

**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 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 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.

## 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.

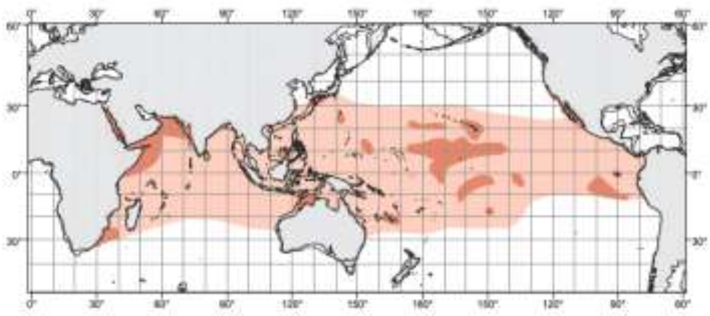

**Fig. 1.** Pelagic thresher shark: The worldwide distribution of the pelagic thresher shark (source: FAO).

**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.<br>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).<br>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.<br>• Fecundity: very low (2)<br>• Generation time: 8–10 years<br>• Gestation period: <12 months<br>• Reproductive cycle: unknown<br>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.<br>New-born pups are around 158–190 cm TL.<br>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.

<table>
<tr><th rowspan="2">Gears</th><th rowspan="2">PS</th><th colspan="2">LL</th><th rowspan="2">BB/TROL/HAND</th><th rowspan="2">GILL</th><th rowspan="2">UNCL</th></tr>
<tr><th>SWO</th><th>TUNA</th></tr>
<tr><td>Frequency</td><td>absent</td><td colspan="2">Common</td><td>rare</td><td>unknown</td><td>unknown</td></tr>
<tr><td>Fishing Mortality</td><td>no</td><td>high</td><td>high</td><td>unknown</td><td>unknown</td><td>unknown</td></tr>
<tr><td>Post release mortality</td><td>N/A</td><td>unknown</td><td>unknown</td><td>unknown</td><td>unknown</td><td>unknown</td></tr>
</table>

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. Five our CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran. South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Indonesia, Japan, Rep. of Korea, Malaysia, Mozambique, Oman, Philippines, Seychelles, Mauritius, UK-territories, Vanuatu).

**TABLE 5.** Pelagic thresher shark: Catch estimates for pelagic thresher shark in the Indian Ocean for 2010 to 2012.

| Catch | | 2010 | 2011 | 2012 |
|---|---|---|---|---|
| Most recent catch (reported) | pelagic thresher | 20 t | 17 t | 328 t |
| | nei-sharks | 51,581 t | 53,658 t | 42,793 t |
| Mean catch (reported) over the last 5 years (2008–2012) | pelagic thresher | | | 76 t |
| | nei-sharks | | | 48,708 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 2012, one country reported catches of pelagic thresher sharks in the IOTC region.

A recent project estimated possible thresher shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al 2013). The estimation was done using target species nominal catch from the IOTC database and assuming that target catches have been accurately declared. The estimated catch from this study highlighted that the possible underestimation of thresher shark in the IOTC database is considerable (i.e. the estimated catch is around 70 times higher than the declared/report and contained in the IOTC database).

***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 com).

***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
iotc ctoi

# 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[30] |
|---|---|---|
| Flatback turtle | *Natator depressus* | Data deficient |
| Green turtle | *Chelonia mydas* | Endangered |
| Hawksbill turtle | *Eretmochelys imbricata* | Critically Endangered |
| Leatherback | *Dermochelys coriacea* | Critically Endangered |
| Loggerhead | *Caretta caretta* | Endangered |
| Olive ridley | *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 is likely to be substantial as shown by the Ecological Risk Assessment undertaken in 2012/13, and an order of magnitude higher than longline and purse seine gears for which mitigation measures are in place.

***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 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 interactions are known to be a severe underestimate: 39 interactions reported in 2010 by 3 CPCs.
- The Ecological Risk Assessment conducted by Nel et al. (2013) concluded that, from the limited data received on longlining and purse seining, the former posed the greater apparent risk to marine turtles. The ERA estimated that ~3,500 marine turtles are caught by longliners annually, followed by ~250 turtles p.a. in purse seine operations. Two separate approaches to estimate gillnet impacts on sea turtles, based on very limited data, calculated that ~ 52,425 turtles p.a. or 11,400 – 47,500 turtles p.a. are caught in

[30] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

gillnets (with a mean of the two methods being 29,488 turtles p.a.) Anecdotal/published studies reported values of >5000 – 16 000 turtles p.a. for each of just India, Sri Lanka and Madagascar. Of these reports, green turtles are under the greatest pressure from gillnet fishing, constituting 50–88% of catches. Loggerhead, hawksbill and olive ridley turtles are caught in varying proportions depending on the region.

- Maintaining or increasing fishing 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.

## 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 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- 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.
- 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.

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 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, one to four times a season (mean = 2.8), laying clutches of between 50 and 60 eggs.<br>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; Limpus 2007

### 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 19$^{th}$ and 20$^{th}$ 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.<br>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. |
| Size (length and weight) | The largest of all the hard-shelled marine turtles, growing up to 1.2 m 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 at around 15 years |
| Spawning season | Females lay clutches of approximately 100 eggs on sandy, tropical beaches. They nest 6–8 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*) is globally 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, three to four times 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 2008–2012 to the IOTC.

| CPC's | | 2008 | 2009 | 2010 | 2011 | 2012 | 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: nil, 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 | | | | | 2 | 24 | Observer data |
| Japan | | | | 14 | | | Non-raised observer data (6 observered trips, July2010-Januaray2011) |
| Kenya | | | | | | | |
| Korea, Republic of | | | 36 | 0 | | 0 | Nil interaction reported (2012) |
| Madagascar | | | | | | | |
| Malaysia | | | | | | 0 | Nil interaction reported |
| Maldives, Republic of | | | | 0 | 0 | 0 | Nil interaction reported |
| Mauritius | | | | | | 0 | Nil interaction reported |
| Mozambique | | | | | | 0 | Nil interaction reported |
| Oman, Sultanate of | | | | | | | |
| Pakistan | | | | | | | |
| Philippines | | 0 | 0 | 0 | | 0 | Nil interaction reported |
| Seychelles | | | | | | | |
| Sierra Leone | | | | | | | |
| Sri Lanka | | | | | | | |
| Sudan | | | | | | | |
| Tanzania | | | | | | | |
| Thailand | | | | | | | |
| United Kingdom (OT) | | 0 | 0 | 0 | 0 | 0 | No active fleet |
| Vanuatu | | | | 0 | | | |
| Yemen | | | | | | | |
| **Cooperating Non-Contracting Parties** | | | | | | | |
| Senegal | | 0 | 0 | 0 | 0 | 0 | No activity since 2007 |
| South Africa | | 15 | 13 | 24 | 14 | 4 | Non-raised observer data include foreign vessel 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[31]. 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[32]. 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 Palangre Réunionnais[33] 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 vessels from 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[34] compiles information through IOSEA National Reports on potential marine turtle fisheries interactions, as well as various mitigation measures put in place by its

[31] IOTC-2008-WPEB-08

[32] IOTC-2006-WPBy-15

[33] 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

[34] (www.ioseaturtles.org/report.php)

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 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[35].
- Loggerhead turtle – 2009 status review under the U.S. endangered species act[36].
- Leatherback turtle – Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia (IOSEA Marine Turtle MoU, 2006)[37].

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[35] http://www.iucnredlist.org/documents/attach/8005.pdf
[36] http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/loggerheadturtle2009.pdf
[37] 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[38] |
|---|---|---|
| **Albatross** | | |
| Atlantic Yellow-nosed Albatross | *Thalassarche chlororynchos* | Endangered |
| Black-browed albatross | *Thalassarche melanophrys* | Near Threatened |
| 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 |
| Grey-headed albatross | *Thalassarche chrysostoma* | Endangered |
| **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), ACAP, 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

[38] 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 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 12/06 *On reducing the incidental bycatch of seabirds in longline fisheries*, is 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 10/06 *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 |

- 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 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.

**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 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 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.

#### 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[39]. In addition, all but one[40] 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,

[39] Amsterdam, black-browed, grey-headed, Indian yellow-nosed, light-mantled, sooty and wandering albatrosses

[40] Atlantic yellow-nosed albatross (*Thalassarche chlororhynchos)*

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 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.

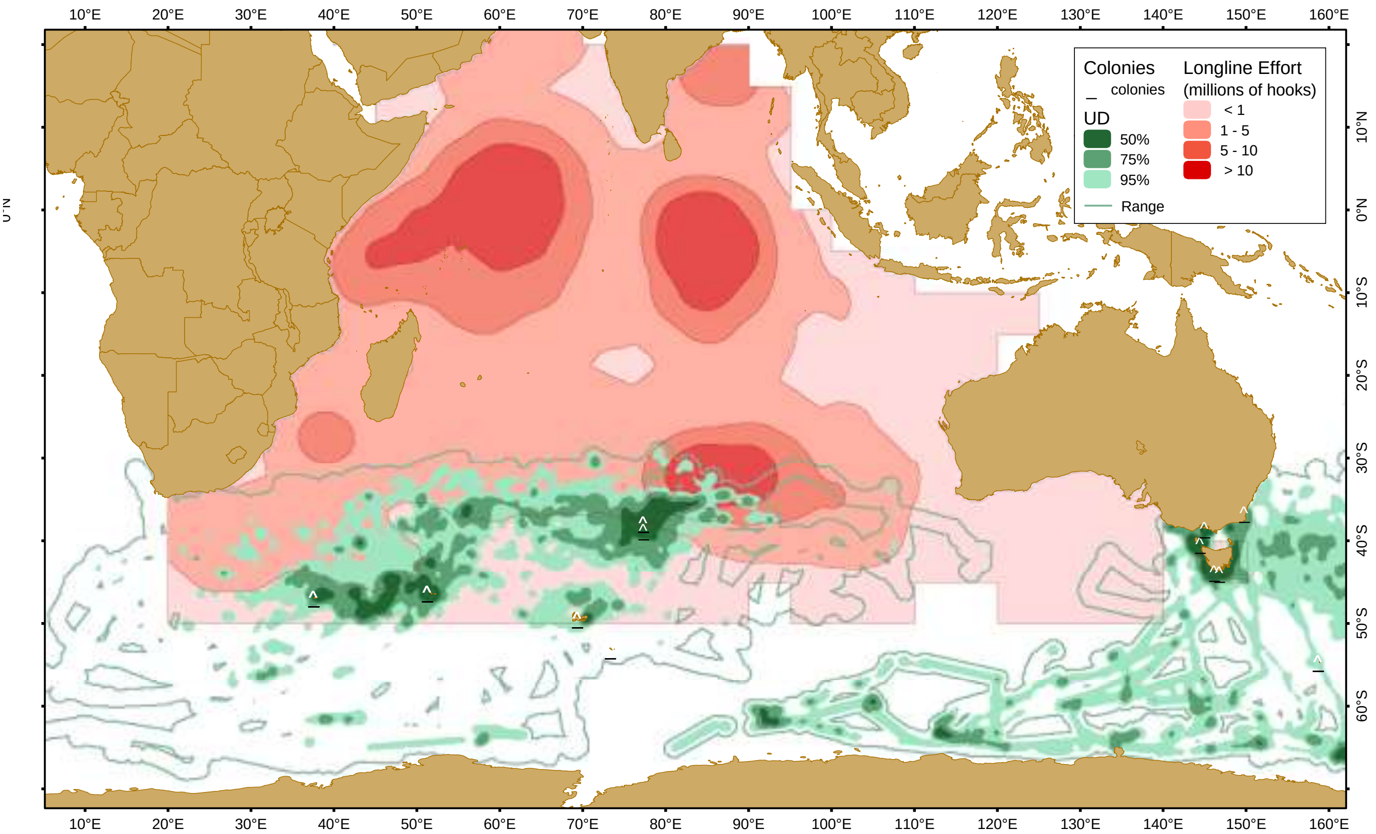


**Fig. 1.** Distribution of breeding albatrosses, petrels and shearwaters in the Indian Ocean (see Table 2 for a list of species included), and overlap with IOTC longline fishing effort for all gear types and fleets (average annual number of hooks set per 5° grid square from 2002 to 2005).

**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 | 2012 | 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 | 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 observed trips, July 2010-January 2011) |
| Kenya | | | | | | No longline activity since 2011 |
| Korea, Republic of | | 94 | 72 | | 84 | Non-raised observer data. |
| Madagascar | | | | | | Longline activities north of 25°S |
| Malaysia | | | | 0 | 0 | Nil interaction reported in 2011-12. No observers deployment |
| Maldives, Republic of | | | | | | No longline activity |
| Mauritius | 0 | 0 | 0 | 0 | 0 | Nil interaction reported in 2012. Longline activities north of 25°S |
| Mozambique | | | | 0 | 0 | Nil interaction reported in 2011-12 |
| Oman, Sultanate of | | | | | | |
| Pakistan | | | | | | No longline activity |
| Philippines | 0 | 0 | 0 | | 0 | Nil interaction reported in 2012 |
| Seychelles | | | | 0 | | Nil interactions reported |
| Sierra Leone | | | | | | |
| Sri Lanka | | | | | | Interaction not reported due to the nature of the fishery and the gear used (activities north of 25°S) |
| Sudan | | | | | | |
| Tanzania | | | | | | |
| Thailand | | | | 0 | | Nil interaction reported in 2011 |

| | | | | | | |
|---|---|---|---|---|---|---|
| United Kingdom (OT) | 0 | 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 | 123 | Include foreign fleets data |

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[41] | | | | Progress | List of accredited observers submitted | Number of observer reports provided (format of reports)[42] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LL | PS | GN | BB | | | 2010 | 2011 | 2012 | 2013[43] |
| **MEMBERS** | | | | | | | | | | |
| Australia | 6 | 5 | | | Australia has implemented an observer programme that complies with the IOTC Regional Observer Scheme. | **YES: 21** | **2** | **1** | **3** | **No** |
| Belize | 6 | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| China | 36 | | | | China has an observer programme. | **YES: 2** | **1** | **No** | **1** | **No** |
| –Taiwan,China | 370 | | | | No observer reports provided. | **YES: 54** | **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: 7** | N/A | N/A | N/A | N/A |
| Eritrea | No information received | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| European Union | 44 | 22 | | | 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.<br>To date, no information has been received from EU,Spain and EU,UK | **33** | **No** | 13 | 14 | 9[44] |
| France (OT) | | 13 | | | France has an observer programme on board it purse seine fleet. | **YES: 27** | **No** | **9** | **7** | **8**[45] |
| Guinea | | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| India | 20 | | | | India has not developed any observer programme so far. | **No** | **No** | **No** | **No** | **No** |
| Indonesia | 1278 | | | | 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** | **No** |
| Iran, Isl. Rep. of | | 4 | 1229 | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| Japan | 72 | | | | Japan has started its observer programme on the 1st of July 2010, and 19 observers are currently being deployed in the Indian Ocean. | **YES: 19** | **6** | **8** | **No** | **No** |
| Kenya | 2 | | | | Kenya is developing an observer programme and 5 observers have been trained under the SWIOFP training. | **YES: 5** | **No** | **No** | **No** | **No** |
| Korea, Rep. of | 7 | 3 | | | Korea has an observer programme since 2002 | **YES: 21** | **2** | **No** | **2** | **No** |

[41] The number of active vessels is given for 2012.
[42] Year in which the observed trip has started.
[43] 2013 data covers only the first quarter. Will be updated for the SC.
[44] Effort not included in Appendix II and III due to late reporting of this information by one EU flag.
[45] *Ditto* 4

| CPCs | Active Vessels LOA≥24m or High Seas vessels[41] | | | | Progress | List of accredited observers submitted | Number of observer reports provided (format of reports)[42] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LL | PS | GN | BB | | | 2010 | 2011 | 2012 | 2013[43] |
| Madagascar | 8 | | | | Madagascar is developing an observer programme. Five and three observers have been trained respectively under the SWIOFP and the IOC projects. Although Madagascar reported observer coverage for the last quarter of 2012, no observer reports have been provided to date. | **YES: 7** | **No** | **No** | **6** | **No** |
| Malaysia | 5 | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| Maldives | | | | 249 | Maldives vessels are monitored by field samplers at landing sites. | **No** | **No** | **No** | **No** | **No** |
| Mauritius | 5 | | | | Mauritius is developing an observer programme, and, 5 and 3 observers have been trained respectively under the SWIOFP and the IOC projects. | **YES: 8** | **No** | **No** | **No** | **No** |
| Mozambique | 1 | | | | No information received by the Secretariat. | **YES: 11** | **No** | **No** | **1** | **No** |
| Oman | 8 | | | | No information received by the Secretariat. | **No** | **No** | **No** | | |
| Pakistan | | | 10 | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| Philippines | 14 | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| Seychelles | 28 | 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** | **No** |
| Sierra Leone | No information received | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| Sri Lanka | | | 2482 | | Sri Lanka has not started the implementation of an observer programme. The fleet is multipurpose, using mainly gillnets and longlines. | **No** | **No** | **No** | **No** | **No** |
| Sudan | No information received | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| Tanzania, United Rep.of | 7 | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| Thailand | 2 | | | | Thailand has not developed an observer programme so far. | **No** | **No** | **No** | **No** | **No** |
| United Kingdom | | | | | UK does not have any active vessels in the Indian Ocean. | N/A | N/A | N/A | N/A | N/A |
| Vanuatu | 2 | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| Yemen | No information received | | | | No information received by the Secretariat. | **No** | **No** | **No** | **No** | **No** |
| **COOPERATING NON-CONTRACTING PARTIES** | | | | | | | | | | |
| Senegal | | | | | Since 2007 Senegal does not have any active vessels in the Indian Ocean. | N/A | N/A | N/A | N/A | N/A |
| South Africa | 13 | | | | South Africa has only an observer programme for foreign vessels operating in the EEZ of South Africa at the moment. | **YES: 16** | **No** | **13[46]** | **13[47]** | **No** |

[46] Reports from South African observers onboard foreign vessels operating in the EEZ of South Africa.
[47] *Ibid.* 3.

# 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** | | | | |
| 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.<br>A study was commissioned for 2011 to determine the feasibility of reporting near real–time for various fleets.<br>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: [Rec. 11 addressed to the SCAF] | *Scientific Committee* | **Ongoing**: See below recommendation 11.<br>Other sources and cooperative arrangements will continue (e.g. IOTC-OFCF Project) or might be available in the future (e.g. SWIOFC, COI, etc.). The Secretariat continues to collaborate with these initiatives. | | 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* | **Partially 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 1$^{st}$ 2010, and is based on national implementation. The Secretariat coordinated the preparation of standards for data requirements, training and forms. Implementation by CPCs has been limited to date. | Review annually at IOTC WP and SC meetings. | High |
| 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 should 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.<br><br>The Secretariat continues to work with CPCs to improve their data collection programs. | 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 is currently being developed.<br><br>In 2013, data poor approaches to determining stock status was applied to a range of marlin and neritic tunas species. This resulted in a stock status being applied to striped marlin, blue marlin and longtail tuna for the first time. | To be considered at the WPM and others.<br><br>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 & Ongoing**: Guidelines for the presentation of stock assessment papers were revised and agreed to by the Scientific Committee in 2010 and 2012.<br><br>The SC actively encourages national scientists to publish in peer reviewed journals, as is the case following the Tuna tagging Symposium held in 2012. | 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.<br><br>The Scientific Committee reviewed the processes for Invited Experts, Consultants and Peer review at its 14$^{th}$ 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* | **Partially completed & 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, 2011 and 2012 Scientific Committee reports included Kobe Matrices for stock assessments where available. The format of the Working Party reports and the resultant Executive Summaries continues to be refined to improve readability and content. | Review annually at IOTC WP and SC meetings. | Medium |
| 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 focused on this process. A smaller group of experts meet twice in 2013 to advance this work, once in April and again in October. | Intersessional start of the MSE process by correspondence, as of Jan.2012<br>Progress at 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*<br>*Scientific Committee*<br>*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

### Working Party on Ecosystems and Bycatch (WPEB)

*(Extracts from IOTC–2013–WPEB09–R)*

***Requests from the Commission***

At Sessions of the Commission, Conservation and Management Measures adopted contained elements which call on the Scientific Committee, via the WPEB, to undertake specific tasks.

**Resolution 13/04** ***On the conservation of cetaceans***

(para. 6) The Commission requests that the IOTC Scientific Committee develop best practice guidelines for the safe release and handling of encircled cetaceans, taking into account those developed in other Regional Fisheries Management Organisations, including the Western and Central Pacific Fisheries Commission, and that these guidelines be submitted to the 2014 Commission meeting for endorsement.

**Resolution 13/05** ***On the conservation of whale sharks (Rhincodon typus)***

(para. 6) The Commission requests that the IOTC Scientific Committee develop best practice guidelines for the safe release and handling of encircled whale sharks, taking into account those developed in other regional fisheries management organisations including the Western and Central Pacific Fisheries Commission, and that these guidelines be submitted to the 2014 Commission meeting for endorsement.

**Resolution 13/06** ***On a scientific and management framework on the Conservation of sharks species caught in association with IOTC managed fisheries***

(para. 2) The SC recommendation or advice shall be conducted taking account of:

a) full stock assessments on sharks, stock assessment and Ecological Risk Assessments (ERAs) by fishing gears, using available best scientific data/information;
b) trend of fishing effort by fishing gear on each shark species;
c) effective IOTC Conservation and Management Measures for certain fishing gears with high risk by shark species;
d) priority in shark species with high risk;
e) review of practical implementation of prohibition to retain on board of shark species;
f) feasibility of implementation of prohibition to retain on board including identification of shark species;
g) impact and bias of IOTC Conservation and Management Measures of sharks on fishing operations and sharks data/information collected and reported by CPCs;
h) further improvement of level for sharks data/information submitted by CPCs, particularly developing CPCs.

(para. 7) Scientific observers shall be allowed to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs, skin samples, spiral valves, jaws, whole and skeletonised specimens for taxonomic works and museum collections) from oceanic whitetip sharks taken in the IOTC area of competence that are dead at haulback, provided that the samples are a part of a research project approved by the IOTC Scientific Committee (SC)/the IOTC Working Party on Ecosystems and Bycatch (WPEB). In order to obtain the approval, a detailed document outlining the purpose of the work, number of samples intended to be collected and the spatio-temporal distribution of the sampling effect must be included in the proposal. Annual progress of the work and a final report on completion shall be presented to the SC/WPEB.

(para. 9) The provisional measures stipulated in this Resolution shall be evaluated in 2016 by the IOTC Scientific Committee to deliver more appropriate advice on the conservation and management of the stocks for the consideration of the Commission.

**Resolution 13/08** ***Procedures on a fish aggregating devices (FADs) management plan, including more detailed specification of catch reporting from FAD sets, and the development of improved FAD designs to reduce the incidence of entanglement of non-target species***

(para. 7) The IOTC Scientific Committee will analyse the information, when available, and provide scientific advice on additional FAD management options for consideration by the Commission in 2016, including recommendations on the use of biodegradable materials in new and improved FADs and the phasing out of FAD designs that do not prevent the entanglement of sharks, marine turtles and other species. When assessing the impact of FADs on the dynamic and distribution of targeted fish stocks and associated species and on the ecosystem, the IOTC Scientific Committee will, where relevant, use all available data on abandoned FADs (i.e. FADs without a beacon).

**Resolution 12/04** ***On the conservation of marine turtles***

(para. 11) The IOTC Scientific Committee shall request the IOTC Working Party on Ecosystems and Bycatch to:

a) Develop recommendations on appropriate mitigation measures for gillnet, longline and purse seine fisheries in the IOTC area;
b) Develop regional standards covering data collection, data exchange and training;
c) Develop improved FAD designs to reduce the incidence of entanglement of marine turtles, including the use of biodegradable materials.

The recommendations of the IOTC Working Party on Ecosystems and Bycatch shall be provided to the IOTC Scientific Committee for consideration at its annual session in 2012. In developing its recommendations, the IOTC Working Party on Ecosystems and Bycatch shall examine and take into account the information provided by CPCs in accordance with paragraph 10 of this measure, other research available on the effectiveness of various mitigation methods in the IOTC area, mitigation measures and guidelines adopted by other relevant organizations and, in particular, those of the Western and Central Pacific Fisheries Commission. The IOTC Working Party on Ecosystems and Bycatch will specifically consider the effects of circle hooks on target species catch rates, marine turtle mortalities and other bycatch species.

(para. 17) The IOTC Scientific Committee shall annually review the information reported by CPCs pursuant to this measure and, as necessary, provide recommendations to the Commission on ways to strengthen efforts to reduce marine turtle interactions with IOTC fisheries.

**Resolution 12/06** ***On reducing the incidental bycatch of seabirds in longline fisheries***

(para. 8) The IOTC Scientific Committee, based notably on the work of the WPEB and information from CPCs, will analyse the impact of this Resolution on seabird bycatch no later than for the 2016 meeting of the Commission. It shall advise the Commission on any modifications that are required, based on experience to date of the operation of the Resolution and/or further international studies, research or advice on best practice on the issue, in order to make the Resolution more effective.

**Resolution 12/09** ***On the conservation of thresher sharks (Family Alopiidae) caught in association with fisheries in the IOTC area of competence***

(para. 7) Scientific observers shall be allowed to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs, skin samples, spiral valves, jaws, whole and skeletonised specimens for taxonomic works and museum collections) from thresher sharks that are dead at haulback, provided that the samples are part of the research project approved by the IOTC Scientific Committee (or IOTC Working Party on Ecosystems and Bycatch (WPEB)). In order to obtain the approval, a detailed document outlining the purpose of the work, number and type of samples intended to be collected and the spatio-temporal distribution of the sampling work must be included in the proposal. Annual progress of the work and a final report on completion of the project shall be presented to the IOTC WPEB and the IOTC Scientific Committee.

**Resolution 11/04** ***On a regional observer scheme***

(para. 15) The elements of the Observer Scheme, notably those regarding its coverage, are subject to review and revision, as appropriate, for application in 2012 and subsequent years. Basing on the experience of other Tuna RFMOs, the IOTC Scientific Committee will elaborate an observer working manual, a template to be used for reporting (including minimum data fields) and a training program.

**Resolution 05/05** ***Concerning the conservation of sharks caught in association with fisheries managed by IOTC***

(para. 2) In 2006 the IOTC Scientific Committee (in collaboration with the IOTC Working Party on Ecosystems and Bycatch) provide preliminary advice on the stock status of key shark species and propose a research plan and timeline for a comprehensive assessment of these stocks.

(para. 5) The ratio of fin-to-body weight of sharks described in paragraph 4 shall be reviewed by the IOTC Scientific Committee and reported back to the Commission in 2006 for revision, if necessary.

*Core topics for research*

The WPEB **RECOMMENDED** that the following core topic areas as priorities for research over the coming years, taking into account data gaps, capacity among CPCs, and areas for implementation:

***High Priority:***

- ***Shark stock status analyses (development of abundance indices)***
    i. Develop/improve accurate standardised CPUE indices for each shark species for the Indian Ocean as a whole or by sub-region as appropriate, once stock structure and management units have been determined.
    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).
- ***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).
- ***Stock assessment***
    i. There is a clear request from the Commission to carry out stock status determinations for sharks in the Indian Ocean, and that at present the data held at the IOTC Secretariat would be insufficient to undertake integrated stock assessments for any stock.
    ii. Alternative approaches should be explored as options 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, as well as the use of data poor assessment approaches.
- ***Bycatch mitigation***
    i. Sharks
    ii. Seabirds – line weighting
    iii. Marine turtles
    iv. Marine mammals

***Medium Priority***

- ***Depredation***
    i. Longline fishery depredation
- ***Stock structure***
    i. genetic research to determine the connectivity of species throughout their distributions: such studies should be developed at the sub-regional level.
    ii. tagging research to better understand and estimate exploitation rates, the movement dynamics, possible spawning locations, natural mortality, fishing mortality and post-release mortality of stocks from various fisheries in the Indian Ocean.
- ***Biological information***
    i. Quantitative biological studies are necessary for all species throughout their range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth, which will be fed into future stock assessments.

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**Working Party on Billfish (WPB)**

*(Extracts from IOTC–2013–WPB11–R)*

***Requests from the Commission***

At Sessions of the Commission, Conservation and Management Measures adopted contained elements which call on the Scientific Committee, via the WPB, to undertake specific tasks.

(S17 para. 28) The Commission **NOTED** that most of the evidence provided to date has indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and that biomass remains below the level that would produce the maximum sustainable yield ($B_{MSY}$), however recent declines in catch and effort have brought fishing mortality rates to levels below the level that would produce the maximum sustainable yield ($F_{MSY}$). A risk of reversing the rebuilding trend remains if there is any increase in catch in this region. Thus, catches of swordfish in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,600 t), until there is clear evidence of recovery and biomass exceeds $B_{MSY}$.

(S17 para. 29) The Commission **REQUESTED** that the southwest region continue to be analysed as a special resource, as it appears to be highly depleted compared to the Indian Ocean as a whole.

***Core topics for research agreed at WPB11***

The following are the core topic areas considered as priorities for research over the coming years, taking into account data gaps, capacity among CPCs, and areas for implementation (taken from the Report of the 11th Session of the WPB).

***Data***

The WPB **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 V, and **REQUESTED** 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.

***Alternative management measures for swordfish***

The WPB **NOTED** that at its 17th Session, the Commission **REQUESTED** that the southwest region continue to be analysed as a special resource [*for swordfish*], as it appears to be highly depleted compared to the Indian Ocean as a whole.

***Historical data series***

The WPB **REQUESTED** that both Japan and Taiwan,China undertake an historical review of their longline fleets 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.

***Length-age keys***

The WPB **RECOMMENDED** that as a matter of priority, CPCs that have important fisheries catching billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) 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***

The WPB **RECOMMENDED** that all CPCs assess and improve the status of catch-and-effort data for marlins and sailfish, noting that improvements to the data for the EU fleets and its provision to the IOTC Secretariat, would be most beneficial to the work of the WPB.

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

The WPB **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).

The WPB **REQUESTED** that Indonesia and India continue to improve their data collection programs and provide catch-and-effort and size frequency data for their longline fleets, to the IOTC Secretariat.

The WPB **REQUESTED** that all CPCs having artisanal and semi-industrial fleets, in particular I.R. Iran, Pakistan and Sri Lanka, provide catch and effort as well as size data as per IOTC requirements for billfish caught by their fleets. Some developing coastal states indicted that they have difficulties meeting these requirements.

***Data inconsistencies***

Noting the progress made to date, the WPB **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 Japan, Taiwan,China, Seychelles and EU,Spain and to report final results at the next WPB meeting.

The WPB **REQUESTED** from 2011 that as a matter of priority, India, I.R. Iran (provided by I.R. in August 2013) and Pakistan provide catch-and-effort data and size data for billfish, in particular gillnet fisheries, by the reporting deadline of 30$^{th}$ June each year, noting that this is already a mandatory reporting requirement. As part of this process, these CPCs shall use the billfish identification cards to improve the identification of marlin species caught by their fisheries.

***Review of data available at the Secretariat for marlins***

The WPB **NOTED** that the quality of the data available at the IOTC Secretariat on marlins (by species) is likely to be compromised by species miss-identification 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.

***I.R. Iran billfish fishery***

The WPB **REQUESTED** that I.R. Iran revisit individual logbook archives to try and obtain more details of historical species composition for its industrial fisheries.

***Thailand billfish fishery***

**NOTING** that data from the research vessels of Thailand are not presented by species, the WPB **REQUESTED** that the species level data be presented at the next WPB meeting. The translation of the IOTC species identification guides into Thai would assist in ensuring higher resolution for species identification.

The WPB **REQUESTED** the authors undertake a more detailed analysis of trends in billfish landings between the 2008 and 2012, a period identified in the current study of high variability in total landings.

***Indonesia billfish fishery***

The WPB **REQUESTED** that Indonesia develop and present a detailed paper on its fleets fishing effort and CPUE, by species, at the next WPB meeting.

The WPB **NOTED** that the current observer coverage for the Indonesian longline fleet is approximately 2% of total fishing effort. In 2013 Indonesia plans to deploy additional scientific observers on its longline, purse seine and gillnet vessels in order to reach the minimum required coverage level of 5%, as specified in Resolution 11/04 *on a regional observer scheme*. At present observers are only being deployed on its longline fleet. The WPB **REQUESTED** that the result of these additional scientific observer deployments be reported at the next WPB meeting.

***Sri Lanka billfish fishery***

The WPB **REQUESTED** 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.

***Recreational and sports fisheries for billfish***

The WPB **REQUESTED** that the African Billfish Foundation continue its important work, particularly in the areas of collaborative research aimed at obtaining more information on movements of billfishes, via both conventional and archival tagging programs that will allow the collection of information on both horizontal and vertical movements as well as on population dynamics.

***Indian billfish research: Environment influences on abundance***

**NOTING** that all billfish species were combined for analysis, which may produce a biased result due to differences in species biology, the WPB **REQUESTED** that the authors undertake a similar analysis by species, for the consideration at the next WPB meeting.

***Maldives billfish landings***

The WPB **RECALLED** 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 **REQUESTED** that the Maldives provide a review of its landings of each marlin species at the next WPB meeting.

The WPB **REQUESTED** 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 standards. The information collected should allow the Maldives to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

***CPUE discussion summary – Marlins***

The WPB **REQUESTED** that both Japan and Taiwan,China undertake a historical review of their longline data and to document the changes in fleet dynamics for presentation and 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***

The WPB **REQUESTED** that a sensitivity analysis be performed using Stock Reduction Analysis methodology, using different series of catch data to assess how robust the estimation of reference points for management are, and how the stock status determination performs.

***Review of data available at the secretariat for Indo-Pacific sailfish***

The WPB **NOTED** the main sailfish 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 V, and **REQUESTED** 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.

***Kenyan sailfish sports fishery***

The WPB **NOTED** that catch and effort data for the sports fishery in Kenya from 1987–2010 should be submitted to the IOTC Secretariat to assist in future assessments for these species. The WPB **REQUESTED** that Kenya undertake a comprehensive analysis based on their long-term sport fisheries for consideration at the next WPB meeting.

**Indo-Pacific sailfish - other**

**NOTING** that limited new information on I.P. sailfish were presented at the WPB11, the WPB **REQUESTED** that the IOTC Secretariat contact scientists from the U.A.E. to obtain the latest information from the sailfish fishery in the Gulf, as the most recent information submitted to the WPB some time ago suggested that the fishery may be collapsing. Any new information received should be submitted to the next WPB meeting as part of a general review of sailfish fisheries in the Indian Ocean.

The WPB **REQUESTED** that all CPCs improve data collection and reporting for sailfish given the importance of this species to many sports fisheries operating in the Indian Ocean. In particular for Kenya who indicated that they have a long catch history series available for potential analysis.

***Review of data available at the secretariat for swordfish***

**NOTING** the potential underreporting of swordfish catches from Indonesian fresh-tuna longline fisheries and the way in which the IOTC Secretariat had estimated swordfish catches, the WPB **REQUESTED** that catch extrapolation must be undertaken, taking into consideration species-specific targeting (day-deep vs. night-shallow sets) for fleets taking SWO as a bycatch. The WPB was informed that major research and commercial operations targeting tuna in day deep sets produce very low levels of swordfish bycatch even in the areas where swordfish is a dominant species in shallow-night sets.

***Priority species for 2014:*** *Swordfish*

***High priority projects***

- ***Stock status analyses (development of abundance indices)***
    i. Develop/improve accurate standardised CPUE indices for Indo-Pacific sailfish for the Indian Ocean as a whole or by sub-region as appropriate.
    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).
- ***Capacity building***
    i. Scientific assistance to CPCs and specific fleets considered to have the highest risk to billfish species (e.g. gillnet fleets and longline fleets).
- ***Stock assessment***
    i. Swordfish: There is a clear request from the Commission to carry out stock status determinations for swordfish in the southwest Indian Ocean, in addition to the Indian Ocean as a whole.

***Medium priority project:***

- ***Stock structure***
    i. genetic research to determine the connectivity of species throughout their distributions: such studies should be developed at the sub-regional level.
    ii. tagging research to better understand and estimate exploitation rates, the movement dynamics, possible spawning locations, natural mortality, fishing mortality and post-release mortality of stocks from various fisheries in the Indian Ocean.
- ***Biological information***
    i. Quantitative biological studies are necessary throughout the species range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth, which will be fed into future stock assessments.

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**Working Party on Tropical Tunas (WPTT)**

*(Extracts from IOTC–2013–WPTT15–R)*

***Requests from the Commission***

At Sessions of the Commission, Conservation and Management Measures adopted contained elements which call on the Scientific Committee, via the WPTT, to undertake specific tasks.

**Resolution 13/08 Procedures on a fish aggregating devices (FADs) management plan, including more detailed specification of catch reporting from FAD sets, and the development of improved FAD designs to reduce the incidence of entanglement of non-target species**

(para. 7) The IOTC Scientific Committee will analyse the information, when available, and provide scientific advice on additional FAD management options for consideration by the Commission in 2016, including recommendations on the use of biodegradable materials in new and improved FADs and the phasing out of FAD designs that do not prevent the entanglement of sharks, marine turtles and other species. When assessing the impact of FADs on the dynamic and distribution of targeted fish stocks and associated species and on the ecosystem, the IOTC Scientific Committee will, where relevant, use all available data on abandoned FADs (i.e. FADs without a beacon).

**Resolution 13/11 On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna, and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence**

(para. 4) The IOTC Scientific Committee, the IOTC Working Party on Tropical Tunas, and the IOTC Working Party on Ecosystems and Bycatch shall annually:

a) review the information available on bycatch (retained and discarded) by purse seine vessels; and

b) provide advice to the Commission on options to sustainably manage discards in purse seine fisheries.

**Resolution 12/13 For the conservation and management of tropical tunas stocks in the IOTC area of competence**

(para. 10) The IOTC Scientific Committee will provide at its 2011, 2012 and 2013 Plenary sessions:

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 tuna 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 tuna and bigeye tuna;
c) an evaluation of the impact on yellowfin tuna and bigeye tuna stocks by catching juveniles and spawners taken by all fisheries. The IOTC Scientific Committee shall also recommend measures to mitigate the impacts on juvenile and spawners;
d) any other advice on possible different management measures based on the Kobe II matrix, on the main targeted species under the IOTC competence.

**Resolution 05/01** ***On Conservation and Management Measures for bigeye tuna***

(para. 7) The IOTC Scientific Committee be tasked to provide advice, including advice on;

- the effects of different levels of catch on the SSB (in relation to MSY or other appropriate reference point);
- the impact of misreported and illegal catch of bigeye tuna on the stock assessment and required levels of catch reduction; and
- evaluation of the impact of different levels of catch reduction by main gear types.

***Priority species for 2014:*** *Skipjack tuna*

***High priority projects 2014–2015***

- ***Stock status analyses (development of abundance indices)***
  i. Develop/improve accurate standardised CPUE indices for all three tropical tuna species, for the Indian Ocean as a whole or by sub-region as appropriate.
  ii. Investigate the source of inconsistencies in the longline length frequency data, as identified by the WPTT.
  iii. Develop methods to estimate historical catch series by gear.
  iv. Develop life history and biological patterns for the species (namely migration patterns and distribution patterns).
- ***Tagging data analysis***
  i. Information and results arising from the RTTP-IO tagging program should be fully utilised and summarised for the 2014 WPTT skipjack tuna stock assessment. Additional analyses are recommended, including, inter alia:
    1. Analysis of the existing tagging data sets.
      - Skipjack tuna movements (taking into account the reporting rates of tags now estimated) using ad hoc models
      - Skipjack tuna growth: VB or others
      - Skipjack tuna total mortality rates based on temporal trends of recoveries
      - Skipjack natural mortality and longevity
      - Analysis of potential interactions between purse seine and pole-and-line fisheries
      - Review of FAD catches and their association to FADs: movements, growth, etc.

  This work should be conducted as soon as possible as all the data needed for this study (on fisheries and tags/recoveries) are now fully available and this work should also make use of the results from the tagging symposium research.

***Stock assessment***

- ***Skipjack tuna***

***Medium priority project:***

- ***Tagging data***

  i. Improved approaches for integrating tagging data into stock assessments.
  The recent RTTP-IO (and similar large-scale tagging programmes in the Pacific Ocean) have provided a wealth of data on tropical tuna population dynamics. However, recent analyses have demonstrated that movement dynamics are not compatible with standard tag-based population estimators for movement and natural/fishing mortality. In attempting to integrate the tagging data within stock assessments, the following problems are encountered:
     1. Tag reporting rates are thought to be low for all fleets except for the purse seine fleet landing in the Seychelles. If reporting rates by longline and artisanal fisheries are low, then this may introduce greater uncertainties in the recovery results.
     2. Tag displacements are relatively low on average (for instance in the Indian Ocean showing a full mixing only within 500 nautical mile radius) and full mixing of the tagged and untagged population is demonstrably limited at the basin scale.
     3. Tag release designs are unbalanced in the west and negligible in the east.
     4. Tagging results show various other complexities that are still difficult to incorporate in current assessments (for instance differential growth and mortality by sex).
     5. Assessments are often sensitive to the inclusion of tagging data, and it is currently not clear that recent Indian Ocean assessments are improved by including tag dynamics, or whether large biases for movement and mortality are being introduced.

  There is not a simple solution for these problems, but there are directions to explore:
     1. Increasing the spatial resolution of the tagging model (for instance with full mixing boxes of ~500 mile radius) will reduce the impact of the tag mixing problem (but this comes at a cost of increased model complexity and over-parameterisation).
     2. There is potential value in attempting to use environmental and physical oceanographic information to make inferences about population dynamics in data-poor regions.
     3. Simulation studies can help to understand the biases, potentially develop bias correction methods, and improve the quantification of uncertainty introduced by constraining assumptions.

Estimated budget for IOTC consultants to be engaged on skipjack tuna analysis

| **Description** | **Unit price** | **Units required** | **Total** |
|---|---|---|---|
| Improved approaches for integrating tagging data into stock assessments (fees) | US$400 | 75 | 30,000 |
| Data preparation for skipjack tuna stock assessment | US$400 | 50 | 20,000 |
| Total estimate (US$) | | | **50,000** |

- ***Stock structure***

  i. genetic research to determine the connectivity of species throughout their distributions: such studies should be developed at the sub-regional level.

  ii. Additional tagging research to better understand and estimate exploitation rates, the movement dynamics, possible spawning locations, natural mortality, fishing mortality and post-release mortality of stocks from various fisheries in the Indian Ocean.

- ***Biological information***

  i. Quantitative biological studies are necessary throughout the species range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth, which will be fed into future stock assessments.

## Working Party on Neritic Tunas (WPNT)

*(Extracts from IOTC–2013–WPNT03–R)*

***Priority species for research in 2014***

The WPNT **AGREED** to the list of priority research topics for neritic tunas (priority species) as provided in Table 1.

The WPNT **AGREED** that as regionally appropriate, kawakawa, longtail tuna and narrow-barred Spanish mackerel, are the priority species for research in 2014, although research may also continue on other neritic tuna species on an opportunistic basis.

The WPNT **AGREED** that once the new Fishery Officer (Science) is recruited to the Secretariat, that he/she shall undertake a literature review of all available population parameters for either kawakawa or longtail tuna, to support further stock assessment of these species in 2014.

***Capacity building***

Capacity building activities (regional or sub-regional) by the IOTC Secretariat should focus on using a single neritic tuna species as an example, for the following core areas. Focus species should be kawakawa and longtail tuna for the eastern Indian Ocean and kawakawa and narrow-barred Spanish mackerel for the western Indian Ocean.

- Data collection, compilation and reporting
- Stock structure determination (population genetics)
- Data poor stock assessment approaches.

***Priority projects for 2013 and 2014***

***Stock structure** – **High priority***

The WPNT **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 unit stocks delineated by geographic distribution and connectivity.

The WPNT **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 WPNT **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 WPNT **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 WPNT **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.

***Biological information***

The WPNT **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, which will be fed into future stock assessments.

***CPUE standardisation***

The WPNT **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.

***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 used 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, as well as the use of data poor assessment approaches. In 2014, kawakawa, longtail tuna and narrow-barred Spanish mackerel should be the focus species.

**Table 1**. 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 |
|---|---|---|
| Stock structure (connectivity) | Genetic research to determine the connectivity of neritic tunas throughout their distributions | High |
| | 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 |
| | 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 | Review of literature on life history parameters to assess stock structure on morphometric data | High |
| | 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 |

**Table 2**. Neritic tunas and tuna-like species under the IOTC mandate with potential sub-regions/countries/management unit/sub-stocks identified for collaborative research.

<table>
<tr><th rowspan="2">Species / Stock</th><th colspan="5">Possible sub-regions and countries / Management Units</th></tr>
<tr><th>East Africa<br>(Kenya, Tanzania, Mozambique, Madagascar, Seychelles, Mauritius, La Réunion, Comoros, Somalia)</th><th>Gulf, Oman Sea<br>(I.R. Iran, Oman, Pakistan, U.A.E., Yemen, Somalia, Qatar)</th><th>West India<br>(India, Pakistan, Sri Lanka, Maldives)</th><th>East India/Bay of Bengal<br>(India, Sri Lanka, Malaysia, Indonesia, Thailand, Myanmar, Bangladesh)</th><th>Indonesia and Australia<br>(Australia, Malaysia, Indonesia, Thailand)</th></tr>
<tr><td>Bullet tuna<br>(Auxis rochei)</td><td>–</td><td>–</td><td colspan="2">▬</td><td>▬</td></tr>
<tr><td>Frigate tuna<br>(Auxis thazard)</td><td>▬</td><td>▬</td><td colspan="2">▬</td><td>▬</td></tr>
<tr><td>Kawakawa<br>(Euthynnus affinis)</td><td colspan="3">▬</td><td colspan="2">▬</td></tr>
<tr><td>Longtail tuna<br>(Thunnus tonggol)</td><td>▬</td><td colspan="2">▬</td><td colspan="2">▬</td></tr>
<tr><td>Indo-Pacific king mackerel<br>(Scomberomorus guttatus)</td><td>▬</td><td>▬</td><td colspan="2">▬</td><td>▬</td></tr>
<tr><td>Narrow-barred Spanish mackerel<br>(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.

## WORKING PARTIES NOT HELD IN 2013

### Working Party on Temperate Tunas (WPTmT)

*(Extracts from IOTC–2012–WPTmT04–R)*

***Revision of the WPTmT work plan***

***CPUE standardisation***

(para. 110) The WPTmT **AGREED** that there was an urgent need to investigate the CPUE issues as outlined in paragraph 72 and for this to be a high priority research activity for the albacore resource in the Indian Ocean in 2013.

(para. 111) The WPTmT 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.

***Stock assessment***

(para. 112) The WPTmT **AGREED** that there was an urgent need to carry out revised stock assessments for the albacore resource in the Indian Ocean in 2013.

(para. 113) **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 WPTmT **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.

(para. 114) The WPTmT **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***

(para. 115) 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 WPTmT **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 by the Scientific Committee in 2013.

***Spawning***

(para. 116) 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 WPTmT **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 in 2013.

***Additional core topics for research***

(para. 117) The WPTmT **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 in 2013.

(para. 118) The WPTmT **RECOMMENDED** that the Scientific Committee add the following core topic areas as priorities for research over the coming year:

- 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 Methods (WPM)**

*(Extracts from IOTC–2012–WPM04–R)*

(para. 43) The WPM **RECOMMENDED** that the SC consider the draft workplan for the development of the IOTC MSE process, provided at Appendix IV. [*of the WPM04 Report*]

(para. 44) The WPM **RECOMMENDED** that the SC consider requesting 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.

# APPENDIX XXXVI
# ASSESSMENT SCHEDULE FOR IOTC WORKING PARTIES

| Species | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| ***Working Party on Neritic Tunas*** | | | | | |
| Bullet tuna | Indicators | **Full assessment** | | | |
| Frigate tuna | Indicators | **Full assessment** | | | |
| Kawakawa | **Full assessment** | Indicators | | | |
| Longtail tuna | **Full assessment** | Indicators | | | |
| Indo-Pacific king mackerel | Indicators | **Full assessment** | | | |
| Narrow-barred Spanish mackerel | **Full assessment** | Indicators | | | |
| ***Working Party on Billfish*** | | | | | |
| Black marlin | Indicators | Indicators | **Full assessment** | Indicators | |
| Blue marlin | Indicators | Indicators | **Full assessment** | Indicators | |
| Striped marlin | Indicators | **Full assessment** | Indicators | Indicators | |
| Swordfish (IO, SWIO) | **Full assessment** | Indicators | Indicators | **Full assessment** | |
| Indo-Pacific sailfish | Indicators | **Full assessment** | Indicators | **Full assessment** | |
| ***Working Party on Tropical Tunas*** | | | | | |
| Bigeye tuna | Indicators | Indicators | **Full assessment** | Indicators | Indicators |
| Skipjack tuna | **Full assessment** | Indicators | Indicators | **Full assessment** | Indicators |
| Yellowfin tuna | Indicators | **Full assessment** | Indicators | Indicators | **Full assessment** |
| ***Working Party on Temperate Tunas*** | | | | | |
| Albacore | **Full assessment** | - | **Full assessment** | - | **Full assessment** |
| ***Working Party on Ecosystems and Bycatch*** | | | | | |
| Blue sharks | Indicators | Full assessment | | Indicators & data poor approaches | |
| Oceanic whitetip sharks | Indicators | | Full assessment | | |
| Scalloped hammerhead sharks | | Indicators | | | Revisit ERA |
| Shortfin mako sharks | | | Indicators | | Revisit ERA |
| Silky sharks | | Indicators | | | Revisit ERA |
| Bigeye thresher sharks | | | | Indicators | Revisit ERA |
| Pelagic thresher sharks | | | Indicators | | Revisit ERA |
| Marine turtles | | Review of mitigation | | Revisit ERA | |

| | | | | | |
|---|---|---|---|---|---|
| | | measures in 12/04 | | | |
| Seabirds | | Review of mitigation measures in 12/06 | | Review of mitigation measures in 12/06 | |
| Marine Mammals | | | | | |
| ***Working Party on Methods*** | | | | | |
| Management Strategy Evaluation | Extension of the MSE process to tropical tunas | | | | |

# APPENDIX XXXVII
# SCHEDULE OF IOTC SCIENCE MEEITNG IN 2014 AND TENTATIVELY FOR 2015

| Meeting | 2014 | | 2015 (tentative) | |
|---|---|---|---|---|
| | Date | Location | Date | Location |
| Working Party on **Neritic Tunas** | 2–5 July (4d) | Phuket, Thailand | 1–9 July (4d) | TBD |
| Working Party on **Temperate Tunas** | 28–31 July (4d) | Japan (or Busan, Korea) | Nil | Nil |
| Working Party on **Billfish** | 21–25 Oct (5d) | Shimizu, Japan (or Tanzania; Kenya) | Early June (5d) or Late-October (5d) | Algarve, EU,Portugal |
| Working Party on **Ecosystems and Bycatch** | 27–30 Oct (4d) | Shimizu, Japan (or Tanzania; Kenya) | Prior to the WPEB (5d) | Algarve, EU,Portugal |
| Management Strategy Evaluation workshop | 15–16 Nov (2d) | Bali, Indonesia | | |
| Working Party on **Tropical Tunas** | 17–21 Nov | Bali, Indonesia | 13–17 or 20–24 Oct (5d) | TBD |
| Working Party on **Data Collection and Statistics** | 10–13 Dec (3d) | Victoria, Seychelles | TBD | TBD |
| Working Party on **Methods** | 13–14 Dec (2d) | Victoria, Seychelles | TBD | TBD |
| **Scientific Committee** | 16–20 Dec (5d) | Victoria, Seychelles | 24–28 Nov (5d) | Bali, Indonesia |
| Working Party on **Fishing Capacity** | Nil | Nil | Nil | Nil |

# APPENDIX XXXVIII
## CONSOLIDATED SET OF RECOMMENDATIONS OF THE SIXTEENTH SESSION OF THE SCIENTIFIC COMMITTEE (2–6 DECEMBER, 2013) TO THE COMMISSION

**STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN**

**GENERAL RECOMMENDATIONS TO THE COMMISSION**

**RECOMMENDATIONS TO SPECIFIC CPCS AND/OR OTHER BODIES**