出國報告(出國類別：其他)

參加「印度洋鮪類委員會（IOTC）第 15 屆科學次委員會（SC15）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：技正　李淑敏
派赴國家：塞昔爾
出國期間：101 年 12 月 8 日至 12 月 17 日
報告日期：102 年 1 月 2 日

摘要

本次印度洋鮪類委員會（IOTC）第 15 屆科學次委員會（SC15）會議於本（101）年 12 月 10 至 15 日在塞昔爾（Seychelles）舉行，共有 24 個會員國代表出席，另有 WWF、ISSF、MSC、IOSEA 等觀察員參與，我國則由本署李淑敏技正、南華大學葉裕民助理教授及對外漁協張舒婷統計員等三人，以受邀專家（Invited Expert）身份與會，現場出席人員(含秘書處人員)估約 60 位。有關本次會議重要結果如次：

一、長鰭鮪：過去 10 年長鰭鮪豐度及標準化 CPUE 序列關係、總漁獲量存在著相當的不確定性；漁獲死亡率大於最大持續生產量（MSY）水準，顯示過漁正在進行中，親魚資源量接近 MSY 水準，顯示該資源量處於過漁狀態之風險；漁獲死亡率需降低至少 20%，以確保親魚資源量維持於 MSY 水準；維持或增加努力量可能導致長鰭鮪資源量下降。

二、大目鮪：漁獲死亡率小於 MSY 水準，顯示未處於過漁正在進行中的狀態，親魚資源量大於 MSY 水準，顯示資源量並未處於已經過漁的狀態；建議大目鮪漁獲量不應超過 MSY 水準，若努力量持續下降，且漁獲量持續低於 MSY 水準，則不需有立即性的管理措施，但仍需加強資料收集及分析，以降低評估的不確定性。

三、正鰹：親魚資源量約爲 MSY 水準的 1.2 倍，顯示資源未處於已經過漁的狀態，漁獲死亡率小於 MSY 水準，顯示並未處於過漁正在進行中的狀態；正鰹之評估結果仍有許多不確定性，因此建議漁獲努力量不應增加，且漁獲量應維持低於 MSY 水準。

四、黃鰭鮪：親魚資源量大於 MSY 水準，顯示資源未處於已經過漁的狀態，漁獲死亡率小於 MSY 水準，顯示並未處於過漁正在進行中的狀態；爲確保長期資源量穩定，黃鰭鮪年度漁獲量不超過 MSY 水準；若黃鰭鮪親魚資源量持續低於長期歷史平均量，在考慮資源量平衡狀態下，則黃鰭鮪漁獲量必須持續低於

MSY。

五、劍旗魚：漁獲死亡率低於 MSY 水準，親魚資源量高於 MSY 水準，顯示該資源並未處於已過漁狀態，且未處於過漁正在進行中。建議年度漁獲量不要超過 MSY 水準。

六、混獲議題：除原作業日誌報表所列 5 種鯊種外，建議新增蒐集黑鯊及花鯊資訊。

七、102 年重要會議安排：生態與混獲工作小組(9 月 12-16 日，留尼旺)、旗魚工作小組(9 月 18-22 日，留尼旺)、熱帶鮪工作小組(10 月 22-27 日，西班牙畢爾包或聖塞巴斯蒂安)、資料蒐集與統計工作小組(11 月 29-30 日，塞昔爾)、科學次委員會(12 月 2-6 日，塞昔爾)。

八、重要魚種資源評估時程：大目鮪(102 及 105 年)、正鰹(103 及 106 年)、黃鰭鮪(104 年)、長鰭鮪(102 年)、劍旗魚(103 年)。

九、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 先生擔任。

關鍵詞：印度洋鮪類委會，科學委員會，鮪旗魚類，資源評估

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壹、目的

「印度洋鮪類委員會(IOTC)爲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，爲近年來該組織最關切之魚種。

印度洋爲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爲重要。由於目前各國際組織爲達資源永續利用之目標，正積極加強對各魚種資源的管理，並以漁獲配額爲管理手段。因此爲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，作爲未來爭取參與 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 15 屆科學委員會會議（SC15）於本（101）年 12 月 10 至 15 日在塞昔爾（Seychelles）舉行。由日本 Nishida 博士擔任主席，，副主席爲 Jan Robinson（未出席），計有中國、歐盟、幾內亞、伊朗、馬爾地夫、模里西斯、賽昔爾、菲律賓、蘇丹、澳洲、日本、韓國、法國、西班牙、泰國、馬來西亞、肯亞、印度、斯里蘭卡、莫三比克、馬達加斯加、印尼、科摩羅及澳洲等 24 會員國代表出席，另有 WWF、ISSF、MSC、IOSEA 等觀察員參與，我國則由本署李淑敏技正、南華大學葉裕民助理教授及對外漁協張舒婷統計員等三人，以受邀專家（Invited Expert）身份與會，現場與會人員(含秘書處人員)估約 60 位。謹將會議重要結果摘述如下：

12 月 10 日

一、開幕（12 月 10 日上午 9 時）：IOTC SC15 由日本籍 Tsutomu Nishida 擔任主席，副主席爲 Jan Robinson（未出席），計有中國、歐盟、幾內亞、伊朗、馬爾地夫、模里西斯、賽昔爾、菲律賓、蘇丹、澳洲、日本、韓國、法國、西班牙、泰國、馬來西亞、肯亞、印度、斯里蘭卡、莫三比克、馬達加斯加、印尼、科摩羅及澳洲等 24 會員國代表出席，另有 WWF、ISSF、MSC、IOSEA 等觀察員參與，我國則以受邀專家（Invited Expert）身份與會，現場與會人員(含秘書處人員)估約 60 位。

二、主席宣佈會議開始並致歡迎詞，隨即檢視會議議程，並討論議題進行之優先順序，澳洲代表建議將議題 13(捕獲大目鮪與黃鰭鮪幼魚與親魚的影響)移到議題 7.5(熱帶鮪類工作小組會議報告)之後； 說明庶務性工作(housekeeping work)，包括每日會議時間規劃、接駁車接送時間與附近餐廳介紹等；接著指派各項議程會議紀錄員：第 1 至第 6 項與第 11、第 14 至第 16 項由 IOTC 秘書處負責、第 7 項至第 9 項由各工作小組主席負責，第 10、12 項至第 13 項由西班牙 Hilario Murua 博士負責；說明本次會議之會議文件編號暨網路設定；與會會員國及受邀專家簡單自我介紹。

三、秘書處報告與科學委員會有關的委員會決議：由副秘書長 David 非常快速說明科學委員會需回應委員會去年的要求與歷年各項建決議案的書面說明，已整理於會議文件中，請會員國自行參閱。

四、2012 年 IOTC 秘書處報告科學相關工作項目：

(一)秘書處統計人員特別說明我國今年提供五度方格月別歷史體長資料，對資料處理相當有助益。

(二)S.Fujiwara 簡報日本海外漁業合作基金計畫 (OFCF) 2012 年的執行概況。 今年是此計畫第三階段，主要是協助印度洋沿岸發展中國家(伊朗、印尼、斯里蘭卡與科摩羅等)改善資料蒐集系統與漁獲統計品質。

(三)Guillermo Moreno 簡報改善 1950 至 2011 年印度、印尼和斯里蘭卡家計型漁業(artisanal) 鮪類、鯊魚類及旗魚類漁具別、魚種別漁獲量的資料品質計畫執行概況。目的是將歷年這些國家提報之漁獲量以漁具別、魚種別分離估計。目前進度，印度的部分已完成，但認爲印度尚有資訊可利用，但 IOTC 無法取得；印尼還在進行中，因面臨許多困難，尤其仍有許多漁獲量未能取得，其中應包含許多大目鮪和黃鰭鮪的幼魚資料；斯里蘭卡的漁獲量明顯低估，且發現許多魚種混著累計的問題。

(四)Julian 報告網站的進展，另表示 IOTC 印製一些圖鑑可供登記索取。

(五)此項議題報告後，印度對 IOTC 指控其資料提交問題表達不滿；歐盟認爲各國本應如期繳交資料，同時建議秘書處對於各國繳交資料的處理方式應更積極，並對未繳交國家的原因予以瞭解，以尋求解決之道；秘書處回應已鼓勵各國繳交國家報告，繳交情況已大幅改善，並提供補助讓許多國家參與提供資料；印尼建議日後執行相關計畫，蒐集印尼漁業相關漁獲統計資料時，應瞭解印尼漁業特性方更有效益。

五、國家報告：每個國家報告五分鐘，討論五分鐘，共 25 個國家提供國家報告；我國以受邀專家身份，由對外漁協張舒婷統計員進行國家報告簡報，並表示國家報告已電郵提交 IOTC 秘書處，會中並無其他國家代表針對我國報告提問或表示意見。其他國家國家報告相關討論如次：

(一)澳洲：歐盟關心其休閒漁業捕獲鯊魚漁獲量估算及捕撈季節；日本請教爲何 2011 年 圍網沒捕捉到正鰹；澳洲表示 許多圍網轉移捕捉南方黑鮪。

(二)中國：2011 年的努力量和漁獲量比 2010 年低。

(三)科摩羅： 歐盟關心其研究 FAD 的計畫，2013 年是否繼續；科國回覆，因經費問題，不會繼續該計畫。

(四)歐盟：強調標識放流計畫亮麗成果；主席關心其執行觀察員計畫情形；歐盟

表示因海盜問題，派遣觀察員的漁船均避開索馬力亞海域作業，所以蒐集之資料會有偏差；IOTC 科學家請教關於鯊魚的拋棄量估計，並未呈現在國家報告；歐盟表示資料之前已提供給 IOTC，另最近捕捉到許多水鯊。

(五)法國：二個主要船隊，一為熱帶鮪類圍網漁業，另一是沿近海家計型漁業；說明因部分船隻空間限制，無法派遣觀察員問題；目前進行各式相關科學研究。

(六)印度：2012 年大型鮪延繩釣漁業捕獲約 700 噸黃鰭鮪，總漁獲量約 1300 噸；歐盟提問，以延繩釣漁業的船數觀之，漁獲量太低，原因為何；印度說明僅 EEZ 內的資料；歐盟表示 EEZ 內外的漁獲資料都應繳交；日本關心延繩釣漁獲組成問題；印度表示會提供後續資訊。

(七)印尼：歐盟希望有更詳細的時空資訊統計資料；印尼回覆目前漁撈作業日誌資料尚有整合問題。

(八)伊朗：提供許多混獲資料，英國關心此類資料取得方法；歐盟表示報告中有些資料呈現的結果和 IOTC 資料庫不符？且關心為何圍網在赤道附近作業，未捕獲大目鮪？

(九)日本：目前資料提送系統更新，要求漁船需於預定卸魚日前十天將相關文件送交政府；歐盟關心體長資料的代表性問題，即涵蓋率問題；澳洲請教觀察員是否蒐集鯊魚的拋棄資料；日本回覆觀察員會做相關記錄。

(十)肯亞：主要有二種漁業，一是家計型漁業，多為 10 公尺以下漁船，漁法為刺網、延繩釣，另一是娛樂型漁業，漁法為拖網。

(十一)韓國：主席請教如何獲得即時漁獲資料；韓國表示透過電子郵件方式；澳洲關心鯊魚的丟棄量；韓國回覆今年的鯊魚丟棄量是以 2010 年的資料估算的值。

(十二)馬爾地夫：發展漁撈作業日誌網路平台，可線上輸入作業日誌、銷售資料、

維護漁船活動記錄與漁業執照；澳洲恭喜馬爾地夫目前漁業管理與研究工作進展。

(十三)模里西斯：日本今年沒有入漁合作，可能是因爲海盜的關係；歐盟提問固定式 FAD（anchored FAD）的漁獲魚種多爲長鰭鮪原因；模國回覆因季節性捕捉長鰭鮪；主席請問海盜活動導致許多船改捉長鰭鮪，是否影響到其國家長鰭鮪的漁獲趨勢；模國回覆是有影響，2007 年的長鰭鮪漁獲量幾乎是 2011 年的兩倍。

(十四)賽昔爾：表示未來會執行觀察員計畫，主席表示期待。

(十五)斯里蘭卡：法國關心刺網漁業鯊魚拋棄量的狀況，量非常低；歐盟表示漁獲資料缺乏漁法與作業漁區的紀錄；斯里蘭卡表示藉由該國漁撈作業日誌系統的建立，希望未來可以提供相關資訊。

(十六)蘇丹：主席表示許多資訊爲首次接觸，並表達感謝；歐盟建議蘇丹應採用 IOTC 的魚類用語，以便比較討論。

(十七)英國：沒有商業性的漁業活動，只有一些休閒式漁業。

六、國家報告的格式要求 ：國家報告、海鳥與鯊魚國家行動方案等格式的確認，現場會員國無意見，主席指示其後若有意見，請提供給秘書處參考。

12 月 11 日

七、2012 年各工作小組會議結果報告相關討論如次：

(一)第 4 屆溫帶鮪類工作小組會議報告：

1、報告 20 項建議案。和我國有關者，除配合整體資源評估作業的研究架構與時程安排外，最重要的是小釣資料的提供；歐盟表示我國早期(1969 年)是唯一以長鰭鮪爲目標魚種的國家，爲何 CPUE 序列只自 1984 年開始，早期重要的訊息無從得知；我方回覆，確實自 1984 年已蒐集相關

資料，但無法確認相關學者對於分析序列年份的篩選原則。

2、歐盟質疑這個評估似乎無法有效讓人理解資源的變動狀況，因爲近年長鰭鮪的漁獲量大增，但是原因爲何？這些增加的漁獲量是從哪裡來的？哪些區域？是族群量增加？或是族群結構改變？建議應瞭解這些漁獲的體長分佈等更多面向的資訊。

3、歐盟詢問爲何 2011 年中國在西印度洋海域作業，該海域應有大目鮪與黃鰭鮪，但漁獲資料顯示，百分百均是長鰭鮪，這是奇怪的現象；中國回覆已向業者洽詢，但目前尚未釐清原因，明年工作小組會議將提出解釋。

4、歐盟強調 CPUE 標準化研究方法的適當性需急迫面對，否則年復一年，所有魚種的評估都會面臨 CPUE 序列無法反應資源變動的相同困境。

(二)第 10 屆旗魚類工作小組會議報告：這是首次投入 4 位科學家專門處理 CPUE 標準化的研究，是一大進展，報告 33 項建議案；魚種辨識與魚種別漁獲量是最需要克服的工作；和我國有關的是，已提供相關資料有助於建立年齡與體長轉換關係。

1、體長資料、資料內容、數量與品質需符合委員會最低要求（各漁具各魚種一噸的漁獲量需有一條魚的樣本量）。

2、平均體重資訊，從作業日誌漁獲努力量與體長資料所計算的結果要一致。

3、體長量測方式需符合要求，或可建立不同量測方式的轉換關係。

4、建議我國提供船隊歷史發展的回顧，包括作業漁區的分佈、目標魚種的轉換、漁具變革等相關資訊。

(三)第 8 屆生態系與混獲工作小組會議報告：報告 29 項建議案，

鯊魚漁獲量與拋棄量的蒐集，仍是建議重點。

1、海龜與海鳥的建議基本上同去年的建議。

2、IOC 表達欲與 IOTC 密切合作並可分析觀察員蒐集到有關海龜的資料，並參與相關報告的準備工作；另建議相關會議重點應包括海龜方面的

討論，會員國無反對意見。

3、Hillario Murua 博士報告關於鯊魚進行生態風險評估的理論、方法與結果。討論的重點是 10 個關鍵鯊種（較易受延繩釣漁業影響的鯊種，即生態風險較大鯊種）的資料蒐集。是要求作業日誌填報，或是由觀察員紀錄？因有多方意見，所以主席建議日本代表組成小組，專門處理此議題。

4、歐盟提出鰭不離身的議題。很快達成協議用去年的相關建議。

5、一篇研究報告發現 drifting FADs 會對黑鯊造成相當大的傷害，所以主席建議組成一個小組針對海龜和鯊魚關於 drifting FADs 建議，另這種漁具的定義亦需釐清。

(四)第 4 屆方法論工作小組會議報告：報告 7 項建議案，歐盟關心訓練工作坊的可行性。

12 月 12 日

七、2012 年各工作小組會議結果報告相關討論如次：續昨日。

(四)第 4 屆方法論工作小組會議報告：

1、馬爾地夫建議亦應進行正鰹的管理策略評估(MSE)。

2、澳洲關心 LRPs (Limit Reference Point)的科學與管理相關議題。

3、海龜與海鳥的建議同去年的建議。

(五)第 14 屆熱帶鮪類工作小組會議報告：

1、正鰹：馬爾地夫建議將 LRPs 等相當量化描述納入評估呈現內容，然而今年沒有做 Kobe II Strategy Matrix 的分析，是將今年作的 SS3 結果和去年的 Kobe II Strategy Matrix 的結果整合，所以類似的比較有混淆誤導的可能。歐盟強烈建議明年再做一次，因爲許多重要資訊，如標識放流的資料沒利用，而且此次結果存在許多不合理之處。主席建議組成小組討論，提供一些參考點的量化描述。

2、黃鰭鮪：歐盟建議比較太平洋與印度洋進行的資源評估工作，因均使用 Multifan-CL 分析，可以探討出一些目前印度洋黃鰭鮪模式分析結果的一些矛盾不合理之處。另需考慮不同資料來源和方法對於自然死亡率的估計結果差異甚大，而此值的選用對於資源評估的結果影響甚鉅。並關心我國與日本延繩釣漁業體長資料的影響。

3、大目鮪：今年沒有評估，相關建議是根據 2010 年的分析結果；另因 3 個延繩釣漁業的 CPUE 呈現的趨勢不同，應先針對此項議題深入討論；報告 22 項建議案。

4、綜合討論：

(1)因應許多會員國的要求，IOTC 秘書處提供一些訓練課程提升會員國的科學素養，使能對科學報告有正確的理解，並助於管理決策的制訂，其整體目標是促進科學家與管理決策人員進行有意義與效率的對話。

(2)IOTC 提供相關文件說明初步規劃，分三類課程：提供給管理決策者，協助其對於資源評估結果的解讀能力；提供給科學家，訓練描述族群動態模式建立能力；提供給科學家，訓練 CPUE 標準化研究能力。歐盟表示這些相關研究理論與實務非常複雜，如何設計使之可行，值得討論。SC 針對執行細節有諸多討論，如預算、地點與參加者等等。

(3)建議 SC 建立一套經費補助原則，以提供經費予各工作小組的主席與副主席參與 SC 會議。

5、圍網捕獲大目鮪與黃鰭鮪幼魚與親魚的影響議題：鑑於幼魚魚種辨識困難，建議圍網 FAD 漁具之漁獲組成應採用科學採樣方法估計大目鮪與黃鰭鮪幼魚所佔的比例。若評估或降低圍網 FAD 漁具對大目鮪與黃鰭鮪幼魚的影響，建議未來可利用 MSE 的方式進行，或研究各漁具對於產量的影響，或考慮採用目前 WCPFC 對於 FAD 漁具利用大目鮪與黃鰭鮪幼魚的管理措施，但須先進行優缺點分析；整體而言，此部分同去年的建議。歐盟建議將幼魚的體長定義納入說明；澳洲建議提供

一些各漁業這些魚種的漁獲死亡係數的資訊；主席建議明年熱帶鮪類工作小組會議針對這些相關資訊進行分析估計。

八、區域觀察員計畫執行情形：由 IOTC 秘書處 Julien Million 報告執行現況，包括各國繳交資料統計及各國執行觀察員的涵蓋率；伊朗提議將各噸級別的觀察員涵蓋率降低；歐盟建議維持現狀；主席裁示維持現狀；另由於許多國家尚未執行觀察員計畫，主席建議將秘書處文件所列之建議事項，提送委員會。

九、禁漁期及禁漁區管理措施的展望：根據去年工作小組的研究，認爲目前禁漁期及禁漁區管理措施，所降低的漁獲量非常有限，然而或許禁漁期增長與禁漁區擴大，預期可有效降低漁獲量，但努力量若因而移轉至其他漁區，效果也是有限；討論結果建議與委員會確認禁漁期及禁漁區管理措施的目標，在此之前，維持現狀。

十、建決議案的目前執行狀況：IOTC 秘書處 David 簡介各建決議案的目前執行狀況。

十一、秘書處與會員國互動議題：體長體重轉換式對於體長資料均重與 TASK2 均重不一致議題，會場秘書處表示他們已針對台灣新提供之五度方格月別歷史體長資料進行分析，會議期間若有空檔，會將初步結果和我們說明討論。

十二、會外其他事項：

(一)泰國漁業部海洋漁業研發局海洋漁業研究及技術發展研究所所長 Praulai 女士洽我方提出二個問題，一爲我國漁船近 2 年(2011 及 2012 年)於普吉港卸售的航次與漁獲量明顯減少，想瞭解原因？Praulai 並將相關數據電郵我方。另一是我國漁船於普吉港卸魚，其漁獲產證核發時間問題，據其表示需耗時二個月，會造成漁獲買賣困難，想知道原因？

我方代表團成員和國內相關同事請教討論後已小心簡單電郵回復：我國漁船近 2 年(2011 及 2012 年)於普吉港卸魚量減少原因，據瞭解，部分小釣船

於 2011 及 2012 年轉至斯里蘭卡卸魚，另會將漁獲產證核發時間問題轉相關承辦單位人員回復。

(二)斯里蘭卡代表表示，以往各國漁船在斯里蘭卡卸魚時所附之相關文件資料，斯里蘭卡並未作進一步確認動作，然因 IOTC 要求卸魚時，要該國做資料確認動作，所以日後斯里蘭卡會和相關國家確認漁民繳交資料之正確性。因此請問若日後相關確認工作，我國的聯絡窗口爲何？

我方已回復，請其明確將所需確認之具體資訊項目列出，再協助提供適當的聯絡管道。

12 月 13 日

十三、海盜活動對於各船隊、後續漁獲與努力量變化趨勢的影響：由主席進行簡報。

(一)海盜活動對於延繩釣漁業有相當大的影響，許多漁船移轉至其他洋區作業，另部分努力量從以熱帶鮪類爲目標魚種的熱帶海域，移轉至以長鰭鮪爲目標魚種的東南海域。

(二)海盜活動對於圍網漁業影響較少，但仍有影響，如圍網作業漁場往東移至少 100 里海域，熱帶鮪類的漁獲量亦減少。

(三)對沿岸國的影響，許多漁船不在公海作業，而返回經濟海域，因此漁獲組成大幅改變。

(四)伊朗表示從 2008 年至今，有 15 艘漁船被攻擊，希望大家提供一些反海盜的活動原則。

(五)歐盟認爲這種議題不應在科學委員會討論，科學委員會應該著重在科學議題。

十四、2013 年科學委員會與工作小組的重點任務與時程安排：

(一)2013 年熱帶鮪類工作小組將針對大目鮪進行完整資源評估，黃鰭鮪與正鰹則針對漁業指標訊息討論，如 CPUE 標準化與體長資料的品質提升。

(二)歐盟建議明年亦應將黃鰭鮪資源評估的工作視爲重點，如比較各資源評估的方法、假設與結果。

(三)馬爾地夫則認爲每一種魚種都有許多的問題要釐清，但是總有優先順序。

(四)熱帶鮪類工作小組主席亦表示 2013 年應將主力放在大目鮪，其他兩個魚種應先處理一些重要課題，否則重做資源評估，一樣會遇到目前的瓶頸。因此主席裁示維持目前的安排。

(五)溫帶鮪類（長鰭鮪）的會議則決議兩年評估一次，2013 年不召開溫帶鮪類工作小組會議，但是各國更新的漁業指標（如 CPUE 標準化序列），可送至 IOTC 彙整。

十五、其他議題：

(一)IOTC 科學家報告資源評估結果的呈現格式原則建議：包括哪些資訊需要納入，哪些模式檢測分析需要執行並呈現結果等。日本建議這些原則應在方法論工作小組討論，而且這些原則都是最高原則，要求非常深度的統計分析，建議應以最低要求爲原則。IOTC 秘書處已根據會員國的要求進行修正。

(二)針對各個工作小組的執行摘要(Executive Summary)做修正和確認，補充一些表格等，如長鰭鮪補充不同情境(Scenarios)的參考點(reference points)資訊或修正一些文句，另針對一些圖表的清晰度與可讀性做改善。

(三)討論建議未來研究方向，如海盜的影響、海洋保護區(MPA)的效益及其對資源狀態的影響，能否或如何將其納入資源評估模式考慮等。

12 月 14 日　休會

因昨日會議議程提前討論完畢，主席宣布 12 月 14 日休會。

十六、秘書處與我國互動議題：續昨日。

(一)下午 2 時，全體團員前往 IOTC 秘書處(位於 Le Chantier Mall)，秘書處漁業統計人員 Miguel Herrera 及 James Geehan 已針對我國新提供之五度方格月別歷史體長資料進行分析，並將初步結果圖表提供說明討論。

(二)IOTC 秘書處統計人員檢視 1980 年至 2006 年大目鮪、黃鰭鮪與長鰭鮪體長資料均重與 TASK2 均重的歷年年別與月別變動趨勢。初步分析結果顯示幾點請我方協助釐清：

１、2002 年以後大目鮪與黃鰭鮪體長資料均重持續增加；

２、歷年大目鮪與黃鰭鮪 TASK2 均重變動的趨勢非常類似；

３、2003 年體長資料佔 TASK2 的樣本比例較近幾年低許多，尤其 1992 年前後特別低，是否仍具代表性；

４、2003 年以後體長資料樣本數雖然大幅增加，然體長頻度分佈全距(range)相較往年卻小很多；

５、在阿拉伯海域，有出現長鰭鮪漁獲體長資料，據其認知在阿拉伯海域因海洋環境的特性（較深層水層溶氧量低）甚少有延繩釣漁業捉到長鰭鮪，若有，根據其他漁法捕捉的長鰭鮪體長分佈會有季節性特徵，如全爲中型魚體，或均是大型魚體；

６、綜合討論結果，Miguel 會提供相關報告內容架構予我方，以利後續分析與報告準備。

(三)關於大目鮪與黃鰭鮪 TASK2 均重不一致的議題，建議我方可朝幾個方向進行分析研究：

１、將觀察員資料納入檢視分析，以幫助瞭解商業性漁獲資料所顯示之趨勢的訊息。必要時，將時空範圍縮小至觀察員資料涵蓋範圍內比較；

２、當整體趨勢有不合理現象時，可從細部資料開始進行確認，如以船別或小區域的資料進行個別檢視，以鑑別問題來源；

3、瞭解不同時期體長資料蒐集系統，並確認體長資料代表性狀況。

12 月 15 日

十七、審閱本次第 15 屆科學委員會會議報告暨定稿：本日進行 SC15 會議報告的最後檢視，會議上午 10 時開始，主席就會議紀錄草案逐段引導進行檢視，會員國參與修正，下午 3 時，主席宣佈會議結束。謹將重要結果摘要如次：

(一)主要魚種資源狀態及管理建議：

1、長鰭鮪：過去 10 年長鰭鮪豐度及標準化 CPUE 序列關係、總漁獲量存在著相當的不確定性；漁獲死亡率大於最大持續生產量（MSY）水準，顯示過漁正在進行中，親魚資源量接近 MSY 水準，顯示該資源量處於過漁狀態之風險；漁獲死亡率需降低至少 20%，以確保親魚資源量維持於 MSY 水準；維持或增加努力量可能導致長鰭鮪資源量下降。

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

2、大目鮪：漁獲死亡率小於 MSY 水準，顯示未處於過漁正在進行中的狀態，親魚資源量大於 MSY 水準，顯示資源量並未處於已經過漁的狀

態；建議大目鮪漁獲量不應超過 MSY 水準，若努力量持續下降，且漁獲量持續低於 MSY 水準，則不需有立即性的管理措施，但仍需加強資料收集及分析，以降低評估的不確定性。

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

3、正鰹：親魚資源量約爲 MSY 水準的 1.2 倍，顯示資源未處於已經過漁的狀態，漁獲死亡率小於 MSY 水準，顯示並未處於過漁正在進行中的狀態；正鰹之評估結果仍有許多不確定性，因此建議漁獲努力量不應增加，且漁獲量應維持低於 MSY 水準。

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

4、黃鰭鮪：親魚資源量大於 MSY 水準，顯示資源未處於已經過漁的狀態，漁獲死亡率小於 MSY 水準，顯示並未處於過漁正在進行中的狀態；為確保長期資源量穩定，黃鰭鮪年度漁獲量不超過 MSY 水準；若黃鰭鮪親魚資源量持續低於長期歷史平均量，在考慮資源量平衡狀態下，則黃鰭鮪漁獲量必須持續低於 MSY。

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

5、劍旗魚：漁獲死亡率低於 MSY 水準，親魚資源量高於 MSY 水準，顯

示該資源並未處於已過漁狀態，且未處於過漁正在進行中。建議年度漁獲量不要超過 MSY 水準。

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2011catch estimate	19,631 t	6,559 t
Mean catch from 2007–2011	21,870 t	6,939 t
MSY	29,900– 34,200	7,100 t–9,400 t
Data period used in assessment	1951–2009	1951–2009
F_{2009}/F_{MSY}	0.50 (0.23–1.08)	0.64 (0.27–1.27)
B_{2009}/B_{MSY}	–	–
SB_{2009}/SB_{MSY}	1.59 (0.94–3.77)	1.44 (0.61–3.71)
B_{2009}/B_0	–	–
SB_{2009}/SB_0	0.35 (0.22–0.42)	0.29 (0.15–0.43)
$B_{2009}/B_{0, F=0}$	–	–
$SB_{2009}/SB_{0, F=0}$	–	–

(二)混獲議題建議：除原作業日誌報表所列五種鯊種外，建議新增蒐集黑鯊及花鯊資訊。

(三)2013 及 2014 年會議安排

Meeting	2013	2014 (tentative)		
	Date	Location	Date	Location
Working Party on **Neritic Tunas**	17–20 June or 1–4 July (4d)	Bali, Indonesia or Tanzania	13–16 July (4d)	Bali, Indonesia or Tanzania
Working Party on **Temperate Tunas**	Nil	Nil	5–8 Aug (4d)	TBD

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

(四)各魚種資源評估時程及方法論工作小組優先項目

Species	**2013**	**2014**	**2015**	**2016**	**2017**
Working Party on Tropical Tunas					
Bigeye tuna	**Full assessment**	Indicators	Indicators	**Full assessment**	Indicators
Skipjack tuna	Indicators	**Full**	Indicators	Indicators	**Full**

		assessment			**assessment**
Yellowfin tuna	Indicators	Indicators	**Full assessment**	Indicators	Indicators
Working Party on Temperate Tunas					
Albacore	**Full assessment**	Indicators			
Working Party on Billfish					
Black marlin	**Full assessment**				
Blue marlin	**Full assessment**				
Striped marlin	**Full assessment**				
Swordfish	Indicators	**Full assessment**			
Indo-Pacific sailfish	Indicators				
Working Party on Neritic Tunas					
Bullet tuna	Indicators				
Frigate tuna	Indicators				
Kawakawa	Indicators	**Full assessment**			
Longtail tuna	Indicators	**Full assessment**			
Indo-Pacific king mackerel	Indicators				
Narrow-barred Spanish mackerel	Indicators	**Full assessment**			
Working Party on Ecosystems and Bycatch					
Bigeye thresher sharks	Indicators				
Blue sharks	Indicators				
Silky sharks	Indicators				
Oceanic	Indicators				

whitetip sharks					
Pelagic thresher sharks	Indicators				
Shortfin mako sharks	Indicators				
Scalloped hammerhead sharks	Indicators				
Working Party on Methods					
Management Strategy Evaluation	Initial operating model for ALB, first run on ALB MSE and analysis of reference points for ALB	Extension of the MSE process to tropical tunas			

十八、其他事項：

(一)日方代表與我方討論關於海龜資料蒐集的建決議案(Resolution 10/02)，日方將於明年年會提出修正建議，建議內容是延繩釣漁業的作業日誌亦應蒐集海龜混獲資訊，建議明年年會與會人員預擬我方立場因應。

(二)IOTC 科學委員會建議明年應舉辦 CPUE 標準化研究工作小組，針對各魚種各漁業歷年來 CPUE 標準化相關的重要議題深入討論，包括理論、模式、資料、各漁業發展演進、實務分析研究，企圖對長久以來一直無法有效改善 CPUE 標準化序列品質與可靠度的議題，進行實質討論。其中一個眾所矚目的議題是熱帶鮪類、溫帶鮪類與旗魚類，我國、日本與韓國 CPUE 標準化序

列趨勢不一致的現象，建議我方指派相關科學家積極參與此研究工作小組。

參、心得與建議

一、本次會議主要魚種資源狀態及管理建議如次：

(一)長鰭鮪：過去 10 年長鰭鮪豐度及標準化 CPUE 序列關係、總漁獲量存在著相當的不確定性；漁獲死亡率大於最大持續生產量（MSY）水準，顯示過漁正在進行中，親魚資源量接近 MSY 水準，顯示該資源量處於過漁狀態之風險；漁獲死亡率需降低至少 20%，以確保親魚資源量維持於 MSY 水準；維持或增加努力量可能導致長鰭鮪資源量下降。

(二)大目鮪：漁獲死亡率小於 MSY 水準，顯示未處於過漁正在進行中的狀態，親魚資源量大於 MSY 水準，顯示資源量並未處於已經過漁的狀態；建議大目鮪漁獲量不應超過 MSY 水準，若努力量持續下降，且漁獲量持續低於 MSY 水準，則不需有立即性的管理措施，但仍需加強資料收集及分析，以降低評估的不確定性。

(三)正鰹：親魚資源量約爲 MSY 水準的 1.2 倍，顯示資源未處於已經過漁的狀態，漁獲死亡率小於 MSY 水準，顯示並未處於過漁正在進行中的狀態；正鰹之評估結果仍有許多不確定性，因此建議漁獲努力量不應增加，且漁獲量應維持低於 MSY 水準。

(四)黃鰭鮪：親魚資源量大於 MSY 水準，顯示資源未處於已經過漁的狀態，漁獲死亡率小於 MSY 水準，顯示並未處於過漁正在進行中的狀態；爲確保長期資源量穩定，黃鰭鮪年度漁獲量不超過 MSY 水準；若黃鰭鮪親魚資源量持續低於長期歷史平均量，在考慮資源量平衡狀態下，則黃鰭鮪漁獲量必須持續低於 MSY。

(五)劍旗魚：漁獲死亡率低於 MSY 水準，親魚資源量高於 MSY 水準，顯示該資源並未處於已過漁狀態，且未處於過漁正在進行中。建議年度漁獲量不要

超過 MSY 水準。

二、混獲議題：除原作業日誌報表所列 5 種鯊種外，建議新增蒐集黑鯊及花鯊資訊。

三、102 年重要會議安排：生態與混獲工作小組(9 月 12-16 日，留尼旺)、旗魚工作小組(9 月 18-22 日，留尼旺)、熱帶鮪工作小組(10 月 22-27 日，西班牙畢爾包或聖塞巴斯蒂安)、資料蒐集與統計工作小組(11 月 29-30 日，塞昔爾)、科學次委員會(12 月 2-6 日，塞昔爾)。

四、重要魚種資源評估時程：大目鮪(102 及 105 年)、正鰹(103 及 106 年)、黃鰭鮪(104 年)、長鰭鮪(102 年)、劍旗魚(103 年)。

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 先生擔任。

六、有關 IOTC SC14 所建議各項科學研究議題，將視可行性及重要性規劃納入 2011 及 2012 年遠洋漁業相關科技計畫。

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	技正	李淑敏
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	統計員	張舒婷

議程

DRAFT ANNOTATED AGENDA FOR THE FIFTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

Last updated: 11 December 2012
Date: 10–15 December, 2012
Location: STC Conference Center, Victoria
Mahé, Seychelles
Time: 09:00 – 17:00 daily
Chair: Dr. Tsutomu Nishida; **Vice-Chair:** Mr. Jan Robinson

1. OPENING OF THE SESSION (Chair)

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION (Chair)

- IOTC–2012–SC15–01a: Draft agenda for the Fifteenth Session of the Scientific Committee
- IOTC–2012–SC15–01b: Draft annotated agenda for the Fifteenth Session of the Scientific Committee
- IOTC–2012–SC15–02: Draft list of documents

3. ADMISSION OF OBSERVERS (Chair)

4. DECISIONS OF THE COMMISSION RELATED TO THE WORK OF THE SCIENTIFIC COMMITTEE (Secretariat)

- IOTC–2012–SC15–03: Outcomes of the Sixteenth Session of the Commission (Secretariat)
- IOTC–2012–SC15–04: Previous decisions of the Commission (Secretariat)

5. SCIENCE RELATED ACTIVITES OF THE IOTC SECRETARIAT IN 2012 (Secretariat)

- IOTC–2012–SC15–05: Report of the secretariat – Activities in support of the IOTC science process in 2012 (Secretariat)

The Secretariat will report on its activities during the 2011 calendar year. It will also outline the technical activities planned for 2012 regarding the acquisition, processing and dissemination of information regarding fisheries for tuna and tuna-like species in the Indian Ocean.

- IOTC–2012–SC15–INF01: IOTC-OFCF Project activities in 2012: Progress Report (S. Fujiwara and M. Herrera)
- IOTC–2012–SC15–INF03: Glossary of scientific terms, acronyms and abbreviations, and report terminology
- IOTC–2012–SC15–INF04: IOTC Species data catalogues (IOTC Secretariat)
- IOTC–2012–SC15–38: Pilot project to improve data collection for tuna, sharks and billfish from artisanal fisheries in the Indian Ocean. Part II: Revision of catch statistics for India, Indonesia and Sri Lanka (1950–2011). Assignment of species and gears to the total catch and issues on data quality (G. Moreno et al.)

6. NATIONAL REPORTS FROM CPCs (CPCs)

- IOTC–2012–SC15–NR01 to NR33 (CPCs)
- Discussions on improving/modifying the National Reporting Template
- IOTC–2012–SC15–06: Status of development and implementation of Nation Plans of Action for seabirds and sharks (Secretariat)

7. REPORTS OF THE 2012 IOTC WORKING PARTY MEETINGS

7.1 IOTC–2012–WPTmT04–R: Report of the Fourth Session of the Working Party on Temperate Tunas

- IOTC–2012–SC15–INF02: Analysis of the genetic structure and life history of albacore tuna in terms of diversity, abundance and migratory range at the spatial and time scales: Project GERMON (GEnetic stRucture and Migration Of albacore tuNa) (N. Nikolic and J. Bourjea)

7.2 IOTC–2012–WPB10–R: Report of the Tenth Session of the Working Party on Billfish

7.3 IOTC–2012–WPEB08–R: Report of the Eighth Session of the Working Party on Ecosystems and Bycatch

- IOTC–2012–SC15–INF05: Ghost fishing of silky sharks by drifting FADs: highlighting the extent of

the problem (J. Filmalter, L. Dagorn and M. Capelo)
- IOTC–2012–SC15–INF09 Rev_1: Ecological Risk Assessment (ERA) and Productivity Susceptibility Analysis (PSA) of sea turtles overlapping with fisheries in the IOTC region (N. Ronel, R. Wanless, A. Angel, B. Mellet and L. Harris)
- IOTC–2012–SC15–INF10 Rev_1: Preliminary Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC) (H. Murua, R. Cohelo, M.N. Santos, H.

Arrizabalaga, K. Yokawa, E. Romanov, J.F. Zhu, Z.G. Kim, P. Bach, P. Chavance, A. Delgado de Molina and J. Ruiz)
7.4 IOTC–2012–WPM04–R: Report of the Fourth Session of the Working Party on Methods
7.5 IOTC–2012–WPTT14–R: Report of the Fourteenth Session of the Working Party on Tropical Tunas
7.6 IOTC–2012–WPNT02–R: Report of the Second Session of the Working Party on Neritic Tunas
7.7 Summary discussion of matters common to Working Parties (capacity building activities – stock assessment course; connecting science and management, etc.)
- IOTC–2012–SC15–INF08: Draft: Building science capacity and understanding among IOTC Members

8. EXAMINATION OF THE EFFECTS OF PIRACY ON FLEET OPERATIONS AND SUBSEQUENT CATCH AND EFFORT TRENDS (Chair)

- IOTC–2012–SC15–07: Examination of the effects of piracy on fleet operations and subsequent catch and effort trends (SC Chair)

9. STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN (Chair)
9.1 Tuna – Highly migratory species
- IOTC–2012–SC15–08: Status of the Indian Ocean Albacore Resource (ALB: *Thunnus alalunga*)
- IOTC–2012–SC15–09: Status of the Indian Ocean bigeye tuna (BET: *Thunnus obesus*) resource
- IOTC–2012–SC15–10: Status of the Indian Ocean skipjack tuna (SKJ: *Katsuwonus pelamis*) resource
- IOTC–2012–SC15–11: Status of the Indian Ocean yellowfin tuna (YFT: *Thunnus albacares*) resource
- IOTC–2012–SC15–12: Report on biology, stock status and management of southern bluefin tuna: 2012 (from CCSBT)

9.2 Tuna and mackerel – Neritic species
- IOTC–2012–SC15–13: Status of the Indian Ocean bullet tuna (BLT: *Auxis rochei*) resource
- IOTC–2012–SC15–14: Status of the Indian Ocean frigate tuna (FRI: *Auxis thazard*) resource
- IOTC–2012–SC15–15: Status of the Indian Ocean kawakawa (KAW: *Euthynnus affinis*) resource
- IOTC–2012–SC15–16: Status of the Indian Ocean longtail tuna (LOT: *Thunnus tonggol*) resource
- IOTC–2012–SC15–17: Status of the Indian Ocean Indo-Pacific king mackerel (GUT: *Scomberomorus guttatus*) resource
- IOTC–2012–SC15–18: Status of the Indian Ocean narrow-barred Spanish mackerel (COM: *Scomberomorus commerson*) resource

9.3 Billfish
- IOTC–2012–SC15–19: Status of the Indian Ocean Swordfish (SWO: *Xiphias gladius*) resource
- IOTC–2012–SC15–20: Status of the Indian Ocean black marlin (BLM: *Makaira indica*) resource
- IOTC–2012–SC15–21: Status of the Indian Ocean blue marlin (BUM: *Makaira nigricans*) resource
- IOTC–2012–SC15–22: Status of the Indian Ocean striped marlin (MLS: *Tetrapturus audax*) resource
- IOTC–2012–SC15–23: Status of the Indian Ocean Indo-Pacific sailfish (SFA: *Istiophorus platypterus*) resource

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

10.1 Marine turtles

- IOTC–2012–SC15–24: Status of marine turtles in the Indian Ocean

10.2 Seabirds

- IOTC–2012–SC15–25: Status of seabirds in the Indian Ocean

10.3 Sharks

- IOTC–2012–SC15–26: Status of the Indian Ocean blue shark (BSH: *Prionace glauca*)
- IOTC–2012–SC15–27: Status of the Indian Ocean oceanic whitetip shark (OCS: *Carcharhinus longimanus*)
- IOTC–2012–SC15–28: Status of the Indian Ocean scalloped hammerhead shark (SPL: *Sphyrna lewini*)
- IOTC–2012–SC15–29: Status of the Indian Ocean shortfin mako shark (SMA: *Isurus oxyrinchus*)
- IOTC–2012–SC15–30: Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*)
- IOTC–2012–SC15–31: Status of the Indian Ocean bigeye thresher shark (BTH: *Alopias superciliosus*)
- IOTC–2012–SC15–32: Status of the Indian Ocean pelagic thresher shark (PTH: *Alopias pelagicus*)

11. IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME (Secretariat)

- IOTC–2012–SC15–33 Rev_2: National Implementation of the regional observer scheme by CPCs (Secretariat).

The IOTC Regional Observer Scheme started on July 1st, 2010 (Resolution 10/04 – superseded by Resolution 11/04). CPCs should report on the action taken for its implementation in their respective countries.

12. OUTLOOK ON TIME-AREA CLOSURES (Chair)

The Commission, at its 15th Session reiterated the **request** *that the Scientific Committee should evaluate the time-area closure established in Resolution 10/01 for the conservation and management of tropical tunas stocks in the IOTC area of competence, in terms of its impacts on the stocks of tuna and tuna-like species* (para. 47 of the S15 report).

13. IMPACT OF CATCHING BIGEYE TUNA AND YELLOWFIN TUNA JUVENILES AND SPAWNERS (Chair)

The Commission, at its 15th Session **requested** *that the Scientific Committee provide advice to the Commission that adds to the information currently available or already requested of the Scientific Committee regarding the take of juvenile yellowfin tuna, bigeye tuna and other species, and on alternative management measures, including an assessment of the impact of current purse seine activities, including the size/fishing capacity (and gear types i.e. mesh size etc.) of vessels, and the potential implications that may arise for tuna and tuna-like species. Such advice should include options for capping purse seine effort and use in conjunction with drifting FADs in the Indian Ocean* (para. 105 of the S15 report).

14. PROGRESS ON THE IMPLEMENTATION OF THE RECOMMENDATIONS OF THE PERFORMANCE REVIEW PANEL (Secretariat)

- IOTC–2012–SC15–34: Update on progress regarding resolution 09/01 – on the performance review follow–up (Secretariat and Chair)

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

- IOTC–2012–SC15–35 Rev_1: Proposed priorities for Working Parties and Scientific Committee meetings for 2013 and 2014 (Chair & Secretariat)
- IOTC–2012–SC15–36: Proposed schedule of Working Party and Scientific Committee meetings for 2013 and 2014 (Chair & Secretariat)

16. OTHER BUSINESS (Chair)

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

- IOTC–2012–SC15–37: Revision: 'Guidelines for the Presentation of Stock Assessment Models'

(Chair & Secretariat)

16.2 GEF-financed global project on tuna fisheries: update & relevance to IOTC
- IOTC–2012–SC15–INF06: GEF-financed global project on the "Sustainable Management of Tuna Fisheries & Biodiversity Conservation in the Areas Beyond National Jurisdiction (ABNJ): update & relevance to IOTC (FAO)

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

附件二、IOTC SC15會議報告

Report of the Fifteenth Session of the IOTC Scientific Committee

Mahé, Seychelles, 10–15 December 2012

Distribution:	Bibliographic entry
Participants in the Session Members of the Commission Other interested Nations and International Organizations FAO Fisheries Department FAO Regional Fishery Officers	IOTC–SC15 2012. Report of the Fifteenth Session of the IOTC Scientific Committee. Mahé, Seychelles, 10–15 December 2012. IOTC–2012–SC15–R[E]: 274 pp.

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Acronyms

BMSY	Biomass at MSY
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CPCs	Contracting parties and cooperating non-contracting parties
CPUE	Catch per unit of effort
EU	European Union
EEZ	Exclusive Economic Zone
ERA	Ecological Risk Assessment
F	Fishing mortality; F2009 is the fishing mortality estimated in the year 2009
FAD	Fish-aggregating device
FAO	Food and Agriculture Organization of the United Nations
FMSY	Fishing mortality at MSY
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
IOSSS	Indian Ocean Swordfish Stock Structure
IUCN	International Union for Conservation of Nature
LL	Longline
LSTLV	Large-scale tuna longline fishing vessel
MFCL	Multifan-CL
MPA	Marine Protected Area
MPF	Meeting Participation Fund
MSE	Management Strategy Evaluation
MSY	Maximum sustainable yield
NGO	Non-governmental organization
NPOA	National plan of action
OFCF	Overseas Fishery Cooperation Foundation of Japan
OT	Overseas Territory
PS	Purse-seine
ROP	Regional Observer Programme
ROS	Regional Observer Scheme
tRFMO	tuna Regional Fishery Management Organization
RTTP-IO	Regional Tuna Tagging Project of the Indian Ocean
SC	Scientific Committee of the IOTC
SSB	Spawning stock biomass
SSBMSY	Spawning stock biomass at MSY
SWIOFP	South West Indian Ocean Fisheries Project
UNCLOS	United Nations Convention on the Law of the Sea
VMS	Vessel Monitoring System
WP	Working Party of the IOTC
WPB	Working Party on Billfish of the IOTC
WPEB	Working Party on Ecosystems and Bycatch of the IOTC
WPM	Working Party on Methods of the IOTC
WPNT	Working Party on Neritic Tunas of the IOTC

WPDCS	Working Party on Data Collection and Statistics of the IOTC
WPTmT	Working Party on Temperate Tunas of the IOTC
WPTT	Working Party on Tropical Tunas of the IOTC

Table of Contents

EXECUTIVE SUMMARY

To be added AFTER adoption.

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

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

Stock	Indicators	Prev[1]	2010	2011	2012	Advice to the Commission
Temperate and tropical tuna stocks: These are the main stocks being exploitation by industrial, and to a lesser extent, artisanal fisheries throughout the Indian Ocean, both on the high seas and in the EEZ of coastal states.						
Albacore *Thunnus alalunga*	Catch 2011: 38,946 t Average catch 2007–2011: 41,609 t MSY (80% CI)): 33,300 t (31,100–35,600 t) F_{2010}/F_{MSY} (80% CI): 1.33 (0.9–1.76) SB_{2010}/SB_{MSY} (80% CI): 1.05 (0.54–1.56) SB_{2010}/SB_{1950} (80% CI): 0.29 (n.a.)	2007				To be added once Report adopted
Bigeye tuna *Thunnus obesus*	Catch in 2011: 87,420 t Average catch 2007–2011: 101,639 t SS3[3] / ASPM[4] MSY (1000 t): 114 (95–183) / 103t (87–119) $^2F_{curr}/F_{MSY}$: 0.79 (0.50–1.22) / 0.67 (0.48–0.86) $^2SB_{curr}/SB_{MSY}$: 1.20 (0.88–1.68) / 1.00 (0.77–1.24) $^2SB_{curr}/SB_0$: 0.34 (0.26–0.40) / 0.39	2008				
Skipjack tuna *Katsuwonus pelamis*	Catch 2011: 398,240 t Average catch 2007–2011: 435,527 t MSY (1000 t): 478 t (359–598 t) F_{2011}/F_{MSY}: 0.80 (0.68–0.92) SB_{2011}/SB_{MSY}: 1.20 (1.01–1.40) SB_{2011}/SB_0: 0.45 (0.25–0.65)					
Yellowfin tuna *Thunnus albacares*	Catch 2011: 302,939 t Average catch 2007–2011: 302,064 t MSY (1000 t): 344 (290–453) F_{2010}/F_{MSY}: 0.69 (0.59–0.90) SB_{2010}/SB_{MSY}: 1.24 (0.91–1.40) SB_{2010}/SB_0: 0.38 (0.28–0.38)	2008				

Stock	Indicators	Prev[1]	2010	2011	2012	Advice to the Commission
Billfish: These are the billfish stocks being exploitation by industrial and artisanal fisheries throughout the Indian Ocean, both on the high seas and in the EEZ of coastal states. The marlins and sailfish are not usually targeted by most fleets, but are caught and retained as byproduct by the main industrial fisheries. They are important for localised small-scale and artisanal fisheries or as targets in recreational fisheries.						
Swordfish (whole IO) *Xiphias gladius*	Catch 2011: 19,631 t Average catch 2007–2011: 21,870 t MSY: 29,900–34,200 t F_{2009}/F_{MSY}: 0.50–0.63 SB_{2009}/SB_{MSY}: 1.07–1.59 SB_{2009}/SB_0: 0.30–0.53	2007				
Swordfish (southwest IO) *Xiphias gladius*	Catch 2011: 6,559 t Average catch 2007–2011: 6,939 t MSY: 7,100 t–9,400 t F_{2009}/F_{MSY}: 0.64–1.19 SB_{2009}/SB_{MSY}: 0.73–1.44 SB_{2009}/SB_0: 0.16–0.58					
Black marlin *Makaira indica*	Catch 2011: 6,890 t Average catch 2007–2011: 6,292 t MSY (range): unknown					
Blue marlin *Makaira nigricans*	Catch 2011: 12,115 t Average catch 2007–2011: 9,443 t MSY (range): unknown					
Striped marlin *Tetrapturus audax*	Catch 2011: 1,885 t Average catch 2007–2011: 2,245 t MSY (range): unknown					
Indo-Pacific Sailfish *Istiophorus platypterus*	Catch 2011: 32,503 t Average catch 2007–2011: 27,103 t MSY (range): unknown					
Neritic tunas and mackerel: These six species have become as important or more important as the three tropical tuna species (bigeye tuna, skipjack tuna and yellowfin tuna) to most IOTC coastal states with a total estimated catch of 605,359 t being landed in 2011. They are caught primarily by coastal fisheries, including small-scale industrial and artisanal fisheries. They are almost always caught within the EEZs of IO coastal states. Historically, catches were often reported as aggregates of various species, making it difficult to obtain appropriate data for stock assessment analyses.						
Bullet tuna *Auxis rochei*	Catch 2011: 4,949 t Average catch 2007–2011: 2,961 t MSY (range): unknown					
Frigate tuna *Auxis thazard*	Catch 2011: 83,210 t Average catch 2007–2011: 75,777 t MSY (range): unknown					

Stock	Indicators	Prev[1]	2010	2011	2012	Advice to the Commission
Kawakawa *Euthynnus affinis*	Catch 2011: 143,393 t Average catch 2007–2011: 134,314 t MSY (range): unknown					
Longtail tuna *Thunnus tonggol*	Catch 2011: 177,795 t Average catch 2007–2011: 134,871 t MSY (range): unknown					
Indo-Pacific king mackerel *Scomberomorus guttatus*	Catch 2011: 49,832 t Average catch 2007–2011: 44,457 t MSY (range): unknown					
Narrow-barred Spanish mackerel *Scomberomorus commerson*	Catch 2011: 146,180 t Average catch 2007–2011: 130,476 t MSY (range): unknown					

Sharks: Although sharks are not part of the 16 species directly under the IOTC mandate, sharks are frequently caught in association with fisheries targeting IOTC species. Some fleets are known to actively target both sharks and IOTC species simultaneously. As such, IOTC Members and Cooperating non-Contracting Parties are required to report information at the same level of detail as for the 16 IOTC species. The following are the main species caught in IOTC fisheries, although the list is not exhaustive.						
Blue shark *Prionace glauca*	Reported catch 2011: 9,540 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 9,452 t Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2011: 388 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 347 t Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					
Scalloped hammerhead shark *Sphyrna lewini*	Reported catch 2011: 120 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 36 t Not elsewhere included (nei) sharks: 63,783 t MSY (range): unknown					
Shortfin mako *Isurus oxyrinchus*	Reported catch 2011: 1,361 t Not elsewhere included (nei) sharks: 55,135 t Average reported catch 2007–2011: 1,207 t Not elsewhere included (nei) sharks: 63,783 t					

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

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

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

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

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

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

1. OPENING OF THE SESSION

1. The Fifteenth Session of the Indian Ocean Tuna Commission's (IOTC) Scientific Committee (SC) was held on Mahé, Seychelles, from 10 to 15 December 2012. A total of 58 individuals attended the Session, comprised of 46 delegates from 21 Member countries and 0 delegates from Cooperating Non-Contracting Parties, as well as 9 observers and invited experts. The list of participants is provided at Appendix I.

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

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

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

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

3. ADMISSION OF OBSERVERS

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

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

Invited experts

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

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

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

Session. The SC **AGREED** to develop advice in response to each of the requests made by the Commission during the current Session.

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

5. SCIENCE RELATED ACTIVITIES OF THE IOTC SECRETARIAT IN 2012

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

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

Meeting participation fund

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

13. The SC **NOTED** that the increased attendance by national scientists from developing CPCs to IOTC Working Parties and the SC in 2012 (46 in 2012; 33 in 2011) was partly due to the IOTC 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*), and **RECOMMENDED** that the Commission maintain this fund into the future.

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

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

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

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

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

Glossary of scientific terms, acronyms and abbreviations

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

Species data catalogues

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

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

Pilot project: Improvements to data collections from artisanal fisheries

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

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

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

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

IOTC website development

26. The SC **NOTED** the work undertaken by the IOTC Secretariat and a company to complete the new IOTC website. The new website is expected to go live in early March, 2013 once it has been populated with all historical IOTC documents and related material. However, the SC **REMINDED** that the reporting requirements were mandatory for all CPCs as per the IOTC resolutions adopted.

6. NATIONAL REPORTS FROM CPCS

27. The SC **NOTED** the 26 National Reports presented by CPCs (Contracting parties and cooperating non-contracting parties) for the meeting, the abstracts of which are provided at Appendix IV. The following matters were raised in regard to the content of specific reports:
    - **Australia**: The SC **NOTED** that catch statistics for sharks by sports fishing operators in Australia is poorly known, although improvements are continually being made to improve data collection systems. The SC also noted that no skipjack tuna was caught by Australian vessels in the IOTC area of competence in 2012, as purse seine vessels limited their targeting to southern bluefin tuna.
    - **Belize**: National report not presented orally as Belize was absent from the SC15 meeting.
    - **China**: Nil comments.
    - **Comoros**: The SC **NOTED** that the current tagging research program funded by SWIOFP in the Comoros will cease at the end of March 2013, once the current funding arrangement concludes.
    - **Eritrea**: The SC **EXPRESSED** its disappointment that Eritrea did not provide a National Report and **REQUESTED** that the SC Chair remind Eritrea to fulfil its reporting obligations to the IOTC.
    - **European Union** (EU): The SC **NOTED** that the EU report does not include shark discards by the EU,Spain fleet for 2011, as requested by the SC in the National Report template. The EU indicated that the information is provided in historical documents provided to the working parties. In a question regarding the EU observer program which resumed in 2011, the EU indicated that the current coverage rate is approximately 10%, although coverage is limited to areas which are not impacted by piracy activities (most of the western Indian Ocean).
    - **France (territories)**: Nil comments.
    - **Guinea**: The SC **EXPRESSED** its disappointment that Guinea did not provide a National Report and **REQUESTED** that the SC Chair remind the Guinea to fulfil its reporting obligations to the IOTC.
    - **India**: The SC **NOTED** the slightly improved situation by India in regard to the mandatory data reporting requirements, as well as the consultations underway with various stakeholders to further improve data collection and reporting. However, substantial improvements remain to be made and higher quality data needs to be provided by India in 2013.
    - **Indonesia**: The SC **NOTED** that although the proportion of longline catches of tuna and tuna-like species by Indonesia has continued to increase, catch and effort

data as per IOTC requirements is yet to be reported (spatial distribution of catch and effort). Indonesia indicated that logbook and observer data for recent years remains to be fully processed and that once this has occurred, Indonesia will provide catch and effort statistics by species, gear and location in accordance with IOTC recording and reporting requirements. The SC **NOTED** that, to date, Indonesia has not reported catch-and-effort data to the IOTC Secretariat, and the provision of size frequency data was discontinued in 2010. In this regard, Indonesia indicated that while part of the data has been collected by various research institutions, the DGCF of Indonesia has not yet compiled the data and reported it to the IOTC Secretariat. The SC **REQUESTED** Indonesia to make the necessary arrangements for this information to be reported in the future.

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

  Maldives, Republic of: The SC **CONGRATULATED** the Maldivian pole and line fishing industry on achieving Marine Stewardship Council (MSC) certification of their pole and line fleet, thereby becoming the first Indian Ocean fishery for tuna or tuna-like species to receive certification according to the MSC standards. The Maldives indicated that it would be willing to share its experiences with other IOTC CPCs and thanked all stakeholders, the MSC, the Conformity Assessment

Body, and NGOs. The Maldives efforts and leadership role in driving sustainable management of tuna fisheries in the Indian Ocean, and their commitment to improve the management of the Indian Ocean skipjack fishery through their strong participation in the IOTC was acknowledged. Certification of this fishery constitutes an example of the benefits of improved governance focused on sustainability.

- **Mauritius**: The SC **NOTED** that the artisanal fleet catches of Mauritius taken around FADs, occurred while targeting albacore.
- **Mozambique**: Nil comments.
- **Oman, Sultanate of**: National report not presented orally as Oman was absent from the SC15 meeting.
- **Pakistan**: The SC **EXPRESSED** its disappointment that Pakistan did not provide a National Report and urged Pakistan to fulfil its reporting obligations to the IOTC.
- **Philippines**: National report not presented orally as the Philippines was absent from the SC15 meeting.
- **Seychelles, Republic of**: Nil comments.
- **Sierra Leone**: The SC **EXPRESSED** its disappointment that Sierra Leone did not provide a National Report and urged Sierra Leone to fulfil its reporting obligations to the IOTC.
- **Sri Lanka**: The SC **NOTED** that logbooks are only being used by a very small proportion of Sri Lankan vessels fishing on the high seas. As a result, 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. However, improvements have been made by Sri Lanka to its data collection, monitoring and reporting systems, and Sri Lanka indicated that as the logbook program expands, the improved data will be provided to the IOTC Secretariat.
- **Sudan**: The SC **NOTED** the importance of using correct terminology when discussing IOTC species, in particular when describing catch of tuna and mackerel species under the IOTC mandate.
- **Tanzania, United Republic of**: The SC **EXPRESSED** its disappointment that Tanzania did not provide a National Report and urged Tanzania to fulfil its reporting obligations to the IOTC.
- **Thailand**: Nil comments.
- **United Kingdom (OT)**: The SC **NOTED** the excellent quality of the size frequency data collected by the recreational fishing of the UK(OT) and encouraged other IOTC CPCs to collect similar data from their sport fishery.

i. The SC **NOTED** the following statement made by the Republic of Mauritius:

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

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

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

ii. The SC **NOTED** the following statement made by the United Kingdom: "The UK has no doubt about its sovereignty over the British Indian Ocean Territory which was ceded to Britain in 1814 and has been a British dependency ever since. As the UK Government has reiterated on many occasions, we have undertaken to cede the Territory to Mauritius when it is no longer needed for defence purposes."

- **Vanuatu**: The SC **EXPRESSED** its disappointment that Vanuatu did not provide a National Report and urged Vanuatu to fulfil its reporting obligations to the IOTC.
- **Yemen**: The SC **WELCOMED** the Yemen to the IOTC as its newest Member, however the SC **EXPRESSED** its disappointment that Yemen did not provide a National Report and urged Yemen to fulfil its reporting obligations to the IOTC.
- **Senegal**: National report not presented orally as Senegal was absent from the SC15 meeting.
- **South Africa, Republic of**: National report not presented orally as South Africa was absent from the SC15 meeting.

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

Recommendation/s

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

30. The SC **REMINDED** CPCs that the purpose of the National Reports is to provide relevant information to the SC on fishing activities of Members and Cooperating Non-Contracting Parties operating in the IOTC area of competence. The report should include all fishing activities for species under the IOTC mandate as well as sharks and other byproduct / bycatch species as required by the IOTC Agreement and decisions by the Commission. The submission of a National Report is mandatory, irrespective if a CPC intends on attending the annual meeting of the Scientific Committee and shall be submitted no later than 15 days prior to the SC meeting.

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

Table 2. CPC submission of National Reports to the Scientific Committee from 2005 to 2012.

CPC	2005	2006	2007	2008	2009	2010	2011	2012
Australia								
Belize	n.a.	n.a.						
China								
Comoros								
Eritrea								
European Union								
France (territories)								
Guinea								
India								
Indonesia	n.a.	n.a.						
Iran, Islamic Republic of								
Japan								
Kenya								
Korea, Republic of								
Madagascar								
Malaysia								
Maldives, Republic of	n.a.	n.a.	n.a.	n.a.				
Mauritius								
Mozambique	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.		

Oman, Sultanate of								
Pakistan								
Philippines								
Seychelles, Republic of								
Sierra Leone	n.a.	n.a.	n.a.					
Sri Lanka								
Sudan								
Tanzania, United Republic of	n.a.	n.a.						
Thailand								
United Kingdom (OT)								
Vanuatu								
Yemen	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Senegal*								
South Africa, Republic of*								

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

Discussions on improving/modifying the National Reporting Template

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

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

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

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

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

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

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

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

7. REPORTS OF THE 2012 IOTC WORKING PARTY MEETINGS

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

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

Data available at the Secretariat for temperate tuna species

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

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

which have accounted for around 40% or more of the total catches of albacore in the Indian Ocean in recent years.

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

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

Indonesian longline fishery for albacore

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

Chinese longline fishery for albacore

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

Sampling coverage

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

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

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

Stock assessments

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

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

Parameters for future analyses: CPUE standardisation and stock assessments

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

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

Stock structure of albacore

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

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

54. The SC **REQUESTED** that the WPTmT assess the feasibility of implementing a tagging Project in the future and present results to the next meeting of the SC.

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

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

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

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

the presentation of a standardised CPUE series for swordfish targeted by UE,Portugal longline fleet was appreciated.

58. The SC **NOTED** that SWIOFP is currently undertaking a research project on swordfish using pop-up archival tags that may shed additional light on the degree of connectivity between swordfish in the southwest and the broader Indian Ocean.

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

Data available at the Secretariat for billfish species

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

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

Length-age keys

62. 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

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

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

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

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

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

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

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

Data inconsistencies

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

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

Sports fisheries

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

Sri Lankan billfish landings

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

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

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

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

Madagascar's billfish landings

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

Maldives billfish landings

77. The SC **NOTED** the attendance of the Maldives at the WPB for the first time and that the aggregated data presented was a useful contribution to the work of the WPB. However,

disaggregated finer scale data would need to be provided to the IOTC Secretariat if the data is to be fully utilised by the WPB.

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

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

Mozambique billfish landings

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

Review of fleet dynamics

81. The SC **RECOMMENDED** that both Japan and Taiwan,China undertake a complete historical review of their longline data and to document the changes in fleet dynamics for presentation 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

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

Indian Ocean Swordfish Stock Structure project (IOSSS)

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

84. The SC **AGREED** that the swordfish resource in the southwest Indian Ocean should continue to be analysed separately from the Indian Ocean as a whole given localised depletion levels.

Swordfish: European Union longline fisheries CPUE indicies

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

Non-compliance matters

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

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

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

Data reporting requirements

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

Gillnet fisheries of the Indian Ocean

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

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

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

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

Sharks

Status of catch statistics and data reporting

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

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

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

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

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

98. **NOTING** that Resolution 10/02 *mandatory statistical requirements for IOTC members and Cooperating Non-Contracting Parties (CPC's)*, makes provision for data to be reported to the IOTC on "*the most commonly caught shark species and, where possible, to*

the less common shark species", without giving any list defining the most common and less common species, and recognising the general lack of shark data being recorded and reported to the IOTC Secretariat, the SC **RECOMMENDED** that Resolution 10/02 is revised in order to include the list of most commonly caught elasmobranch species (Table 3) for which nominal catch data shall be reported as part of the statistical requirement for IOTC CPCs.

TABLE 3. List of the most commonly caught elasmobranch species

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

Mitigation measures

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

Shark mortality in relation with the use of drifting FADs

100. The SC **NOTED** the presentation of the information paper IOTC–2012–SC15–INF05 on ghost fishing of silky sharks by drifting FADs. This analysis shows that the magnitude of mortality due to entanglement of sharks in the nets hanging under the FADs is larger than the mortality of sharks hauled onboard.

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

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

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

Only non-entangling FADs, both drifting and anchored, should be designed and deployed, based on the following three basic principles:

1. The surface structure of the FAD should not be covered, or only covered with non-meshed material.

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

Ecological risk assessment

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

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

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

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

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

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

8	Longfin mako (*Isurus paucus*)	LMA
9	Dusky shark (*Carcharhinus obscurus*)	DUS
10	Tiger shark (*Galeocerdo cuvier*)	GAC

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

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

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

107. The SC **ACKNOWLEDGED** that catch data for all shark species (or group of species) listed in Resolution 12/03 for longline gear and the two additional shark species mentioned in paragraph 106, should be collected and submitted to the IOTC Secretariat by the most appropriate means. The SC **NOTED** that some CPCs considered that logbooks, supplemented by observer data (field samplers data for artisanal fishing vessels), as the most appropriate way of capturing the information, whereas other CPCs considered that such data collection would preferably be conducted under the IOTC Regional Observer Scheme because of some practical difficulties, and a possible negative effect on data quality by requiring the additional data to be collected through logbooks and frequent changes to the logbook format.

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

109. The SC **RECOMMENDED** that, in line with Recommendation 12/15 on the best available science, the list of shark species (or groups of species) for longline gear under Resolution 12/03 should be supplemented by two other shark species which were estimated to be at risk in longline fisheries by the ERA conducted in 2012, the silky shark and the oceanic whitetip shark. The SC **ADVISED** the Commission to define the most appropriate means of collecting this additional information, considering the limitations of both options (logbooks and/or regional observer scheme) presented in paragraphs 107 and 108.

Fin to body weight ratio

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

111. The SC **NOTED** that it is now mandatory for all EU fleets to land all sharks caught during fishing operations with fins naturally attached.

Wire leaders/traces

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

Marine turtles

Data and reporting requirements

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

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

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

114. 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.

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

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

Ecological Risk Assessment Marine Turtles

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

118. The SC **NOTED** that the analyses were based on data provided by Australia, EU,France, France(OT), EU,Portugal and South Africa, supplemented by bibliographic sources. The most threatened species by longline and gillnet are the hawksbill turtle, loggerhead turtle

and leatherback turtle, to varying degrees across the sub-populations. The study identified several sources of uncertainties in the data (e.g. species identification, post release survival, gillnet fishing effort and interactions with marine turtles, size data lacking).

119. The SC **RECOGNISED** the quality of the work undertaken and the highly valuable information provided by this ERA, but **AGREED** that the mortality rate of marine turtles in gillnet fisheries is likely to be underestimated as it is based on comparative data from a well-managed coastal gillnet fishery in the Atlantic, as no data was available for the Indian Ocean gillnet fisheries.

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

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

Requests contained in IOTC Conservation and Management Measures

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

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

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

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

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

Purse seine: see c) below

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

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

through IOTC Resolutions, to ensure that the IOTC has the means to collect quantitative and qualitative data on marine turtle bycatch.

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

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

1. Refer to paragraph 102 above.

Collaboration with IOSEA

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

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

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

Capacity building

125. 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.

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

一、Implicit and explicit objectives

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

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

Work on MSE development

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

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

131. The SC **NOTED** that HCRs are the tools used to operationalise management objectives through the use of reference points in an attempt to best meet the Commission's overall objectives. Therefore, clearly stated management objectives from the Commission will be critical because they will guide the refinement of the interim reference points and define the success of a future harvest strategy for IOTC stocks.

132. The SC **NOTED** with concern that the interim LRP contained in IOTC Recommendation 12/14 may not be precautionary (see IOTC Resolution 12/01), or consistent with the FAO Code of Conduct for Responsible Fisheries. The fishing mortality rate which generates MSY should be regarded as a minimum standard for LRP. Thus, the SC **AGREED** that through the MSE process, the robustness of TRPs and LRPs must be analysed further.

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

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

Date and place of the Fifth Session of the WPM

135. The SC **NOTED** that while the MSE process was still in its early stages of development, there was no pressing need to hold a WPM meeting in 2013, as the work to be undertaken was of a highly technical nature and would require the involvement of a very limited number of experts in the field of development and implementation of population and fishery models for MSE. Thus, as suggested in the MSE workplan, one or two workshops composed of experts actively involved in the development work should be held in 2013 to continue the development of the MSE process. The WPM chair will organize these workshops and venues and dates agreed by all participants, with the assistance of the IOTC Secretariat. A document will then be presented to the next session of SC on the progress of the MSE process.

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

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

Data availability

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

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

139. **NOTING** that there were discrepancies in catch, effort and size data in the Japanese and Taiwan,China tropical tuna data sets, the SC **RECOMMENDED** they review the data to assess reasons for discrepancies identified by the IOTC Secretariat and to report results at the next meeting of the WPTT, including a comparison of length frequency data samples collected from commercial, research and training vessels.

Bigeye tuna

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

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

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

Skipjack tuna

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

144. **NOTING** there are data irregularities and with the ongoing expansion of the logbook work to improve the CPUE analyses for skipjack in the Indian Ocean the SC **RECOMMENDED** further investigation prior to the next meeting of the WPTT.

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

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

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

148. **NOTING** the use and application of interim target and limit reference points, the SC **RECOMMENDED** that Kobe –II strategy matrix should include the risk levels associated with those reference points. Furthermore, SC **AGREED** that the probability of exceeding the limit reference points for $1.5*F_{MSY}$ and to go below $0.4*SB_{MSY}$ is extremely low and this information should be added to the executive summary.

149. The SC **AGREED** that the advice on the status of skipjack tuna in 2012 be derived from models using an integrated statistical assessment method from 2011 and 2012. Model formulations were explored by the WPTT to ensure that various plausible sources of uncertainty were explored and represented in the final stock status advice.

150. The SC **NOTED** a series of issues identified with the stock assessment carried out in 2012, as detailed in the Executive Summary for skipjack tuna (Appendix XI). Briefly, these include, but are not limited to the following, noting that the reader is referred to the skipjack tuna Executive Summary for a detailed description:

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

Yellowfin tuna

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

151. The SC **NOTED** that changes in gear configuration during the early 1990's appears to have had the effect of increasing the ratio of yellowfin tuna in the Japanese longline catch when compared to bigeye tuna. Other factors associated with targeting shifts could be explored in more detail (e.g. NHFCL might not always be the best indicator of hook depth or targeting). Understanding the interactions among NHFCL, fine-scale oceanographic condition, and gear shape under the water might bring further improvement of the CPUE standardisation. Further examination of those issues in the future.

Stock Assessment

152. The SC **NOTED** that a range of quantitative modelling methods were applied to the yellowfin tuna assessment in 2012, ranging from the non-spatial, age-structured

production model (ASPM) to the age and spatially-structured MULTIFAN-CL and SS3 analysis.

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

154. The SC **NOTED** a series of issues identified with the MFCL stock assessment carried out in 2012, as detailed in the Executive Summary for yellowfin tuna (Appendix XII). Briefly, these include, but are not limited to the following, noting that the reader is referred to the yellowfin tuna Executive Summary for a detailed description:
    - A strong temporal decline in recruitment and in biomass within the eastern equatorial region (Region 5).
    - The model estimates limited movement between the two equatorial regions.
    - Similarly, movement rates between the western equatorial region and the Arabian Sea (Region 1) were estimated to be very low.
    - The model estimated that fishing mortality rates within the western equatorial region did not increase during 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).

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

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

157. The SC **AGREED** that the review on stock status of yellowfin tuna in 2013 should firstly examine the report of the above-mentioned comparative analysis if available, noting that the2013 IOTC budget will not be approved until May 2013. It should also include a discussion on major structural changes which could be proposed for the full assessment which will be undertaken in the coming years, for instance covering a number of topics such as: revision of spatial stratification (towards smaller areas), input the latest findings in growth patterns and the differential growth between males and females, age-specific natural mortality, input more age classes (12 instead of 7) and spatial dynamics exhibited by tag-recovery data.

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

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

Stock assessment consultant

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

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

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

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

161. The SC **RECOMMENDED** the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPTT in 2013, by an Invited Expert:

- CPUE analysis and standardisation
- Tuna tagging data analysis
- Tuna stock assessment models

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

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

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

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

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

IOTC database for neritic tunas

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

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

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

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

Data set availability

169. **NOTING** that some CPCs, in particular from India, Indonesia and Thailand, have collected large data sets on neritic tuna species over long time periods, the SC **RECOMMENDED** that this data, as well as data for other CPCs, be submitted to the IOTC Secretariat as per the requirements adopted by IOTC Members in Resolution 10/02. This would allow the WPNT to develop stock status indicators or comprehensive stock assessments of neritic tuna species in the future.

Requests for guidance from CPCs

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

Stock structure

171. The SC **NOTED** 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 need for genetic and tagging studies on neritic tunas in order to further define the stock structure of neritic tunas was identified.

Priorities for an Invited Expert at the next WPNT meeting

172. The SC **RECOMMENDED** the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPNT in 2013, by an Invited Expert:

- Expertise: stock structure/connectivity; including from regions other than the Indian Ocean; data poor assessment approaches.
- Priority areas for contribution: kawakawa, longtail tuna and narrow-barred Spanish mackerel biology, ecology and fisheries.

7.7 Summary discussion of matters common to Working Parties

Capacity building activities

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

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

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

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

Funding for Chairs and Vice-Chairs to attend IOTC meetings

176. The SC **RECOMMENDED** that the IOTC Secretariat include a proposed budget line in the IOTC budget for 2013 and all future years, that would cover the travel expenses of Chairs and Vice-Chairs who are otherwise unable to obtain funding to support their attendance at their respective working party meeting, and for a Chair or Vice-Chair to attend the SC meeting each year.

IOTC species identification cards

Billfish identification cards

177. **NOTING** that the IOTC Secretariat has developed identification cards for billfish species at the request of the WPB and SC, but no funds have yet been allocated to print the cards, the SC **RECOMMENDED** that the Commission allocate funds in the 2013 budget to print sets of identification cards for the billfish species, noting that the total estimated printing costs for the first 1000 sets of the identification cards is around a maximum of US$6,700 (Table 7). The IOTC Secretariat shall seek funds from potential donors to print additional sets of the identification cards at US$5,500 per 1000 sets of cards.

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

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

Shark, marine turtle and seabird identification cards

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

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

Tunas and mackerels

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

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

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

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

Fishing hook identification cards

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

Identification card – general

183. The SC **RECOMMENDED** that IOTC CPCs translate, print and disseminate the identification cards to their observers and field samplers (Resolution 11/04), and as

feasible, to their fishing fleets targeting tuna, tuna-like and shark species. This would allow accurate observer, sampling and logbook data on tuna and tuna-like species to be recorded and reported to the IOTC Secretariat as per IOTC requirements.

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

CPUE discussion summary

185. The SC **EXPRESSED** concern that the majority of the recommendations issued by the SC to the various working parties in previous years in regards to CPUE standardisation have not been addressed and **RECOMMENDED** that the scientists in charge of this work make every possible effort to address the recommendations in future CPUE standardisation work.

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

Dedicated workshop on CPUE standardisation

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

Risk-based approaches to determining stock status

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

Working Party Reports

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

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

Incorporation of the Risk levels associated with Reference Points

191. **NOTING** that Resolution 12/01 *on the implementation of the precautionary approach* was adopted by the Commission in 2012, and that provisional reference points have been

adopted in Recommendation 12/14 *on interim target and limit reference points*, the SC **AGREED** that future Kobe II strategy matrices should show the levels of risk of breaching the reference points and that the Executive Summaries for tropical tuna species incorporate explanatory text in this regard.

On Interim Target and Limit Reference Points

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

Employment of a Fisheries Officer (Science)

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

194. Noting the rapidly increasing workload at the IOTC Secretariat, including a wide range of additional duties assigned to it by the SC and the Commission, the SC **REITERATED** its **recommendation** that the Commission increase the staff of the IOTC Secretariat to incorporate a new Fisheries Officer post to work on a range of matters in support of the scientific process.

Chairs and Vice-Chairs of the Working Parties

195. 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

196. 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).

197. 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).

198. The SC **NOTED** that although no specific analysis of the impacts of piracy on fisheries in the Indian Ocean were presented at IOTC working party meetings in 2012, many papers demonstrated some level of impact on fishing operations in the western Indian Ocean (Somali Basin) and other areas as a result of relocated fishing effort. Specifically, that there has been a substantial displacement of effort into traditional albacore fishing areas, thereby increasing fishing pressure on this species. In recent years, the proportion of fishing effort of the Japanese longline fleet sharply decreased in the north-western Indian

Ocean (off the Somalia coastline), while fishing effort increased in the area south of 25°S, especially off western Australia, where catch rates of albacore are higher (Fig. 1). Similarly, as a direct result of piracy activities in the western Indian Ocean, many of the vessels from the I.R. Iran targeting tropical tuna species on the high seas have moved back to the EEZ of I.R. Iran and are now targeting neritic tuna and tuna-like species. This has resulted in substantial increases in the total catch and effort of neritic tuna and tuna-like species under the IOTC mandate.

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

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

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

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

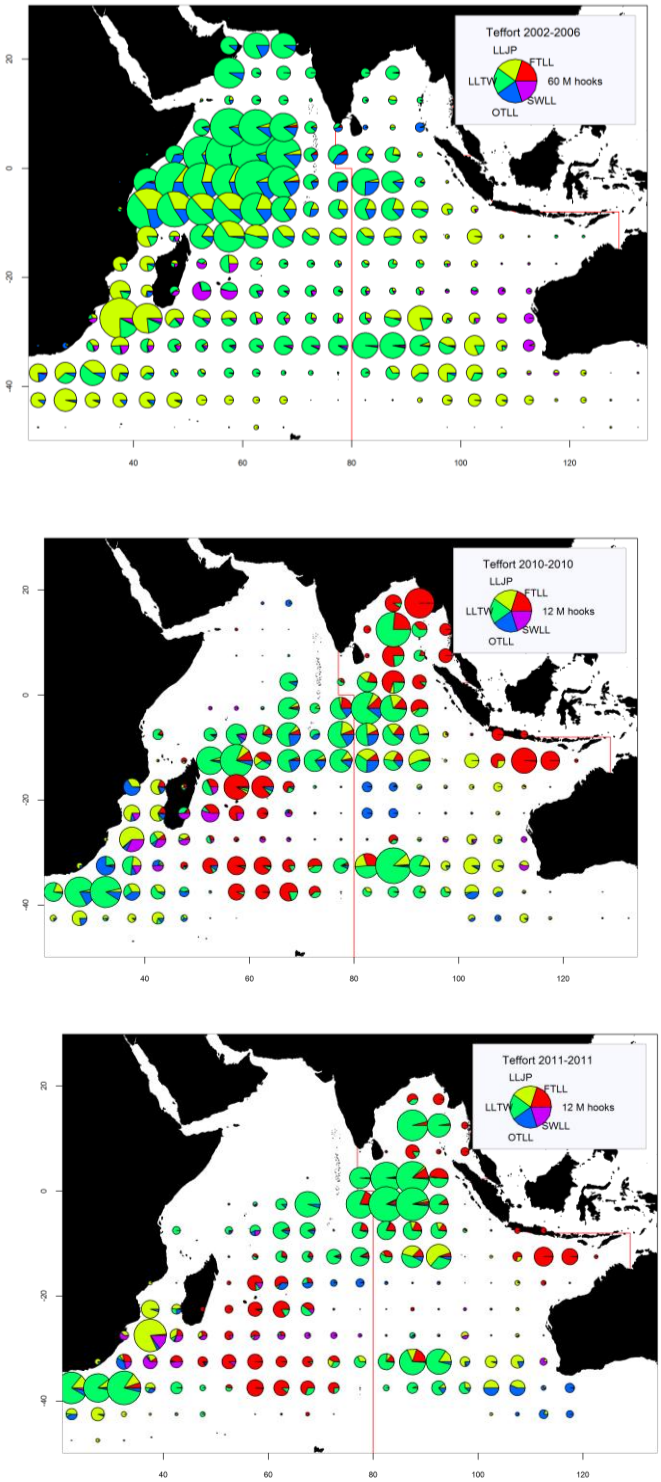

Fig. 1. The geographical distribution of fishing effort (millions of hooks) as reported for the longline fleets of Japan (LLJP), Taiwan,China (LLTW), fresh-tuna longline (FTLL), other longline (OTLL), and longline directed at swordfish (SWLL), in the IOTC area of competence, 2002–06, and 2010–11. The red line represents the boundary between western and eastern Indian Ocean regions. LLJP

(light green): deep-freezing longliners from Japan; LLTW (dark green): deep-freezing longliners from Taiwan,China; SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets); FTLL (red): fresh-tuna longliners (China, Taiwan,China

and other fleets; OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, South Korea and various other fleets).

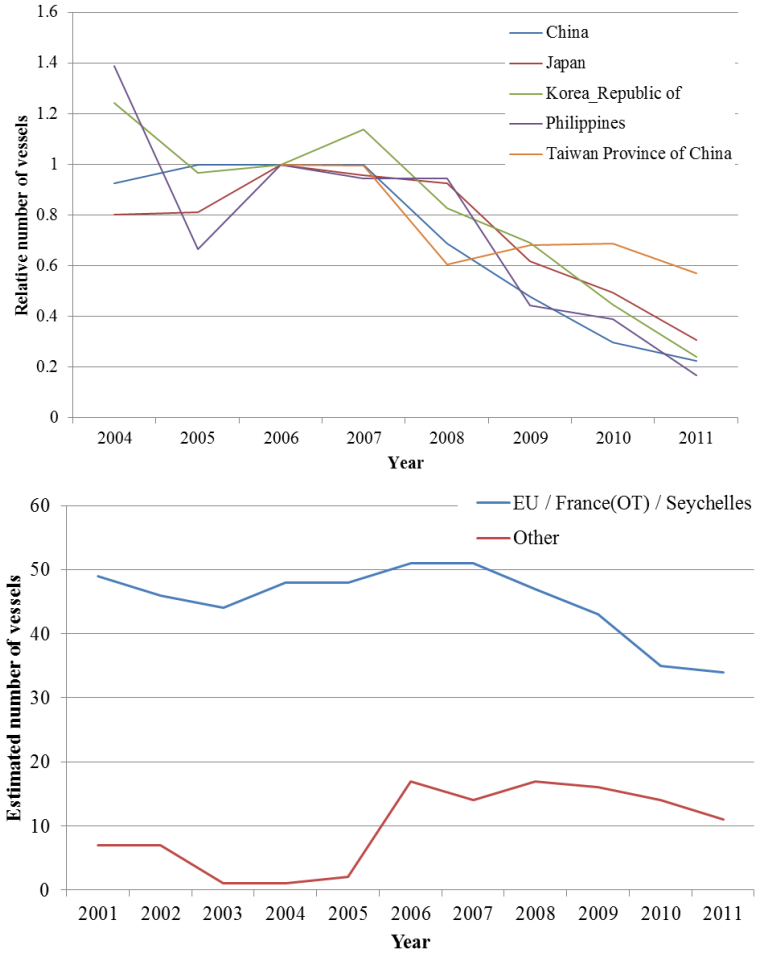

Fig. 2. The change in the relative number of some active longline fleets since 2004 (upper – numbers have been scaled to the number of active vessels in 2006) and estimated numbers of active purse seine vessels from 2001 to 2011 (lower) in the Indian Ocean.

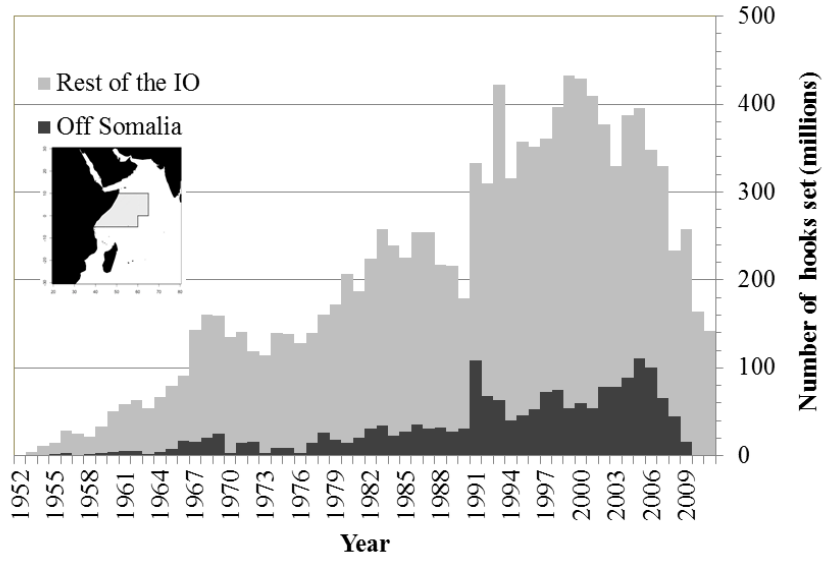

Fig. 3. The total number of hooks set (in millions), by year and geographical area: off the Somalia coastline (area shown in the insert) and for the rest of the Indian Ocean (IO), from 1952 to 2011.

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

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

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

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

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

9.1 Tuna – Highly migratory species

206. 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

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

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

9.2 Billfish

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

9.3 Tuna and mackerel – Neritic species

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

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

10.1 Sharks

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

10.2 Marine turtles

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

10.3 Seabirds

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

11. IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME

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

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

216. 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.

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

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

218. 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.

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

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

12. OUTLOOK ON TIME-AREA CLOSURES

221. 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

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

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

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

225. **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 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.

226. Noting the lack of research examining time-area closures in the Indian Ocean by the WPTT in 2011 and 2012, as well as the slow progress made in addressing the Commission request, the SC reiterated its **RECOMMENDATION** that the SC Chair begins a consultative process with the Commission in order to obtain clear guidance from the

Commission about the management objectives intended with the current or any alternative closure. This will allow the SC to address the Commission request more thoroughly.

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

227. 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*

228. The SC **NOTED** that the most direct measure of impact of fishing fleets on juveniles could be obtained by looking at the catches of juvenile yellowfin tuna and bigeye tuna by gear, as presented in Table 9 below. It should be noted that the estimates of catches of juvenile fish are doubtful for some gears, for which catch-at-length information is severely limited or almost non-existent. The SC reiterated its **AGREEMENT** from 2011, that the WPTT should provide the SC with multi-gear yield-per-recruit estimates for all stocks assessed in 2013, as this is another useful indicator of the impact of each gear on potential yields.

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

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

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

229. 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.

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

231. 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 Management Strategy Evaluation 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.

232. The SC **ADVISED** the Commission that the Western and Central Pacific Fisheries Commission has implemented since 2009 a FAD closure for the conservation of yellowfin

tuna and bigeye tuna juveniles which has been very effective. The SC **REQUESTED** further investigation of the feasibility and impacts of such a measure, as well as other measures, in the context of Indian Ocean fisheries and stocks.

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

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

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

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

Research Recommendations and Priorities

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

236. 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.

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

Schedule of meetings for 2013 and 2014

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

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

240. **NOTING** the difficulty of carrying out stock assessments for three tropical tuna species in a single year, the SC **AGREED** to a revised assessment schedule on a two- or three-year cycle for the three tropical tuna species as outlined in Appendix XXXVI. Following the

uncertainty remaining in the bigeye tuna assessment carried out for the previous WPTT meetings in 2010 and 2011, bigeye tuna would be the priority species for stock assessments in 2013, while only stock status indictors (i.e. standardised CPUE series) should be updated for skipjack tuna and yellowfin tuna, including the revision of the executive summaries to incorporate any new work being completed during the WPTT sessions.

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

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

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

Meeting	**2013**		**2014 (tentative)**	
	Date	**Location**	**Date**	**Location**
Working Party on **Neritic Tunas**	17–20 June or 1–4 July (4d)	Bali, Indonesia or Tanzania	13–16 July (4d)	Bali, Indonesia or Tanzania
Working Party on **Temperate Tunas**	Nil	Nil	5–8 Aug (4d)	TBD
Working Party on **Ecosystems and Bycatch**	12–16 Sept (5d)	La Réunion	9–13 Sept (5d)	TBD
Working Party on **Billfish**	18–22 Sept (5d)	La Réunion	17–21 Sept (5d)	TBD
Working Party on **Tropical Tunas**	22–27 Oct (6d)	Bilbao or San Sebastián, Spain	21–26 Oct (6d)	TBD
Working Party on **Methods**	Nil	Nil	30 Nov (1d)	Victoria, Seychelles
Working Party on **Data Collection and Statistics**	29–30 Nov (2d)	Victoria, Seychelles	Nil	Nil
Scientific Committee	2–6 Dec (5d)	Victoria, Seychelles	1–5 Dec (5d)	Victoria, Seychelles
Working Party on **Fishing Capacity**	Nil	Nil	Nil	Nil

16. OTHER BUSINESS

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

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

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

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

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

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

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

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

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

248. The SC **NOTED** paper IOTC–2012–SC15–INF06 which provided an overview of the GEF-financed global project on the sustainable management of tuna fisheries and biodiversity conservation in the areas beyond national jurisdiction (ABNJ) and the projects relevance to the IOTC.

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

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

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

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

Date: 10–15 December, 2012
Location: STC Conference Center, Victoria
Mahé, Seychelles
Time: 09:00 – 17:00 daily
Chair: Dr. Tsutomu Nishida; **Vice-Chair:** Mr. Jan Robinson

1. OPENING OF THE SESSION (Chair)

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION (Chair)

3. ADMISSION OF OBSERVERS (Chair)

4. DECISIONS OF THE COMMISSION RELATED TO THE WORK OF THE SCIENTIFIC COMMITTEE (Secretariat)

5. SCIENCE RELATED ACTIVITES OF THE IOTC SECRETARIAT IN 2012 (Secretariat)

6. NATIONAL REPORTS FROM CPCs (CPCs)

7. REPORTS OF THE 2012 IOTC WORKING PARTY MEETINGS

7.1 IOTC–2012–WPTmT04–R: Report of the Fourth Session of the Working Party on Temperate Tunas
7.2 IOTC–2012–WPB10–R: Report of the Tenth Session of the Working Party on Billfish
7.3 IOTC–2012–WPEB08–R: Report of the Eighth Session of the Working Party on Ecosystems and Bycatch
7.4 IOTC–2012–WPM04–R: Report of the Fourth Session of the Working Party on Methods
7.5 IOTC–2012–WPTT14–R: Report of the Fourteenth Session of the Working Party on Tropical Tunas
7.6 IOTC–2012–WPNT02–R: Report of the Second Session of the Working Party on Neritic Tunas
7.7 Summary discussion of matters common to Working Parties (capacity building activities – stock assessment course; connecting science and management, etc.)

8. EXAMINATION OF THE EFFECTS OF PIRACY ON FLEET OPERATIONS AND SUBSEQUENT CATCH AND EFFORT TRENDS (Chair)

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

9.1 Tuna – Highly migratory species
9.2 Tuna and mackerel – Neritic species
9.3 Billfish

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

10.1 Marine turtles
10.2 Seabirds
10.3 Sharks

11. IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME (Secretariat)

12. OUTLOOK ON TIME-AREA CLOSURES (Chair)

13. IMPACT OF CATCHING BIGEYE TUNA AND YELLOWFIN TUNA JUVENILES AND SPAWNERS (Chair)

14. PROGRESS ON THE IMPLEMENTATION OF THE RECOMMENDATIONS OF THE PERFORMANCE REVIEW PANEL (Secretariat)

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

16. OTHER BUSINESS (Chair)

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

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

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

APPENDIX III
LIST OF DOCUMENTS

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

Document	Title	Availability
IOTC–2012–SC15–25	Status of seabirds in the Indian Ocean	✓ (12 November 2012)
IOTC–2012–SC15–26	Status of the Indian Ocean blue shark (BSH: *Prionace glauca*)	✓ (9 November 2012)
IOTC–2012–SC15–27	Status of the Indian Ocean oceanic whitetip shark (OCS: *Carcharhinus longimanus*)	✓ (9 November 2012)
IOTC–2012–SC15–28	Status of the Indian Ocean scalloped hammerhead shark (SPL: *Sphyrna lewini*)	✓ (12 November 2012)
IOTC–2012–SC15–29	Status of the Indian Ocean shortfin mako shark (SMA: *Isurus oxyrinchus*)	✓ (12 November 2012)
IOTC–2012–SC15–30	Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*)	✓ (12 November 2012)
IOTC–2012–SC15–31	Status of the Indian Ocean bigeye thresher shark (BTH: *Alopias superciliosus*)	✓ (12 November 2012)
IOTC–2012–SC15–32	Status of the Indian Ocean pelagic thresher shark (PTH: *Alopias pelagicus*)	✓ (12 November 2012)
IOTC–2012–SC15–33 Rev_2	National Implementation of the regional observer scheme by CPCs (Secretariat)	✓ (14 November 2012) ✓ (29 November 2012) ✓ (6 December 2012)
IOTC–2012–SC15–34	Update on progress regarding Resolution 09/01 – on the performance review follow–up (Secretariat and Chair)	✓ (25 November 2012)
IOTC–2012–SC15–35 Rev_1	Proposed priorities for Working Party's and the Scientific Committee for 2013 and 2014 (Chair & Secretariat)	✓ (25 November 2012) ✓ (6 December 2012)
IOTC–2012–SC15–36	Proposed schedule of Working Party and Scientific Committee meetings for 2013 and 2014 (Secretariat)	✓ (13 November 2012)
IOTC–2012–SC15–37	Revision: 'Guidelines for the Presentation of Stock Assessment Models' (Chair & Secretariat)	✓ (25 November 2012)
IOTC–2012–SC15–38	Pilot project to improve data collection for tuna, sharks and billfish from artisanal fisheries in the Indian Ocean. Part II: Revision of catch statistics for India, Indonesia and Sri Lanka (1950-2011). Assignment of species and gears to the total catch and issues on data quality (G. Moreno, M. Herrera and L. Pierre)	✓ (25 November 2012)
Working Party Reports		
IOTC–2012–WPTmT04–R	Report of the Fourth Session of the Working Party on Temperate Tunas	✓ (7 September 2012)
IOTC–2012–WPB10–R	Report of the Tenth Session of the Working Party on Billfish	✓ (10 October 2012)
IOTC–2012–WPEB08–R	Report of the Eighth Session of the Working Party on Ecosystems and Bycatch	✓ (8 October 2012)
IOTC–2012–WPM04–R	Report of the Fourth Session of the Working Party on Methods	✓ (23 October 2012)
IOTC–2012–WPTT14–R	Report of the Fourteenth Session of the Working Party on Tropical Tunas	✓ (14 November 2012)
IOTC–2012–WPNT02–R	Report of the Second Session of the Working Party on Neritic Tunas	✓ (23 November 2012)
National Reports – Members		
IOTC–2012–SC15–NR01	Australia	✓ (21 November 2012)
IOTC–2012–SC15–NR02	Belize	✓ (30 July 2012)
IOTC–2012–SC15–NR03 Rev_1	China	✓ (19 November 2012) ✓ (12 December 2012)
IOTC–2012–SC15–NR04	Comoros	✓ (29 November 2012)
IOTC–2012–SC15–NR05	Eritrea	NOT RECEIVED
IOTC–2012–SC15–NR06	European Union	✓ (4 December 2012)
IOTC–2012–SC15–NR07	France	✓ (7 December 2012)

Document	Title	Availability
IOTC–2012–SC15–NR08	Guinea	NOT RECEIVED
IOTC–2012–SC15–NR09	India	✓ (12 November 2012)
IOTC–2012–SC15–NR10 Rev_1	Indonesia	✓ (2 December 2012) ✓ (9 December 2012)
IOTC–2012–SC15–NR11	Iran, Islamic Republic of	✓ (28 November 2012)
IOTC–2012–SC15–NR12	Japan	✓ (6 December 2012)
IOTC–2012–SC15–NR13	Kenya	✓ (25 November 2012)
IOTC–2012–SC15–NR14 Rev_1	Korea, Republic of	✓ (25 November 2012) ✓ (9 December 2012)
IOTC–2012–SC15–NR15	Madagascar	✓ (5 December 2012)
IOTC–2012–SC15–NR16	Malaysia	✓ (1 December 2012)
IOTC–2012–SC15–NR17	Maldives, Republic of	✓ (27 November 2012)
IOTC–2012–SC15–NR18 Rev_1	Mauritius	✓ (29 November 2012) ✓ (7 December 2012)
IOTC–2012–SC15–NR19	Mozambique	✓ (25 November 2012)
IOTC–2012–SC15–NR20	Oman, Sultanate of	✓ (5 December 2012)
IOTC–2012–SC15–NR21	Pakistan	NOT RECEIVED
IOTC–2012–SC15–NR22	Philippines	✓ (10 December 2012)
IOTC–2012–SC15–NR23	Seychelles, Republic of	✓ (4 December 2012)
IOTC–2012–SC15–NR24	Sierra Leone	NOT RECIEVED
IOTC–2012–SC15–NR25	Sri Lanka	✓ (23 November 2012)
IOTC–2012–SC15–NR26 Rev_1	Sudan	✓ (18 October 2012) ✓ (5 December 2012)
IOTC–2012–SC15–NR27	Tanzania	NOT RECEIVED
IOTC–2012–SC15–NR28 Rev_2	Thailand	✓ (22 November 2012) ✓ (6 December 2012) ✓ (12 December 2012)
IOTC–2012–SC15–NR29	United Kingdom	✓ (23 November 2012)
IOTC–2012–SC15–NR30	Vanuatu	NOT RECEIVED
IOTC–2012–SC15–NR31	Yemen	NOT RECEIVED
National Reports – Cooperating non-Contracting Parties		
IOTC–2012–SC15–NR32	Senegal	✓ (7 December 2012)
IOTC–2012–SC15–NR33	South Africa, Republic of	✓ (28 November 2012)
Information Papers		
IOTC–2012–SC15–INF01	IOTC-OFCF Project activities in 2012: Progress Report (S. Fujiwara and M. Herrera)	✓ (8 November 2012)
IOTC–2012–SC15–INF02	Analysis of the genetic structure and life history of albacore tuna in terms of diversity, abundance and migratory range at the spatial and time scales: Project GERMON (GEnetic stRucture and Migration Of albacore tuNa) (N. Nikolic and J. Bourjea)	✓ (24 November 2012)
IOTC–2012–SC15–INF03	Glossary of scientific terms, acronyms and abbreviations, and report terminology	✓ (25 November 2012)
IOTC–2012–SC15–INF04	IOTC Species data catalogues (IOTC Secretariat)	✓ (30 November 2012)
IOTC–2012–SC15–INF05	Ghost fishing of silky sharks by drifting FADs: highlighting the extent of the problem (J. Filmalter, L. Dagorn and M. Capelo)	✓ (4 December 2012)
IOTC–2012–SC15–INF06	GEF-financed global project on the “Sustainable Management of Tuna Fisheries & Biodiversity Conservation in the Areas Beyond National Jurisdiction (ABNJ): update & relevance to IOTC	✓ (4 December 2012)

Document	Title	Availability
IOTC–2012–SC15–INF07	Action Plan for reducing incidental catches of seabirds in fishing gears (European Union)	✓ (5 December 2012)
IOTC–2012–SC15–INF08	Draft: Building science capacity and understanding among IOTC members	✓ (5 December 2012)
IOTC–2012–SC15–INF09 Rev_1	Ecological Risk Assessment (ERA) and Productivity Susceptibility Analysis (PSA) of sea turtles overlapping with fisheries in the IOTC region (N. Ronel, R. Wanless, A. Angel, B. Mellet and L. Harris)	✓ (25 November 2012) ✓ (5 December 2012)
IOTC–2012–SC15–INF10 Rev_1	Preliminary Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC) (H. Murua, R. Cohelo, M.N. Santos, H. Arrizabalaga, K. Yokawa, E. Romanov, J.F. Zhu, Z.G. Kim, P. Bach, P. Chavance, A. Delgado de Molina and J. Ruiz)	✓ (5 December 2012) ✓ (10 December 2012)
IOTC–2012–SC15–INF11	Comments for IOTC Scientific Committee on CITES draft proposals to amend Appendixes I and II (WPEB)	✓ (12 December 2012)

APPENDIX IV
NATIONAL REPORT ABSTRACTS

Australia

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

Belize

Long line is the main fishing technique used by Belize flagged vessels to target tuna and tuna like species in the Indian Ocean Tuna Commission (IOTC) Convention area. Belize has no national fleet operating outside its jurisdiction. All our fishing vessels are foreign owned vessels licensed to operate on the high seas or in the EEZ of other States under licensing agreements. In 2011 our fleet consisted of 7 long line tuna fishing vessels which operated mainly between 10°- 40°S and 55° - 75°E. Together, our vessels caught 164 m/t of Albacore tuna, 13.9 m/t of yellowfin tuna, 9.634 m/t of bigeye

tuna, 2.536 m/t of swordfish, 5.175 m/t of black marlin, 1.04 m/t of blue marlin, 3.388 of striped marlin, 8.85 m/t of wahoo and 1.833 m/t of blue shark. There have been 83% reductions in our overall catches from 1257 m/t in 2007 to 210 m/t in 2011. Albacore has always been the main target species for our vessels from 2007 to 2011 followed by bigeye tuna, yellowfin and swordfish. The number of active long liners and levels of fishing effort have declined significantly in recent years due to reduced profitability, principally resulting from reduced fish prices and increased operating cost. The average size of our vessels from 2007 to 2011 has fluctuated over the years from a low of 88gt to a high of 628 gt. There has also been a reduction in the number of vessels operating in the area from 10 vessels in 2007, 9 in 2008, 6 in 2009 and 7 in 2010 and 2011.

China

Longline is the only fishing method used by Chinese vessels to catch tuna and tuna-like species in the IOTC waters. The number of longliners operating in the Indian Ocean reduced from 32 in 2009 to 20 in 2010 due to piracy, with the main fishing area shifting to the central and eastern Indian Ocean (60 ºE ~ 85ºE , 5ºN ~20ºS). Chinese fishing fleet caught 1894 MT of main tunas (BET, YFT) in 2010 (39 % lower than the catch of 3114 MT in 2009). The bigeye tuna and yellowfin tuna catches both from deep freezing longliners and ice fresh longliners have been declined dramatically since 2006. There was a remarkable increase in albacore catch for deep freezing longliner since 2009 and for ice fresh longliners since 2008. The logbook and observer programs are going on for the Chinese longline fleets in the Indian Ocean, for which catch and effort data collection of bycatch species are being improved. Number of longliners operating in Indian Ocean in 2011 was less than that in 2010. No scientific observer was sent out for work due to the piracy issue in 2011.

Comoros

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

Eritrea

National Report not provided.

European Union

In accordance with IOTC Resolution 10/02, scientific data for fleets flying the flag of Member States of the European Union have been submitted to the IOTC. The EU fleet, composed of fleets of some Member States of the European Union (Spain, France,

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

France (territories)

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

Guinea

National Report not provided.

India

India’s tuna fishing fleet includes coastal multipurpose boats operating a number of

traditional gears, small pole and line boats, small longliners and industrial longliners. The total production of tunas and tuna-like fishes, including neritic and oceanic tunas, billfishes and seerfishes during the year 2011 was 15,9924 tonnes, against a total production of 12,7616 tonnes during the year 2010. There was a reduction in production by the oceanic fishery and increase in the tuna landings by coastal sector during the year under report. Survey conducted by the Fishery Survey of India in the EEZ revealed that sharks constitute 19.49% by number and 28.39% by weight to the total catch in the longline fishery. There are no reported instances of sea bird interaction in any of the Indian tuna fishery. Sea turtles, marine mammals and whale sharks are protected in India under various national legislations. Data on tuna production is collected by different agencies in India including Fishery Survey of India (FSI), Central Marine Fisheries Research Institute (CMFRI) and Marine Products Export Development Authority (MPEDA). Policy decisions on fishery management are being formulated by the Department of Animal Husbandry, Dairying and Fisheries (DAHD&F), Ministry of Agriculture, Government of India.

Indonesia

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

Iran, Islamic Republic of

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

Japan

This Japanese national report describes following 8 issues in recent five years (2007-2011), i.e., (1) tuna fisheries (longline fishery and purse seine fishery) (2) fleet

information, (3) catch and effort by species and gear, (4) ecosystem and bycatch, (5) national data collection and processing systems including "logbook data collection and verification", "vessel monitoring system", "scientific observer programme", "port sampling programme" and "unloading/transhipment", (6) national research programs and (7) Implementation of Scientific Committee recommendations & resolutions of the IOTC relevant to the Scientific Committee and (8) literature cited and working documents.

Kenya

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

Korea, Republic of

Longline is the only type of fishing gear for Korean fishing for tuna species in the Indian Ocean. Korean longline fishery in the Indian Ocean commenced in 1957. 7 longliners were operated in 2011, which were the lowest in number of vessels as it ranged from 31 to 13 during previous 5 years. With this fishing capacity, Korean longliners caught 1,985 mt in 2011, which was 30.4% decreasing of the catch in 2010. In 2011, fishing effort was 5,362 thousand hooks and distributed higher in the western and eastern areas around 20-40°S, while the fishing efforts averaged for 2007-2011 were 8,140 thousand hooks and distributed higher in the western areas around 20°N-20°S, as well as in the western and eastern areas around 20-40°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 became important in catch. Due to some operational difficulties in Korean observer programs including safety incidents, no observer was placed on board Korean longline vessels in 2011. In relation to this matter, Korea improved the scientific observer program, and in 2012 three observers had been deployed on board for a period of 60-70 days to implement the coverage of 2012 as well as to cover that of 2011.

Madagascar

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

observed according by the statement of the fishing Companies compared to the last year (2010)

Malaysia

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

Maldives, Republic of

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

Mauritius

About 110 000 tonnes of raw tuna are processed annually for export as canned and tuna loins mainly to the EU market. Seafood processing contributes to about 1% to GDP and plays an important role in the socio-economic activity of the country. In 2011, Mauritius issued 98 fishing licences to longliners and purse-seiners of various nationalities to fish in its waters. Moreover, under the fishing agreements between Mauritius and the Seychelles, 7 purse-seiners and 7 longliners were issued with fishing licences. However, under fishing agreement with the Federation of Japan Tuna Fisheries Co-operative Associations no application were received from the Japanese fishing vessels probably due to the piracy threats in the Western Indian Ocean. Tuna fishing longliners regularly call at the Port Louis harbour with an approximate of over 600 calls yearly for unloading and transhipment of tuna. During the year under report, 40 013 tonnes of tuna were transhipped through the Port Louis harbour and albacore tuna constituted more than 40% of the total catch. An increase in the volume of yellowfin, bigeye and skipjack tuna transhipped was also noted due to transhipment effected by European purse-seiners. Four national fishing vessels, less than 24 meters in length, targeting swordfish landed 89 tonnes of chilled fish. The catch composed of 49.2% swordfish and 18.4% yellowfin tuna. The fishing areas were spread between latitudes 120S and 230S and longitudes 520E and 630E. About 350 small-scale fishermen operating around the 27 anchored Fish Aggregating Devices set around the island landed 258 tonnes of tuna and the catch was mainly composed of albacore tuna. The sports/recreational fishery supplied the local market with an additional estimated amount of 350 tonnes and the species comprised marlins, sailfish, tuna, dolphinfish and wahoo. Mauritius has been putting all its effort to comply with the IOTC resolutions and is looking forward to further enhance its contribution for the conservation and management of tuna and tuna-like species and address the ecosystem and by-catch issues within the IOTC area of competence.

Mozambique

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

Oman, Sultanate of

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

Pakistan

National Report not provided.

Philippines

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

Seychelles, Republic of

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

Sierra Leone

National Report not provided.

Sri Lanka

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

obtain approval from the Cabinet of Ministers and presenting same in parliament enabling High seas fishing as well as to incorporate the provisions in compliance with the international obligations and conventions.

Sudan

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

Tanzania, United Republic of

National Report not provided.

Thailand

Neritic tuna and king mackerel species in the Andaman Sea Coast, Thailand comprise 7 species (*Thunnus tonggol*, *Euthynnus affinis*, *Auxis thazard*, *A. rochie*, *Katsuwonus pelamis* and *Sarda orientalis*, *Scomberomorus* spp.). These species were caught from purse seine, king mackerel gill net and trawl, while purse seine was the main fishing gear. The trend of neritic tuna catches have been decreasing from 45,083 tons in 1997 to 13,093 tons in 1999. The production was quite stable around 10,711 and increase to 11,861 in 2009. These neritic tuna species are more or less have its production trend similarity. Three Thai tuna longliners were operated in the Indian Ocean in 2007 and in 2008-2009 only two Thai tuna longliners kept on fishing there. Fishing grounds were mainly in the western coast of Indian Ocean. The total catches were 1,634.09 tons with 1,904 days of fishing effort. The average catch rate of total catch was the highest at 13.62 number/1,000 hooks in 2010 followed by 10.20 and 5.88 number/ 1,000 hooks in 2007 and 2008. Albacore was the dominant species in 2010 followed by bigeye tuna 2010 and yellowfin tuna in 2007. While, tuna purse seine fishery operated by four Thai purse seiners, 227-670 fishing operations was conducted in the Indian Ocean during 2007-2010. Fishing ground was mainly in the western Indian Ocean. Tuna purse seine fishery can be operated throughout the year in both the eastern and western parts of the Indian Ocean with the peak from February - May and September - October. Total catch was 35,977.20 tonnes. It was found that skipjack tuna comprised the highest proportion (64.94%) followed by bigeye tuna (18.83%), yellowfin tuna (13.78%) and bonito (2.44%). The average size of skipjack, yellowfin and bigeye tuna were 50.34±9.87, 63.32±23.09 and 63.24±16.94 cm, respectively.

United Kingdom (OT)

On 1 April 2010 the BIOT Commissioner proclaimed a Marine Protected Area (MPA) in the British Indian Ocean Territory [UK (BIOT)]. No fishing licences have been issued since that date and the last foreign fishing licences expired on 31 October 2010. Diego Garcia and its territorial waters are excluded from the MPA and include a recreational fishery. The United Kingdom National Report summarises fishing in its recreational

fishery in 2010 and provides details of research activities undertaken. UK (BIOT) does not operate a flag registry and has no commercial tuna fleet or fishing port. The recreational fishery landed 21.29t of tuna and tuna like species on Diego Garcia in 2011. Length frequency data were recorded for a sample of 748 yellowfin tuna from this fishery. The mean length was 76cm. Sharks caught in the recreational fishery are released alive. IUU fishing remains one of the greatest threats to the BIOT ecosystem. Research was undertaken into the impact of the network of Indian Ocean MPAs. A Science Advisory Group has been formed to define a science strategy for BIOT and future research priorities, including those relevant to the pelagic ecosystem and IOTC fisheries. Recommendations of the Scientific Committee and those translated into Resolutions of the Commission have been implemented as appropriate by the BIOT Authorities and are reported.

Vanuatu
National Report not provided.

Yemen
National Report not provided.

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

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

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

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

					in 2010 (funded by ACIAR Australia—DGCF). Training to occur in 2011, including data collection for sharks based on forms of statistical data to national standards (by DGCF (supported by ACIAR Australia). Implementation expected late 2011/early 2012. Seabirds: Development has not begun.
Iran, Islamic Republic of		–		–	Sharks: Have communicated to all fishing cooperatives the IOTC resolutions on sharks. Have in place a ban on the retention of live sharks. Seabirds: I.R. Iran determined that seabird interactions are not a problem for their fleet as they consist of gillnet vessels only.
Japan		03-Dec-2009		03-Dec-2009	Sharks: NPOA–Shark assessment report submitted to COFI in Jan. 2011 Seabirds: NPOA–Seabird implementation report submitted to COFI in Jan. 2011.
Kenya					Sharks: Development has not begun. Scheduled for development in 2012. Sharks are considered a target species by Kenya. Seabirds: Development has not begun. Scheduled for development in 2012. Kenya has a single longliner targeting swordfish and no seabird interactions have been reported to date.
Korea, Republic of		–		–	Sharks: Approved on 18/08/2011 but not yet implemented. Seabirds: Early stages of development.
Madagascar		–		–	Sharks: Development has not begun. Seabirds: Development has not begun. Note: A fisheries monitoring system is in place in order to ensure compliance by vessels with the IOTC's shark and seabird conservation and management measures.
Malaysia		2006			Sharks: No update received by the Secretariat. Seabirds: No information received by the Secretariat.
Maldives, Republic of		–		–	Sharks: An earlier draft of the NOPA is available: Gaps/issues that arose following the total shark ban have been identified through support from the Bay of Bengal Large Marine Ecosystem (BOBLME) Project. Presently Maldives is seeking further support from BOBLME Project to finalize the plan and associated regulation to be published in Government Gazette. Seabirds: Article 12 of IPOA states that if a 'problem exists' CPCs adopt an NPOA. IOTC Resolution 05/09 suggests CPCs to report on seabirds to the IOTC Scientific Committee if the issue is appropriate'. Maldives considers that seabirds are not an issue in Maldives fisheries, both in the pole-and-line fishery and in the longline fishery. The new longline fishing regulations has provision on mitigation measures on seabird bycatch. Maldives will be reporting on seabirds to the appropriate technical Working Party meetings of IOTC.
Mauritius					Sharks: Currently being drafted. Seabirds: Drafting will commence upon completion of NPOA–Sharks. In the meantime fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions.
Mozambique		–		–	Sharks: Development has not begun. Seabirds: Development has not begun.

Oman, Sultinate of					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Pakistan					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Philippines		Sept. 2009		–	Sharks: Under periodic review. Shark catches for 2010 provided to the Secretariat. Seabirds: Development has not begun. No seabird interactions recorded.
Seychelles, Republic of		Apr-2007		–	Sharks: NPOA-sharks to be reviewed in 2012. Seabirds: Development has not begun.
Sierra Leone					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Sri Lanka					Sharks: An NPOA-sharks is planned for development in 2012 and an update will be provided at the next SC meeting. Seabirds: Sri Lanka has determined that seabird interactions are not a problem for their fleets.
Sudan					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Tanzania, United Republic of		–		–	Sharks: Initial discussions have commenced. Seabirds: Initial discussions have commenced. Note: Terms and conditions related to protected sharks and seabirds contained within fishing licenses.
Thailand		23-Nov-2005		–	Sharks: Second NPOA-sharks currently being drafted. Seabirds: Development has not begun.
United Kingdom	n.a.	–	n.a.	–	Not applicable: British Indian Ocean Territory (Chagos Archipelago) waters are a Marine Protected Area closed to fishing except recreational fishing around Diego Garcia. For sharks, UK is the 24th signatory to the Convention on Migratory Species 'Memorandum of Understanding on the Conservation of Migratory Sharks' which extends the agreement to UK Overseas Territories including British Indian Ocean Territories; Section 7 (10) (e) of the *Fisheries (Conservation and Management) Ordinance* refers to recreational fishing and requires sharks to be released alive. No seabirds are caught in the recreational fishery.
Vanuatu					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Yemen					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
COOPERATING NON-CONTRACTING PARTIES					
Senegal		25-Sept-2006		–	Sharks: The Sub-Regional Fisheries Commission supported the development of a NPOA-sharks for Senegal in 2005. Other activities conducted include the organization of consultations with industry, the investigation of shark biology and social -economics of shark fisheries). The NPOA is currently being revised. Consideration is being made to the inclusion of minimum mesh size, minimum shark size, and a ban on shark finning.

					Seabirds: The need for a NPOA-seabirds has not yet been assessed.
South Africa, Republic of		–		2008	Sharks: The gazetting of the draft NPOA-sharks for public comment has been approved by the Minister of the Department of Agriculture, Forestry and Fisheries (6 July 2012). Seabirds: Published in August 2008 and fully implemented. The NPOA-seabirds has been earmarked for review.

APPENDIX VI
AVAILABILITY OF CATCH DATA FOR SHARKS BY GEAR

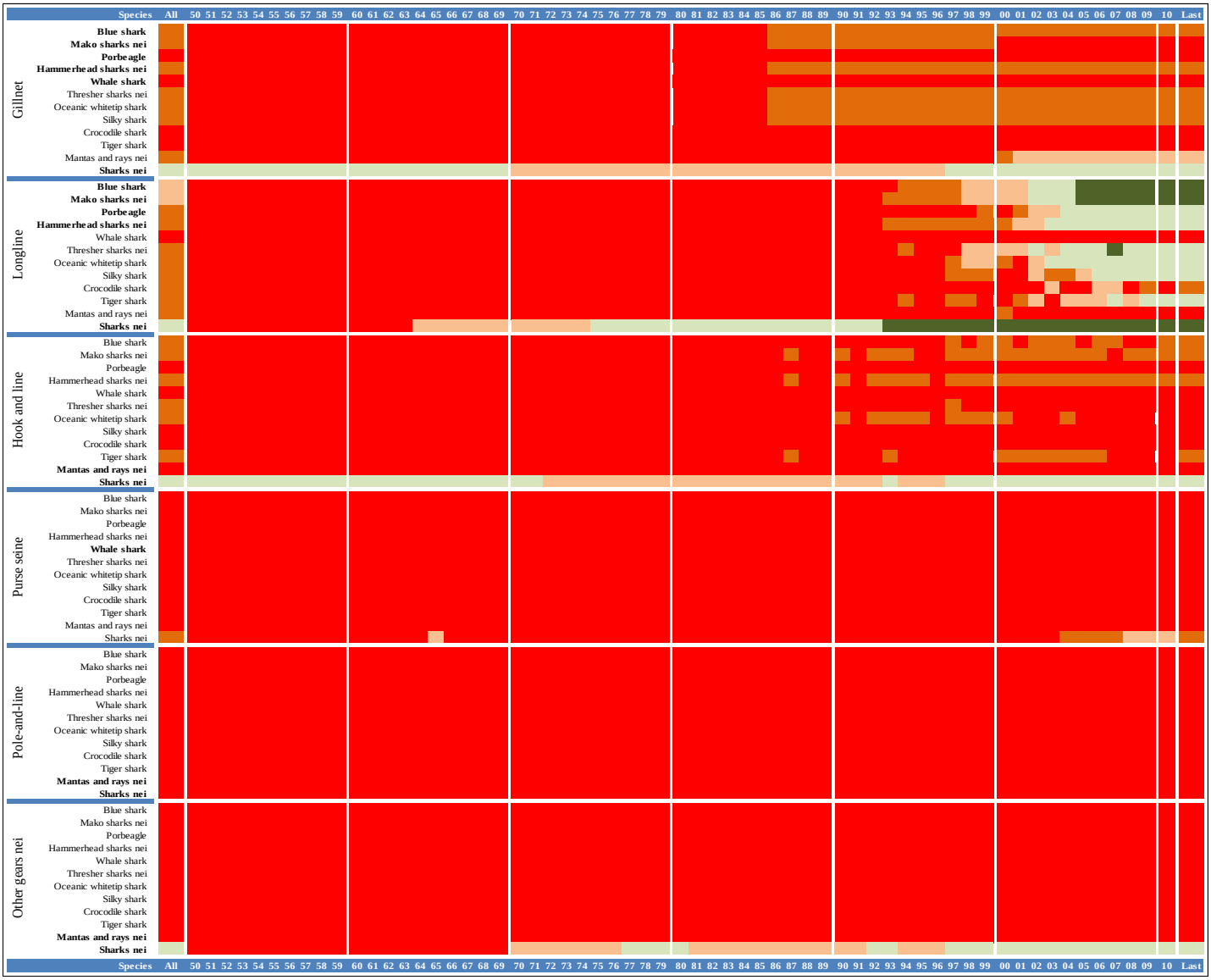
Availability of catch data for the main shark species expressed as the amount of fleets (%) for which catch data on sharks are available out of the total number of fleets for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2010

Shark species in bold are those identified by the Commission in 2012, for which data shall be recorded in logbooks and reported to the IOTC Secretariat; reporting of catch data for other species can be done in aggregated form (i.e. all species combined as ***sharks nei*** or ***mantas and rays nei***).

Hook and line refers to fisheries using handline and/or trolling and ***Other gears nei*** to other unidentified fisheries operated in coastal waters

Catch rates of sharks on pole-and-line fisheries are thought to be nil or negligible.

Average levels of reporting for 1950–2010 and 2006–10 are shown column ***All*** and ***Last***, respectively.


Species All 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 Last
Gillnet
Blue shark
Mako sharks nei
Porbeagle
Hammerhead sharks nei
Whale shark
Thresher sharks nei
Oceanic whitetip shark
Silky shark
Crocodile shark
Tiger shark
Mantas and rays nei
Sharks nei
Longline
Blue shark
Mako sharks nei
Porbeagle
Hammerhead sharks nei
Whale shark
Thresher sharks nei
Oceanic whitetip shark
Silky shark
Crocodile shark
Tiger shark
Mantas and rays nei
Sharks nei
Hook and line
Blue shark
Mako sharks nei
Porbeagle
Hammerhead sharks nei
Whale shark
Thresher sharks nei
Oceanic whitetip shark
Silky shark
Crocodile shark
Tiger shark
Mantas and rays nei
Sharks nei
Purse seine
Blue shark
Mako sharks nei
Porbeagle
Hammerhead sharks nei
Whale shark
Thresher sharks nei
Oceanic whitetip shark
Silky shark
Crocodile shark
Tiger shark
Mantas and rays nei
Sharks nei
Pole-and-line
Blue shark
Mako sharks nei
Porbeagle
Hammerhead sharks nei
Whale shark
Thresher sharks nei
Oceanic whitetip shark
Silky shark
Crocodile shark
Tiger shark
Mantas and rays nei
Sharks nei
Other gears nei
Blue shark
Mako sharks nei
Porbeagle
Hammerhead sharks nei
Whale shark
Thresher sharks nei
Oceanic whitetip shark
Silky shark
Crocodile shark
Tiger shark
Mantas and rays nei
Sharks nei
Species All 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 Last
Key
No catch data available at all
Catch data available from less than 10% of the fleets for which nominal catches of IOTC species are available
Catch data available from 10% to 30% of the fleets for which nominal catches of IOTC species are available
Catch data available from 30% to 75% of the fleets for which nominal catches of IOTC species are available
Catch data available from more than 75% of the fleets for which nominal catches of IOTC species are available

APPENDIX VII
TERMS OF REFERENCE FOR THE IOTC CPUE STANDARDISATION WORKSHOP

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

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

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

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

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

Terms of Reference

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

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

1. Development of common guidelines for CPUE standardisation

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

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

2. Fishery changes affecting CPUE series

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

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

3. Spatial structure and statistical issues

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

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

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

4. Sources of data

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

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

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

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

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

6. Impact on advice

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

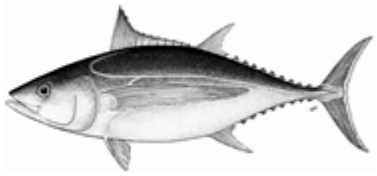
- To carry out initial simulations on the effect of the most important sources of error and bias in CPUE series on management advice as provided with different stock assessment models.

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

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

APPENDIX IX
EXECUTIVE SUMMARY: ALBACORE

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



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

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

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

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

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
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. Trends in the Taiwan,China CPUE series suggest that the longline vulnerable biomass has declined to about 29% of the level observed in 1950. There were 20 years of moderate fishing before 1980, and the catch has more than doubled since 1980. Catches have increased substantially since 2007, attributed to the Indonesian fishery although there is substantial uncertainty remaining on the catch estimates. It is considered that recent catches have been well above the MSY level, recent fishing mortality exceeds F_{MSY} (F_{2010}/F_{MSY} = 1.33). Spawning biomass is considered to be at or very near to the SB_{MSY} level (SB_{2010}/SB_{MSY} = 1.05) (Table 1, Fig. 1). Fishing mortality needs to be reduced by at least 20% to ensure that spawning biomass is maintained at MSY levels (Table 2).

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

- The available evidence indicates considerable risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- The lack of consistency in the data inputs to the analysis and the impacts of using different areas for each fleet on the CPUE standardisations, makes interpretation of the results difficult.
- The use of fine-scale versus aggregated data in the CPUE standardisations by fleet introduces substantial uncertainty.
- Current catches (average 41,609 t over the last five years, 38,946 t in 2011) exceed the MSY level (33,300 t, range: 31,100–35,600 t). Maintaining or increasing effort will result in further declines in biomass, productivity and CPUE.
- A Kobe 2 Strategy matrix was calculated to quantify the risk of different future catch scenarios, using the projections from the ASPM model (Table 2). The projections indicated that a minimum reduction in fishing mortality of 20% would be required to ensure that the stock does not move to an overfished state by 2020 (i.e. below SB_{MSY}) (Table 2).
- Provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be well above the provisional target reference point of F_{MSY}, but below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1; Table 3).
  - **Biomass**: Current spawning biomass is considered to be at or very near the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1; Table 3).

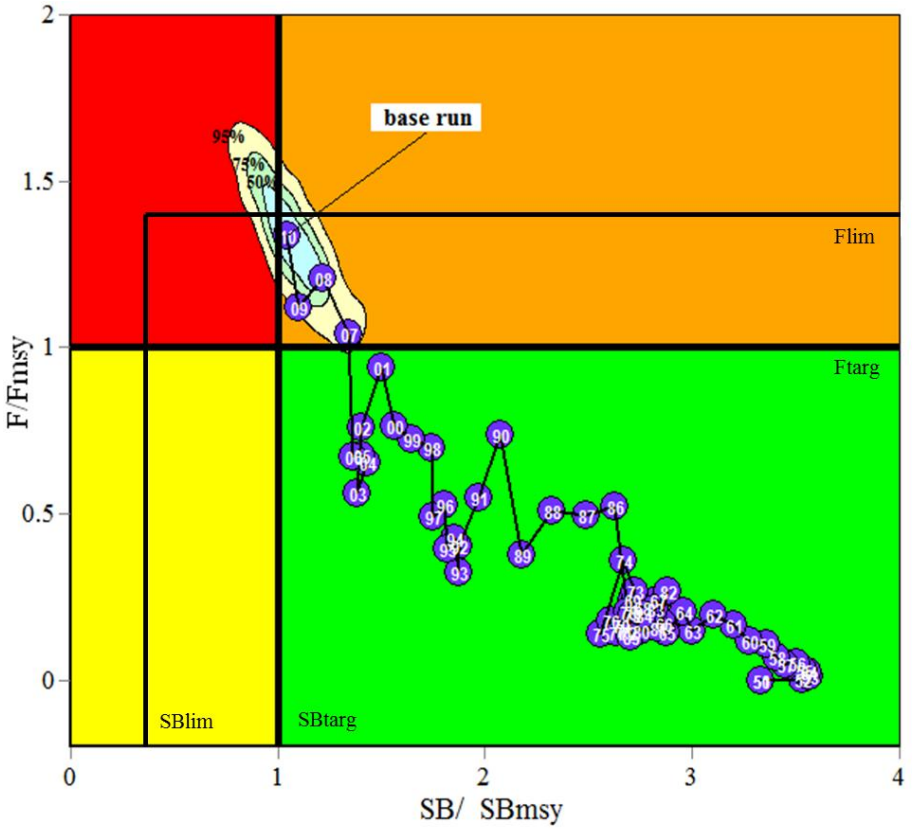


Fig. 1. Albacore: ASPM Aggregated Indian Ocean assessment Kobe plot (95% bootstrap confidence surfaces shown around 2010 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2010. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference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

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

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

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

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

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

FISHERIES INDICATORS

General

Overall, the biology of the albacore stock in the Indian Ocean is not well known and there is relatively little new information on albacore stocks. Albacore (*Thunnus alalunga*) life history characteristics, including a relatively late maturity, long life and sexual dimorphism, make the species vulnerable to over exploitation. Table 3 outlines some of the key life history traits of albacore specific to the Indian Ocean.

TABLE 3. Albacore: Biology of Indian Ocean albacore (*Thunnus alalunga*)

Parameter	Description
Range and stock structure	A temperate tuna living mainly in the mid oceanic gyres of the Pacific, Indian and Atlantic oceans. In the Pacific and Atlantic oceans there is a clear separation of southern and northern stocks associated with the oceanic gyres that are typical of these areas. In the Indian Ocean, there is probably only one southern stock, distributed from 5°N to 40°S, because there is no northern gyre. Albacore is a highly migratory species and individuals swim large distances during their lifetime. It can do this because it is capable of thermoregulation, has a high metabolic rate, and advanced cardiovascular and blood/gas exchange systems. Pre-adults (2–5 year old albacore) appear to be more migratory than adults. In the Pacific Ocean, the migration, distribution availability, and vulnerability of albacore are strongly influenced by oceanographic conditions, especially oceanic fronts. It has been observed on all albacore stocks that juveniles concentrate in cold temperate areas (for instance in a range of sea-surface temperatures between 15 and 18°C), and this has been confirmed in the Indian Ocean where albacore tuna are more abundant north of the subtropical convergence (an area where these juvenile were heavily fished by driftnet fisheries during the late 1980's). It appears that juvenile albacore show a continuous geographical distribution in the Atlantic and Indian oceans in the north edge of the subtropical convergence. Albacore may move across the jurisdictional boundary between ICCAT and IOTC. It is likely that the adult Indian Ocean albacore tunas do yearly circular counter-clockwise migrations following the surface currents of the south tropical gyre between their tropical spawning and southern feeding zones. In the Atlantic Ocean, large numbers of juvenile albacore are caught by the South African pole-and-line fishery (catching about 10,000 t yearly) and it has been hypothesized that these juveniles may be taken from a mixture of fish born in the Atlantic (north east of Brazil) and from the Indian Ocean. For the purposes of stock assessments, one pan-ocean stock has been assumed.
Longevity	10+ years
Maturity (50%)	**Age**: females 5–6 years; males 5–6 **Size**: females n.a.; males n.a.
Spawning season	Little is known about the reproductive biology of albacore in the Indian Ocean but it appears, based on biological studies and on fishery data, that the main spawning grounds are located east of Madagascar between 15° and 25°S during the 4th and 1st quarters of each year. Like other tunas, adult albacore spawn in warm waters (SST>25°C).
Size (length and weight)	Reported to 128 cm FL in the Indonesian longline fishery $W = aL^b$ with $a = 5.691 \times 10^{-5}$, $b = 2.7514$.

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

Albacore – Catch trends

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

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

Catches of albacore in recent years have come almost exclusively from vessels from

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

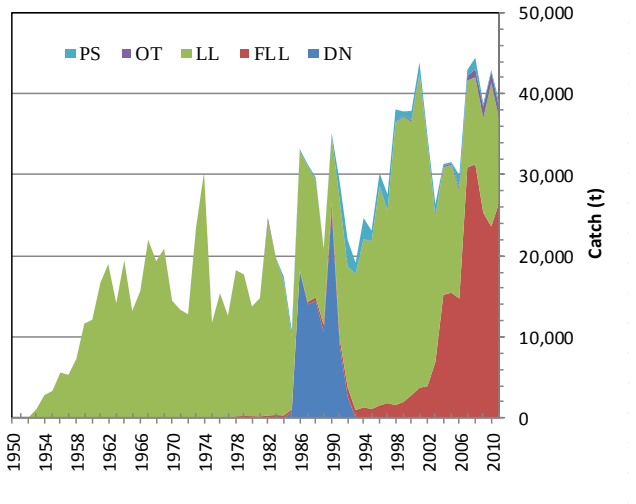


Fig. 2. Albacore: Annual catches of albacore by gear recorded in the IOTC Database (1950–2011) (Data as of October 2012). Freezing-longline (LL); Fresh-tuna longline (FLL); Purse seine (PS); Other gears NEI (OT).

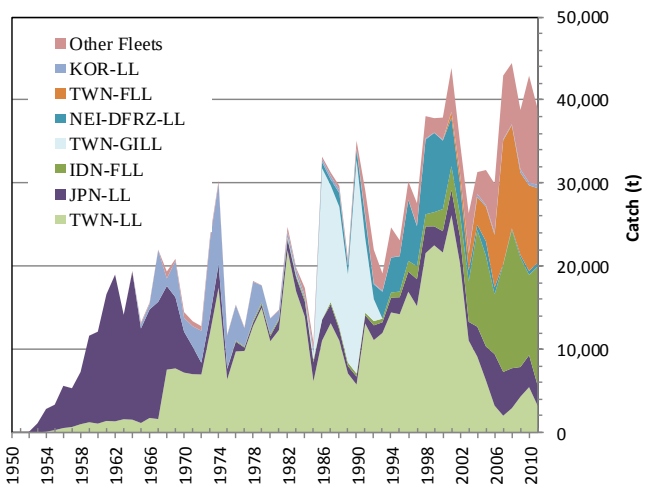
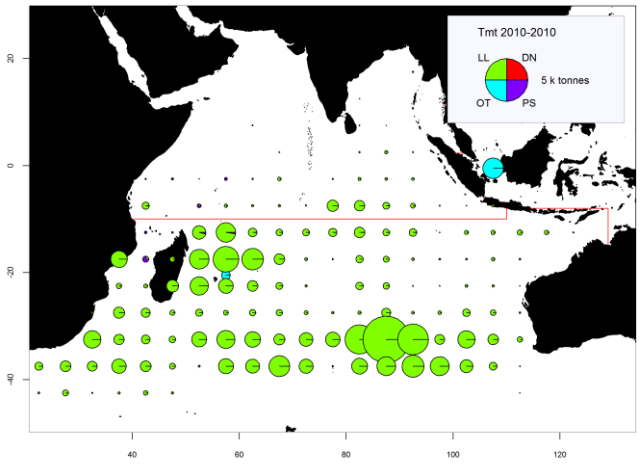


Fig. 3. Albacore: Annual catches of albacore by fleet recorded in the IOTC Database (1950–2011) (Data as of October 2012). Freezing Longlines of Taiwan,China (LL-TWN), Japan (LL-JPN), Rep. of Korea (LL-KOR), and other nei fleets (LL-NEI-DFRZ); Fresh-tuna longlines of Indonesia (FLL-IDN), and Taiwan,China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



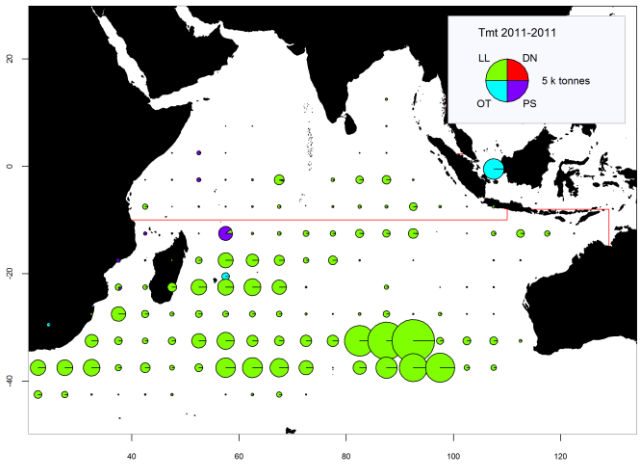


Fig. 4a–b. Albacore: Time-area catches (total combined in tonnes) of albacore estimated for 2010 (left) and 2011 (right) by type of gear: Longline (LL, green), Driftnet (DFRT, red), Purse seine (PS, purple), Other fleets (OT, blue). The catches of fleets for which the flag countries do not report detailed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

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

In contrast to the Japanese longliners, catches by Taiwan,China longliners increased steadily from the 1950's to average around 10,000 t by the mid-1970s. Between 1998 and 2002 catches ranged between 21,500 t to 26,900 t, equating to just over 60% of the total Indian Ocean albacore catch. Between 2003 and 2010 the albacore catches by Taiwan,China longliners have been between 10,000 and 18,000 t, with catches appearing to be increasing in recent years. There has been a shift in the proportion of catches of albacore by deep-freezing and fresh-tuna longliners in recent years, with increasing catches of fresh-tuna (72% of the total catches for 2008–10) as opposed to deep-freezing longliners (Fig. 2; Table 3).

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

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

TABLE 4. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by gear and main fleets [or type of fishery] by decade (1950–2000) and year (2002–2011) in tonnes. Data as of October 2012. Catches by decade represent the average annual catch, noting that some gears were not used for all years (refer to Fig. 3).

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

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

TABLE 5. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by fishing area for the period 1950–2011 (in metric tons). Data as of October 2012.

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

Areas: North of 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 estimates since that time has been compromised due to poor catch reports from some fleets, in particular:

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

moderately high during the 1990s, they have not exceeded 2,000 t in recent years.

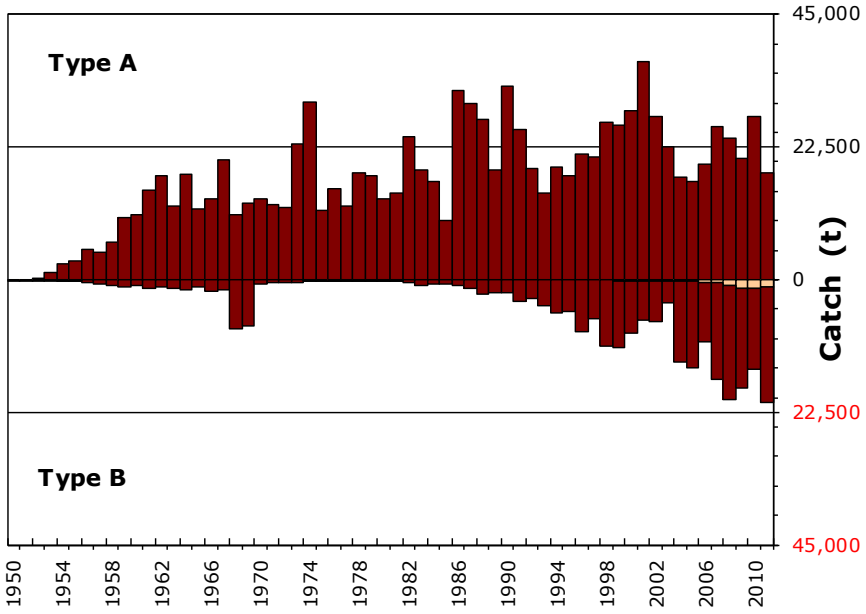


Fig. 5. Albacore: Uncertainty of annual catch estimates for albacore (1950–2011) (Data as of October 2012). Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by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

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

Albacore – Effort trends

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

Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2010 and 2011 are provided in Fig. 7.

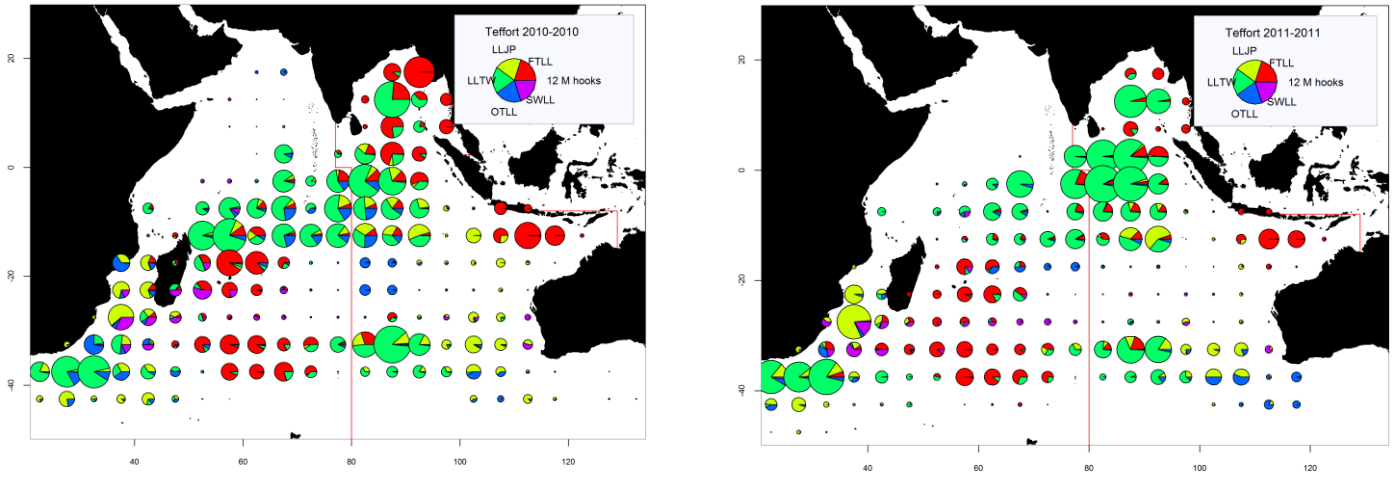


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise):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

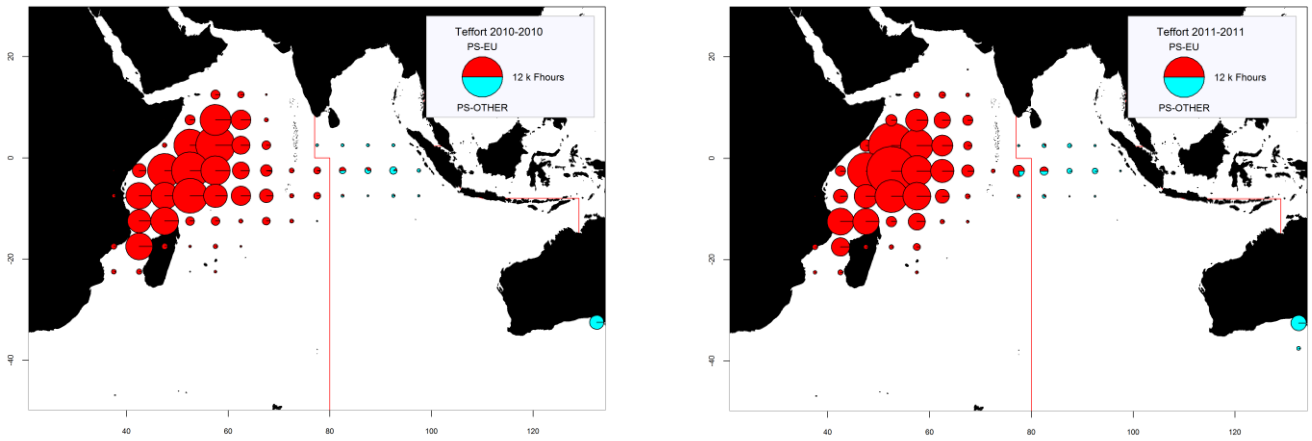


Fig. 7. Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles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

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

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

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

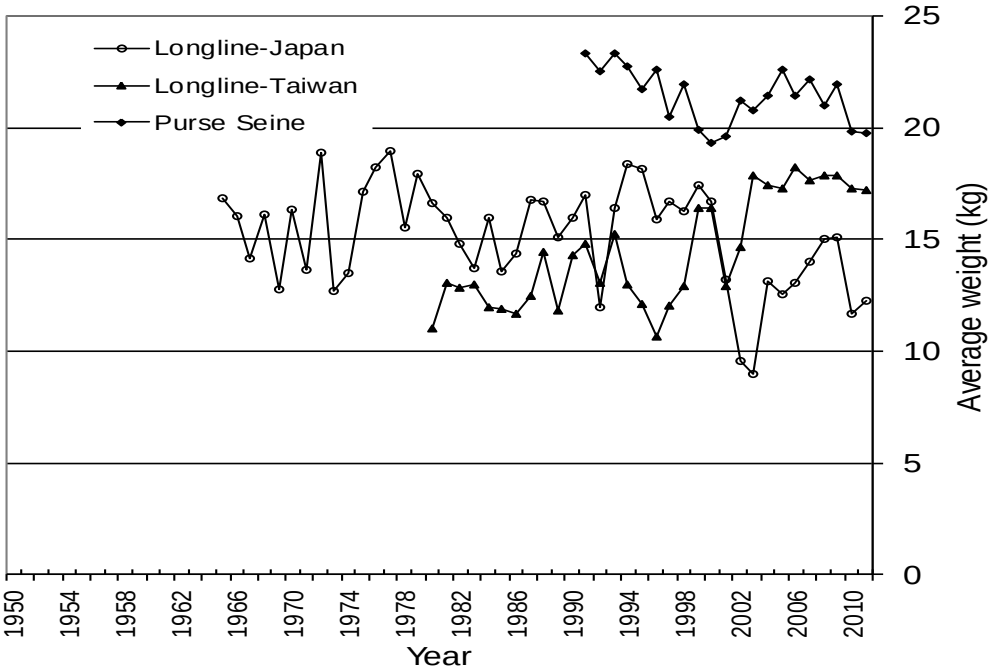


Fig. 8. Albacore: Average weight in kg of the catches of all fleets (blue), gillnet (red), LL-JPN (dark green), LL-TWN (black), Purse seine (green) and other gears (grey) from 1950 to 2011.

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

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

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

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

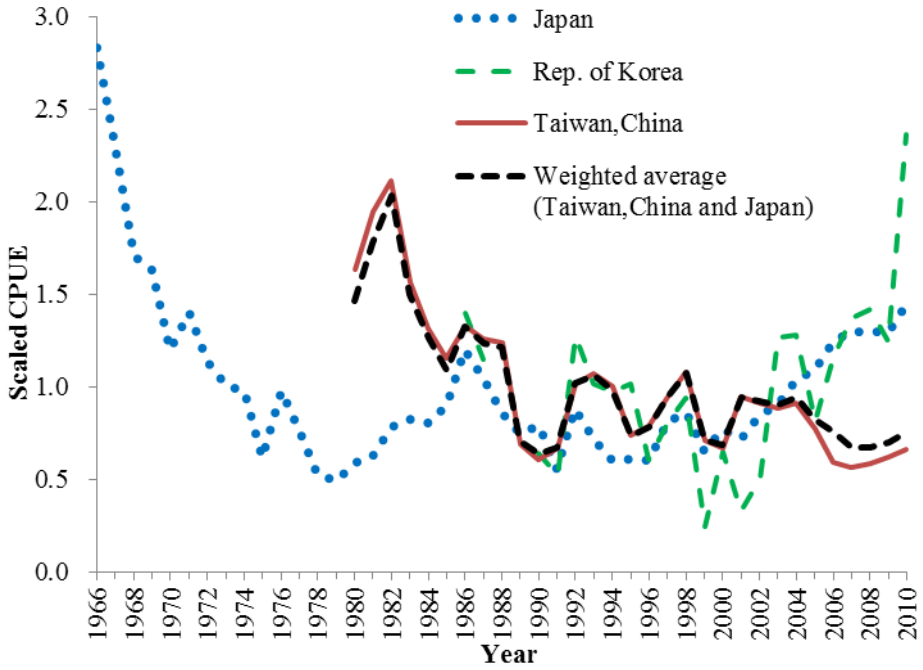


Fig. 9. Albacore: Comparison of the three CPUE series for longline fleets fishing for albacore in the IOTC area of competence, as well as the weight average of the Taiwan,China and Japan series. Series have been rescaled relative to their respective means from 1966–2010.

STOCK ASSESSMENT

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

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

- There was more confidence in the abundance indices this year due to the additional CPUE analyses from Japan and Taiwan,China, and the exploration of the Rep. of Korea catch and effort data. This has led to improved confidence in the overall assessments.

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

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

In deciding upon the most appropriate way to present the integrated stock assessment results, the output of the ASPM model were considered to most likely numerically and graphically represent the current status of albacore in the Indian Ocean (Table 6). 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 6. Albacore (*Thunnus alalunga*) stock status summary.

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

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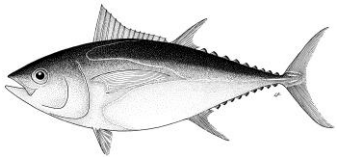
APPENDIX X
EXECUTIVE SUMMARY: BIGEYE TUNA

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



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

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

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

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

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
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 in 2012. Revised stock status indicators (e.g. standardised CPUE series) do not show any substantial differences from those carried out in 2011 that would warrant a change in the overall stock status advice. Both of the stock assessments carried out in 2010 and 2011 indicate that the stock is above a biomass level that would produce MSY in the long term and that current fishing mortality is below the MSY-based reference level (i.e. $SB_{current}/SB_{MSY} > 1$ and $F_{current}/F_{MSY} < 1$) (Table 1 and Fig. 1). Current spawning stock biomass was estimated to be 34–40 % (Table 1) of the unfished levels. The central tendencies of the stock status results from the WPTT 2011 when using different values of steepness were similar to the central tendencies presented in 2010. Catches in 2011 (87,420 t) remain lower than the estimated MSY values from the 2010 and 2011 stock assessments (Table 1). The average catch over the previous five years (2007–2011; 101,639 t) also remains below the estimated MSY. On the weight of stock status evidence available, the bigeye tuna stock is therefore not overfished, and is not subject to overfishing.

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

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

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

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

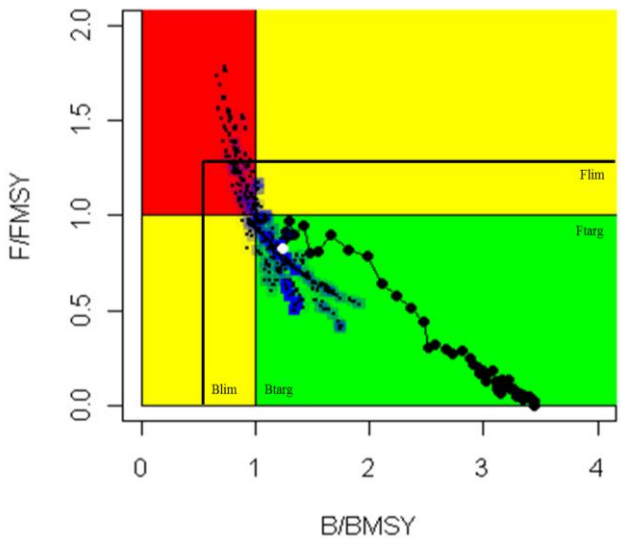


Fig. 1. Bigeye tuna: SS3 Aggregated Indian Ocean assessment Kobe plot. Black circles represent the time series of annual median values from the weighted stock status grid (white circle is 2009). Blue squares indicate the MPD estimates for 2009 corresponding to each individual grid C model, with colour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

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

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and probability (%) of violating reference point**				
	2010 SS3				
	60% (61,200 t)	**80%** (81,600 t)	**100%** (102,000 t)	**120%** (122,400 t)	**140%** (142,800 t)
$SB_{2012} < SB_{MSY}$	19	24	28	40	50
$F_{2012} > F_{MSY}$	<1	<6	22	50	68
$SB_{2019} < SB_{MSY}$	19	24	30	55	73
$F_{2019} > F_{MSY}$	<1	<6	24	58	73
Reference point and projection timeframe	**Alternative catch projections (relative to 2010) and probability (%) of violating reference point**				
	2011 ASPM				
	60% (42,900t)	**80%** (57,200t)	**100%** (71,500t)	**120%** (85,800t)	**140%** (100,100t)
$SB_{2013} < SB_{MSY}$	4	8	15	24	35
$F_{2013} > F_{MSY}$	<1	<1	1	8	33
$SB_{2020} < SB_{MSY}$	<1	<1	1	11	41
$F_{2020} > F_{MSY}$	<1	<1	<1	5	38

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

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

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and*

swordfish in the IOTC area

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

FISHERIES INDICATORS

Bigeye tuna – General

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

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

Parameter	Description
Range and stock structure	Inhabits the tropical and subtropical waters of the Pacific, Atlantic and Indian Oceans in waters down to around 300 m. Juveniles frequently school at the surface underneath floating objects with yellowfin and skipjack tunas. Association with floating objects appears less common as bigeye grow older. The tag recoveries from the RTTP-IO provide evidence of rapid and large scale movements of juvenile bigeye tuna in the Indian Ocean, thus supporting the current assumption of a single stock for the Indian Ocean. The average minimum distance between juvenile tag-release-recapture positions is estimated at 657 nautical miles. The range of the stock (as indicated by the distribution of catches) includes tropical areas, where reproduction occurs, and temperate waters which are believed to be feeding grounds.
Longevity	15 years
Maturity (50%)	Age: females and males 3 years. Size: females and males 100 cm.
Spawning season	Spawning season from December to January and also in June in the eastern Indian Ocean.
Size (length and weight)	Maximum length: 200 cm FL; Maximum weight: 210 kg. Newly recruited fish are primarily caught by the purse seine fishery on floating objects. The sizes exploited in the Indian Ocean range from 30 cm to 180 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack tuna and juvenile yellowfin tuna and are mainly limited to surface tropical waters, while larger fish are found in sub-surface waters.

Sources: Nootmorn 2004, Froese & Pauly 2009

Bigeye tuna – Fisheries and catch trends

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

Total annual catches have increased steadily since the start of the fishery, reaching the 100,000 t level in 1993 and peaking at 150,000 t in 1999 (Fig. 2). Catches dropped since

then to values between 120,000–140,000 t (2000–07), further dropping in recent years, to values under 90,000 t in recent years (2010–11). The SC believes that the recent drop in catches could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean, which has led to a marked drop in the levels of longline effort in the core fishing area of these species.

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

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

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

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

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

continue operating in the northwest Indian Ocean (Fig. 4).

By contrast with yellowfin tuna and skipjack tuna, for which the major catches are taken in the western Indian Ocean, bigeye tuna is also exploited in the eastern Indian Ocean (Fig. 3). The relative increase in catches in the eastern Indian Ocean in the late 1990's was mostly due to increased activity of small longliners fishing tuna to be marketed fresh. This fleet started its operation in the mid 1970's (Fig. 3, Indonesia). However, the catches of bigeye tuna in the eastern Indian Ocean have shown a decreasing trend in recent years, as some of the vessels moved south to target albacore.

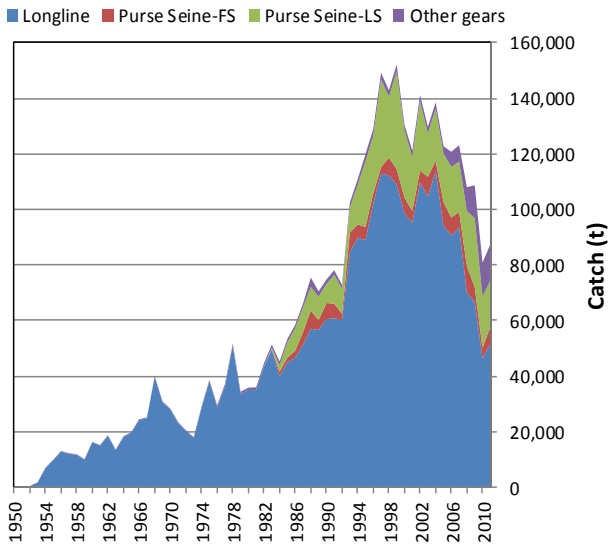


Fig. 2. Bigeye tuna: Annual catches of bigeye tuna by gear (1950–2011) (Data as of September 2012)

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

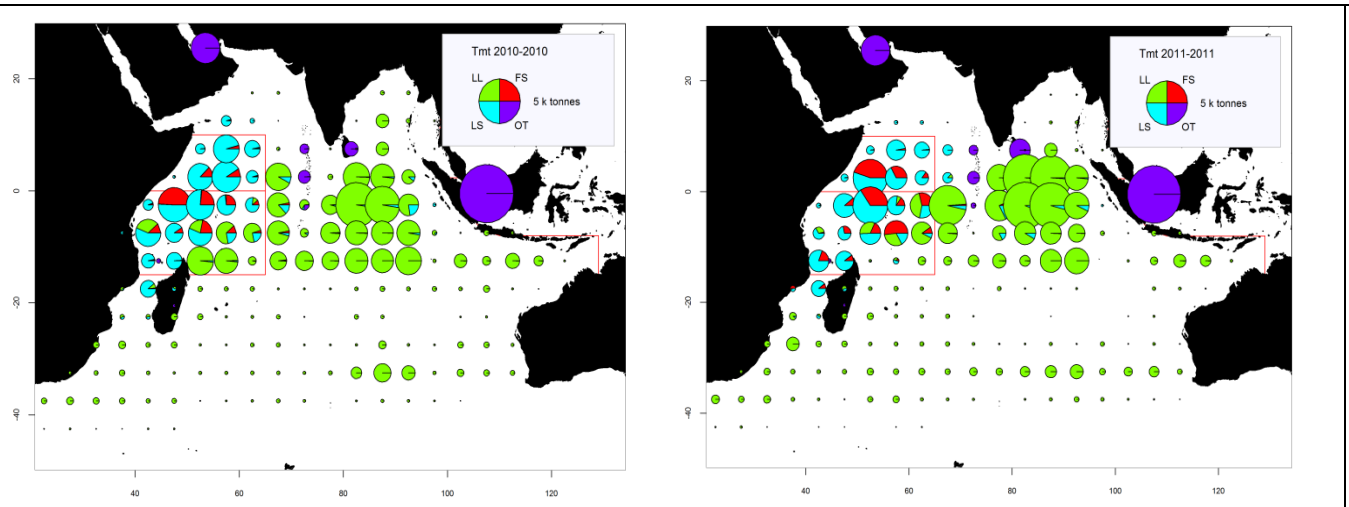


Fig. 4. Bigeye tuna: Time-area catches (total combined in tonnes) of bigeye tuna estimated for 2010 (left) and 2011 (right) by gear. Longline (LL), Purse seine free-schools (FS), Purse seine associated-schools (LS), and other fleets (OT), including pole-and-line, drifting gillnets, and various coastal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

Bigeye tuna – uncertainty of catches

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

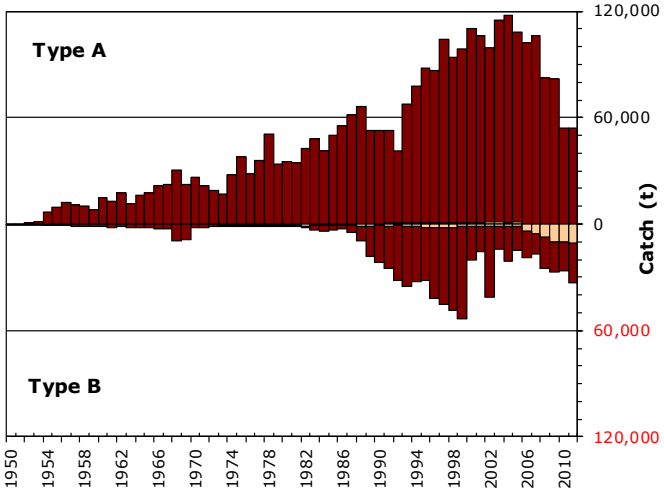


Fig. 5. Bigeye tuna: Uncertainty of annual catch estimates for bigeye tuna (Data as of September 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and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

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

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

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

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

Bigeye tuna – Effort trends

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

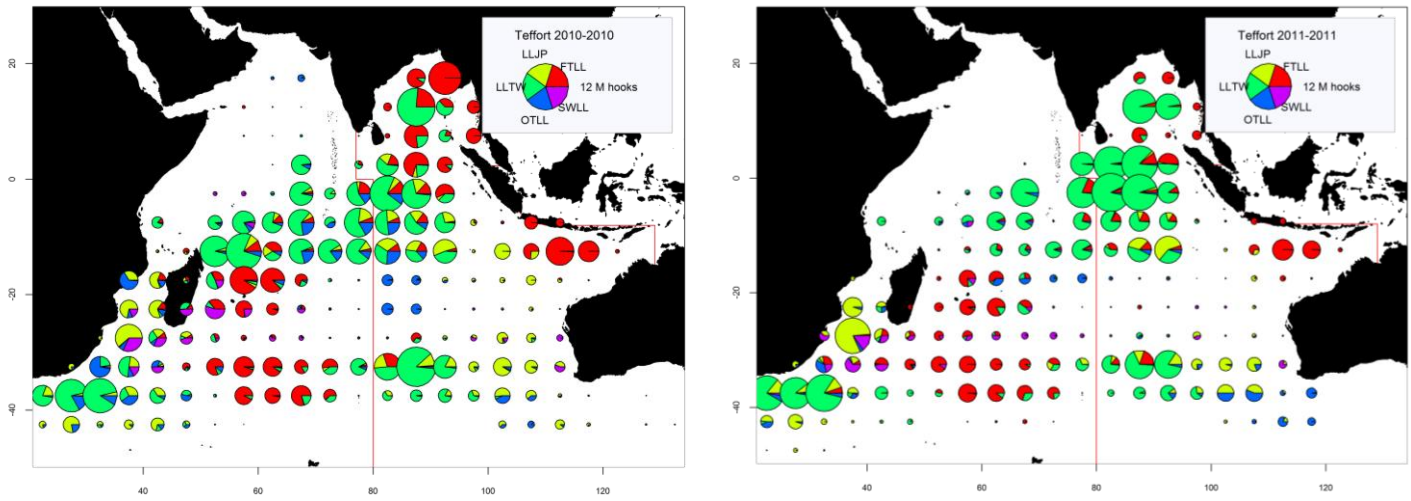


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise):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

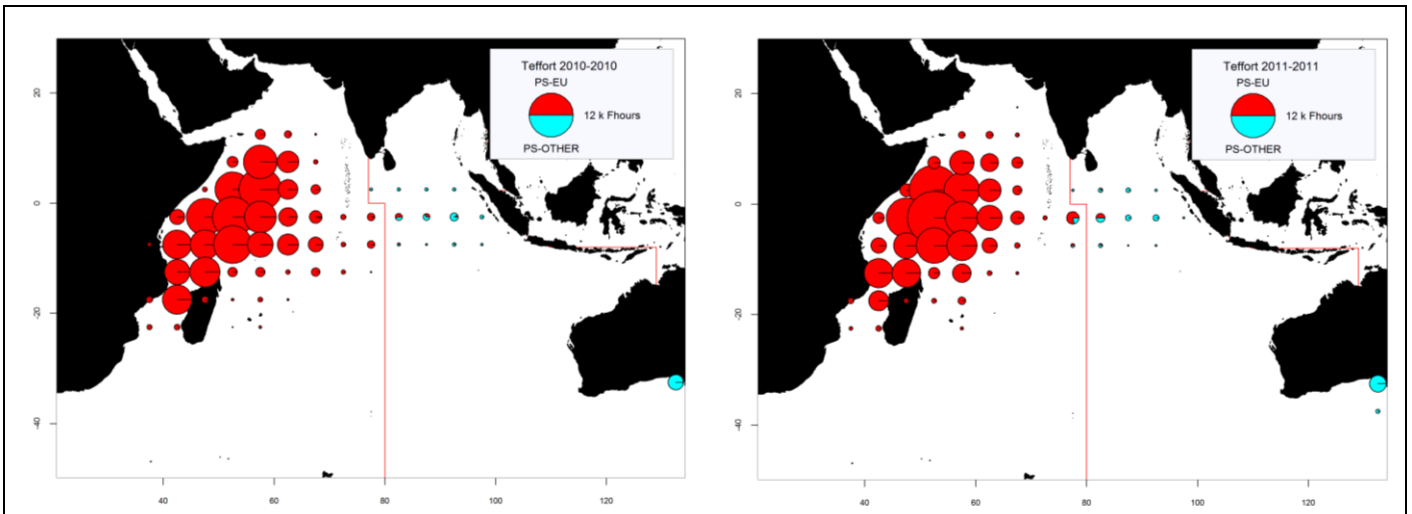


Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)

PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

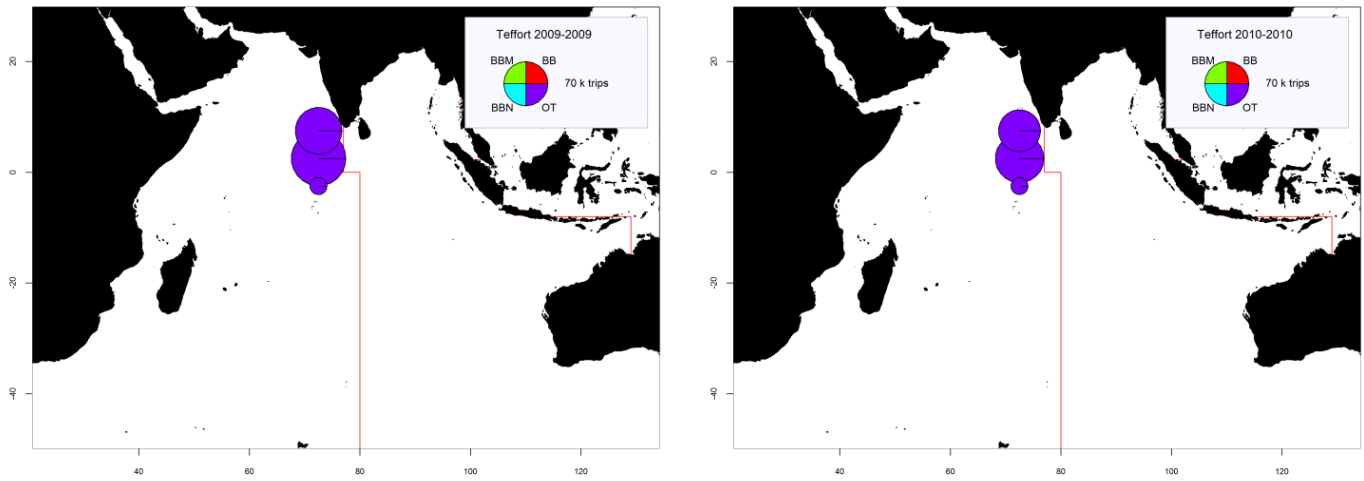


Fig. 8. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of September 2012)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple):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

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

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

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

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

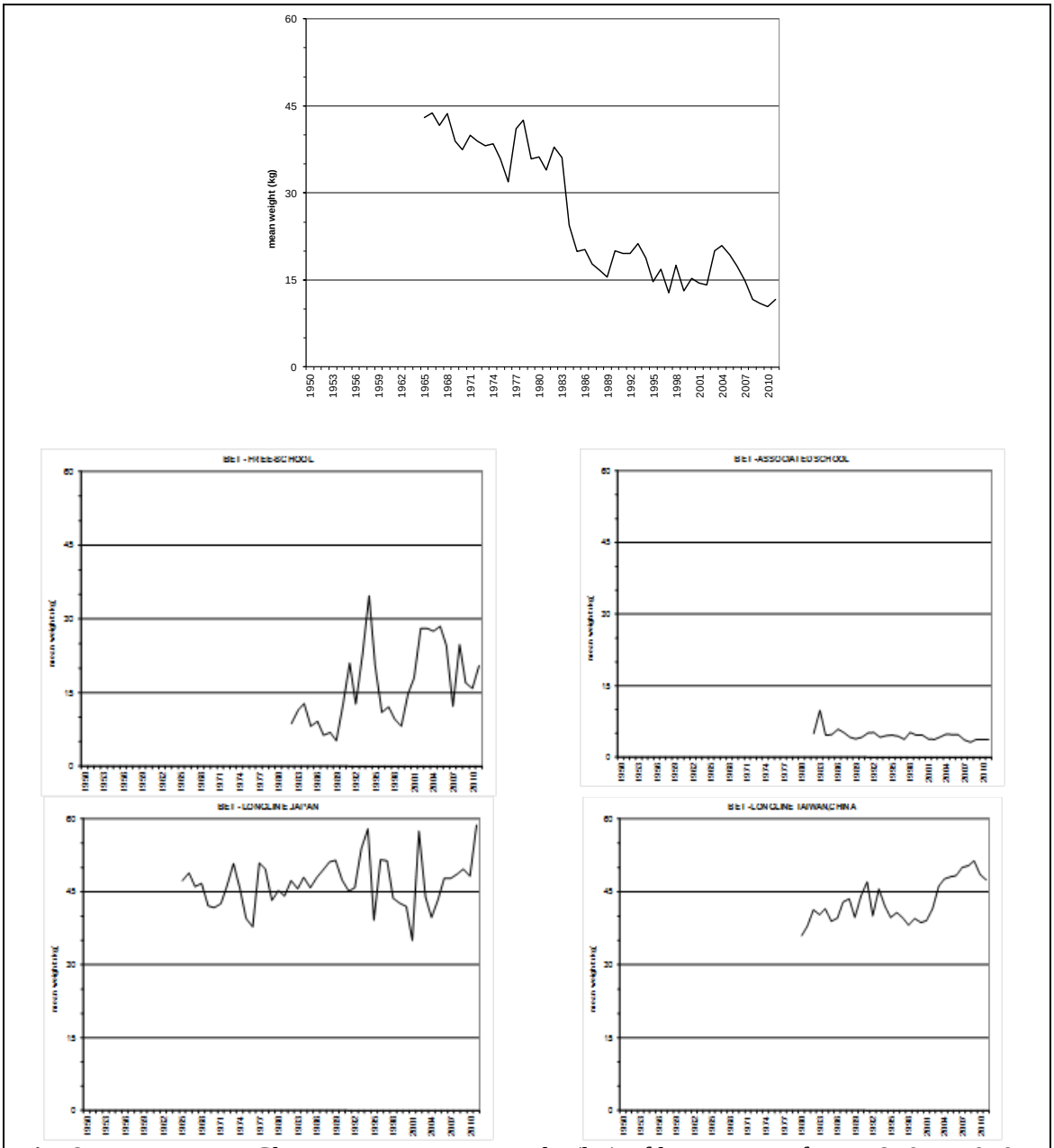


Fig. 9. Bigeye tuna: Changes in average weight (kg) of bigeye tuna from 1950 to 2010 – all fisheries combined (top) and by main fleet (Data as of September 2012)

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

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

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

- Japan data (1960–2011): Series 1 from document IOTC–2012–WPTT14–26. Tropical area of Indian Ocean.

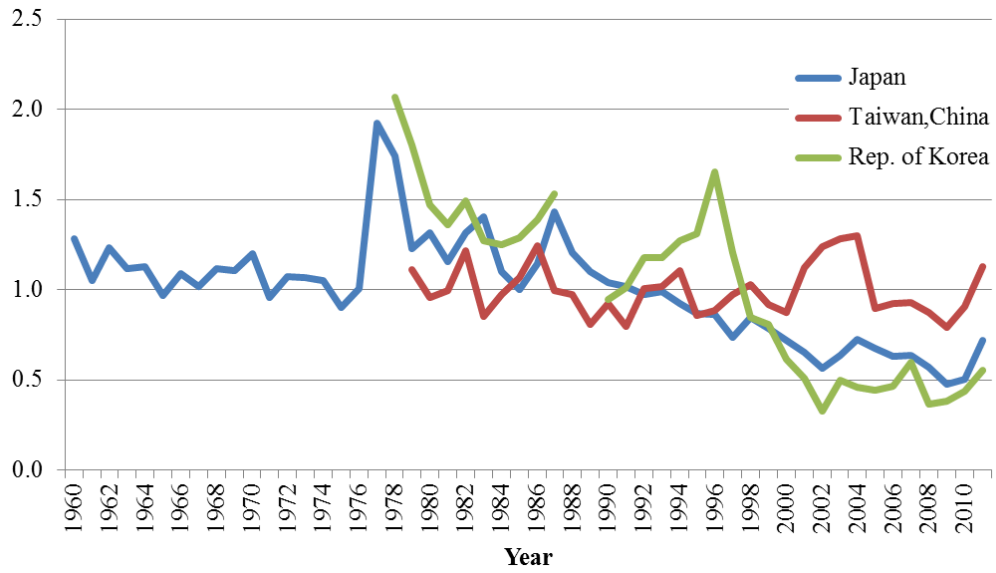


Fig. 10. Comparison of the three standardised CPUE series for Indian Ocean bigeye tuna. Series have been rescaled relative to their respective means from 1960–2011

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

Bigeye tuna – tagging data

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

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

stock assessment analysis of the bigeye tuna stock. Any new information on bigeye tuna biology verified by the WPTT should be incorporated in the next executive summaries.

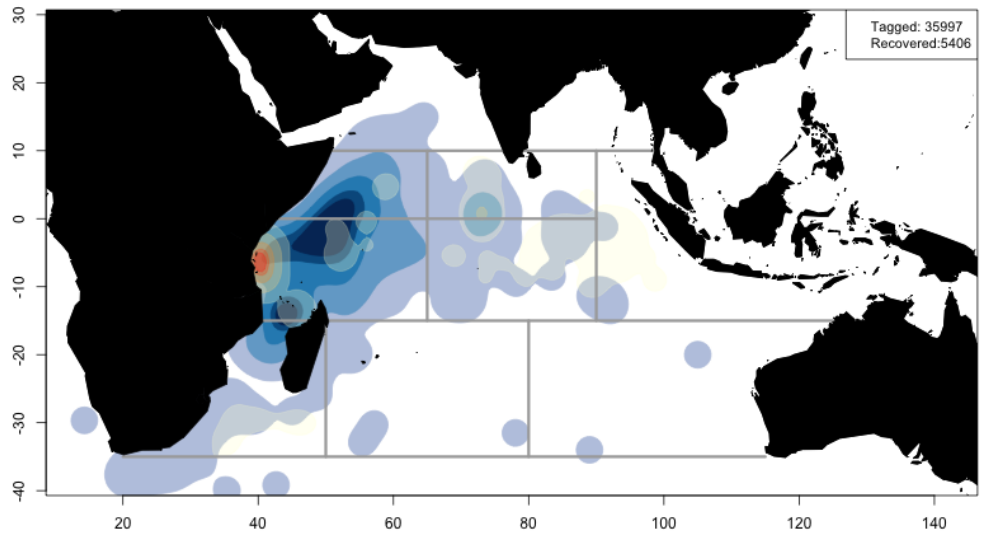


Fig. 11. Bigeye tuna: Densities of releases (in red) and recoveries (in blue). Data as of September 2012

STOCK ASSESSMENT

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

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

- The steepness value (h=0.5) was selected on the basis of the likelihood and was near the lower boundary of what would be considered plausible for bigeye tuna. Selection of steepness on the basis of the likelihood was not considered reliable because i) steepness is difficult to estimate in general, and ii) substantial autocorrelation in the recruitment deviates was ignored in the likelihood term.
- Cohort-slicing to estimate ages from lengths introduces substantial errors, for long-living species such as bigeye tuna, except for the youngest ages.
- Uncertainty in natural mortality was not considered.

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

Management advice for bigeye tuna was based on the 2010 SS3 stock assessment and

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

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

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

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

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

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

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

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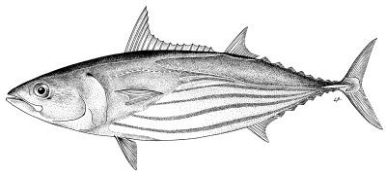
Froese R, Pauly DE (2009) *FishBase*, version 02/2009, FishBase Consortium, <www.fishbase.org>

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

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

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

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

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

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

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

- The mean estimates of the Maximum Sustainable Yield for the skipjack tuna Indian Ocean stock is 478,190 t (Table 1) and considering the average catch level from 2007–2011 was 435,527 t, the stock appears to be in no immediate threat of breaching target and limit reference points.
- If the recent declines in effort continue, and catch remains substantially below the estimated MSY, then urgent management measures are not required. However, recent trends in some fisheries, such as Maldivian pole-and-line, suggest that the situation of the stock should be closely monitored.
- The Kobe strategy matrix (Table 2: from the 2011 assessment) illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of $1.5*F_{MSY}$ (Fig. 1). Based on the current assessment there is a very low probability that the limit reference points of $1.5*F_{MSY}$ at the current catch levels will be exceeded in 3 or 10 years.
  - **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1). Based on the current assessment, there is a low probability that the spawing stock biomass, at the current catch levels, will be below the limit reference point of $0.4*SB_{MSY}$ in 3 or 10 years.

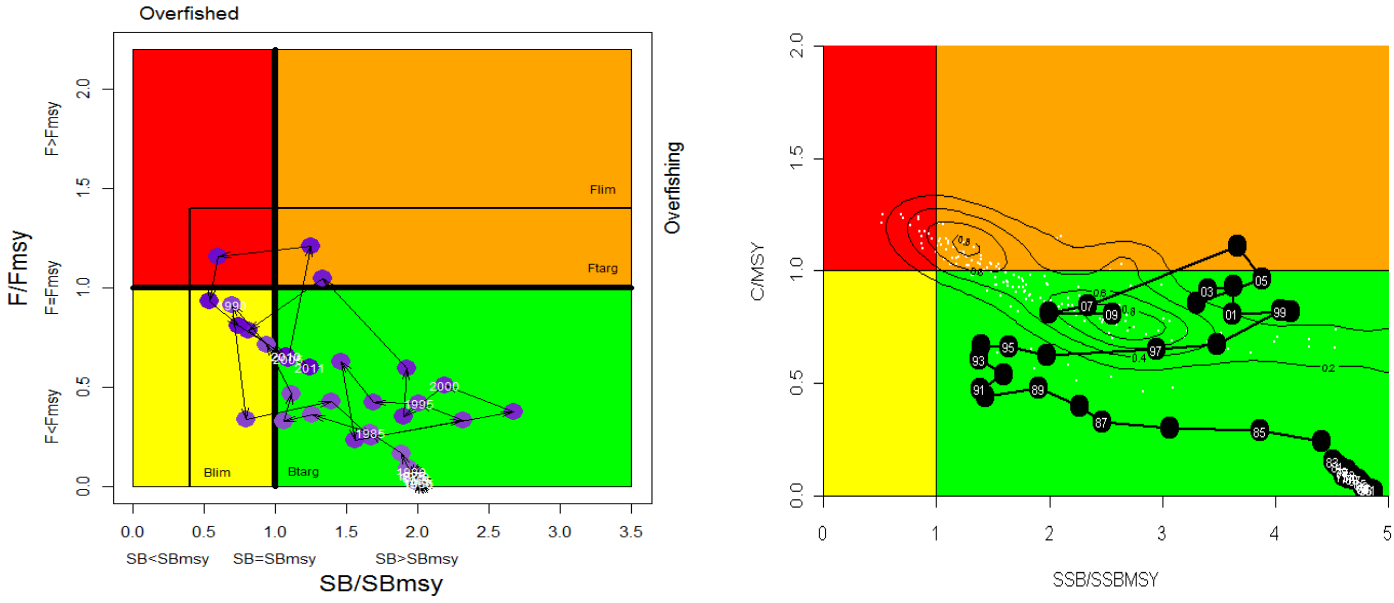


Fig. 1. Skipjack tuna: 2012 SS3 Indian Ocean assessment Kobe plot (left; mean values of the weighted models used in the analysis in 2012). Circles indicate the trajectory of the point estimates for the SB ratio and F/FMSY ratio for each year 1950–2011. 2011 SS3 Aggregated Indian Ocean assessment Kobe plot (right). Black circles indicate the trajectory of the weighted median of point estimates for the SB ratio and C/MSY ratio

for each year 1950–2009. Probability distribution contours are provided only as a rough visual guide of the uncertainty (e.g. the multiple modes are an artifact of the coarse grid of assumption options). Due to numerical problems in the F_{MSY} calculations for this population, the proxy reference point C/MSY is reported instead of F/F_{MSY}, which should be interpreted with caution for the reasons given under Table 1 above

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

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

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

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

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

FISHERIES INDICATORS

Skipjack tuna – General

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

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

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

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

Skipjack tuna: Fisheries and catch trends

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

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

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

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

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

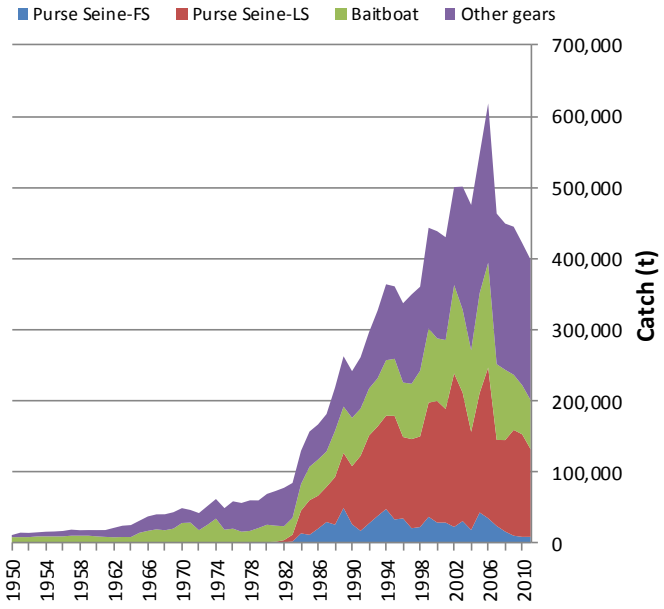


Fig. 2. Skipjack tuna: Annual catches of skipjack tuna by gear (1950–2011) (Data as of September 2012)

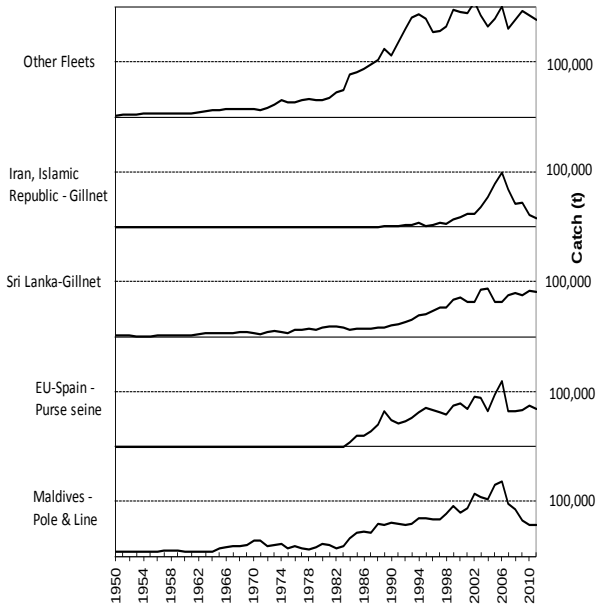


Fig. 3. Skipjack tuna: Catches of skipjack tuna by fleet by year (1950–2011) (Data as of September 2012)

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

Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean (Fig. 2), including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of Iran and Pakistan, and gillnet fisheries of India and Indonesia. In recent years gillnet

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

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

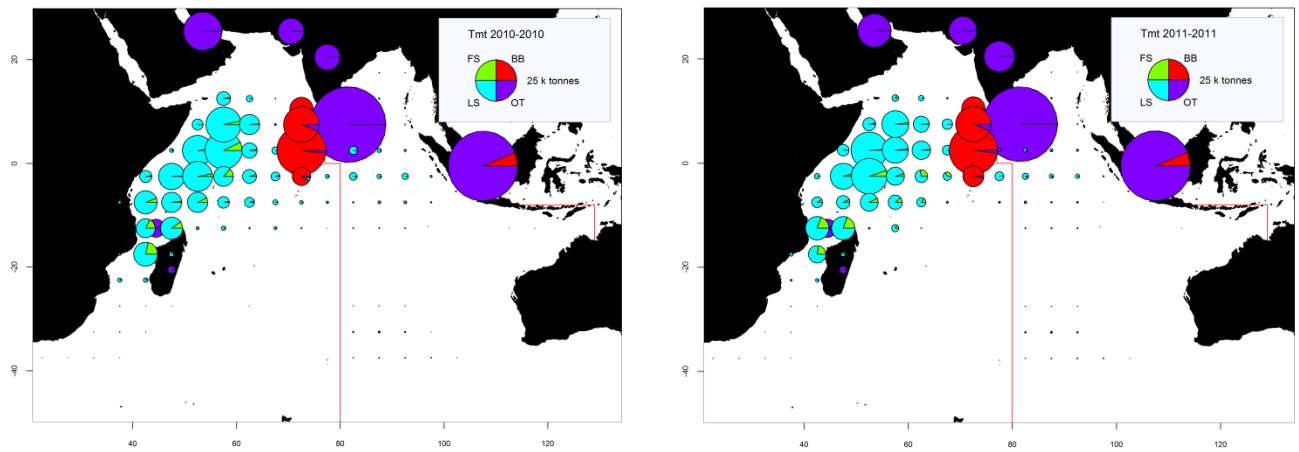


Fig. 4. Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for 2010 (left) ad 2011 (right) by gear. Purse seine free-schools (FS), Purse seine associated-schools (LS), pole-and-line (BB), and other fleets (OT), including longline, drifting gillnets, and various coastal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

Skipjack tuna – uncertainty of catches

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

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

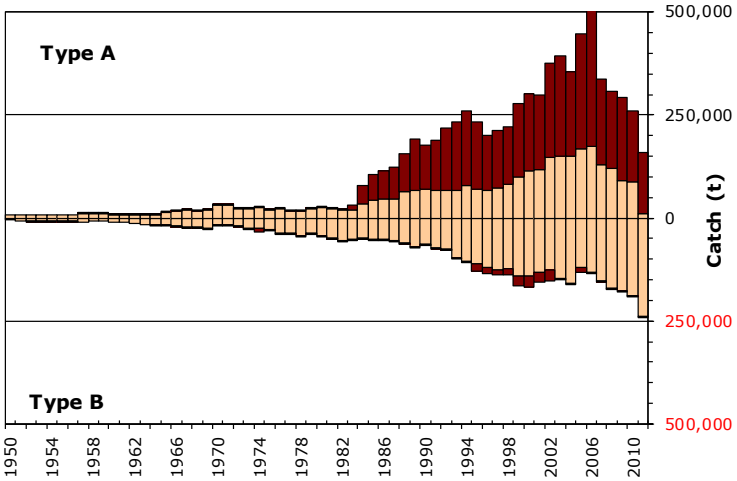


Fig. 5. Skipjack tuna: Uncertainty of annual catch estimates for skipjack tuna (Data as of September 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear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

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

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

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

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

Skipjack tuna – Effort trends

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

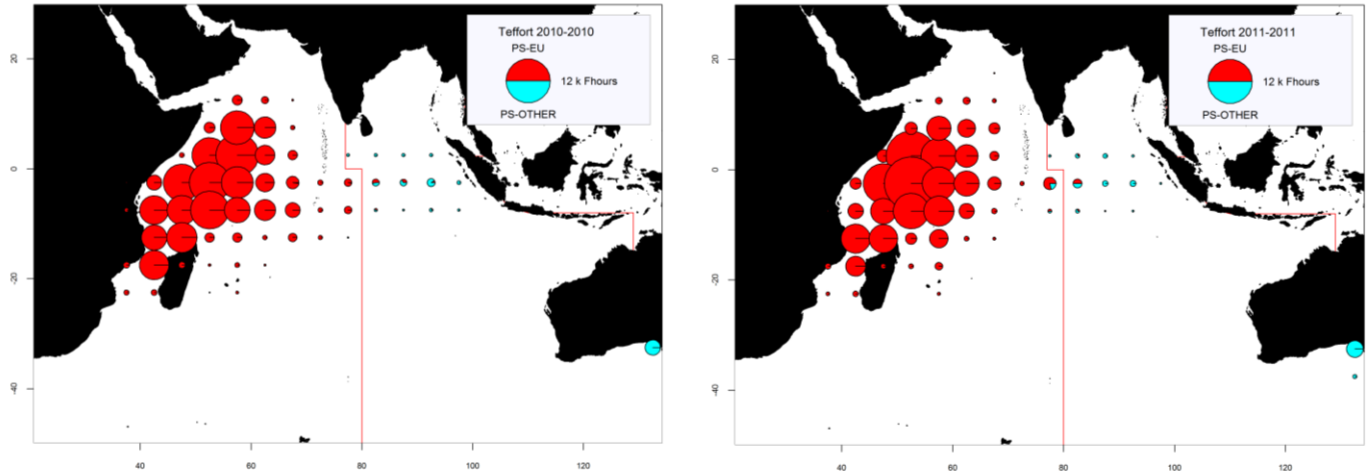


Fig. 6. Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles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

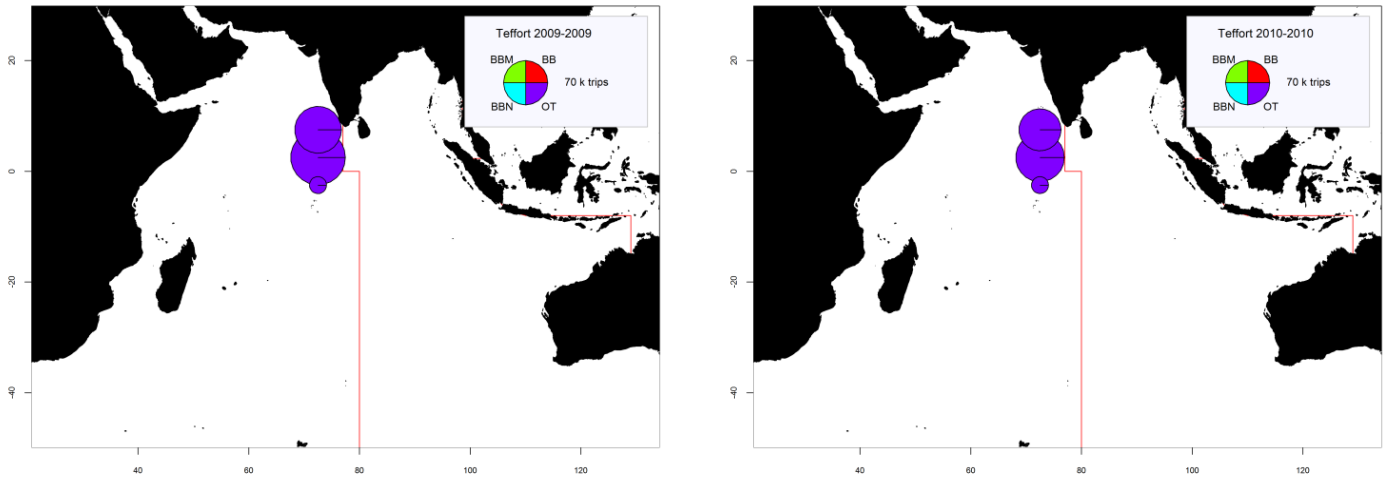


Fig. 7. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of September 2012)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple):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

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

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

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

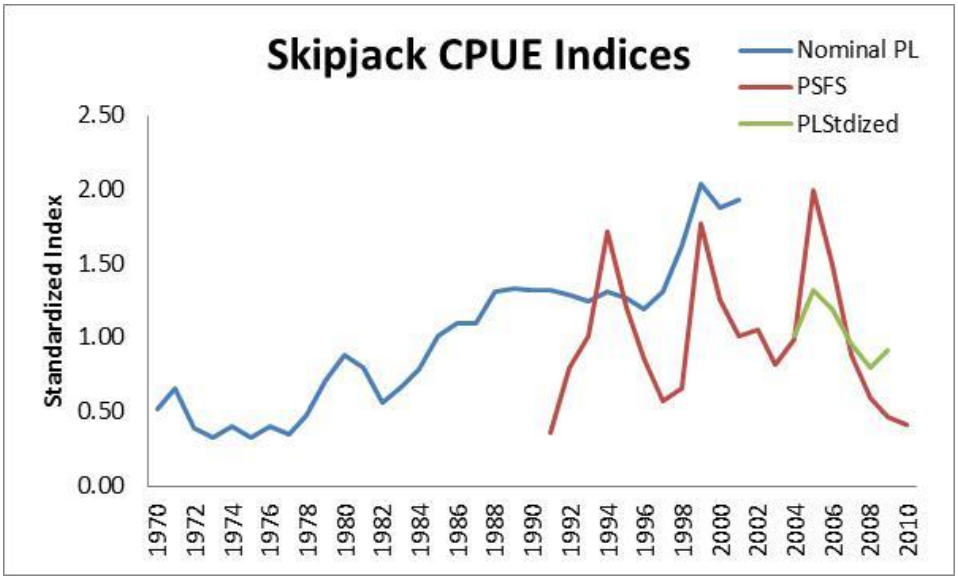


Fig. 8. Skipjack tuna: CPUE Indices based on different fisheries, and methods examined

The EU purse seine free-school CPUE is not a good indicator of the skipjack tuna population abundance as this fishery is seasonal and mainly located in the Mozambique Channel. As such, it would not be as representative as the Maldivian pole-and-line CPUE series of the overall population abundance. The FAD-associated school purse seine fishery should be used in future assessments which may better represent the abundance index trends of the population.

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

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

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

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

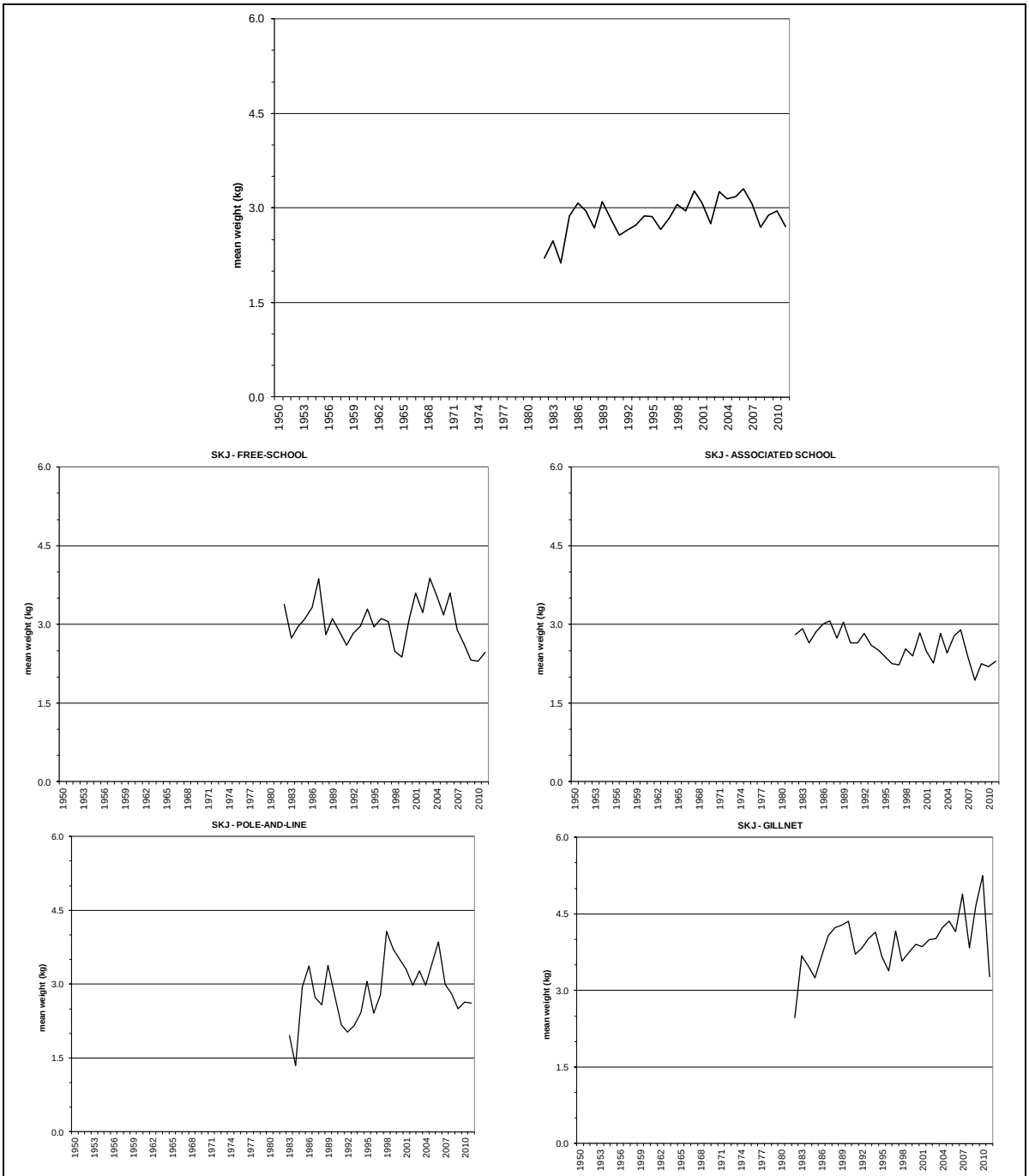


Fig. 9. Skipjack tuna: Changes in average weight (kg) of skipjack tuna from 1950 to 2011 – all fisheries combined (top) and by main fleet (Data as of September 2012)

Skipjack tuna – Tagging data

A total of 101,212 skipjack (representing 50.2% of the total number of fish tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of them, 77.4%, were released during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were released around Seychelles, in the Mozambique Channel and off the coast of Tanzania, between May 2005 and September 2007 (Fig. 10). The remaining were tagged during small-scale tagging projects, and by other institutions with the support of IOTC, around the Maldives, India, and in the south west and the eastern

Indian Ocean. To date, 15,729 (15.5%), have been recovered and reported to the IOTC Secretariat. Around 78% of the recoveries were from the purse seine fleets operating from the Seychelles, and around 20% by the pole-and-line vessels mainly operating from the Maldives. The addition of the data from the past projects in the Maldives (in 1990s) added 14,506 tagged skipjack tuna to the databases, or which 1,960 were recovered mainly in the Maldives.

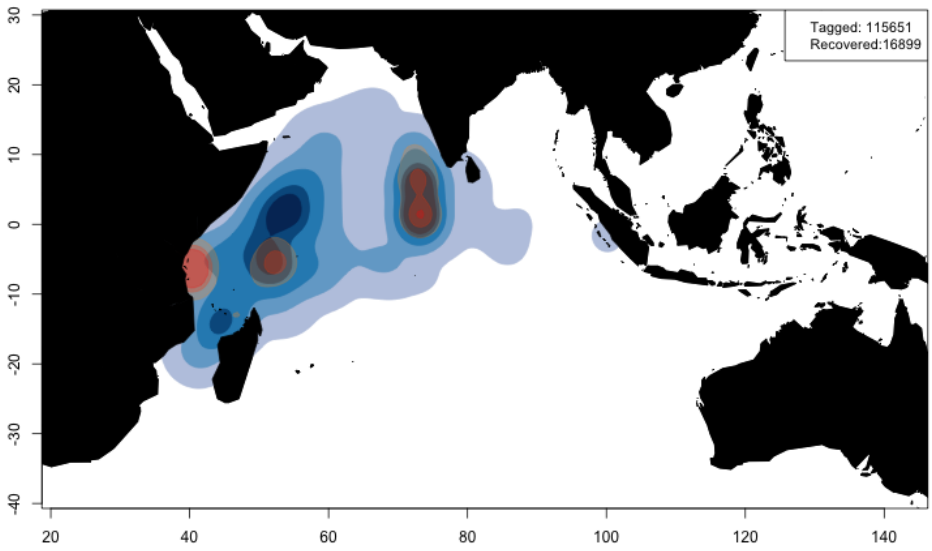


Fig. 10. Skipjack tuna: Densities of releases (in red) and recoveries (in blue) (Data as of September 2012)

STOCK ASSESSMENT

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

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

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

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

model runs were presented.

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

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

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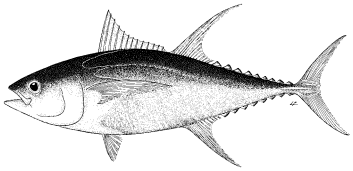
APPENDIX XII
EXECUTIVE SUMMARY: YELLOWFIN TUNA

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



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

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

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

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

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

The following key points should be noted:

- The Maximum Sustainable Yield estimate for the whole Indian Ocean is 344,000 t with a range between 290,000–453,000 t

for MFCL; 320,000 t with a range between 283,000 and 358,000 t for ASPM (Table 1), and annual catches of yellowfin tuna should not exceed the lower range of MSY (300,000 t) in order to ensure that stock biomass levels could sustain catches at the MSY level in the long term.

- Recent recruitment estimated by MFCL is estimated to be considerably lower than the whole time series average. If recruitment continues to be lower than average, catches below MSY would be needed to maintain stock levels. However, although recent recruitment estimated by ASPM are similar to MFCL estimates, the ASPM recruitment trend are estimated to be at a lower level without any declining trend.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
  - **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).

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

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

The decrease in longline and purse seiner effort in recent years has substantially lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality has not exceeded the MSY-related levels in recent years. If the security

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

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

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

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

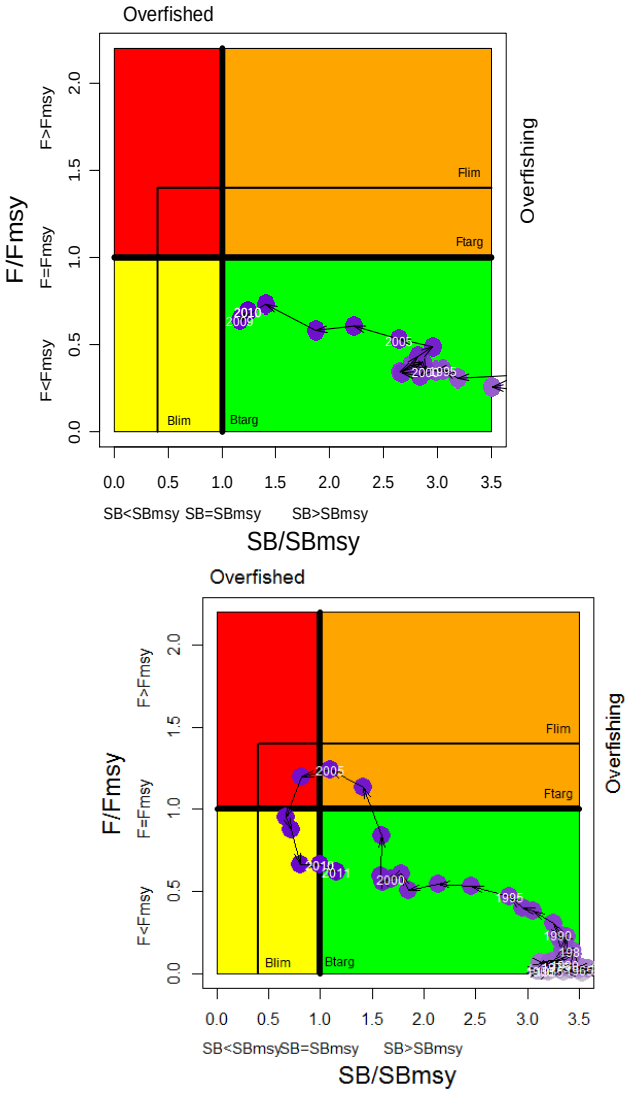


Fig. 1. Yellowfin tuna: MULTIFAN-CL Indian Ocean yellowfin tuna stock assessment Kobe plot. Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1972–2010 for a steepness value of 0.8. The left panel is output obtained from the base case run in MFCL.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

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

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

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

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

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

FISHERIES INDICATORS

General

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

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

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

Sources: Froese & Pauly 2009

Yellowfin tuna – Fisheries and catch trends

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

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

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

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

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

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

The longline fishery (Table 4; Figs. 2 and 3) started in the early 1950's and expanded rapidly over throughout the Indian Ocean. Longline gear mainly catches large fish, from 80 to 160 cm FL, although smaller fish in the size range 60 – 100 cm (FL) have been taken by longliners from Taiwan,China since 1989 in the Arabian Sea. The longline fishery targets several tuna species in different parts of the Indian Ocean, with yellowfin tuna and bigeye tuna being the main target species in tropical waters. The longline

fishery can be subdivided into a deep-freezing longline component (large scale deep-freezing longliners operating on the high seas from Japan, Korea and Taiwan,China) and a fresh-tuna longline component (small to medium scale fresh tuna longliners from Indonesia and Taiwan,China). The total longline catch of yellowfin tuna reached a maximum in 1993 (≈200,000 t). Catches between 1994 and 2004 fluctuated between 85,000 t and 120,000 t. The second highest catches of yellowfin tuna by longliners were recorded in 2005 (≈150,000 t). As was the case for the purse seine fleets, since 2005 longline catches have declined with current catches estimated to be at around 45,000 t, representing a three-fold decrease from the catches taken in 2005. The SC believes that the recent drop in longline catches could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean, which has led to a marked drop in the levels of longline effort in one of the core fishing areas of the species (Fig. 5).

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

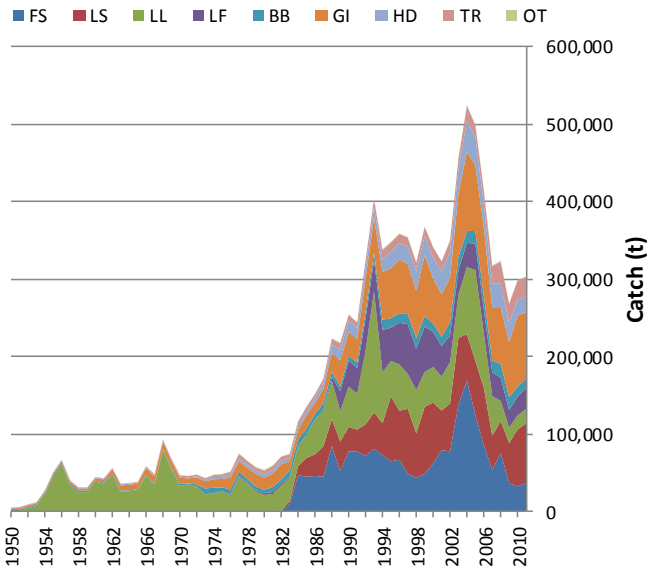


Fig. 2. Yellowfin tuna: Catches of yellowfin tuna by gear by year estimated for the WPTT (1950–2011). Data as of September 2012. Purse seine free-school (FS); Purse seine associated school (LS); Deep-freezing longline (LL); Fresh-tuna longline (LF); Pole-and-Line (BB); Gillnet (GI); Hand line (HD); Trolling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

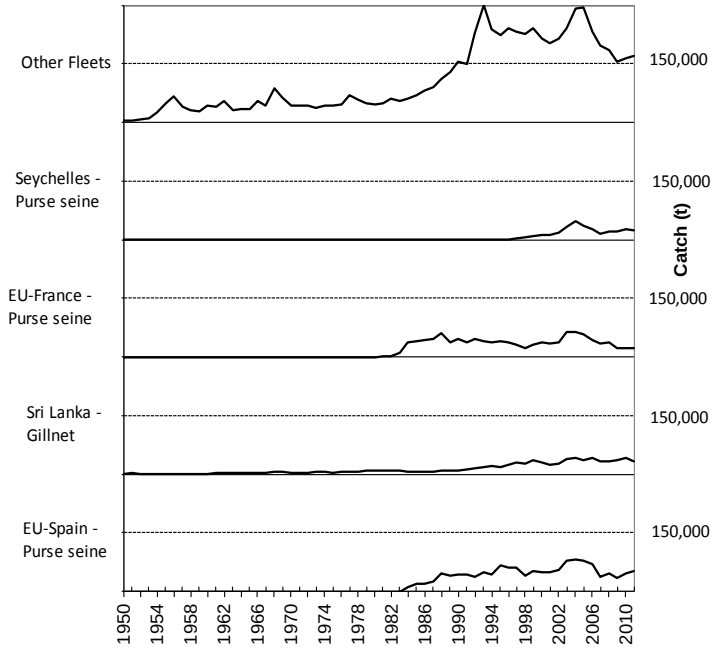


Fig. 3. Yellowfin tuna: Catches of yellowfin tuna by fleet by year estimated for the WPTT (1950–2011) (Data as of September 2012)

Yellowfin tuna catches in the Indian Ocean during 2003, 2004, 2005 and 2006 were much higher than in previous years (Fig. 2), while bigeye tuna catches remained at their

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

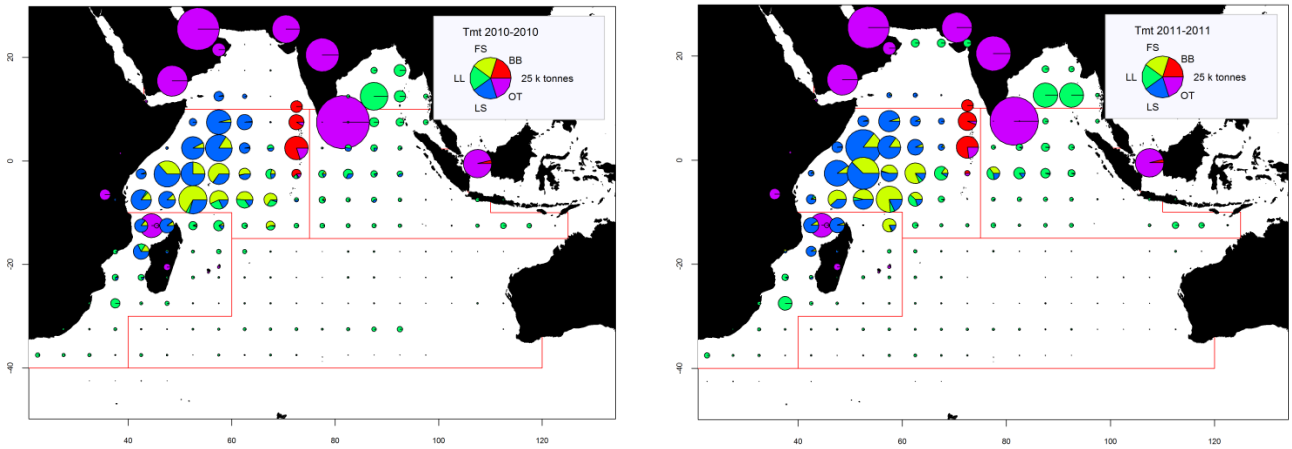


Fig. 4. Time-area catches (total combined in tonnes) of yellowfin tuna estimated for 2010 (left) and 2011 (right) by gear. Longline (LL), Purse seine free-schools (FS), Purse seine associated-schools (LS), pole-and-line (BB), and other fleets (OT), including drifting gillnets, and various coastal fisheries.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

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

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

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

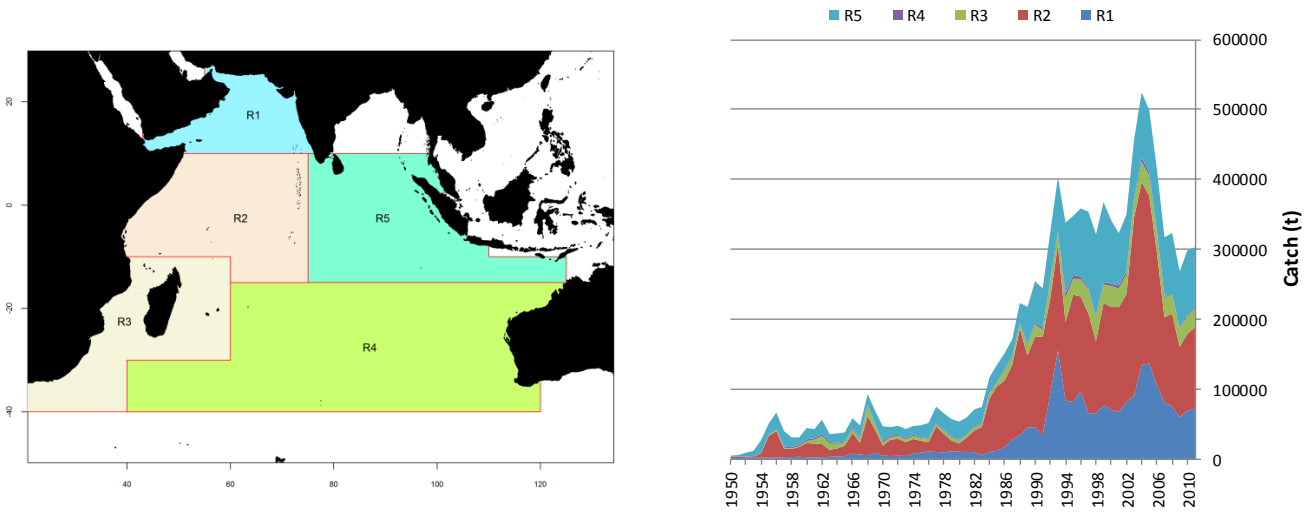


Fig. 5. Yellowfin tuna: Catches of yellowfin tuna by area (left) by year (right) estimated for the WPTT (1950–2011) (Data as of September 2012). Catches outside the areas presented in the Map were assigned to the closest neighbouring area. Arabian Sea (**R1**); Off Somalia (**R2**); Mozambique Channel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

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

Yellowfin tuna – uncertainty of catches

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

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

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

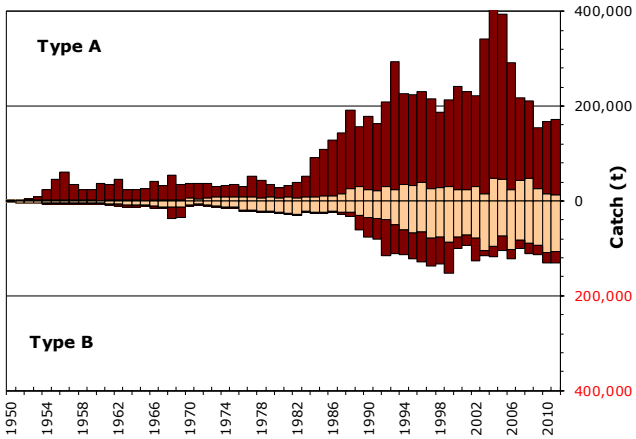


Fig. 6. Yellowfin tuna: Uncertainty of annual catch estimates for yellowfin tuna (Data as of September 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by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

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

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

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

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

Yellowfin tuna – Effort trends

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

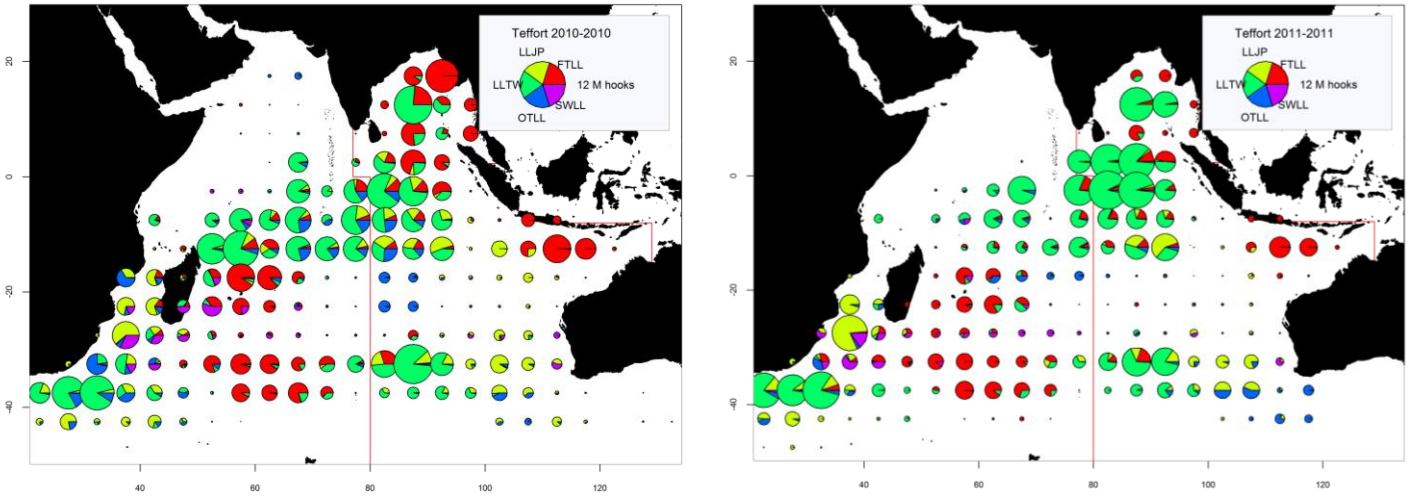


Fig. 7. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise):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

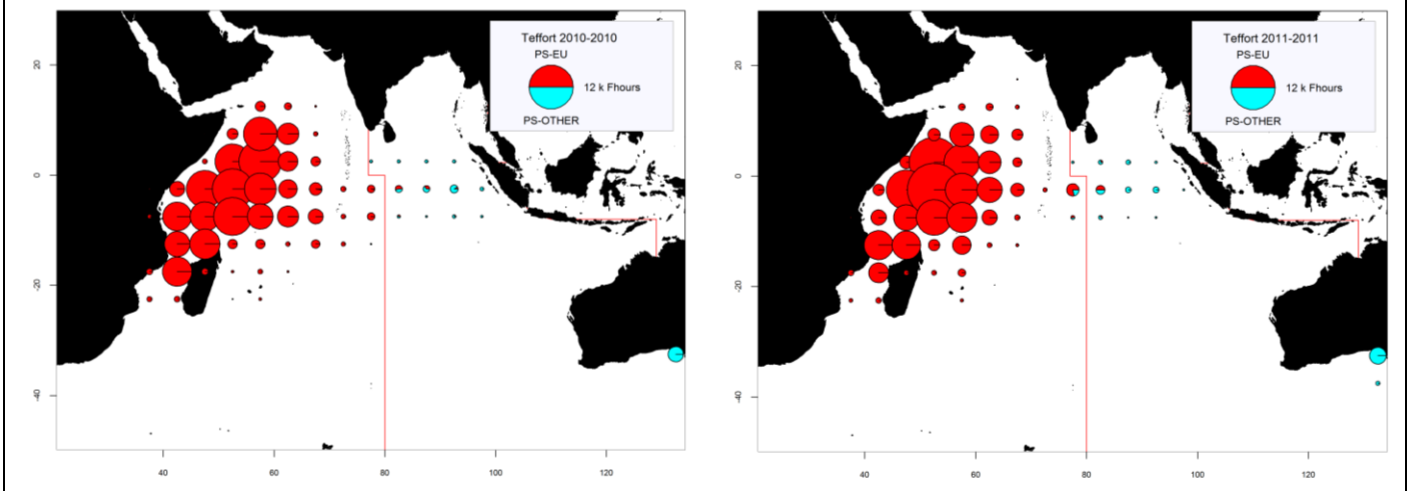


Fig. 8. Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles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

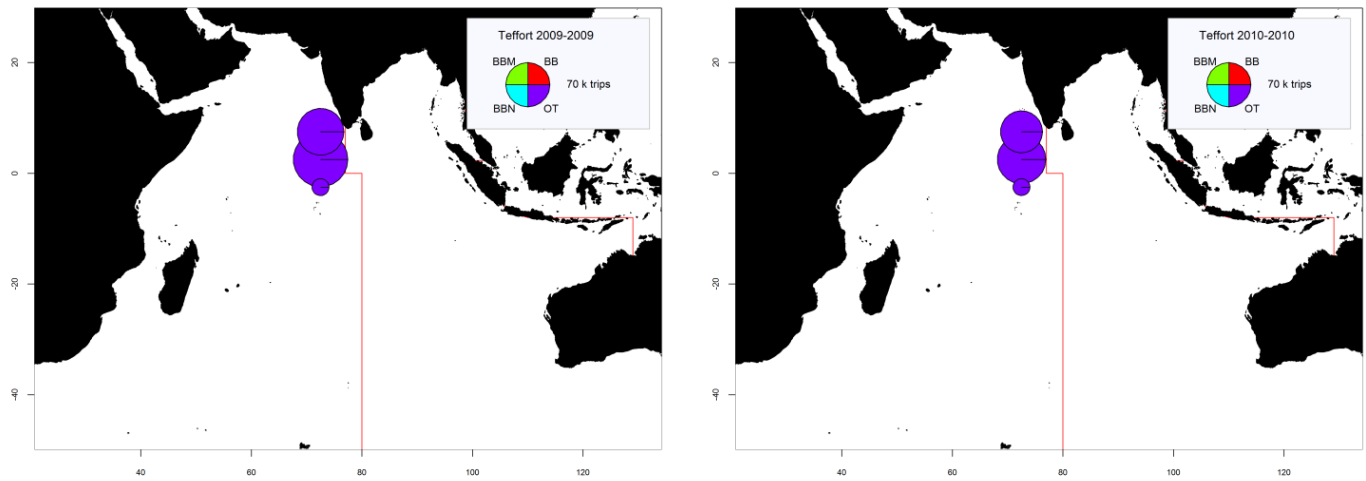


Fig. 9. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of September 2012)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple):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

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

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

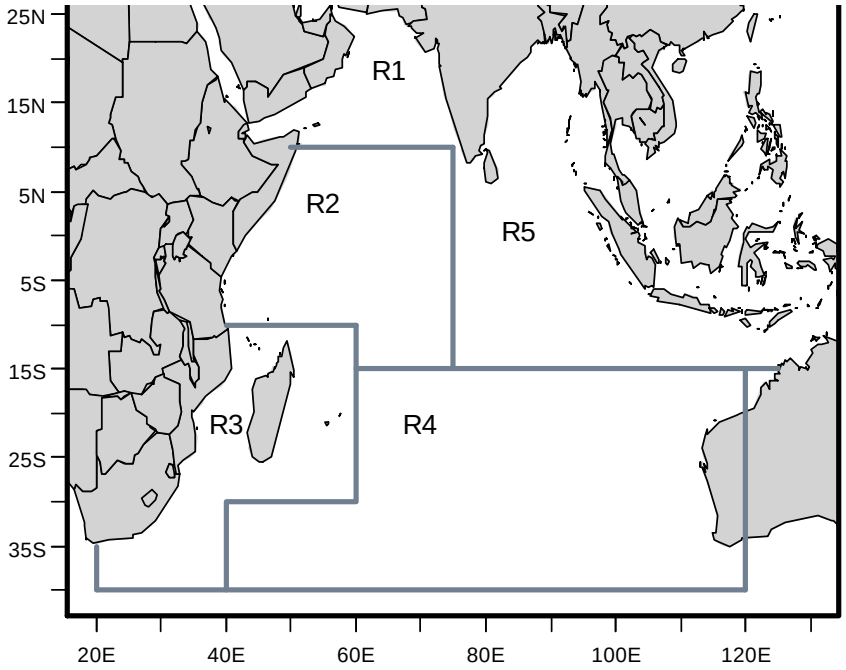


Fig. 10. Spatial stratification of the Indian Ocean for the MFCL assessment model

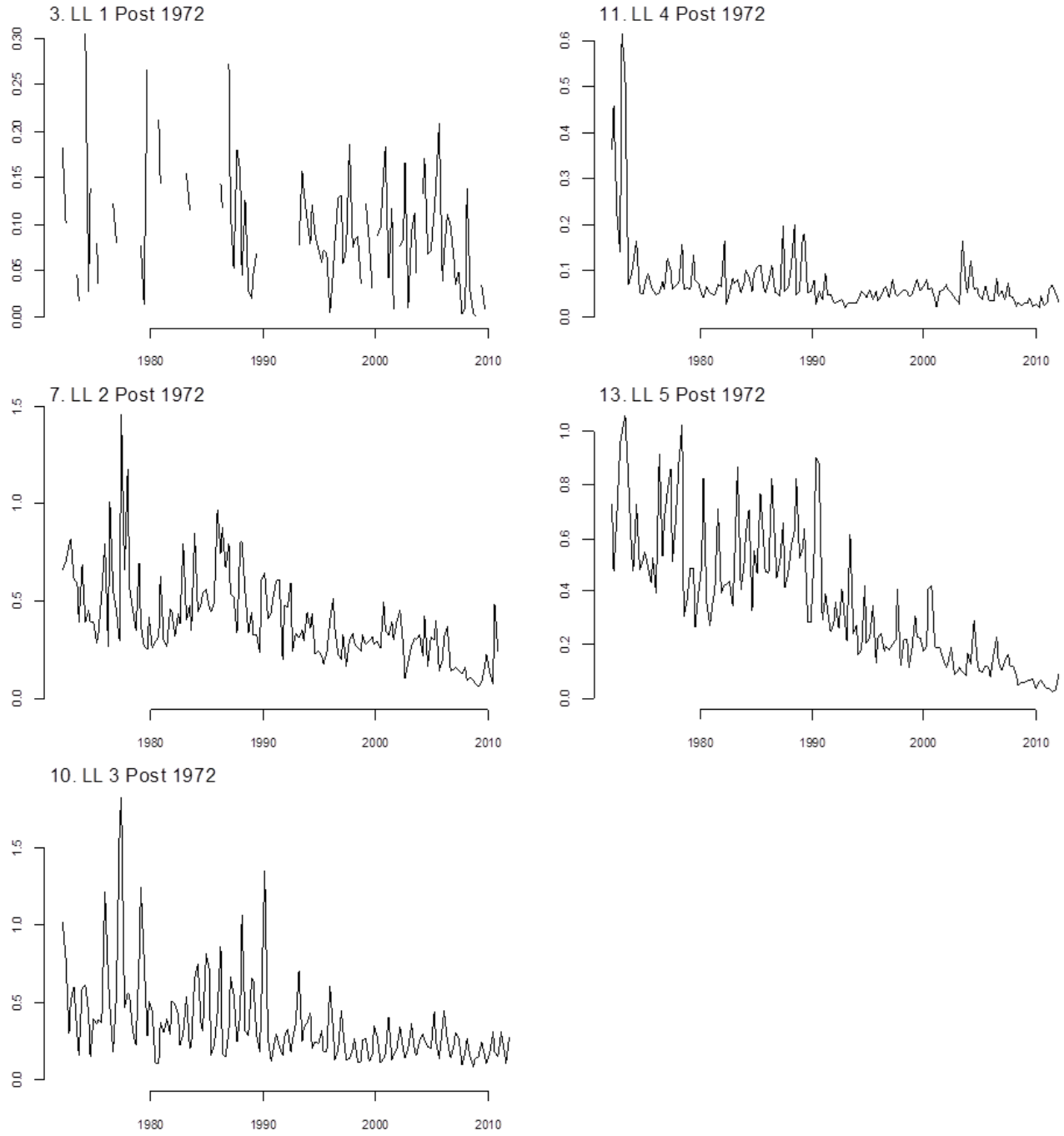


Fig. 11. Yellowfin tuna: Quarterly GLM standardised catch-per-unit-effort (CPUE) for the principal longline fisheries (LL 1 to 5) scaled by the respective region scalars.

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

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

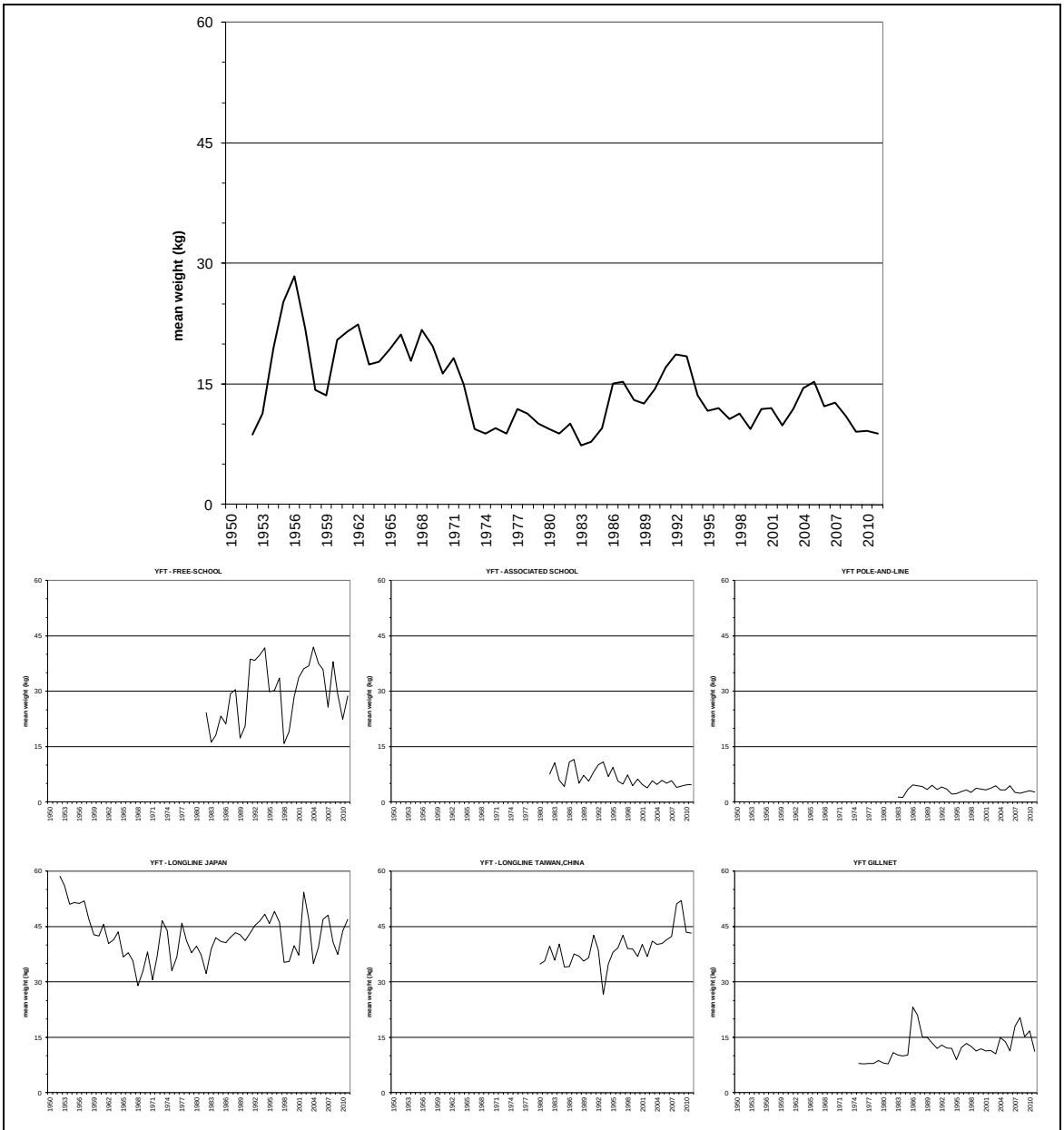


Fig. 12. Yellowfin tuna: Changes in average weight (kg) of yellowfin tuna from 1950 to 2011 – all fisheries combined (top) and by main fleet (Data as of September 2012)

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

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

Yellowfin tuna – tagging data

A total of 63,328 yellowfin tuna (representing 31.4% of the total number of specimens

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

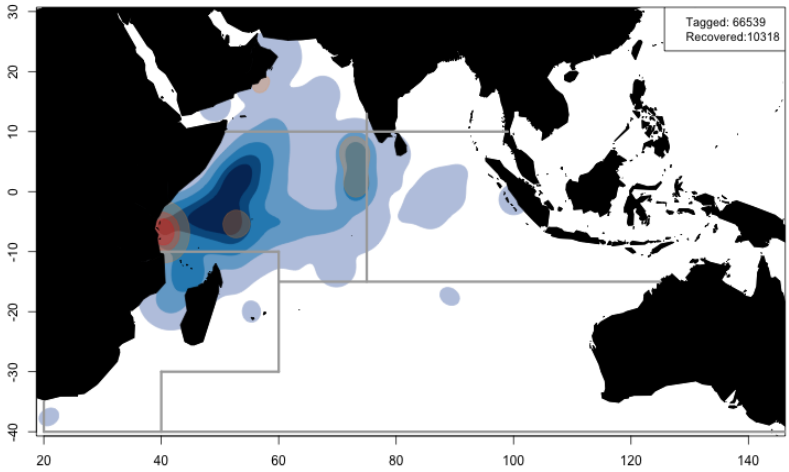


Fig. 13. Yellowfin tuna: Densities of releases (in red) and recoveries (in blue). The red line represents the stock assessment areas (Data as of September 2012)

STOCK ASSESSMENT

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

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

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

- The main features of the model in the 2012 assessment included a fixed growth curve (with variance) with an inflection, an age-specific natural mortality rate profile (M), the modelling of 25 fisheries including the separation of two purse seine fisheries into three time blocks, using logistic and cubic spline functions to estimate longline selectivities, separation of the analysis into five regions of the Indian Ocean as well as the three steepness parameters for the stock recruitment relationship (h=0.7, 0.8 and 0.9).

- In addition to another year of data, the 2012 assessment included several changes to the previous assessment: the longline CPUE indices were modified (Japanese updated with latest year which included information about latitude and longitude in the standardisation process for Regions 2–5 was supplied except for Region 2 in 2011; no update was available for the Taiwan,China index for Region 1; All of the analyses were conducted using a new version of MFCL provided by the Secretariat of the Pacific Community.

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

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

- The model estimates a strong temporal decline in recruitment and in biomass within the eastern equatorial region (Region 5). This declining trend in recruitment is driven by the decline in the Japanese longline CPUE indices over the model period. There are limited data to reliably estimate recruitment in the region as the size data included in the model are considered uninformative. Consequently, the resulting recruitment and biomass trends may be unreliable. A participant noted that during this period the Taiwan,China longline fleet, a fleet more active than the Japanese longline fleet in this area, showed a stable nominal CPUE trend and high stable catches.
- The model estimates limited movement between the two equatorial regions. This is consistent with the low number of tag recoveries from the eastern equatorial region, an area from where recovery rates are difficult to estimate but probably low. Nonetheless, the low movement rate is consistent with the oceanographic conditions that prevailed during the main tag recovery period (see papers IOTC–2012–WPTT14–9 and 31). The model assumes a constant movement pattern throughout the model period and estimated movement pattern may not persist under different oceanographic conditions.
- Similarly, movement rates between the western equatorial region and the Arabian Sea (Region 1) were estimated to be very low. Although various recoveries crossing the border limit of 10°N line in both directions may suggest a higher mixing rate, the observation is consistent with the tag release/recovery observations (few tag releases from Region 2 were recovered in Region 1 and vice versa). However, reporting rates of most fisheries operating in Region 1 are estimated to be low and this may underestimate the low mixing rate observed by the model.
- The model estimated that fishing mortality rates within the western equatorial region did not increase during 2002–2006 period to the extent that would be anticipated given the large increase in catch from the purse seine fishery during that period (on average 470,000 t: well above all estimated MSY values). The large increase of catch, previously described due mainly to a catchability increased, will suggest an expected corresponding increase in fishing mortality well above the level of F_{MSY}. The explanation for this is that the longline

standardised CPUE remained relatively constant during the period of high purse seine catch and in the subsequent years. To fit to the longline CPUE indices during this period the model increases the level of recruitment in the period that precedes the high purse seine catches which may be considered unreliable. This recruitment pattern was evident in all model options. However, further examination of the size frequency data is warranted to confirm that this recruitment trend is consistent with the other fisheries data. The status of the yellowfin tuna stock assessed by the model during the period of very high catches (2003–2006), estimated to be in the middle of the green area of the Kobe plot, was questioned by some participants.

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

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

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

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

multi-gear/multi-species fishery or the practicalities of substantially changing the harvest pattern.

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

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

LITERATURE CITED

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

APPENDIX XIII
EXECUTIVE SUMMARY: SWORDFISH

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

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

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

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

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

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

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

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is 29,900–34,200 t (range of best point estimates from Table 2) and annual catches of swordfish should not exceed this estimate.
- if the recent declines in effort continue, and catch remains substantially below the estimated MSY of 30,000–34,000 t, then management measures are not required which would pre-empt current resolutions and planned management strategy evaluation. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.
- the Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.

- advice specific to the southwest region is provided below, as requested by the Commission.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
    a. **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, but below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
    b. **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).

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

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

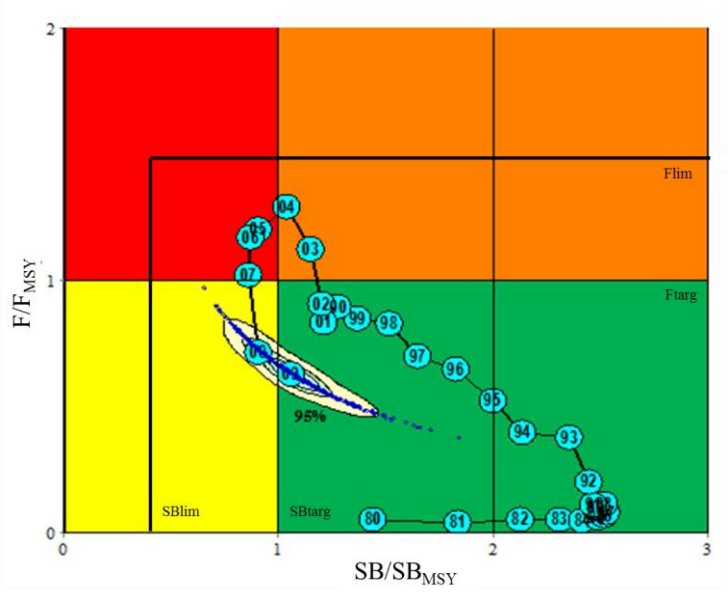


Fig. 1. Swordfish: ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2010. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference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

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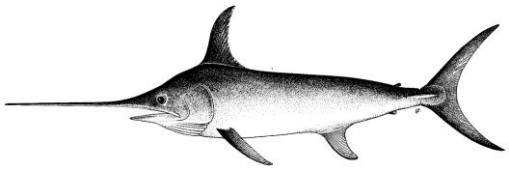


Status of the southwest Indian Ocean swordfish (SWO: *Xiphias gladius*) resource

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

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

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

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

SOUTHWEST INDIAN OCEAN – MANAGEMENT ADVICE

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

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

reversing the rebuilding trend if there is any increase in catch in this region (Table 4). The following key points should be noted:

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

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

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

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

Swordfish in the Indian Ocean is currently subject to a single direct conservation and management measure adopted by the Commission: Resolution 12/11 *On The implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties.* This Resolution applies a freezing of fishing capacity for fleets targeting swordfish in the Indian Ocean to levels applied in 2007. The Resolution limits vessels access to those that were active (*effective presence*) or under

construction during 2007, and were over 24 metres overall length, or under 24 meters if they fished outside the EEZs. At the same time the measure permits CPCs to vary the number of vessels targeting swordfish, as long as any variation is consistent with the national fleet development plan submitted to the IOTC, and does not increase effective fishing effort. This Resolution is effective for 2012 and 2013.

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

FISHERIES INDICATORS

General

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

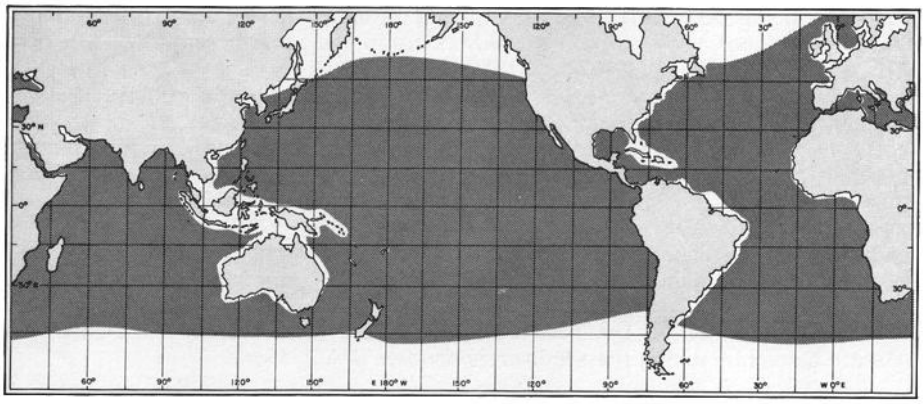


Fig. 2. Swordfish: The worldwide distribution of swordfish (Source: Nakamura 1984)

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

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

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

Swordfish: Catch trends

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

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

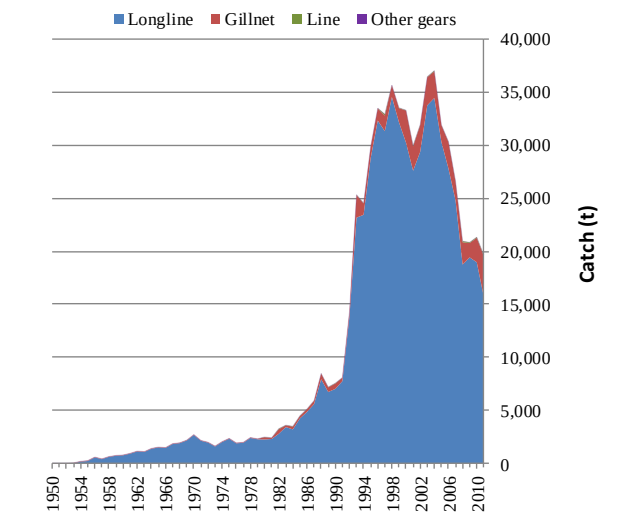


Fig. 3 Swordfish: Catches of swordfish per gear and year recorded in the IOTC database (1960–2011)

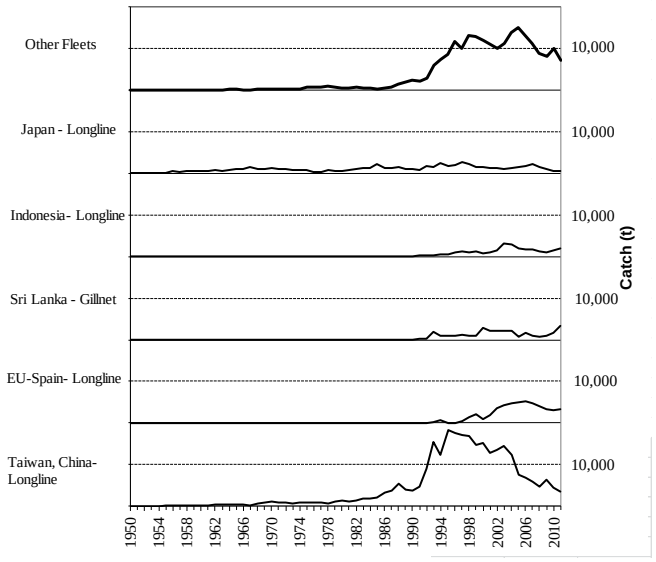


Fig. 4. Swordfish: Catches of swordfish by fleet recorded in the IOTC database (1960–2011)

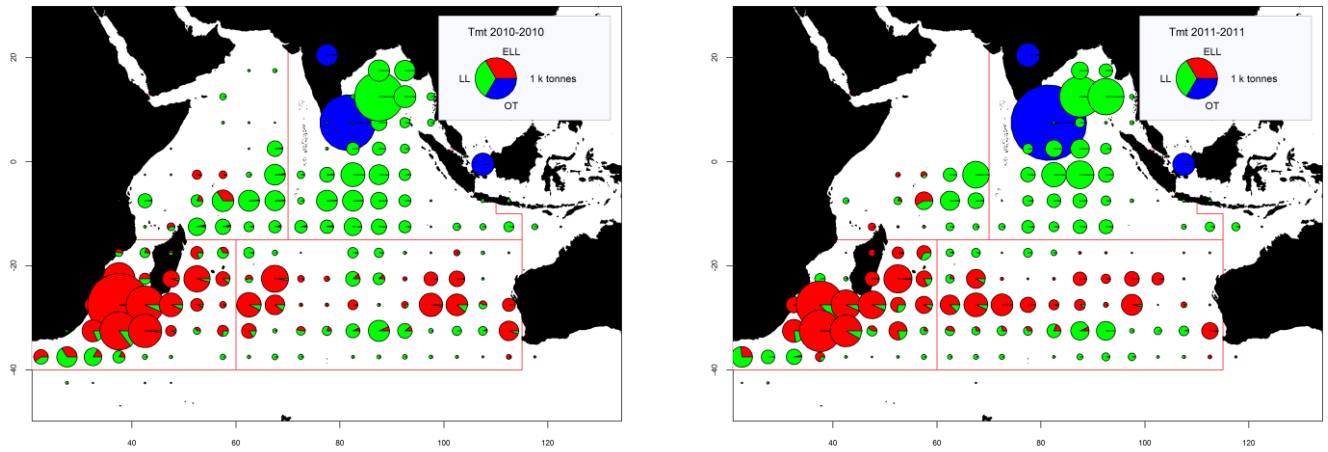


Fig. 5a–b. Swordfish: Time-area catches (total combined in tonnes) of swordfish as reported for the longline fleets of Japan (JPN), Taiwan,China (TWN), and EU-Spain (ESP), the latter directed at swordfish, for 2010 and 2011 by type of gear. Red lines represent the boundaries of the areas used for the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

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

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

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

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

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

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

Swordfish: Uncertainty of time–area catches

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

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

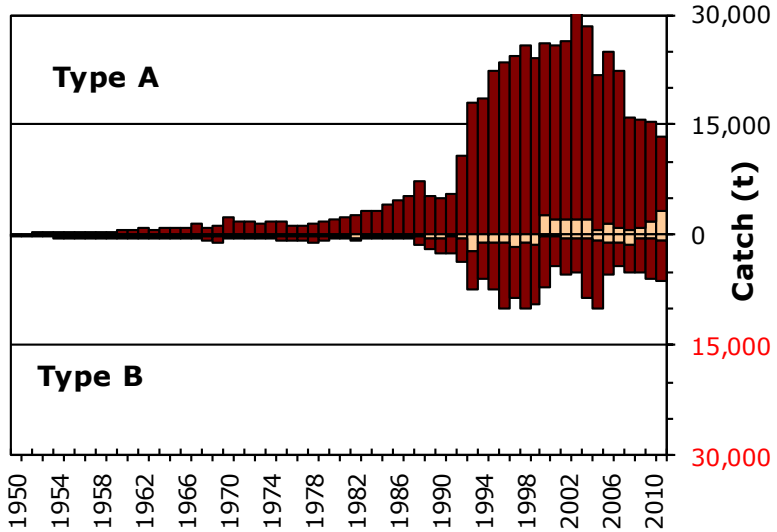


Fig. 6. Swordfish: Uncertainty of annual catch estimates for swordfish (Data as of October 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species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

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

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

- Average fish weight (Fig. 7) can be assessed for several industrial fisheries although they are incomplete or poor quality for most fisheries before the early-80s and in recent years (low sampling coverage and time-area coverage of longliners from Japan). The average weights of swordfish are variable but show no clear trend. It is considered encouraging that there are no clear signals of declines in the size-based indices, but these indices should be carefully monitored, as females mature at a relatively large size, therefore, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.

- Catch-at-Size(Age) data are available but the estimates are thought to have been compromised for some years and fisheries due to:
  - the uncertainty in the catches of swordfish for the drifting gillnet fisheries of Iran and the fresh-tuna longline fishery of Indonesia.
  - the total lack of size data before the early-70s and poor coverage before the early-80s and for most artisanal fisheries (Pakistan, India, Indonesia).
  - the paucity of size data available from industrial longliners since the early-1990s (Japan, Philippines, India and China).
  - the lack of time-area catches for some industrial fleets (Indonesia, India, NEI).
  - the paucity of biological data available, notably sex-ratio and sex-length-age keys.

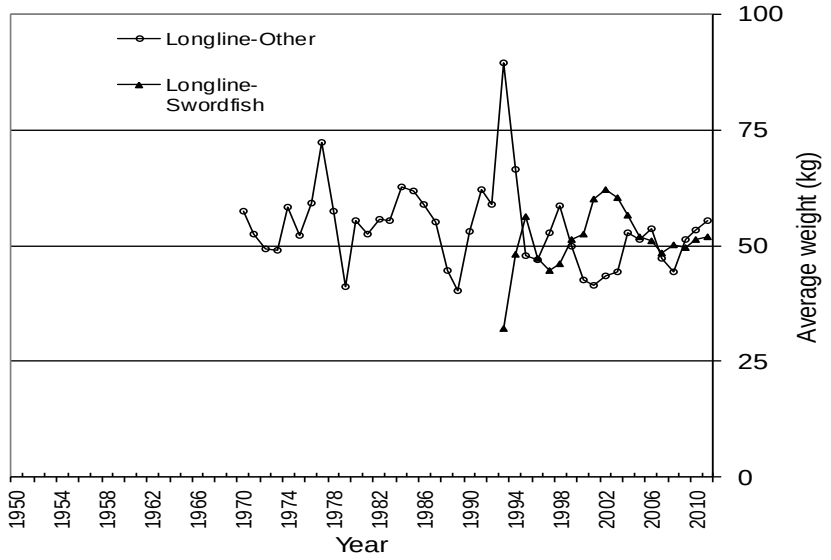


Fig. 7. Swordfish: Average weight of swordfish (kg) estimated from the size samples available for longliners targeting swordfish (1993–2011) and other longliners (1970–2011). NOTE: Average weights are shown only for years in which 300 or more specimens were sampled for length

Swordfish: Effort trends

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

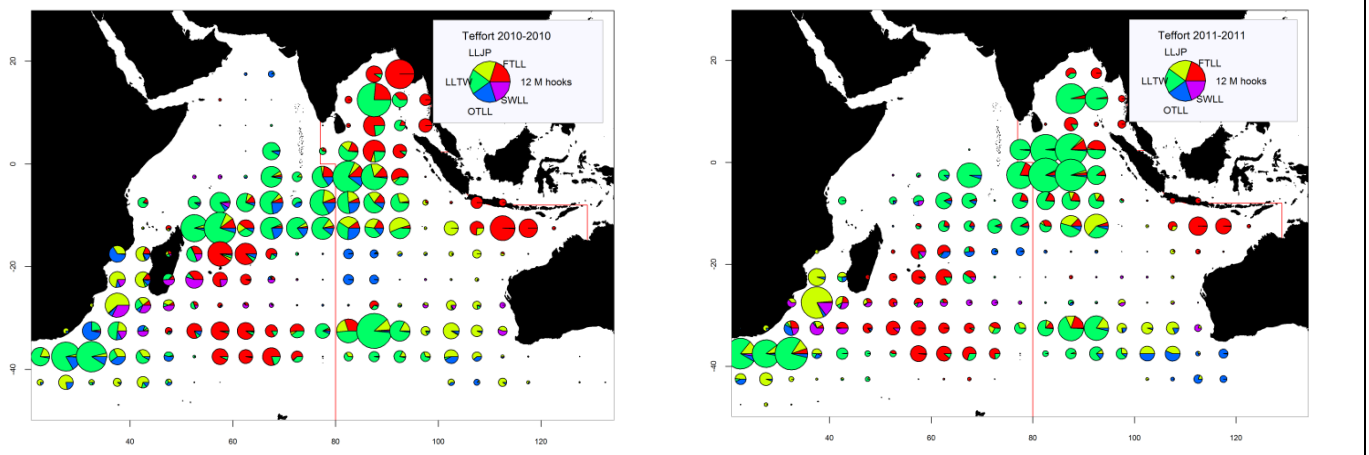


Fig. 8. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise):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

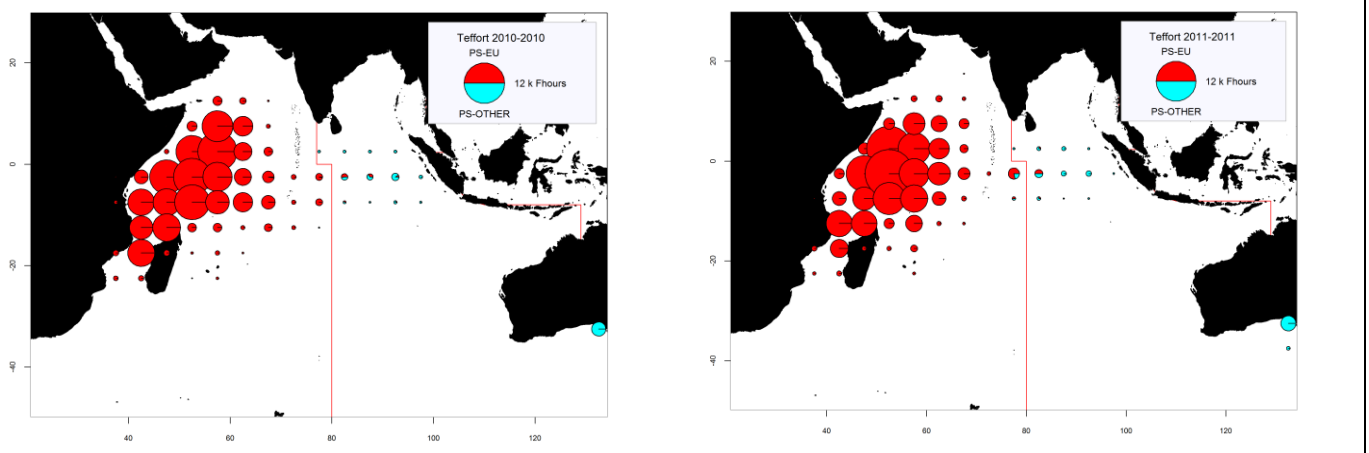


Fig. 9. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles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

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

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

individual analyst to determine and justify.

- Japan data (1980–2009): Series 3.2 from document IOTC–2011–WPB09–14, which includes fixed latitude and longitude effects, plus environmental effects.
- Taiwan,China data (1995–2009): Model 10 from document IOTC–2011–WPB09–23, which includes fixed latitude and longitude effects, plus environmental effects.
- EU,Spain data (2001–2009): Series 5 from document IOTC–2011–WPB09–23, calculated for the southwest area only (includes sub-region factors and species ratio factors) area and run 1 for the assessment of whole Indian Ocean.
- EU,La Reunion data (1994–2000): Same series as last year (IOTC–2010–WPB–03).

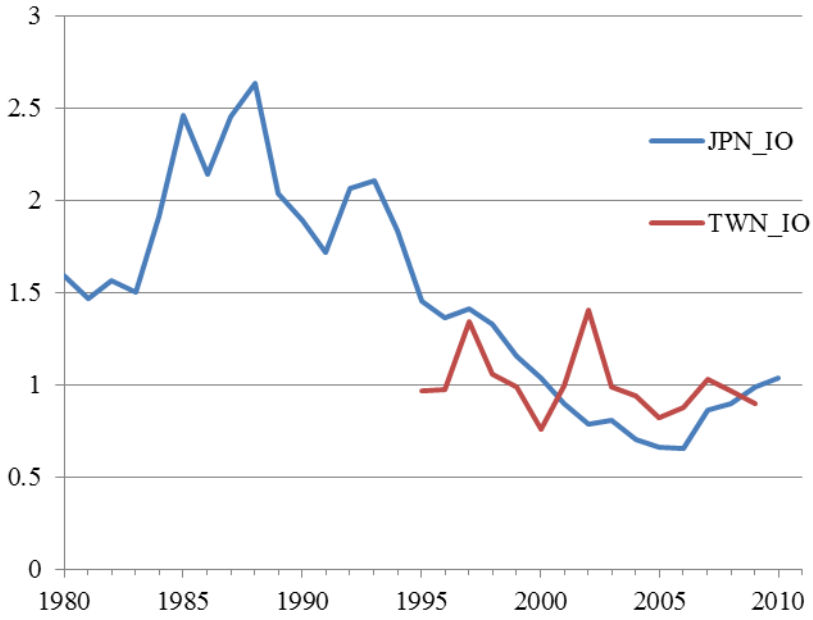
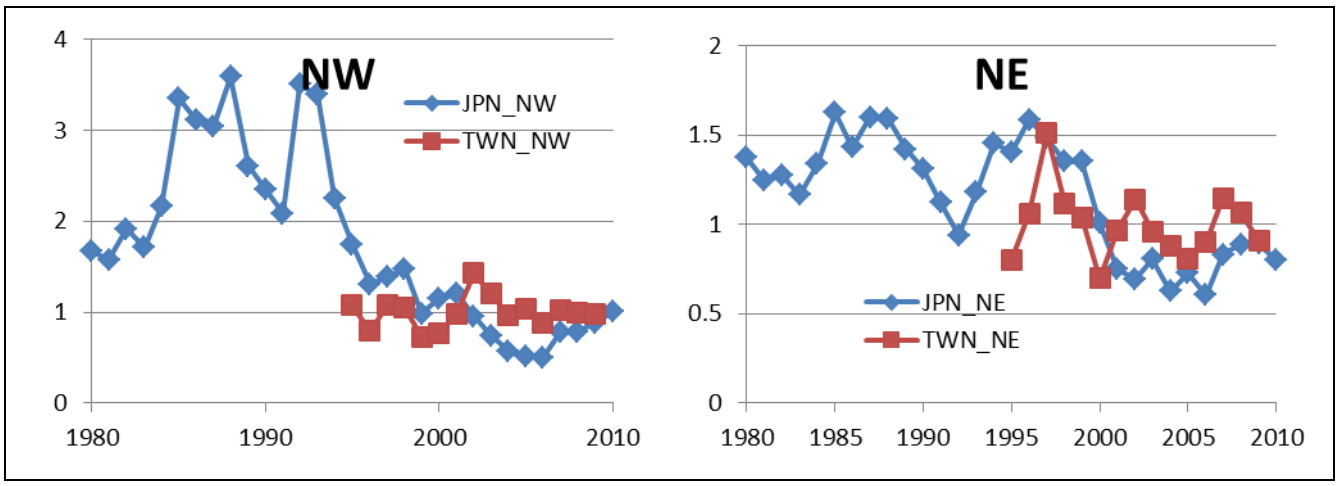


Fig. 10. Swordfish: Aggregate Indian Ocean CPUE series for swordfish. Series have been rescaled relative to their respective means from 1995–2010



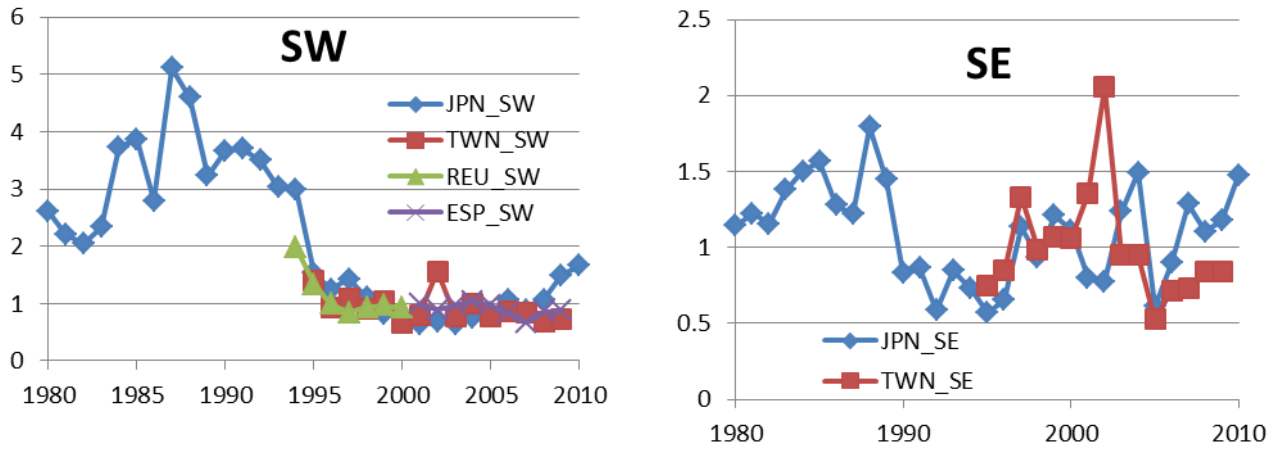


Fig. 11. Swordfish: CPUE series for Indian Ocean swordfish assessments by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods). NW – north-west; SW – south-west; NE – north-east; SE – south-east Indian Ocean.

STOCK ASSESSMENT

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

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

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

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

TABLE 8. Swordfish: Key management quantities from the 2011 Stock Synthesis 3 assessments, for the aggregate and southwest Indian Ocean. Values represent the 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
2011catch estimate	19,631 t	6,559 t
Mean catch from 2007–2011	21,870 t	6,939 t
MSY	29,900– 34,200	7,100 t–9,400 t
Data period used in assessment	1951–2009	1951–2009
F_{2009}/F_{MSY}	0.50 (0.23–1.08)	0.64 (0.27–1.27)
B_{2009}/B_{MSY}	–	–
SB_{2009}/SB_{MSY}	1.59 (0.94–3.77)	1.44 (0.61–3.71)
B_{2009}/B_0	–	–
SB_{2009}/SB_0	0.35 (0.22–0.42)	0.29 (0.15–0.43)
$B_{2009}/B_{0, F=0}$	–	–
$SB_{2009}/SB_{0, F=0}$	–	–

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