出國報告（出國類別：其他）

參加印度洋鮪類委員會（IOTC）第七屆熱帶鮪類小組及第一屆混獲小組會議出國報告

服務機關：行政院農業委員會漁業署
姓名職稱：張水鍇 / 科長、王勝平 / 替代役
派赴國家：泰國普吉島
出國期間：中華民國九十四年七月十七日至七月二十四日
報告日期：中華民國九十四年十月四日

摘　要

一、　本次會議特別感謝我國第一次提供全系列歷史資料，使今年能更深入分析黃鰭鮪資源狀況，且對我國資料品質之討論，亦多為正面，與往年情況明顯有別。惟仍有部分不足之處，仍待我國持續加強統計資料蒐集與查核系統，以改觀各國對我國資料正確性之印象。

二、　日本最近曾於許多國際會議中以我國大目鮪漁獲比例與日本趨勢不同為由，質疑我國資料。然日本於本次會議發表之報告，承認其漁業確有目標魚種轉移之現象，此為造成兩國漁獲比例不同之主因。此報告與我國和歐盟合作之分析結果相符，並澄清對我國資料之誤解。

三、　我國於 1992-93 年在阿拉伯海曾有巨量的黃鰭鮪漁獲，十幾年後，歐盟及日本漁業在西印度洋區再現高產量，我國今年亦在阿拉伯海再度出現豐收情況，此亦為本次會議之重點。初步認為環境異常、圍網漁捕效率增加、以及補充群增加，同為造成之主因。

四、　有關黃鰭鮪資源狀況，資源評估結果一致認為，1999 至 2002 年漁獲量就已接近或超出最適水準，而 2003-04 年漁獲量則已大幅超過，因此會中建議未來的漁獲量或努力量皆不應超出 1999 年至 2002 年間的水準，除非有很大量的補充群，而此點仍待確定。

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壹、目的

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

印度洋為我國鮪釣漁船主要作業漁場之一，近年來我國在該洋區作業的中大型鮪釣船達 300 餘艘，年漁獲量達十萬公噸，位居各國前茅。我國於 1992-93 年在阿拉伯海曾有巨量的黃鰭鮪漁獲，十幾年後，歐盟及日本漁業在西印度洋區再現高產量，我國今年亦在阿拉伯海再度出現豐收情況，此亦為本次會議之重點。此外，混獲亦為近年來世界各漁業資源管理組織十分關注的重要議題。由於目前各國際組織為達資源永續利用之目標，正種極加強對各魚種資源的管理，並以漁獲配額為管理手段。因此為避免影響我國漁船於印度洋作業權益，並善漁業國之責任、及獲取各國支持我國參與 IOTC 之立場，我國乃派員參加本次會議。

貳、會議時地、代表

本屆熱帶鮪類小組及混獲小組會議會議於泰國普吉島召開，本屆會議含主辦單位安排之行程為七月十八日至二十三日。熱帶鮪類小組會議由小組主席西班牙 Pilar Pallares 博士主持，混獲工作小組會議則由澳洲籍科學家擔任主席。出席者包括我國、日本、西班牙、法國、澳洲等三十餘位科學家，我國代表為漁業署遠洋漁業組資源評估科張水鍇科長與替代替王勝平博士，參加全程會議。

參、工作紀要

➢ 七月十八日至七月十九日

一、有關我國資料：

（一） 本日上午會議主要由秘書處報告統計資料情形，其中對我國資料有多次討論。秘書處特別強調，今年統計資料之最大改善為取得我國之歷年月別加總資料（TASK2）及體長資料。科學委員會英籍主席亦發言，肯定我國的資料提供，使今年會議能更深入分析黃鰭鮪資源狀況。

（二） 惟秘書處隨後說明，其使用我國提供之各項資料計算大目鮪及黃鰭鮪平均體重，發現有些歧異度很大。我代表說明，秘書處所計算之三條曲線中，其中被認為歧異度很大的那一條，為對我國資料之誤解，不具意義，其餘兩條趨勢則相同，甚至比日本資料之差異更小，其變動也與漁業變動相符。主席及秘書處接受我國之澄清。

（三） 歐盟首席科學家接續表示，經使用我國體長資料分析，顯示我國資料與日本資料很像。由於日本體長量測樣本數已經非常稀少，歐盟建議改變50 年來的作法，明年起考慮使用我國資料取代日本，但希望我國能提供更詳細資料，以便作資料的取代。

（四） 日本回應主席之詢問，說明因目前日本船都使用外籍船員，對於國際組織沒有強制要求的體長量測，配合度都不高，未來只能考慮從觀察員資料及採樣資料來補足。我國亦表示，我國漁民亦有相同之報怨，因此未來體長回報率也會下降，目前正考慮可否有其他替代採樣方式。

（五） 除了平均體重及小釣資料（舊問題）外，會中對我國統計資料（品質或提供）無其他質疑，與去年情況顯著不同。部分資料歧異性問題，我代表已先與秘書處討論，將請對外漁協協助釐清；小釣資料問題，則將於會期間與秘書處再進一步討論。

二、 日本目標魚種轉變

（一） 日本於本次會議中發表一篇報告，分析日本印度洋鮪釣漁業近幾年黃鰭鮪漁獲比例增加之原因，認為可能為三原因：(一)日本鮪釣船改變漁場，到黃鰭鮪比較的海區作業；(二)日本改變放鉤深度，有比較高的黃鰭鮪釣獲率；(三)近幾年大目鮪 CPUE 下降、黃鰭鮪反較好，因此船東改變措施，去捕資源量較多的黃鰭鮪。

（二） 日本這篇報告印證我代表去年分析結果，顯示日本近幾年大目鮪漁獲率降低主要並非因大目鮪資源問題，並且日本以此推論我國洗魚並不合理。

（三） 主席及歐盟皆對日本提供這項重要資訊表示肯定與感謝，我代表亦肯定此篇報告之重要性。科學委員會主席則詢問日本，依據此分析，去年日本大目鮪 CPUE 下降是因資源出狀況，還是只是目標魚種的轉移，日本代表則表示無法推論。

三、 黃鰭鮪近幾年之高產量

（一） 我國在 1992-93 年代曾在阿拉伯海有非常高的黃鰭鮪產量，十幾年後，自 2003 年起，歐盟圍網及日本鮪釣在西印度洋區再現高產量，我國今年也在阿拉伯海又出現豐收情況，使得各國關心是氣候或環境異常造成的黃鰭鮪聚集（若此，對資源將是傷害），還是出現很好的補充群（若此，對資源是正面的）？而且，我國當年的高產量與此次是否為同性質？

（二） 日本發表一篇報告，顯示 92 年代之高產量可能是高補充量及環境改變的影響，而最近年代之高產量則可能為近幾年環境的改變造成。歐盟對最近幾年現象之研究，亦有類似之看法。會中有相當多討論，不過由於

資料仍不足，因此未有確定結論，但希望各國儘可能蒐集詳細資料，包括下鉤深度、胃內含物等。

（三） 由於在阿拉伯海主要為我國作業，且阿曼合作船都要進港，觀察員容易派遣，會中建議我國儘快派觀察員登船，俾蒐集此段有時間性之漁獲及生物資料，作為未來分析近幾年特異現象之基礎（及回應我國業者加強此處研究之要求）。這是我國對黃鰭鮪研究提出貢獻之好時機。

四、 黃鰭鮪資源研究

（一） 歐盟在本次會議提出與以往完全不同的成長式研究結果，並且泰國之採樣計畫，顯示不同體型的性比與其他洋之認知不同，這些現象對本次資源評估的正確性將有影響。本次會議將在時間許可下儘可能全採用，但為改善結果，會中建議主要漁捕國應加強生物方面之調查研究。我國可在今年觀察員計畫中，加強較簡單的體長別性比調查，以在下次會議中提出。

（二） 本次會議，我國、日本及歐盟分別報告 CPUE 標準化結果，我國由王博士報告。我國之結果與日本相當近似，主席及歐盟表示欣慰，可以不用再花時間討論兩國差異問題。

（三） 日本會中提出一份魚價與台、日漁業目標魚種改變關係之初步報告。結果儘發現黃鰭鮪魚價與台灣漁業是否以黃鰭鮪為目標魚種顯著關係，其他都不是那麼明顯。歐盟對此開創性的報告表示歡迎，但由於我國提出之「洋區別魚價不同」、「大目鮪/黃鰭鮪魚價差距會有影響」等問題無法解決，且魚價內涵及何謂「目標魚種」太複雜，因此此報告僅能作為引石，還需進一步研究。

➢ 七月二十日至七月二十一日

一、 混獲會議

（一） 本次會議主要為蒐集各國混獲資訊，並訂定工作計畫，以因應 IOTC 決議案的要求。會中皆認為觀察員計畫是最好的方式（目前已有許多國家在推動），因此建議作成建議案，要求各國加強推動觀察員計畫。日本則表示，今年 11 月科學委員會，日本依要求將整合各國計畫狀況，於會中報告及建立共同規範，而各國各有自己的觀察員計畫目標，因此建議不應有強烈建議案。（為該目的，日本首席科學家將於 10 月份來台訪問）。

（二） 秘書處在報告 IOTC 混獲資料狀況時，提及我國在印度洋有鯊魚專業船，包括小釣及大釣。我代表詢問資料來源及作業漁場。渠表示確定我國有許多小釣船於東南亞海域捕鯊，大釣船則為某個國家提供違規被捕的資料，其印象為至少 2 艘在南非附近捕鯊。

（三） 西班牙會中報告其在馬達加斯加南方海域 2 艘劍旗魚試驗船之初步結果。該試驗為西國政府租用民船進行科學調查（為期 2 年），包括圓形鉤、不同餌料、鉤深等。此與我國將進行之租用民間漁船試驗計畫類似。

（四） 會中部分國家說明該國之鯊魚國家行動計畫（NPOA），我國雖然已有 NPOA，但見日本及歐盟國家皆未報告，因此也未特別提出。會中建議各國於 11 月科學會議中，說明 NPOA 建立進度，以因應去年大會通過之決議案。

（五） 鳥盟代表會中強烈要求作成建議案，要求各國依 IOTC 決議案，儘速建立海鳥 NPOA 並進行資源評估。日本反對，認為成立混獲小組之共識為針對鯊魚，海鳥已有其他組織（CCSBT）在關心，並且建立 NPOA 為管理者之事。主席及各國皆有不同看法，最後僅提及若有國家完成海鳥資源評估報告，小組將會討論，但不主動。

（六） 針對混獲資料蒐集，會中建議：鼓勵各國提交混獲資料、加強各國觀察員計畫間之合作、鼓勵混獲專家參與會議。另並希望明年會議前，我國能透過觀察員協助蒐集鯊魚魚鰭比例，以回應鯊魚決議案之要求。

二、 歐盟國家資料庫計畫（National Database Plan, PNDB）：

（一） 會外與西班牙主席討論其統計系統，渠提到歐盟與台灣一樣，有許多船於遠洋國家作業，資料蒐集上也有許多困難且分散，為此，自 2002 年起，歐盟推動建立整體資料蒐集（改善）計畫，歐盟各國相應建立各自「國家資料庫計畫」，除了總漁獲量之外，其他資料的蒐集及處理，包括觀察員、港口採樣、試驗船等等，都由這個計畫整體規劃及經費支助，以把經費、人力資源集中運用，所有成果亦都先回歸計畫再分享出去。

（二） 渠表示這個計畫對資料品質改善及研究影響相當明顯，西國近幾年派觀察員及租用民間船進行試驗等，都是由這個計畫推動。我國現面臨前所未有的國際壓力及統計改善的需求，並體認到改善資料品質比推動研究更迫切急需，可以考慮趁此時機，推動類似的鮪漁業資料蒐集改善計畫，以整合各類經費和人力，重整統計蒐集及處理流程。

三、 有關小釣採樣

（一） 泰國於會中談及，其與 IOTC 合作之採樣計畫將於 2007 年 3 月結束(OFCF 表示於 2006 年 12 月即停止)，為了延續小釣資料的蒐集，希望 OFCF/IOTC 能繼續此計畫，或請台灣參與提供經費。

（二） 印尼代表於會中說明，除港口採樣計畫之外，澳洲於今年開始資助印尼派觀察員登小釣船（含我國人經營者），將於本（7）月底出發。另，IOTC 強調，印尼今年已開始加強查察改籍印尼之小釣船，預計許多船會被除籍，到時會出現許多被印尼除籍的台灣船在該海區作業，希望我國提早在管理及資料蒐集上預備。

四、 有關 IOTC 小釣資料

（一） 我代表於會外向 IOTC 秘書處洽我國小釣資料提供問題。我代表表示，我國對建立小釣統計系統將更積極，希望秘書處能協助。渠表示 IOTC 很願意協助我國，並表示目前 IOTC 蒐集到之我國小釣資料主要來自泰國，至於印尼採樣資料，可以看出那些船是台灣人經營，但目前仍都是印尼籍。

（二） 討論後之瞭解及結論為：小釣資料主要分兩類，進普吉島卸魚船的基本資料（來自進出港資料），以及從這些船抽樣取得的卸魚資料（來自採樣紀錄，採樣率約三成）。前者進港資料，渠同意將所有其取得之資料（含船名、噸位），提供給我方，供我方分析我國小釣船之作業動態，我方並可協助確認是否全為台灣船。

（三） 至於卸魚量資料，祕書處與 OFCF 討論後，認為需要取得泰國政府的授權。經我代表私下討論後，泰國採樣負責人表示願意協助取得漁業部的授權，因此希望我方先去函其漁業部長官，渠會代為說明。IOTC 亦表示收到副本後，會去函泰國表示支持。

五、 討論大目鮪不當提報量對資源評估的影響

（一） 會中 SC 主席說明，IOTC 決議案 05/01 限制台灣產量在 35,000 噸，另外也要求科學委員會進行三項工作，其中兩項可以更新使用我國新資料，利用原模式達成；但另一項要求評估誤報及非法漁獲量（暗指台灣）對資源評估的影響並建議應降低的產量，就很困難進行，希望大家提供意見。

（二） 歐盟說明，依其分析結果，並沒有發現台灣資料有明顯洗魚的現象。SC 主席則回答，無法以「沒有發現對資源評估的影響」回應委員會的要求，必須要有某種分析。

（三） 日本則表示，台灣聲稱洗魚量 4000 噸，但日本認為有 18000 噸，這兩者為最大及最小底線，可以計算看看台灣產量若降低 4000-18000 噸，將對整個資源評估有多大影響。

（四） SC 主席認為這是好方法，並詢問秘書處可否協助計算？日本表示願協助，因此秘書處同意負責計算。至於如何討論結果，主席建議透過網路通信，或在 11 月 SC 會議前一天（週日）召開臨時會，並表示希望採第二案。我代表則表示，這個議題很複雜又敏感，建議先透過網路通信（以於國內先討論），再於 SC 會議前一天的臨時會中確認結果，以便向 SC 報告。

（五） 主席認為這種作法較妥當，決議採這種方式。日本亦同意，並表示台、日兩國要各自重新進行 CPUE 的標準化，於 10 月完成，交給秘書處及日本計算。

➢ 七月二十二日至七月二十三日

一、 黃鰭鮪資源評估計算結果：

會議中討論西、法、日所進行之資源計算結果，我國亦協助計算 CPUE 變動。本次會議同時使用許多模式計算，不過歐盟首席科學家綜合歷年有關黃鰭鮪資源研究之結果，認為黃鰭鮪的資源變動仍然是謎，許多現象無法解釋，需要更多的生物研究，而在此之前，任何的結論都必須保守謹慎。

二、 黃鰭鮪資源評估結果：

（一） 在此次會議中使用許多種不同的分析模式，針對黃鰭鮪進行的資料評估。其中有兩種模式進行了完整的分析，並在會議中提出分析報告及發

表其對黃鰭鮪資源的評估結果。此兩分析模式分別是由日本科學家所進行的 age structured production model（ASPM）以及法國科學家所進行的 Bayesian two-age-class production model。

（二） 在會議進行的同時法國科學家也另外使用 PROCEAN 和 CATAGE 分析模式進行黃鰭鮪的資源評估。此外，法國與日本科學家也根據會議所修正的資料重新計算其模式分析的結果。

（三） 雖然每種分析方法所估計出的詳細結果不盡相同，但大致上對黃鰭鮪的資源變動描述是相當接近的，尤其是在資源量與漁獲死亡率的估計方面幾乎是呈現一致的變動趨勢。在漁獲死亡率的估計方面，在 1980 年代之前大致上維持在低且平穩的水準，而 1980 至 1990 間則大幅增加，並維持在相當高的水準，特別是 2003 年的估計值明顯較其他各年高。資源量的估計方面則和漁獲死亡率呈現相反的趨勢，1990 至 2003 年間的高漁獲死亡率導致了段期間的資源量維持在相當低的水準。在漁獲能率估計方面，結果指出自 1980 年代中期之後，延繩釣和圍網漁業的漁獲能率皆有相當明顯的增加。

（四） 此次會議的資源評估結果一致認為近 1992 年至 2002 年間的漁獲死亡率已經接近於 MSY 的水準，漁獲量可能也接近或超過了 MSY，而 2003 年與 2004 年的漁獲量估計已經超過 MSY。對於未來資源狀態的預估，若未來無相當高水準的加入量支撐，則未來的黃鰭鮪資源將無法長久維持。

（五） 此次會議也強調目前的資源評估結果仍存有高度的不確定性，尤其是早期的 CPUE 仍無法從漁獲能率或加入量的角度來進行解釋。

（六） 自 1980 年代早期之後，圍網及小型漁業的增加導致了黃鰭鮪幼魚漁獲量的增加，這些漁獲量的增加並不是因為漁場的擴展所致，而是增加了現存漁場的漁獲壓力。幼魚漁獲量的大量增加將引發資源的潛在危機，因此這些漁業的漁獲利用情形已引起委員會的高度關心。

（七） 對於 2003 年及 2004 年漁獲量的大幅增加，此次會議提出了以下兩種可能：

(1) 生物量的增加：於 1990 年代和 2000 年代早期，良好的環境條件造就了大量的黃鰭鮪加入量，也因此使得漁獲量大幅增加。但會議中也強調目前仍無法從表層漁業的資料中獲得證實。

(2) 漁獲能率的增加：圍網的人工集魚（FAD）的進步使其能大量的捕撈漁獲。此外，自 2002 年起，大部份的圍網漁船都裝置了新式的聲納設備而增加了探索魚群的能力。然而在大西洋海域的作業漁船也同樣改善了其聲納設備，但卻沒有出現漁獲量大幅增加的情形。在延繩釣的部份，並無報告指出有漁獲技術改善。

此次會議認為 2003 年及 2004 年的黃鰭鮪漁獲量增加，應是由於上述兩種原因同時發生所致。

三、 建議案：

（一） 1999 年至 2002 年的漁獲量應接近或已超出 MSY 水準，而 2003 年及 2004 年的黃鰭鮪漁獲量則已大幅地超過 MSY，因此未來的漁獲量或努力量皆不應超出 1999 年至 2002 年間的水準。

（二） 若圍網與小型漁業的漁獲物體型持續小於 2002 年所估計的最適漁獲體型，則黃鰭鮪資源將因此些漁業的漁獲壓力而造成決定性的影響。

（三） 此會議也提出黃鰭鮪幼魚主要是由以正鰹為目標魚種的圍網漁業所捕獲，因此減少 FAD 漁業捕撈黃鰭鮪幼魚的管理措施，將會同時伴隨正鰹漁獲量的減少。

四、 主辦國安排港口訪談概要：

（一） 普吉島主要有五個小釣卸魚港，其中政府主導之港口（FMO）最大，其他皆為私人港口，而我國鮪釣船大都在私人港口卸魚。泰國政府為加強管理及食品安全，於今年年底前將規劃大部分漁船皆在 FMO 卸魚。

（二） 目前停泊在港口的台灣籍漁船並不多，大約僅有十艘不到的台灣籍漁船在港，漁船噸位為 CT-3 與 CT-4 級。其中一艘台籍漁船聘用的大陸籍船長指出，現在是菲律賓卸魚的旺季（7-8 月），因此停泊在普吉港口的台灣籍漁船很少。至九月至十月後台灣籍漁船才會返回印度洋海域作業及卸魚。

（三） 台灣籍漁船的作業海域大多是在斯里蘭卡以及安曼海域作業，主要是以黃鰭鮪與大目鮪為主要漁獲對象。台灣的漁獲物主要區分為三級，最高級的鮪類漁獲物主要銷往日本供應其生魚片市場，次級的鮪類漁獲物與劍旗魚則是銷往美國，而再次級的漁獲物則銷往中國大陸或內陸。

肆、心得與建議

一、 有關我國統計資料品質

（一） 本次會議對我國資料仍有多次討論，但較屬正面。秘書處特別強調，今年統計資料之最大改善為取得我國之歷年資料。科學委員會主席亦發言肯定我國的資料提供，使今年會議能更深入分析黃鰭鮪資源狀況。

（二） 對我國資料品質，秘書處主要關切我國資料有明顯不一致現象，並引起主席關切，經我代表分析說明其計算上之問題及認知誤解，已於會中澄清。歐盟則接續表示，經使用我國體長資料分析，顯示我國資料與日本

資料相當近似，由於日本資料已經非常稀少，因此建議改變多年來的作法，考慮使用我國資料來取代日本之不足。

二、 有關日本目標魚種轉換議題

（一） 日本於去年及今年之國際組織會議中不斷質疑我國大目鮪洗魚，其中一項訴求為日本大目鮪比例持續下降，而我國大目鮪比例卻維持一樣。經我代表與歐盟合作之分析，卻認為日本大目鮪比例下降主要係因日本漁業轉移目標魚種，改捕黃鰭鮪，但招日本否認。

（二） 日本於本次會議中承認確有目標魚種轉移之現象，可能原因有三：漁場改變，到黃鰭鮪比較多的海區作業；（二）放鉤深度改變，造成比較高的黃鰭鮪釣獲率；（三）船東經營策略改變，放棄大目鮪，改捕資源量較多的黃鰭鮪。

（三） 主席、歐盟及我國皆分別對日本提供這項重要資訊表示肯定與感謝。科學委員會主席則詢問日本，依據此分析，去年日本大目鮪 CPUE 下降是因資源出狀況，還是目標魚種的轉移，日本代表則表示無法推論。

三、 近幾年黃鰭鮪產量劇增現象

（一） 我國在 1992-93 年曾在阿拉伯海有巨量的黃鰭鮪漁獲，十幾年後，自 2003 年起，歐盟圍網及日本鮪釣漁業在西印度洋區再現高產量，我國今年在阿拉伯海也再度出現豐收情況，因此各國關心是環境異常造成的黃鰭鮪聚集（負面傷害資源），還是出現很好的補充群（正面強化資源）？

（二） 經會中之討論，認為兩種原因都可能存在，可能環境異常、圍網漁捕效率增加、以及補充群增加，都同是主因。不過由於資料仍不足，因此未有確定結論，但希望各國（特別我國）加強漁獲資料及生物樣本的蒐集。依據業者表示，今年在僅有我國作業的阿拉伯海有出漁現象，而出漁時間又與其他國家不一致，因此歐盟私下提醒應我國加強資料蒐集與查核，暗示避免洗魚再起嫌疑。

四、 黃鰭鮪資源狀況

資源評估結果一致認為，1999 至 2002 年漁獲量應接近或已超出 MSY 水準，而 2003 年及 2004 年的黃鰭鮪漁獲量則已大幅地超過 MSY，因此會中建議未來的漁獲量或努力量皆不應超出 1999 年至 2002 年間的水準，除非有很大量的補充群。不過會中也強調本次評估有很高的不確定性，需要更多資料與研究的支持。另外，若圍網與小型漁業持續大量捕小魚，則這些漁業將對黃鰭鮪資源造成決定性的影響。

五、 大目鮪產量不當提報之影響

會中依五月大會之要求，亦討論如何評估洗魚量對資源評估之影響。有關評估方式，決議依日本之建議，將從我國聲稱之 4,000 噸及日本聲稱之 18,000 噸範圍中，進行模擬分析；至於進行方式，則依我國建議，考量此案之複雜及敏感，將先透過網路通訊連繫溝通，再於 11 月科學委員會前召開結果討論會議；資料運算部分，則先由台、日兩國分別完成新 cpue 標準化，再交由秘書處進行模擬計算。此案之結果將影響大會對我國洗魚問題之進一步處理態度。

六、 有關我國小釣資料

（一） 泰國於會中談及，其與 IOTC 合作之採樣計畫將於 2007 年 3 月結束，為了延續小釣資料的蒐集，特別是非其國籍（指台灣）之資料，希望此計畫能延續，或請台灣參與提供經費。

（二） 為瞭解我國小釣船在印度洋之動態，經與秘書處、OFCF 及泰國協商後，進普吉島卸魚船的基本資料，秘書處同意將取得之資訊，提供給我方，至於卸魚量資料，泰國港口負責人表示願意協助取得政府授權，希望我方先去函其漁業處長官，渠會代為說明，IOTC 亦表示收到副本後，會去函泰國表示支持。IOTC 則希望我國取得資料後，能積極進行分析及聯繫討論。

七、　混獲會議結論

本次第一屆會議主要討論各國混獲資訊之蒐集，並訂定工作計畫，以因應IOTC 決議案的要求。最後小組建議：鼓勵各國提交混獲資料、加強各國觀察員計畫間之合作、鼓勵邀請混獲專家參與會議。另並希望明年會議前，我國能透過觀察員協助蒐集鯊魚魚鰭比例，以回應鯊魚決議案之要求。

八、　建議事項

（一）有關大目鮪產量不當提報之影響，建議積極與日本及相關國家科學家進行合作分析，並根據分析結果進行討論與溝通。

（二）有關我國小釣船資料的收集,建議可與 IOTC 及泰國連繫取得我國小釣船資料，以瞭解我國小釣船在印度洋之動態。

（三）有關混獲資訊之蒐集，應加強我國觀察員收集鯊魚魚鰭比例之資料，以進行混獲會議中鯊魚決議案所要求我國進行之工作。

伍、會議報告

我國代表於議會中，有關：

一、　我國印度洋黃鰭鮪 CPUE 標準化之簡報（附件一）

二、　熱帶鮪類工作小組會議報告（附件二）

三、　混獲工作小組會議報告（附件三）

Standardization of CPUE for yellowfin tuna caught by Taiwanese longline fishery in the Indian Ocean using generalized linear model

Sheng-Ping Wang[1], Shui-Kai Chang[1] and Hiroshi Shono[2]

1. Fisheries Agency, Council of Agriculture, Taipei, Taiwan
2. National Research Institute of Far Sears Fisheries, Japan

Data used

- Updated data of 2000 and new data of 2001-2003 were used in the calculation.
- Environmental factors have been included in the model.
  - Sea Surface Temperature (SST)
  - Mixed Layer Depth (MLD)

General Linear Model

- Log(CPUE+c)=Y+M+A+BET+ALB+ SST+MLD+interactions
- Akaike's Information Criterion (AIC) is used to select among alternative models.

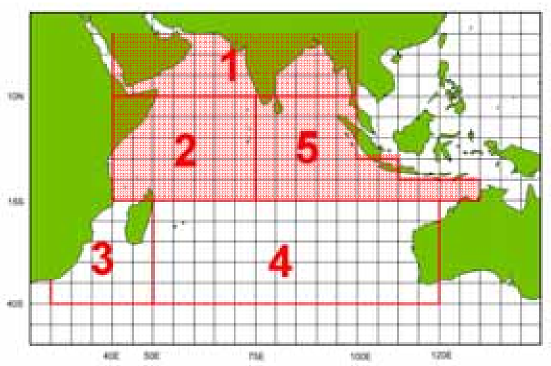
Abundance index

$$I_i = \sum_{j=1}^{N_j} w_j \cdot CPUE_{i,j}$$

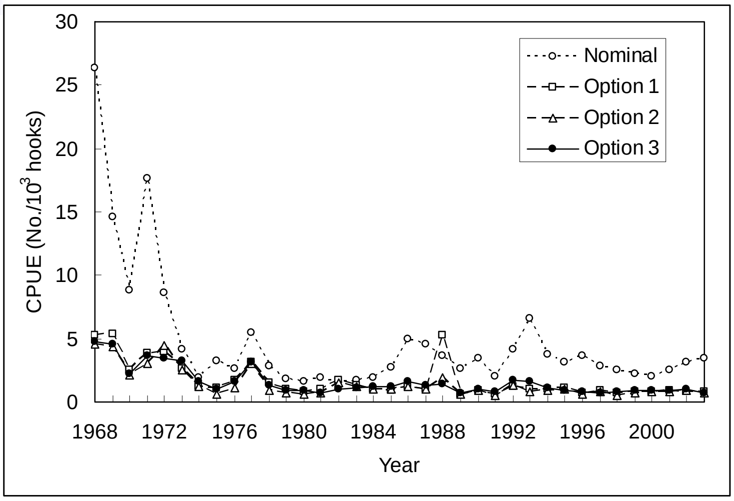
w_j is the weight for the size of area

Options

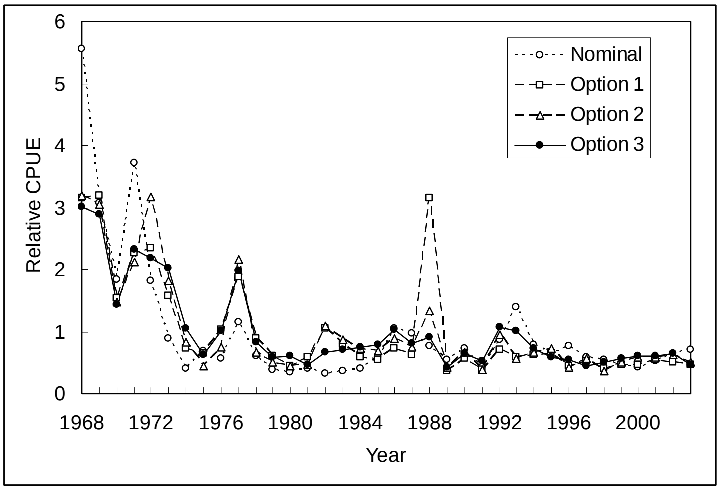
- Option 1: fit the model to whole data sets.
- Option 2: interactior s.
- Option 3: in main Ta yellowfin t



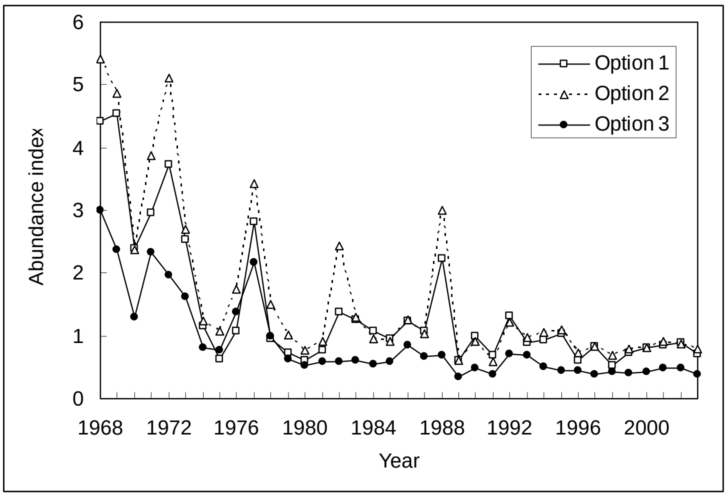
Trends of CPUEs



Trends of CPUEs



Trends of Abundance indices



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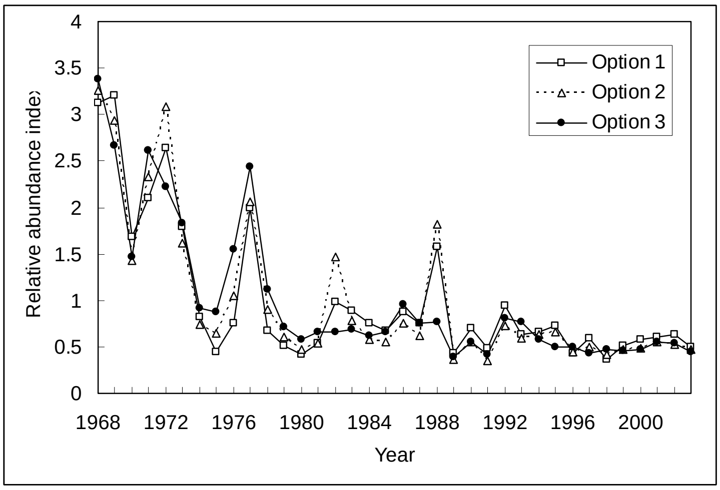

附件二

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

Report of the Seventh Session of the IOTC Working Party on Tropical Tunas

Phuket, Thailand, 18-22 July, 2005

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1. Opening of the Meeting and Adoption of the Agenda

1. The Seventh Meeting of the Working Party on Tropical Tunas (WPTT) was opened on 18 July 2005 in Phuket, Thailand, by Dr. Jaranthada Karnasuta, Deputy Director-General of Department Fisheries in Thailand and Mr Nirun Kalayamit, Phuket Deputy Governor of Phuket.

2. Chairperson, Dr. Pilar Pallarés, from the Instituto Español de Oceanografia, Spain, also welcomed the participants (Appendix I) and the Agenda for the meeting was adopted as presented in Appendix II.

3. In accordance with the instructions of the Commission, the WPTT objectives for the meeting were to review and analyse issues relevant to the fisheries and status of yellowfin tuna, and consideration to the exceptional catches of yellowfin tuna in 2003.

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

2. Review of Statistical Data for the Tropical Tuna Species

2.1. Nominal Catch (NC) data

5. The nominal catch data series of yellowfin (YFT), bigeye (BET) and skipjack (SKJ) tunas are considered to be almost complete since 1950. Bigeye tuna are mainly caught by longlines and purse seines, while catches of yellowfin tuna are reported mainly by purse seines, longlines and gillnets and Skipjack tuna by purse seines, gillnets and pole and lines. Large increases in the catches of these three species have been noted since the mid-1980's.

6. The IOTC Secretariat conducted several reviews of the NC database during 2004. In particular, the work to disaggregate catch statistics aggregated by species and/or gear led to changes in the estimates of catches of skipjack tuna and, to a lesser extent, yellowfin tuna and bigeye tuna. Details about this work can be found in IOTC-2004-WPTT-06. There have been significant changes in the estimates of yellowfin tuna catches in recent years following reviews of the various catch series, especially that of Yemen (IOTC-2005-WPTT-04).

7. Although the quality of the information on the three tropical tunas is generally considered to be good, the completeness and accuracy of the records are compromised by:

- **Some catch data are not being available**: several countries were not collecting fishery statistics, especially in years prior to the early seventies, and others have not reported their statistics to IOTC. In most cases, the catches of tropical tunas in those countries were probably minor.
- **Poor resolution of catch data:** catches of tunas and tuna-like species are sometimes reported in an aggregated form1. The Secretariat estimates the species and gear composition of these aggregates using a range of information but the accuracy of such estimates is probably low.
- **There is considerable uncertainty associated with the catch estimates for the following fisheries:**
- **Yemen gillnet and hand line fisheries:** The catches of yellowfin tuna recorded in the FAO database for Yemen, the only existing source in the past, amount to about 800 t in recent years. This is in contradiction with reports from other sources that indicate that catches of yellowfin tuna might have been around 25,000 t in recent years. Although the catch series for this species was reviewed in 2005 and the database updated with the new estimates, the new figures are likely to be highly uncertain due to the scarce information available on catches or effort in this country.
- **Sri Lankan gillnet (and longline) fishery:** The catch series for yellowfin and skipjack tunas in Sri Lanka were re-estimated for the period 1950-2004. Marked differences between the re-estimated catches and those produced in Sri Lanka are of concern. However, the new catch series is considered to be more accurate.
- **Fresh tuna longliners based in Indonesia:** The data collected since June 2002 has allowed the estimation of the catches by longline vessels based in Benoa for 2003. The new catch estimates differ from those obtained by using the previous catch estimation procedure (CSIRO-RIMF sampling). Therefore, the catch

[1] This is the case notably when data are not reported to the Secretariat and have to be taken from the FAO nominal catch database.

series is expected to change once that new catches are estimated for 2003 (all previous estimates were based on the catches obtained through CSIRO-RIMF sampling in Benoa).

- **Other fresh tuna longline fleets:** Although the catches of fresh tuna longline vessels based in various ports of the Indian Ocean were re-estimated from data coming from past or recent sampling schemes, the accuracy of the estimates is still considered to be poor, especially for those fleets operating from ports not covered by these schemes, and where past catches have been estimated using recent catch levels.
- **Deep-freeze longline fleets:** The Secretariat re-estimated catches for the period 1992-2004 using new information collected during 2004. These catch estimates remain uncertain due to the many assumptions made in estimating total catches and the species breakdown. The number of vessels operating under flags of non-reporting countries has decreased markedly since 2001. The reason for this decrease is not fully known and revisions to the catch estimates may be undertaken when more information become available.
- **Former Soviet Union purse seiners:** The catch statistics of the nine to 11 former Soviet Union purse seiners operating under the flags of Panama and Belize in recent years are not available for the period 1995-1997. Total catches and effort for the period 1998-2002 were reported in 2003, but the new data did not include catch by species and type of school (consequently, these will have to be estimated by the Secretariat).

2.2. Catch-and-Effort (CE) data

8. Catch-and-effort records are available for the main fleets fishing for tropical tunas in the Indian Ocean, namely baitboat (SKJ and YFT), purse seine (SKJ, YFT and BET) and longline (BET and YFT). Some gillnet fisheries produce substantial catches of tropical tunas, but the contribution of other gears to the total catches is small.

- **Baitboat:** Catch-and-effort statistics from the Maldives are available by species, month and atoll for 1970-1993. Only catches and effort by species, year and atoll are available for 1993-2001. Baitboat Catch-and-Effort data are not available since 2002.
- **Longline:** Catch-and-effort statistics are available since 1952 for Japan; since 1967 for Taiwan,China[2] and since 1975 for Korea. Catch and effort data for other fleets is scarce or inaccurate (e.g. there are some non-reporting fleets such as Philippines). Total longline catches by species and area are provided in Figures 1, 2 and 3

9. The catch and effort statistics provided by Japan and Taiwan,China are generally considered to be accurate. Taiwan,China provided revised CE for 1991-93. Nevertheless, some inconsistencies were found when comparing nominal catches and catch and effort data for Taiwan,China. These would indicate that either nominal catches or catches in the CE are not accurate or that size data are not representative.

10. Korean CE statistics are considered to be highly inaccurate. Many inconsistencies have been found in the data, e.g. when comparing the catches in this database with those reported as nominal catches.

- **Purse seine:** Catch-and-effort statistics are complete for European-owned purse seiners and those monitored by scientists from Europe and Seychelles. Statistics are also available for other fleets including the former Soviet purse seine fleet (1998-2002; under Belize and Panama flags), Mauritius and Japan. As is the case for the NC data, the CE data for the purse-seine fleet formerly under the Soviet Union flag are not considered to be accurate, especially the species composition and type of school fished information. Partial catch and effort data are available for the Iran purse seine fleet. Recent trends in the spatial distribution of purse seine catches are shown in Figures
- **Gillnet:** Few CE data are available for gillnet fisheries. This is of concern because gillnets have been used in both coastal waters and on the high seas in recent years.

11. Catches by gear-type are given in Figures 1, 2 and 3. Figures 4, 5 and 6 illustrate the changes to the catch estimates following recent revisions to the catch data series.

12. Figures 7 to 12 illustrate mean annual catches for the periods 1990-1999, 2000-2002 and 2003 respectively. 2003 is separated to highlight the very high catches of yellowfin that occurred in that year.

[2] Taiwan, China refers to Taiwan province of China.

Figure 1: Catches of yellowfin tuna (YFT) per gear type and year in the IOTC Area from 1964 to 2003

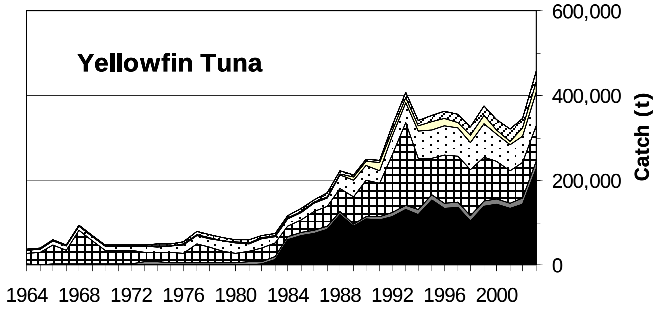
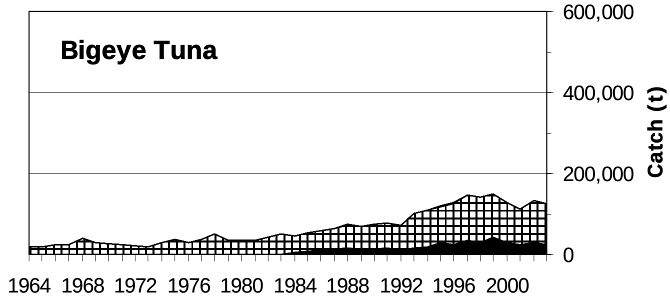


Figure 2: Catches of bigeye tuna (BET) per gear type and year in the IOTC Area from 1964 to 2003



Legend:

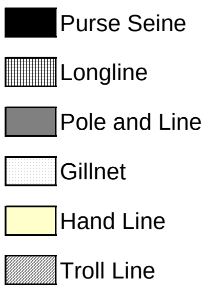
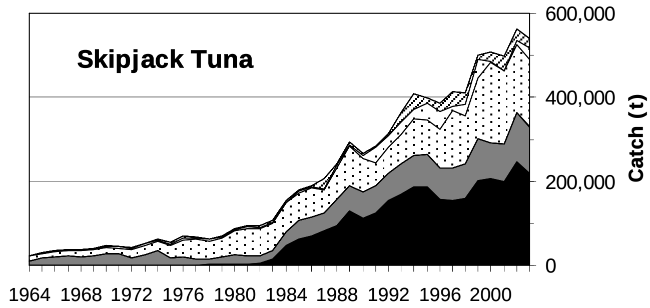


Figure 3: Catches of skipjack tuna (SKJ) per gear type and year in the IOTC Area from 1964 to 2003



Note that the catches series estimated during 2004-05 include catches assigned to each species after allocation of species aggregates to individual species by the Secretariat.

Figure 4: Yellowfin tuna catch estimates in 2005 *versus* catch estimates in 2004 (1964-2002)

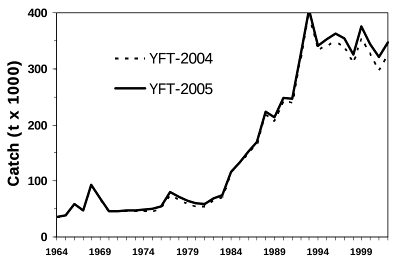


Figure 5: Bigeye tuna catch estimates in 2005 *versus* catch estimates in 2004 (1964 to 2002)

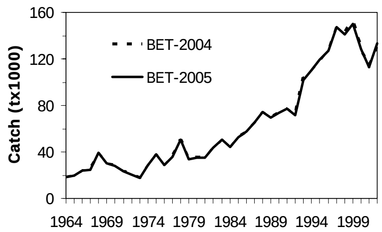
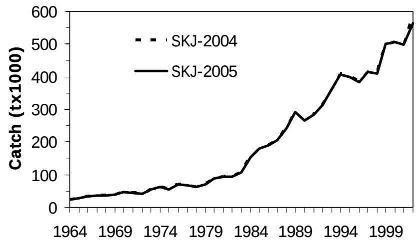


Figure 6: Skipjack tuna catch estimates in 2005 *versus* catch estimates in 2004 (1964-2002)



Note: Ibid. footnote Figures 1-3

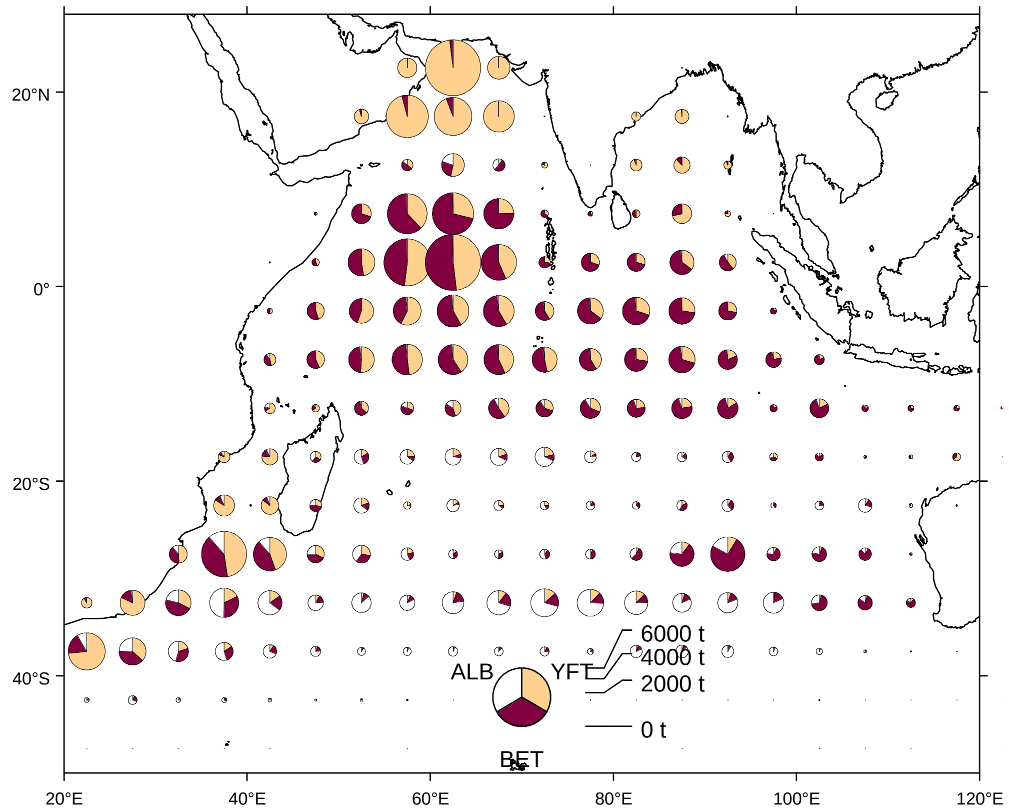


Figure 7. Mean of annual total catches (t) of tropical tunas: yellowfin (YFT), bigeye (BET) and albacore (ALB) by Japanese and Taiwanese long line vessels operating in the Indian Ocean over the period 1990 to 1999.

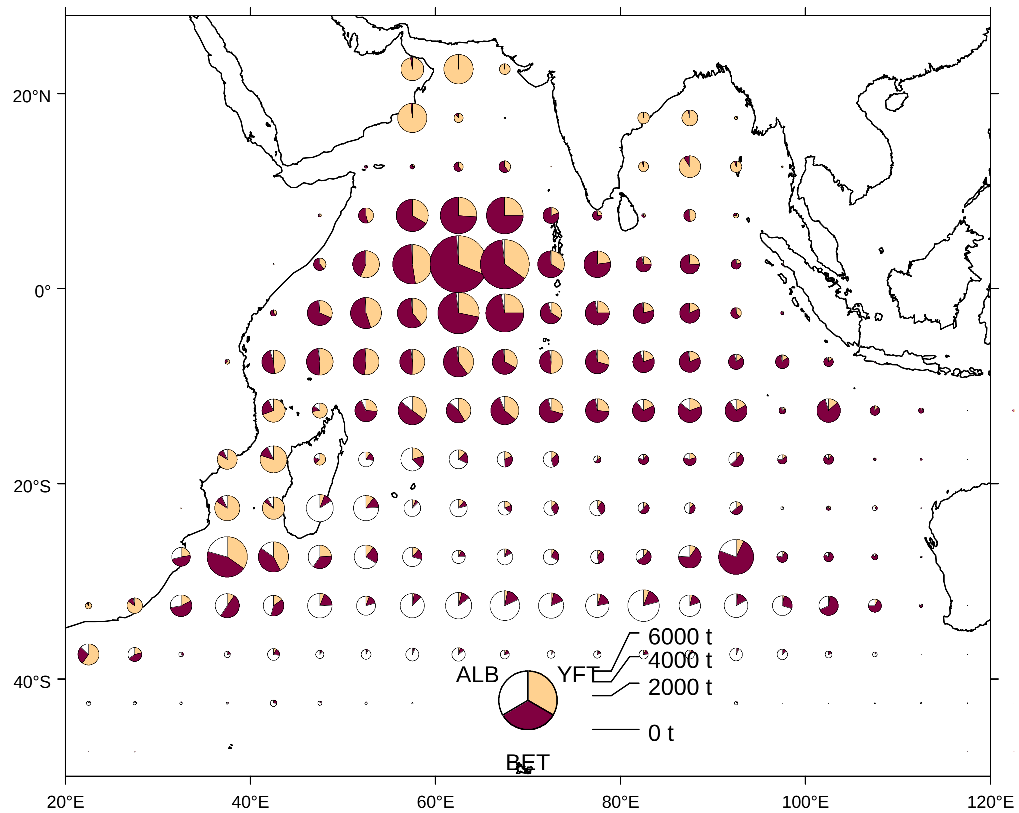


Figure 8. Mean of annual total catches (t) of tropical tunas: yellowfin (YFT), bigeye (BET) and albacore (ALB) by Japanese and Taiwanese long line vessels operating in the Indian Ocean over the period 2000 to 2002.

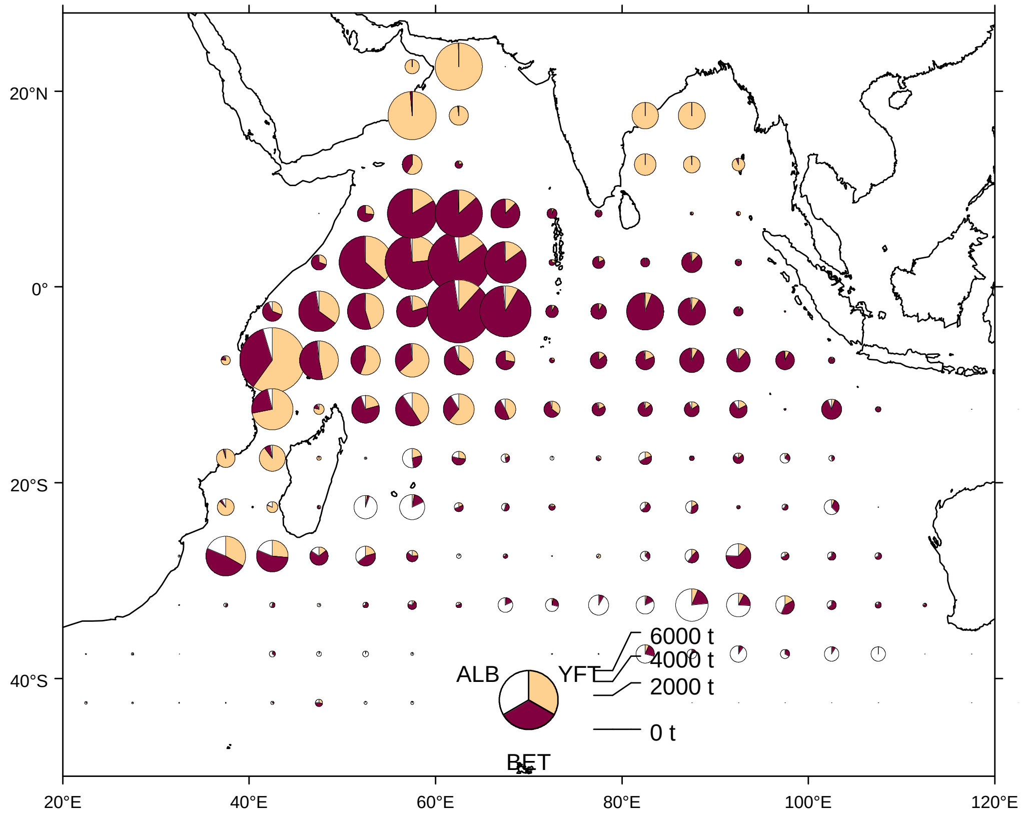


Figure 9. Mean of annual total catches (t) of tropical tunas: yellowfin (YFT), bigeye (BET) and albacore (ALB) by Japanese and Taiwanese long line vessels operating in the Indian Ocean in 2003.

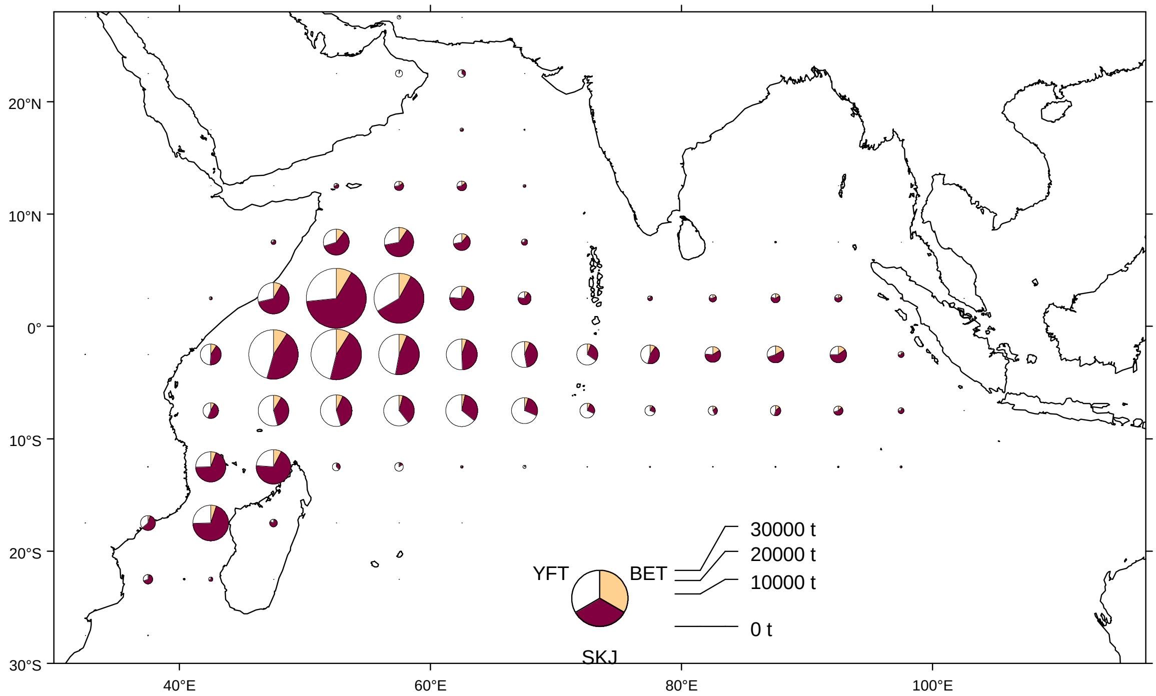


Figure 10. Mean of annual total catches (t) of tropical tunas: yellowfin (YFT), bigeye (BET) and skipjack (SKJ) by purse seine vessels operating in the Indian Ocean over the period 1990 to 1999.

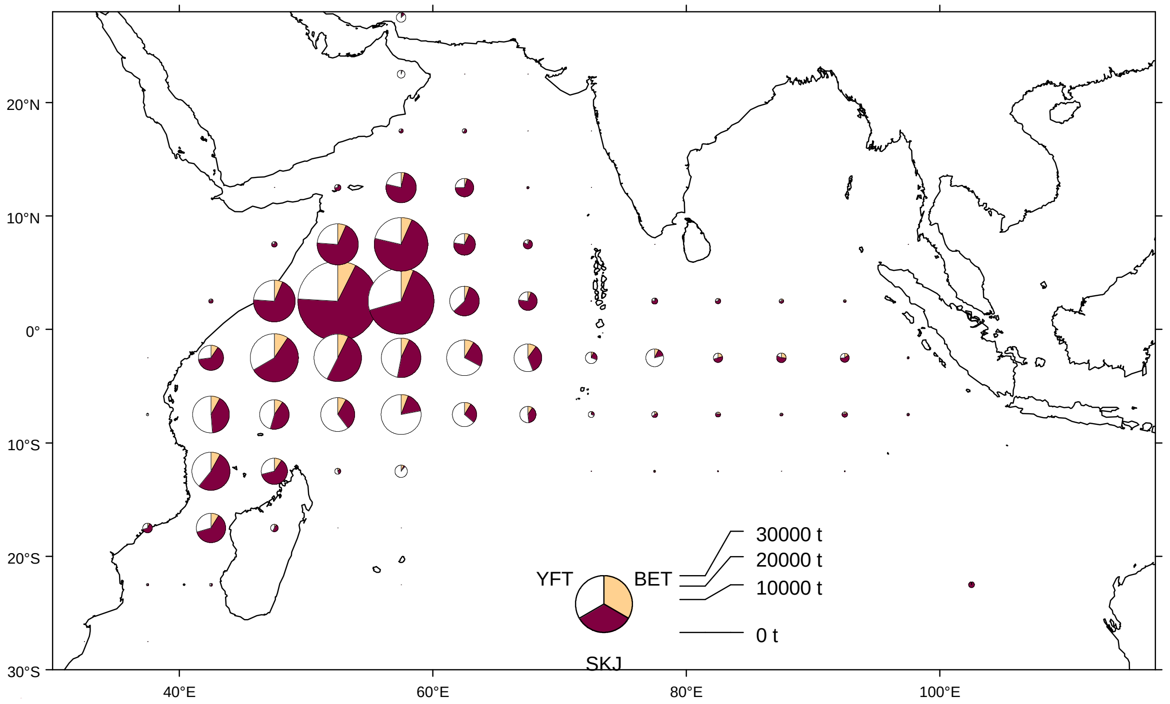


Figure 11. Mean of annual total catches (t) of tropical tunas: yellowfin (YFT), bigeye (BET) and skipjack (SKJ) by purse seine vessels operating in the Indian Ocean over the period 2000 to 2002.

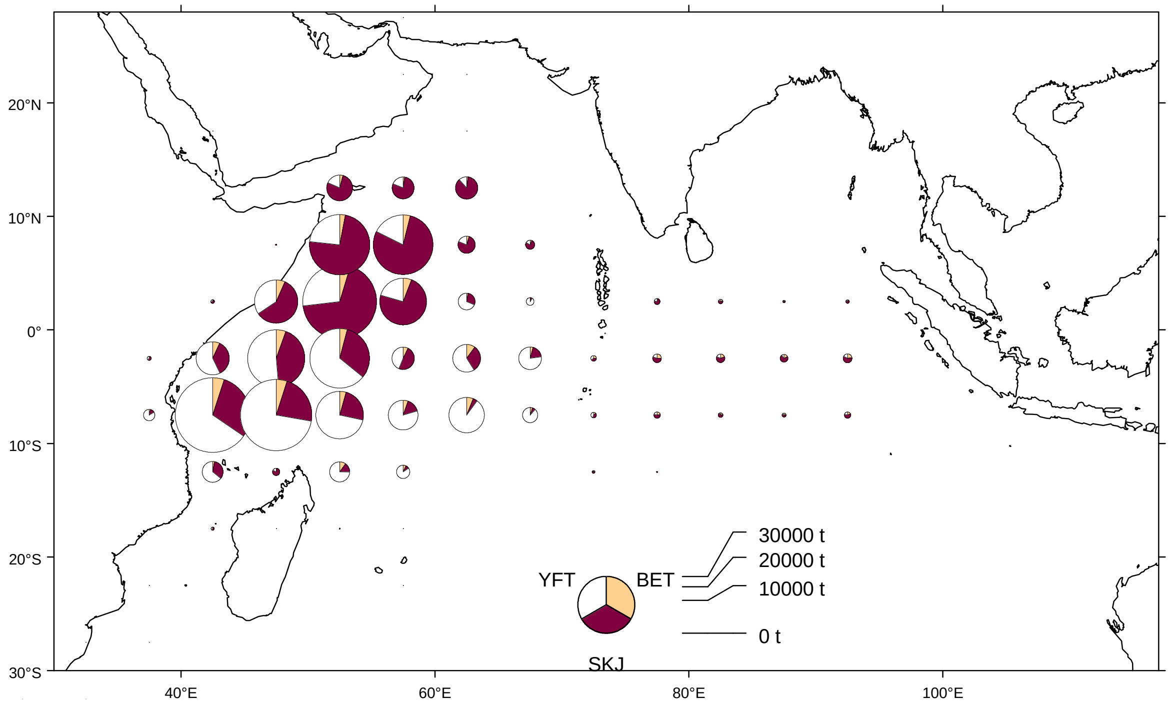


Figure 12. Mean of annual total catches (t) of tropical tunas: yellowfin (YFT), bigeye (BET) and skipjack (SKJ) by purse seine vessels operating in the Indian Ocean in 2003.

2.3. Size-Frequency (SF) data

- **Purse seine:** The quality of the purse seine data is considered to be good for fleets under European monitoring. Little or no data is available for Iranian, Japanese and former Soviet Union purse seiners. The size frequency statistics for Mauritian purse seiners since 1986 is complete.
- **Baitboat:** The completeness and quality of the sampling on baitboat fisheries (Maldives) is considered to be good up to 1998. No data are available from 1999 to 2002.
- **Longline:** Only Japan has been reporting size-frequency data since the beginning of the fishery. In recent years, the numbers of fish being measured have been very low in relation to the total catch; furthermore, they have been decreasing year by year. Coverage rates in some areas are very low. Taiwan,China provided size data on yellowfin tuna and bigeye tuna for its longline fleet for 1980-2004. The size-frequency statistics available from Korea are inaccurate (Korea), which limits their use. The recovery of size data from port sampling regarding fresh tuna longline fleets operating in Thailand and Indonesia continued in 2004 and 2005. Catch-at-size tables were estimated for fresh tuna longline vessels operating in Indonesia during 2003-04 and other ports for 1998-2004.
- **Gillnet:** Although size data are available for some important gillnet fisheries (including Iran, Sri Lanka and Oman3) sample sizes are very low.
- **Other gears:** Few size data are available for other gears.

2.4. Estimation of catch for non-reporting fleets

13. The catch estimates for several non reporting fleets were updated in 2003:

- **Yemen:** The catches for Yemen domestic fisheries, mainly hand line, troll line and gillnet, were re-estimated in 2005 for the period 1950-2004. The new estimates of yellowfin tuna catches are much higher than those recorded previously, especially for the last decade.
- **Other non-reporting fleets (NEI):** The high number of non-reporting fleets operating in the Indian Ocean in recent years has led to large increases in the number of catches that need to be estimated. This reduces confidence in the catch estimates for yellowfin tuna and bigeye tuna and, to a lesser extent, skipjack tuna.
- **Purse seine:** Catches for former Soviet Union purse seiners were re-estimated for 1995-2003. Total catches were estimated using to the number of vessels available, the average catches of the former Soviet Union purse seiners in previous years, and average catches available for other fleets for 1995-97 and 2003. Total catches for 1998-2002 were obtained from available catch and effort data. Total catches were assigned to species and type of school fished according to data available for European Community purse seiners during the same period (1995-2003). The new catch estimates (averaging around 30,000 t per year) are very similar to those estimated previously by the Secretariat.
- **Fresh tuna longline:** Catches by fresh tuna longliners were estimated for each port where the different fleets were based. Most of the fresh tuna longline catch appears to be taken by Taiwanese vessels.
    - **Indonesia**: The catches by Indonesian vessels during 2003-04 were estimated from the information collected through the multilateral catch monitoring program. Further changes in the total catch estimates and species composition are expected in the future, especially for years before 2003.
    - **Thailand**: The catches of fresh tuna longliners from Taiwan,China and Indonesia in Phuket were estimated using data collected through the AFRDEC (Andaman Sea Fisheries Research and Development Centre)-OFCF (Overseas Fishery Cooperation Foundation of Japan)-IOTC Sampling Programme.
    - **Malaysia and Singapore**: The catches of fresh tuna longliners based in Malaysia and Singapore were estimated using data from the IPTP Sampling Program, new estimates from Fisheries Research Institute of Penang and AFRDEC, and vessel activity information for Singapore (Jurong).

[3] Size frequency data of yellowfin tuna was collected during 2003 in Oman

- **Sri Lanka**: The catches of fresh tuna longliners that unload to processing plants in Sri Lanka were estimated on the basis of previous data collected by NARA (National Aquatic Resources Research and Development Agency) in Colombo and estimates from Phuket and Penang sampling. Data on the number of vessels or number of vessel-unloadings have not been available since 2002.
- **Maldives:** Around 50 fresh tuna longliners are currently licensed to operate within the Maldives EEZ. Most of these vessels are, however, unloading their catches in Colombo (Sri Lanka). Catches for this fleet were estimated along with fleets operating in Sri Lanka.
- **Seychelles:** Several Indonesian and Taiwanese fresh-tuna longliners were based in Victoria (Seychelles) during 2000-02. Catch and effort data for these vessels are available from the Seychelles Fishing Authority.

- **Deep-freeze longline:** The catches by large longliners from several non-reporting countries were estimated using IOTC vessel records and the catch data from Taiwanese longliners, based on the assumption that most of the vessels operate in a way similar to the longliners from Taiwan,China. The collection of new information on the non-reporting fleets during the last year, in particular the number and characteristics of longliners operating, led to improved estimates of catches. The number of vessel operating since 1999 has decreased and this has led to a marked decrease in catch levels. The reason for this decrease in the number of vessels (and catches) operating in the Indian Ocean is not fully explained. Nevertheless, this decrease is somewhat proportional to an increase in the number of vessels recorded operating under flags of reporting countries, such as Philippines, Taiwan, China and the Seychelles.

2.5. Documents relating to statistics

14. Document IOTC-2005-WPTT-03 provided an update on the status of the IOTC tropical tuna databases and is elaborated in Section 2 above. The IOTC Secretariat conducted several reviews of the databases during 2004. In particular, the work to disaggregate catch statistics aggregated by species and/or gear led to changes in the estimates of catches of skipjack tuna and, to a lesser extent, yellowfin tuna and bigeye tuna. Details about this work can be found in IOTC-2004-WPTT-06.

15. Document IOTC-2005-WPTT-08 provided information on the extent of size frequency data available in the IOTC database by area, year and quarter for Japan and Taiwan,China longliners that operated in the Indian Ocean during 1956-2003. It was noted that, during the last decade, areas with high catches of yellowfin tuna reported for the Japanese longline fleet have not been sampled or not sufficiently sampled. It was further noted that the quality of the Catch-at-Size data estimated upon this dataset might be compromised due to the paucity of size data.

16. Document IOTC-2005-WPTT-04 provided revised catch estimates for tuna and tuna-like species caught by artisanal boats in Yemen. The IOTC Secretariat noted that due to the paucity information available, the revised catch estimates had to be derived after much interpolation and extrapolation and by making numerous assumptions. While the new estimates are still highly uncertain, they are, arguably, much more realistic than before. In general they are much higher than those recorded by the FAO, especially for the last decade. Current catches of yellowfin tuna are estimated at around 30,000 t.

17. Document IOTC-2004-WPTT-10 provided a summary of the Korean tuna longline fishery in the Indian Ocean. 36 longliners from Korea operated in the Indian Ocean during 2004 with catches estimated at 7,735 t. The document provides also some information on a small-scale tagging programme and an observer program recently implemented on Korean longliners.

18. Document IOTC-2005-WPTT-23 provided a summary of the activities of French, Spanish, Italian, Seychelles and EU related NEI purse seine fleets (representing some 90% of the total purse seine activity in the Indian Ocean) fishing since 1981. This included effort, catch by species and fishing type (log and free swimming schools), catch per unit of effort, sampling, mean weights and size distribution for the main species. Nominal effort slightly increased in 2004, the number of free school sets dramatically increasing while the number of log sets decreased. The total catch exceeded 350,000 t in 2004. The catches of yellowfin tuna in 2004, at around 205,000 t, are the highest ever recorded.

19. Document IOTC-2005-WPTT-22 provided a summary of the French purse-seine activities in the Indian Ocean since 1981, including, effort, catch by species and fishing type (log and free swimming schools), catch per unit of effort, sampling, mean weights and size distribution for the main species. While the number of free-school sets in 2004 increased significantly, the number of log sets remained stable. Following 2003, 2004 was again an

exceptionally good year, with a total catch of 107,441 t – and the highest catches of yellowfin tuna observed since the beginning of the French fishery.

20. Document IOTC-2004-WPTT-18 provided summary statistics of the Spanish purse seine fleet fishing in the Indian Ocean from 1984 to 2004. Data included catch and effort statistics as well as some fishery indicators by species and fishing mode. While the total catches in 2004 decreased to 2002 levels the catches of yellowfin tuna are the highest recorded ever, standing at 81,000 t.

21. Document IOTC-2004-WPTT-30 provided an overview of the recent trend (2000-04) in the Indian Ocean FAD fishery for purse seine vessels operating under different EC and other flags. While the catches on FAD have shown a downward trend since 2002, catches on free schools that have been increasing. Catch rates of purse seiners operating in association with supply vessels are significantly higher than those of other purse seiners.

22. Document IOTC-2005-WPTT-06 presented the preliminary results of the Multilateral Catch Monitoring Programme on Fresh –tuna longliners operating from ports in Indonesia. Indonesia, with catches of tuna and tuna-like species exceeding the 150,000 t in recent years, is one of the major fishing countries operating in the Indian Ocean. The rapid evolution of its longline tuna fishery, especially during the last decade made it a priority for Indonesia to strengthen the monitoring activities. The fresh tuna longline catches estimated, at around 45,000 t, are thought much more accurate than previous catches estimates. The quality of the size data and other key biological information now available for this fishery is some of the best existing in the Indian Ocean for a longline fishery.

23. Document IOTC-2005-WPTT-07 provided a summary of the activities of fresh-tuna longliners operating from Phuket since 1994. The catches of fresh-tuna longliners, mainly from Taiwan,China and Indonesia have been estimated for the period 1994-2004, with current catches estimated at around 11,000 t. The collection of size frequency data in Phuket enables Catch-at-Size tables to be estimated for these fleets in the eastern Indian Ocean for 1998-2004. Other important biological information is also collected. The current activities are conducted through IOTC/OFCF-AFRDEC cooperation.

24. Document IOTC-2004-WPTT-13 provides a summary of the activities of two deep-freeze Thai longliners that have been operating in the Indian Ocean since 2000. Fishing grounds were reported in six IOTC areas, namely Bay of Bengal, west coast of Indonesia, Maldives and Chagos archipelagos, east and south of Seychelles, east coast of Somalia and southern part of the Indian Ocean. The highest catch rates were in west coast of Indonesia, followed by Maldives and Chagos archipelagos while the lowest catch rate reported in the Bay of Bengal. Yellowfin tuna made up 48 % of the total catch. It occurred in all fishing grounds, however the highest abundance was found in the east and south of Seychelles while the lowest abundance was in the southern part of the Indian Ocean. Yellowfin varied from 20 to 120 kg (mode 40 kg). Bigeye tuna comprised 31% of the total catch and was found in all fishing grounds with the highest catch in east Somalia. Bigeye varied from 20 to 150 kg (mode 50 kg). Albacore tuna comprised 11 % of the total catch, and was caught only in the southern part of Indian Ocean in 2003 and 2004. Albacore ranged from 10 to 50 kg (mode 30 kg). The rest of catch comprised swordfish (4.2%), sharks (1%), and billfish.

2.6. General discussion on statistics

25. The WPTT noted the progress achieved in the preparation of 'disaggregated' catch statistics for use by scientists participating to IOTC Working Parties and important reviews to catch series, such as the artisanal fishery of Yemen.

26. In view of the high catches of yellowfin tuna recently estimated for the Yemen artisanal fishery the WPTT stressed the need to collect more information on the size range of the specimens caught by this fishery. The WPTT requested that staff from the IOTC Secretariat travel to Yemen in order to collect more information on this subject. The IOTC Secretariat informed the meeting that a World Bank Programme is due to start on next October and one of its main aims is the implementation of data collection in Yemen. The IOTC Secretariat indicated that a trip to Yemen was being considered for just after the implementation of this programme.

27. The scientists from Taiwan,China noted that the discrepancies existing on the catches and effort of yellowfin tuna for 1988-92 regarding its longline fleet were due to the low logbook coverage rates that were recorded during that time. It was noted that the representativeness of the catch-and-effort data for this period may be compromised by the low coverage rates.

28. The WPTT commended Taiwan,China for supplying the size frequency data available for its longline fishery for 1980-2004. The dataset is expected to contribute greatly to the work of the WPTT.

29. The WPTT noted that the low sample size and coverage per area regarding the size frequency data available from longliners of Japan during the last decade is of concern. It was noted that the Japanese size data was used to estimate the size frequency on most non-reporting longline fleets. The WPTT stressed the need to increase the amount of size data collected on longline vessels agreeing that the use of existing data greatly compromises the quality of any Catch-at-Size tables derived from it.

30. The scientists from Taiwan,China and Japan informed the WPTT that the collection of size data on its longline vessels was voluntary, the amount of size data collected not likely to increase in the future. The scientists from Taiwan,China noted that the collection of size data through alternative methods, e.g. images of the specimens caught taken on board, was being tested and that its implementation would depend on the results of the study. Japan informed that the collection of size data through observers will improve the amount of size data collected for its fishery.

31. The WPTT commended Indonesia and Thailand for the collection of information on fresh-tuna longliners operating from ports in these countries. The WPTT stressed the need to complete the existing information through the collection of information on catches and effort per area. Indonesia informed the meeting that a pilot observer program was currently under way the implementation of a logbook system being one of its objectives.

32. Korea informed the WPTT that the catch-and-effort data was currently under review noting that more complete catch-and-effort data is expected to be available in the near future.

2.7. Data related issues for tropical tunas

33. The following data related issues were highlighted by the WPTT:

- Poor knowledge of the catches, effort and size-frequency from fresh tuna longline vessels, especially from Taiwan,China, before 1998.
- Poor knowledge of the catches, effort and size-frequency from non-reporting fleets of deep-freezing tuna longliners, especially since the mid-1980's.
- Lack of accurate catch, effort and size-frequency data for the Indonesian longline fishery before 2002.
- Poor knowledge of the species composition and size-frequency data for former Soviet Union purse seine boats flying flags of convenience in recent years.
- Scarcity of data, especially size frequency data, for the Maldives hand line, troll line, gillnet and pole and line fisheries since 1998.
- Uncertainty about the catches, mainly gillnet, hand line and troll line, by domestic boats operating in Yemen and Sri Lanka.

34. Improvements have taken place in a number of areas. These include:

- **A better level of reporting:** New NC, CE and SF datasets have been obtained for Sri Lanka domestic fisheries and Taiwan,China longline fisheries. Taiwan,China provided size data for its longline fleet for 1980-2003.
- **Revision of the IOTC databases:** Several revisions have been conducted during the last year on the IOTC databases. This has led to revised NC data for some countries.
- **An improved Vessel Record:** More information has been obtained on the number and type of vessels operating under flags of non-reporting parties. This information comes mostly from various licensing schemes in the Indian Ocean and has become an important element in the estimation of the catches of non reporting fleets.
- **Improved estimation of catches of non-reporting fleets:** The collection of historical and current information on the landings of small fresh tuna longliners in ports in the Indian Ocean has improved the accuracy of earlier estimates. The more complete Vessel Record also permitted the estimation by flag of the catches of deep-freezing longliners. The catches of the former Soviet Union purse seiners for 1998-2002 are considered to be more accurate.
- **Estimation of catch-at-size for Indonesia, Taiwan,China and China fresh tuna longliners:** The collection of size data in Thailand, Sri Lanka and Indonesia underpins the estimates of catch-at-size for

fresh tuna longliners for 1998-2004 (longliners based in ports other than Indonesia) and 2002-04 (longliners based in Indonesia).

- **IOTC/OFCF sampling programmes:** The collection of information on the activities of fresh tuna longliners landing in Phuket and Indonesia has continued during 2004. This has led to more complete and accurate estimates of the catches by these fleets. Other valuable data collected under these programmes include length frequencies (which will allow length-length, length-weight and weight-length relationships to be updated). Size data were also obtained for Oman (Yellowfin tuna) and Maldives (skipjack tuna and yellowfin tuna) artisanal fisheries since 2003.
- **Yemen NC:** The catches of Yemen domestic fisheries were updated during 2004. New catch estimates are markedly higher than previous estimates, especially since the early 1990's.

35. The current status of the data for each of the tropical tuna species is summarised below.

YELLOWFIN AND BIGEYE TUNA

Nominal Catch data: Relatively well known for most purse-seine fisheries and the main longline fleets (Japan, Korea and Taiwan,China). Catches of non-reporting longline and purse seine fleets are still uncertain, although they are believed more accurate than the estimates reported in the past.

Artisanal catches of bigeye tuna are negligible. By contrast, the levels of yellowfin tuna catches by artisanal gears (mainly gillnets) while uncertain are believed to have increased markedly in recent years.

Catch and Effort data: Well known for the purse-seine fisheries and the main longline operations (Japan, Korea and Taiwan,China). Nevertheless, the Korean data are considered to be inaccurate. No catch-and-effort statistics are available for non-reporting longline, purse seine and most gillnet fisheries.

Size Frequency data: Sampling coverage from Japan and Korea has been low in recent years. Size data is not available at the five degrees square resolution. The only data available for non-reporting fleets come from sampling in Phuket, Penang, Sri Lanka and Indonesia. Little information is available on important artisanal catches (e.g. Pakistan, Yemen and Comoros).

SKIPJACK TUNA

NC and CE data: Relatively well known for most purse-seine fisheries. Data are available for the important artisanal fishery in Maldives although only up to 2001. Artisanal components (not well known) are important for this species. In several coastal countries (e.g. Indonesia) the catches are not reported by gear.

SF data: Available for reporting purse seine fleets (1984-2003), Maldivian baitboats (1983-1998 and 2003) and some gillnet fisheries and years (Pakistan, Iran, Indonesia and Sri Lanka), although sample sizes are low in some cases.

3. New information on biology and stock structure of tropical tunas

36. Document IOTC-2005-WPTT-28 summarised the results of the predation survey conducted by the Japanese commercial tuna longline fisheries for four years and four months from September 2000 to December, 2004. Currently about 480 longliners are cooperating in this survey. The focus is on predation by killer whales (*Orcinus orca*) and false killer whales (*Pseudorca crassidens*). The WPTT noted that the definition of predation rates used in the survey has changed from that used in the past. The number of predators observed between 2000-2004 was 1,564. Of these, 58% were sharks, 40% false killer (including killer whales) and 2 % other species. There are a few cases that squid and fur seals attacked tuna. The total number of fish attacked during the period 2000-2004 was 8,296. Yellowfin, bigeye and albacore tunas are three major species attacked by predators (47%, 27% and 14% respectively). Information on the seasonality and geographical distribution of predation events is provided. Mitigation measures are also described. Data compilation and processing will continue in 2006 and a workshop to discuss the results of the programme is tentatively scheduled for 2007.

37. Document IOTC-2005-WPTT-14 described aspects of the reproductive biology of yellowfin from the eastern Indian Ocean. Data was conducted between January 2001 and December 2003 from surface longliners that unloaded their catch at Phuket fishing port, Thailand. A total 355 ovary and 140 testis samples were collected.

The spawning season was between in November to April, coinciding with a period when the sex ratio was equal 1:1 (compared with the mean monthly sex ratio of 1:0.4). Size at first maturity of female and male was 109.69 cm and 104.95 cm, respectively. Small sized yellowfin (95-135 cm) comprised more females than males as did larger yellowfin (145-155 cm) but the proportion of females was slightly less. Counts of hydrated oocytes varied from 0.3 to 5.3 million oocytes, while the average diameter of oocytes was 0.56 mm.

38. Document IOTC-2005-WPTT-19 described results of a preliminary analysis on biological features of yellowfin tuna based on observer data from Chinas observer programme which began in the Indian Ocean in 2003. A total number of 746 yellowfin tuna were sampled in 2003 and 2004. The document provides length, weight, sex and stomach content information and compares the results with other studies.

39. Document IOTC-2005-WPTT-20 presents the preliminary sex ratio results for yellowfin tuna obtained by observers in an experimental Spanish longline fishery in international waters between 25º S and 35º S and 30º E and 50º E. Until now the sex of 244 yellowfin specimens has been determined, resulting in a total of 129 males (53%) and 115 females (47%). All the yellowfin specimens caught by long line in the campaign were between 110 and 170 cm LF, with 92% of the samples between 120 and 165 cm LF.

40. No new information on bigeye or skipjack tuna was available to the WPTT. New information on the biology of yellowfin tuna relevant to the stock assessment and interpretation of the high yellowfin catches in 2003 and 2004 is discussed in Section 4.

4. Review of new information on the status of yellowfin tuna

4.1. Review of the high catches of yellowfin in 2003 and their potential causes

Background

41. The high catches of yellowfin observed in the Indian Ocean in 2003 and 2004 have been confirmed by the final data submitted to the IOTC. In 2003 yellowfin catches reached a record high level of 457,000 t. This was well above the average annual catch over the 10 previous years (353,000 t) and well above the previous highest catch of 406,000 t taken in 1993 (Figure 1). While the 2003 catch of yellowfin was unprecedented in the Indian Ocean, the WPTT noted that similar events have occurred in yellowfin fisheries in other oceans, e.g. the eastern and western Pacific in recent years (IOTC-2005-WPTT-21).

42. Purse seiners were responsible for the highest catches, however, some longline fleets (e.g. Japan) and by some artisanal fleets operating in the western Indian Ocean (such as those from South Africa, Iran) also experienced major increases in their catches of yellowfin.

43. Fishery data recently submitted to the IOTC on the EU purse seine and Japanese and Taiwanese LL catch and effort indicates that high catches of yellowfin were also taken in 2004. Monthly yellowfin CPUE by purse seiners during the period 1999-2004 in the Western Indian Ocean shows that CPUEs increasing from December 2002, peaking at the end of 2003 and the beginning of 2004, then decreasing back to average levels during the year 2004 in the purse seine fishery (Figure 13). Purse seine CPUEs in 2005 (provisional estimates) have been relatively low.

44. The most common size of yellowfin taken by purse seiners in 2003 and 2004 was between 110 and 150 cm (equivalent to individuals weighing 25 to 70 kg) (Figure 14).

45. For both the purse seine and longline fisheries, most of the catch of yellowfin in 2003 was taken in mainly in the south western Indian Ocean (Figure 15).

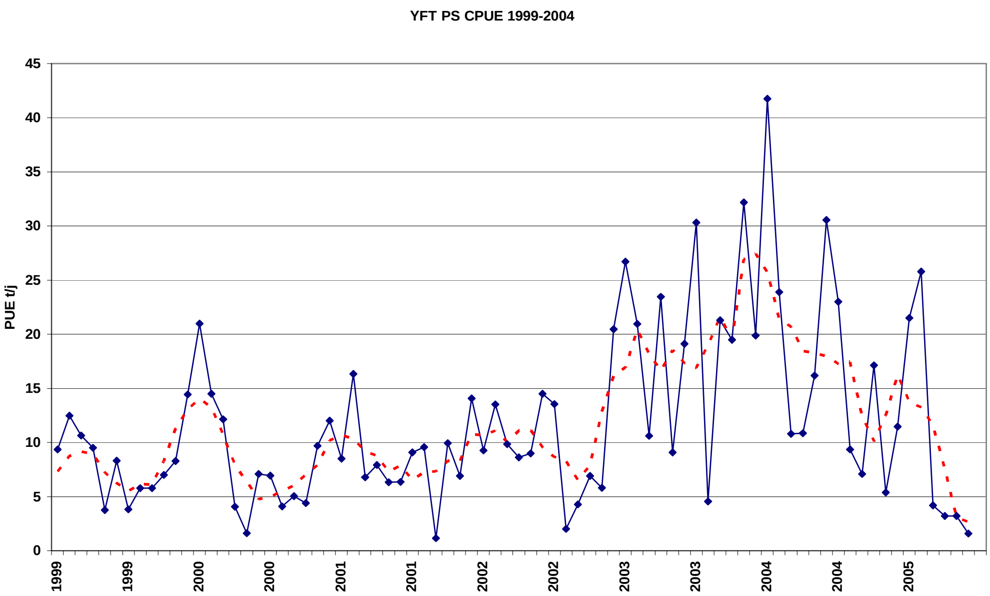


Figure 13. Monthly yellowfin tuna CPUE's from purse seine vessels (solid line) and smoothed average of CPUE (dotted line) for the period January 1999 to June 2005 (Note: 2005 is provisional data)

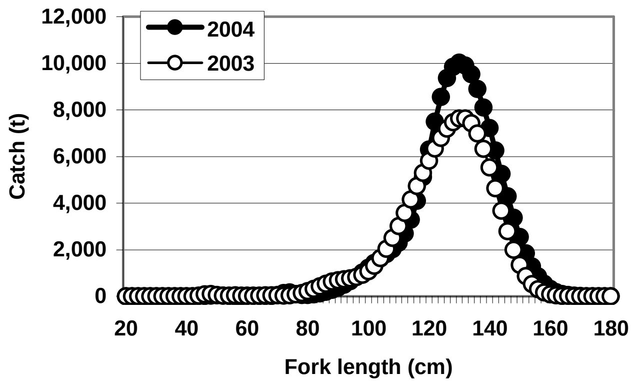


Figure 14. Size of yellowfin tuna taken by purse seiners in 2003 and 2004 in the Indian Ocean

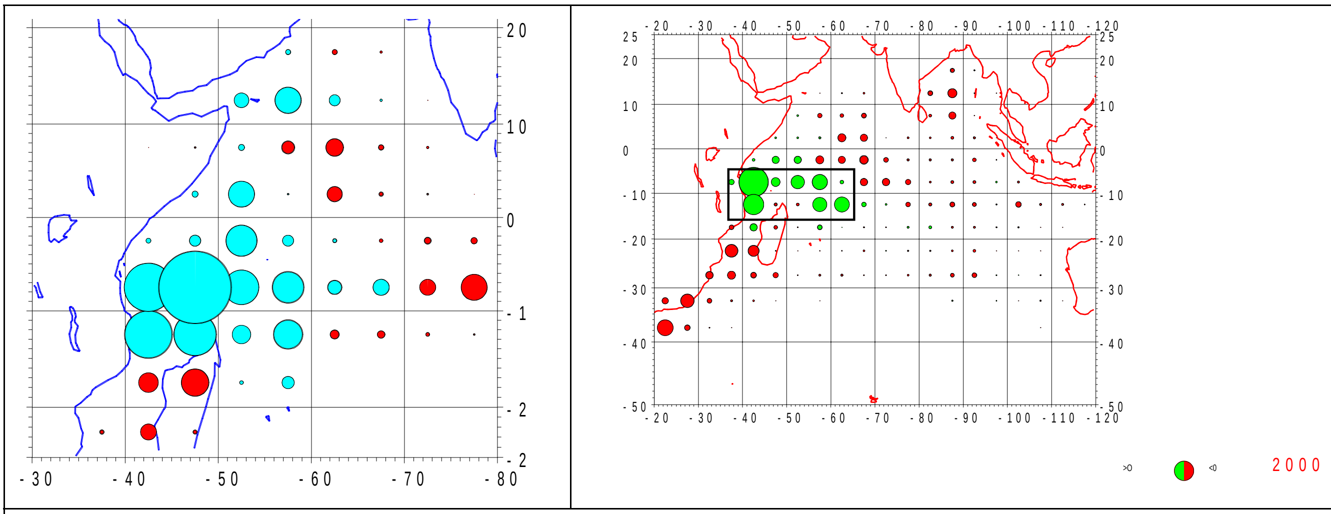


Figure 15. Maps showing the locations of the 2003 yellowfin catch anomalies in the purse seine (left) and Japanese longline (right) fisheries (anomalies are indicated by the relatively larger circles). Figures are from IOTC-2005-WPTT-INF04.

46. The WPTT noted that the 2003 anomaly appears to have continued into 2004 and there are signs that the purse seine and Japanese longline catches in 2004 will be similar (possibly higher) to those reached in 2003. Preliminary data shows that the 2004 high catches are being taken in the same area as those in 2003 (although it appears that in 2003 the Taiwanese longline fleet was not been targeting yellowfin in the same areas, keeping its traditional fishing zones and target species — mainly bigeye and swordfish). Verbal reports given to the WPTT indicated that Taiwanese longline fleet have taken large catches of yellowfin in the Arabian Sea in 2004 (Taiwanese yellowfin catches in 2004 being estimated to be 70% larger than in 2003), and also in 2005, but these data are not yet available to the IOTC.

47. The WPTT also noted from an analysis of the preliminary 2005 data that the yellowfin catches and catch rates by purse seiners during the first months of 2005 are relatively low (Figure 13), indicating that the 2003-2004 anomaly of high yellowfin catches may not be repeated in 2005.

Why did the 2003-2004 anomalies occur ?

48. In 2004 the Scientific Committee (IOTC-2004-SC-R) considered that the high catches could be explained by various mechanisms and causes, mainly:

- An increase of adult stock biomass due to an increased recruitment e.g. the presence of one or several large recruitments entering into the adult stock. Such increased recruitment could for instance have been due to favourable environmental conditions in the spawning/nursery areas in the late 1990's/early 2000's. However, it was noticed that catch rates of juveniles in the purse seine fishery do not show any very large year class during the period 2000-2001 (when in other yellowfin fisheries, such as in the Atlantic and Pacific oceans, these large classes tend to be "visible" at early ages in the purse seine fishery). This could indicate (1) either that juveniles of these large cohorts could have been outside the purse seine fishing zones, for instance in the eastern Indian Ocean (2) or that these recent cohort were at average levels.
- An increased catchability of the yellowfin stock, e.g. an increased fishing mortality due to certain conditions present in 2003 and 2004. The potential sources of increased catchability were listed and discussed in the various documents and some of these potential causes were considered as being more likely than others: (1) the increased efficiency of the purse seine fleet due to new sonars recently implemented, (2) the effect of the crustacean *Natosquilla* a new shallow species that is now frequently eaten by yellowfin in the western Indian Ocean and potentially facilitating the capture of yellowfin schools by purse seine; large biomass of a deep swimming crab was also noticed by Japanese longline fishermen in the same area and it may have concentrated the yellowfin biomass in the area, (3) the geographical concentration of the yellowfin stock in a peculiar area, where the yellowfin adult stock could have been more easily caught by purse seine and by longline, (4) the increased efficiency and better local targeting on yellowfin by Japanese longline.

49. New information submitted to the WPTT in 2005 (IOTC-2005-WPTT-27) discussed the potential effects of ecological anomalies on recruitment and catchability. This paper showed that various environmental anomalies (in the thermocline depth and primary productivity) have been observed in the western Indian Ocean, and may have played a role in the high yellowfin catches due primarily to an increased catchability of the stock. The same paper also discussed a new hypothesis that the recent deployment of noisy and massive war navy fleets in the north-west Indian Ocean could have produced a displacement of the northern yellowfin tuna biomass towards the southern Indian Ocean.

50. The conclusion of this document is that the 2003 high yellowfin catches were probably due to a combination of increased recruitments and increased catchability in the adult yellowfin stock (due to a combination of fishery and environmental factors).

51. A preliminary examination of various environmental parameters was also presented (IOTC-2005-WPTT-35). This paper described the seasonal variability and interannual trends of SST, chlorophyll s and it showed that various cycles and anomalies have been observed in these environmental parameters which could have influenced yellowfin.

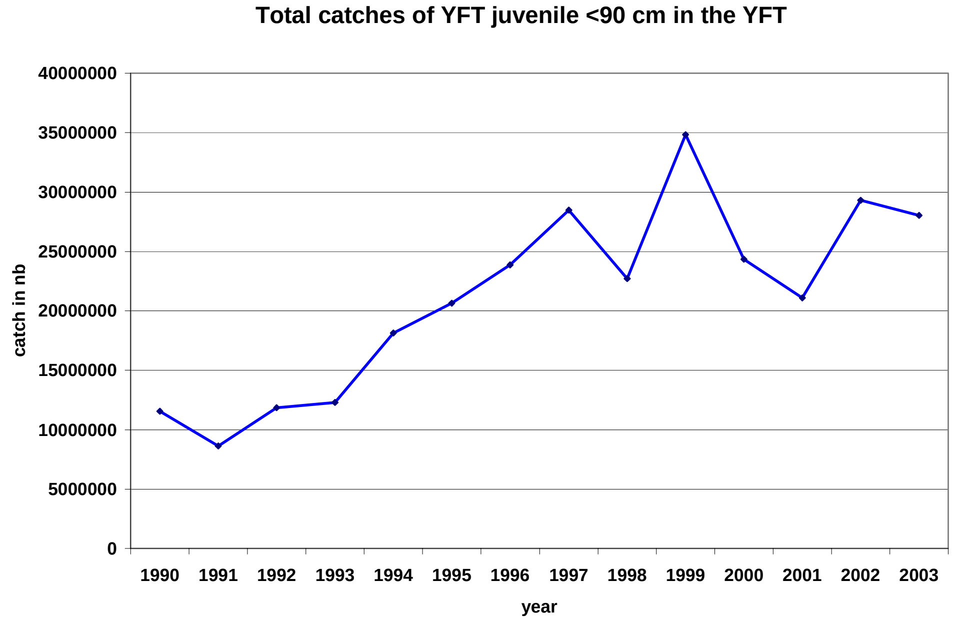


Figure 16. Total catches (numbers) of yellowfin juveniles <90 cm fork length.

52. Various environmental information on wind speed, sea surface temperature and upwelling were also examined in document IOTC-2005-WPTT-26. This information indicated that conditions were highly favourable for good recruitment in the area during the late 1990's, and these favourable conditions could explain the large recruitment of adult yellowfin in the 2003 and 2004 fishery. However, the same data set would also indicate that the environmental conditions could have been quite poor since 2000, then potentially producing poor recruitments in subsequent years. These potential low levels of yellowfin recruitment have not yet been identified in the fisheries of juvenile yellowfin, total catches of juvenile yellowfin (sizes <90cm, Figure 16) being estimated to be quite stable during recent years.

Conclusions on the 2003-2004 high YFT catches

53. The data examined by the WPTT lead to the conclusion that the recent high yellowfin catches taken by purse seine and to less degree by other fleets in the South Western Indian Ocean were probably due a combination of factors

(1) one or two **high recruitments** entering into the adult stock; these increased recruitments should lead to an increased MSY if they could be maintained at high levels in the long run. If there was only a recruitment anomaly with 1 or 2 large year classes, the previously estimated MSY would still be valid.

(2) simultaneous **increased catchability** of the stock due to several additive factors (linked with fishery technology and behaviour, as well as a peculiar behaviour and biology of yellowfin tuna during this period). If real, this increased catchability of the yellowfin stock could temporarily lead to increased catches (as it would simply produce an **increased F at constant nominal effort**), but such increased catch would not be maintained in the long run, as the basic MSY of the stock would stay unchanged (the preliminary 2005 PS data tend to indicate such decline towards lower levels of catches).

54. These conclusions are simply based on the examination of various fishery and environmental data and qualitative information, and not upon a comprehensive stock assessment, but they would tend to indicate that the high 2003-2004 catches are probably not sustainable in the long run, being mainly driven by two large year classes and an increased catchability of the yellowfin stock, but not by a long term improvement of its biological productivity.

55. Such complex situation should preferably be analysed using complex integrated analytical assessment models, as they are the only suitable models to precisely evaluate the exact roles played by the various factors linked in peculiar geographical areas to changes in stock catchability and stock size.

4.2. Data for input to stock assessments

CATCH AND EFFORT

56. A comparative overview of tuna stocks worldwide, in terms of biology, catches, population status and stock assessment, was presented (IOTC-2005-WPTT-21). Comparisons of a range of variables and indicators across all four yellowfin tuna areas (Indian, Atlantic, and western and eastern Pacific Oceans) were made. The various ways the scientific communities involved with the four stocks are dealing with common problems were also highlighted. The WPTT recognised the usefulness of such comparisons across stocks and paid special thanks the author for his hard work.

CATCH AT SIZE

57. Catch by length data for all fisheries were generated by Mrs. V. Nordstrom (IOTC-2005-WPTT-INF05). The WPTT thanked Mrs. Nordstrom for her good work. Questions were raised on the level of extrapolation necessary when generating this dataset. Unfortunately, sampling levels in many fisheries is very low, and it is even going down in some of them. This is the case, for example, of the Japanese longline fishery. The quality of the size frequency data needs also to be taken into account. For some fleets, sizes in the catch are measured by the crew while in others a complex sampling programme, stratified by area, season and vessel type, is in place. However, the generation of a complete catch-at-size matrix is absolutely necessary for the application of both length and age based assessment methods.

GROWTH CURVES AND REVISED LENGTH-AGE KEY

58. Document IOTC-2005-WPTT-32 re-examined the growth model for yellowfin tuna in the Indian Ocean using an analysis of length frequencies from purse seiners and in the Taiwanese longliners and Iranian gillnets between 2000 and 2004. A two stanza growth model was fitted. Growth appeared to be correctly described until 140 cm FL. L infinity was constrained in order to have result more realistic than the Stéquert growth curve or the Lumineau growth curve used in the previous assessment. Questions were raised about the implications of the growth curve proposed. The differences observed with the growth curves estimated for other oceans could be explained by the differences in methodology, or could arise from real differences between the various oceans where yellowfin is present. If this was the case, the use of natural mortality rates estimated in other oceans for the Indian ocean yellowfin stock could be misleading.

59. An ad hoc ‘Task Force on biological parameters’ was formed to discuss the pros and cons of the various growth curves available for use in the yellowfin stock assessment (the full report of the group is given in Appendix IV). The group made a comparison of the various growth models available in the Indian Ocean (based on modal progressions such as the Lumineau and Viera models, and otolith readings such as the Stequert models), comparing them to models used in other oceans for yellowfin stock assessments. The conclusion by the group was that the age reading done by Stequert was highly relevant but his growth parameters using his best fit of an L infinity at 2.60 m should not be used in a stock assessment. The WG reprocessed the Stequert data, and it was found that alternative growth model fitted to the two stanza growth model with an L infinity fixed at a realistic biological level of 1.65 m (e.g. at the 99% highest sizes taken by the historical longline fisheries). The fit of this new growth curve was nearly identical in statistical terms to the original Stequert curve;

60. The new growth curve fitted to the Stequert 1998 data with a L infinity = 1.65 m using a 2 stanza model was called the revised Stequert growth curve. For fish sizes > 70 cm, this new growth curve shows good agreement in growth curves obtained from modal progression. However, the WPTT could not reach a consensus on which of the revised Viera or revised Stequert growth curves best describe growth of yellowfin <70 cm.

61. The final conclusion by the WPTT was to use:

(1) two alternate growth curves for YFT <60 cm: i.e. the revised Stequert and Viera (noting that there is a difference of 12 month or 1 year in the absolute age of the 60 cm fishes).
(2) the revised Stequert growth curve for YFT over 60 cm

62. It was noted that the usefulness of Stequert's original growth curve was limited by the unrealistic estimate of L_infinity obtained when fitting a growth curve to data with a limited length range. A model was thus fitted to the original data that fixed the value of L_infinity to 165 cm. The fit obtained was equally valid as the original one, and the group considered this to be a better approach.

CATCH AT AGE

63. Given that both the revised Stequert and Viera's curves were markedly different from what was used for generating the previous catch-at-age matrix, new matrices were derived using both growth curves (Figure 17). Assessment models were thus re-run using one or both of these new matrices.

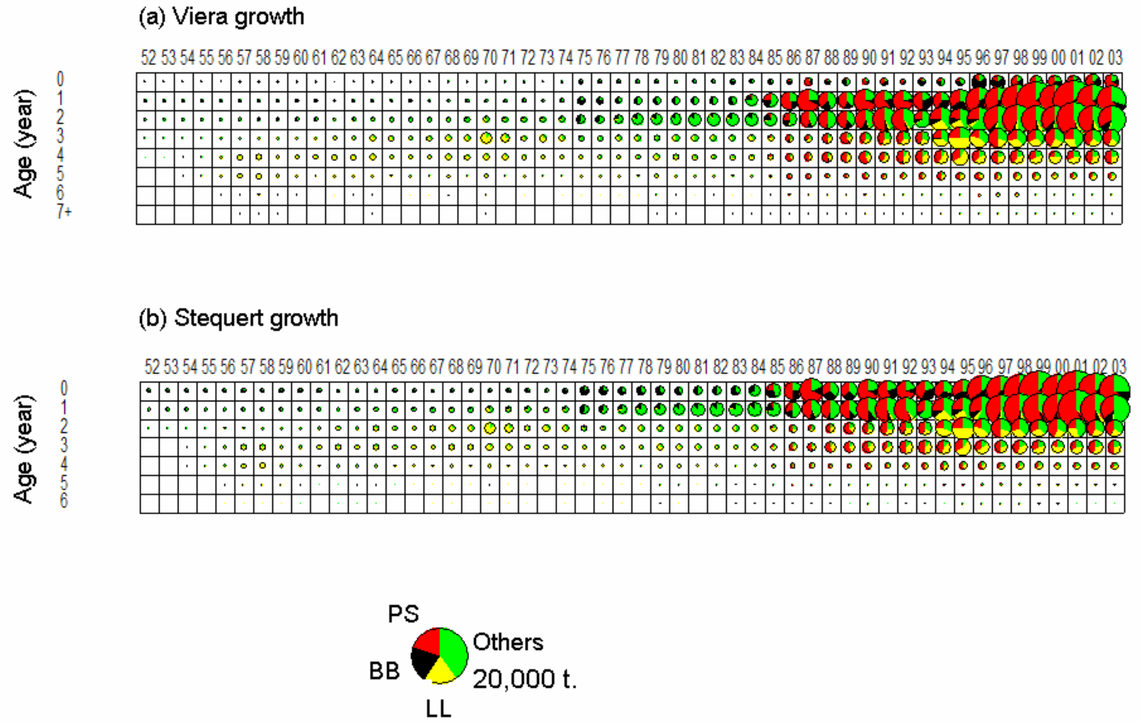


Figure 17. Catch at age (tonnes) for yellowfin tuna caught in the Indian Ocean (a) estimated using the revised Viera growth curve (b) estimated using the revised Stequert growth curve. PS: purse seine; BB: bait boat; LL: longline fishing.

INDICES OF ABUNDANCE

Longline fisheries

64. Document IOTC-2005-WPTT-11 described recent trends of the Japanese longline fishery in the Indian Ocean with special reference to the targeting and asked the question "is the target shifting from bigeye to yellowfin ?". Since the late 1990s, the proportion of yellowfin in the total bigeye and yellowfin combined catch has increased in the Indian Ocean. – especially in the western areas. Distribution of catch by species, species composition, CPUE were analysed in an attempt to determine whether the target species has been changing. The proportion of yellowfin has probably increased due to one or a combination of factors: 1) a shift of fishing ground (distribution of effort concentration) to a yellowfin dominant region in the western Indian Ocean; 2) an introduction of more than 17 hooks between floats and use of Nylon materials since 1990; 3) a decrease of bigeye abundance (CPUE) and increasing or flat level in yellowfin CPUE in the last 10 years in the tropical Indian Ocean.

65. Document IOTC-2005-WPTT-12 described the estimation of longline gear configuration using species composition data from the Japanese longline fisheries 1975 to 2002. In the four species combinations tested, the combination of six species (BET, YFT, ALB, SWO, MLS and BUM) resulted in the highest correct estimation ratio. By substitution of the strata whose species composition could not determined for one or both gear types, the ratio of un-judged observation decreased from 0.464 to 0.300. In the estimation using composition of six species and applying the substitution, the correct estimation ratio averaged about 63%. When the estimated and actual gear configurations were applied into GLM, both of estimated and actual NHFCLs had a significant effect on the bigeye CPUE standardization, although the difference of effects between estimated NHFCLs (regular and deep longlines) was smaller than that observed between actual gear types.

66. Document IOTC-2005-WPTT-29 described the results of a study to examine the affects of Japanese tuna prices on targeting practices and CPUE of yellowfin tuna and bigeye tuna exploited by Japanese and Taiwanese tuna longline fisheries in the Indian Ocean. The results indicated that some changes in the fishery may have occurred as a result of prices around 1980.

67. Nominal CPUE is illustrated for the period 1953-2003 (Figure 18). Standardised CPUE analyses using the same analytical approach were reported for the Japanese longline fishery (Figure 19) and the Taiwanese longline fisheries (Figure 20), respectively. In the analysis of the Taiwanese data (IOTC-2005-WPTT-16), environmental factors were included in the model for the first time this year. For the Japanese analysis (IOTC-2005-WPTT-15), the GLM model incorporated both environmental and of technological factors.

68. The group discussed the relative merits and shortcomings of each of those indices, concentrating on their suitability for the purposes of stock assessment. Doubts were raised on the need for such a complex GLM-based standardisation for the LL fleets, specially the Japanese, when they did not differ greatly from the nominal. Also the WPTT generally agreed that too many parameters tend to be incorporated in the GLM models.

69. IOTC-2005-WPTT-INF03 informed the WPTT that in Japan basic tuna price (fresh & frozen) data are available in more than 200 fishing ports since 1961. It is not clear whether these data are electronic at this stage. The WPTT suggested that the price data might be digitized so that they can be utilized in the CPUE standardization. When tuna price data are used for the analyses, however, four points need to be taken care, i.e., (a) to use fresh(or frozen) tuna prices as the representative tuna price statistics in Japan, (b) to use tuna price data in major 6-10 cities to represent average situation because tuna prices are different among cities (or landing ports) in Japan, (c) to apply the inflator to standardize tuna prices using consumer price indices (CPI) and (d) to apply the exchange rates (US$-Japan yen) to standardize tuna prices.

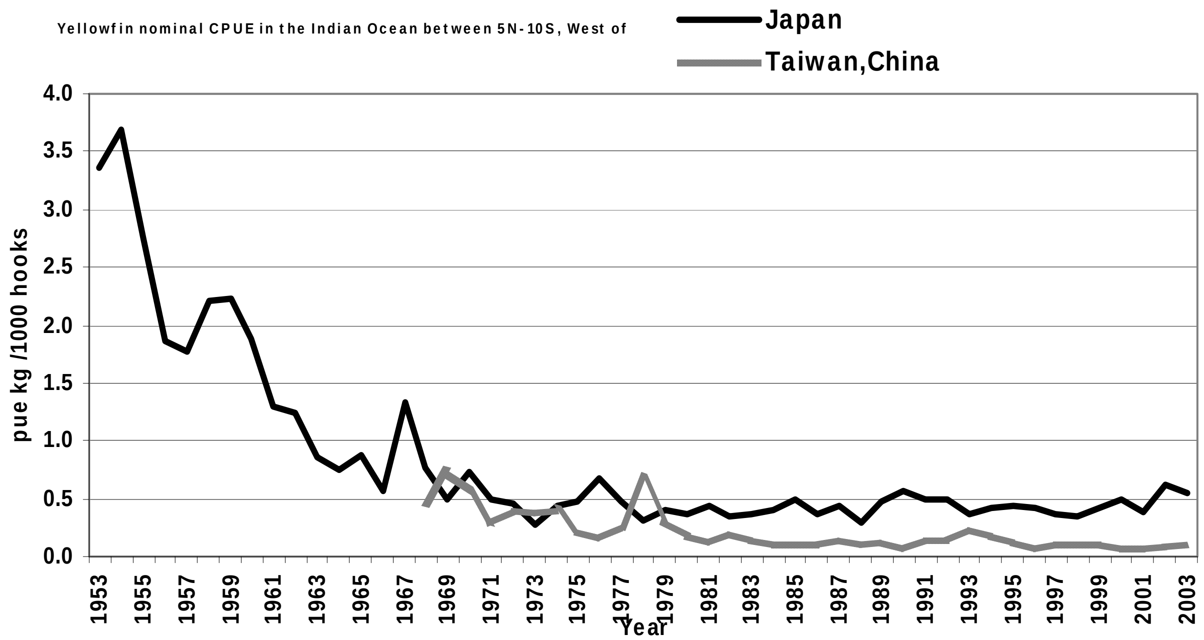


Figure 18. Nominal CPUE for yellowfin in the Indian Ocean for longline fleets from Japan and Taiwan,China.

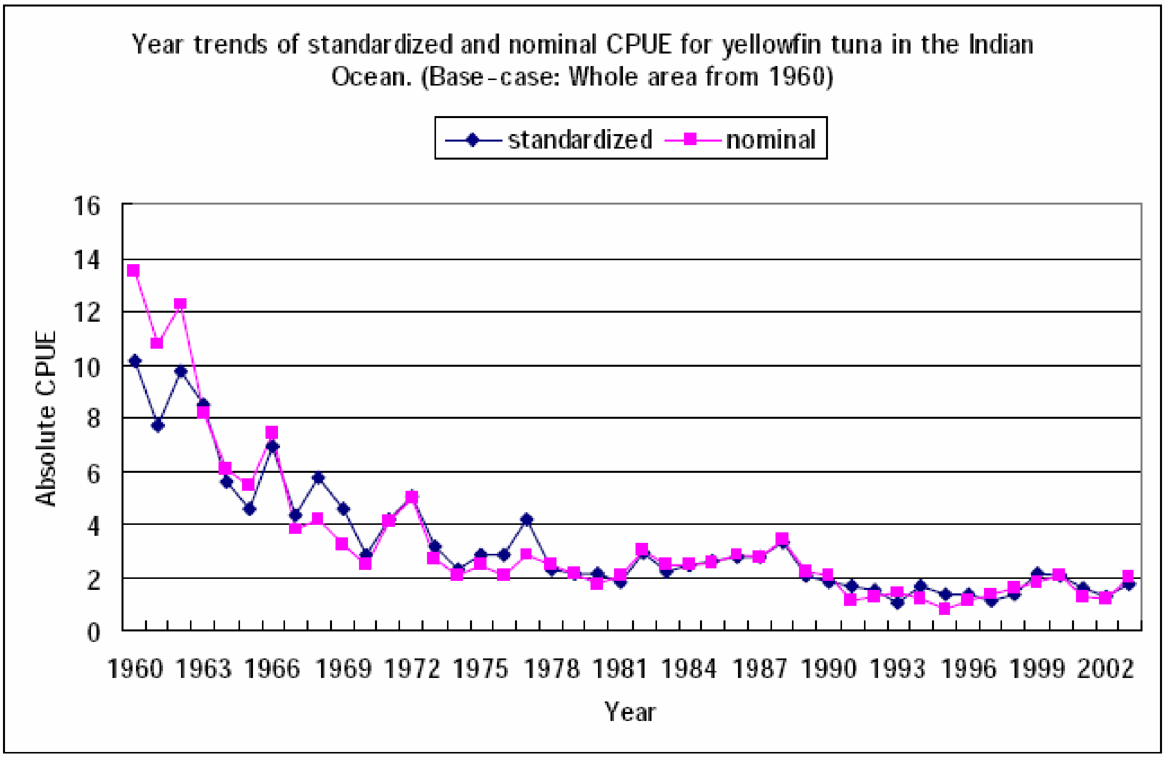


Figure 19. Standardised CPUE index: Japanese longline fishery.

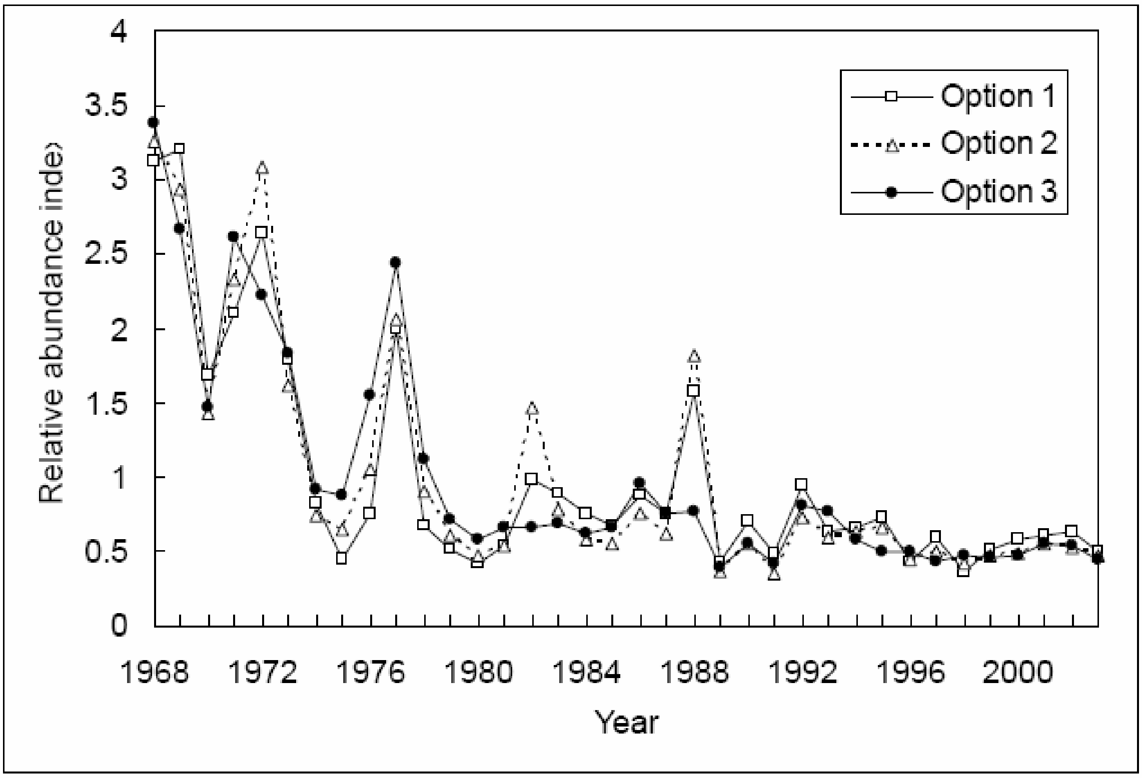


Figure 20. Standardised CPUE index: Taiwanese longline fishery for a range of options. Option 1 is a full model, option 2 is excluding area x the effect of mix layer depth, and option 3 excludes the effect of SST.

Purse seine fisheries

70. Document IOTC-2005- WPTT-17 described a standardization of yellowfin purse seine catch rates using GLM. Two sources of data were considered in the analyses: catch and effort data by 1ºx1º square and month, from the IOTC data base, as well as more detailed logbooks data at boat level. The standardized catch rates resulting of the different models were unlikely to be representative of yellowfin abundance. In all the cases, the increasing trend showed by the indexes seemed to be more related with trends in efficiency than abundance. The European PS index was clearly recognised as needing to be standardised, given the known technological changes this fleet has been involved with. The group acknowledged the effort of the team behind this work but conceded that the present data on technological and procedure changes, as well as the knowledge of the effect and interaction among them, was too limited to permit the use of the presented index of abundance for assessment purposes.

4.3. Stock assessments

71. A comprehensive assessment was attempted for yellowfin tuna in 2005 by the WPTT. Two papers presenting assessment results were presented, one using the age structured production model (ASPM) method and one using a new Bayesian two-age-class production model. Additional assessments were carried out during the WPTT meeting using agreed data sets and the following methods: the PROCEAN method, the CATAGE trend (statistical catch at age analysis) method, ASPM, and the Bayesian two-age-class production model.

Age-structured production model ASPM

72. A stock assessment on yellowfin tuna was presented using the stochastic age-structured production model, ASPM (IOTC-2005-WPTT-09 and addendum 1). This ASPM model assumes that the catchability coefficients relating the longline fleet CPUEs to abundance are constant over time. Results of several model runs were presented that used various combinations of input parameters such as indices of abundance (JPN and TWN, starting 1960 or 1968), stock-recruitment relationships and natural mortality vectors.

73. Although this model was used in the previous yellowfin assessment and its behaviour is well known, there the WPTT noted certain limitations and these were discussed. A problem appeared to be present with the stock-recruitment parameters. For example, steepness was not reliably estimated from the current data, as shown by the tendency of the model fix on a estimate of 0.99 i.e. the upper limit of possible values and not considered by the WPTT to be realistic. Estimation of steepness in the S/R relationship appears to be extremely complex for many tuna stocks. A suggestion was made that runs could be attempted by fixing the steepness parameter to an agreed value, so that the estimation of MSY and their related reference points would be more successful, but this was apparently not possible in the present model implementation.

74. The ASPM model outputs showed a marked decline in SSB and a singular pattern in recruitment. This appeared to be motivated by the sharp decline implied by the longline indices of abundance at the start of the fishery, when catches were relatively low. In the ASPM, assuming a constant q, the only possible explanation for such a decline in CPUE is that it was due to a parallel decline in recruitment. The biological reasons for such a decline in recruitment are not clear, and no indication of a decline has been detected.

Bayesian age-structured production model

75. Document (IOTC-2005-WPTT-24) presented a Bayesian age-structured production model, modelling two age groups, juveniles and adults, to avoid the problems introduced by the uncertainty in growth. The cutoff point between the two age groups was 85 cm fork length, a length were the FAD fishery catches separate from the free school and Longline fisheries, and close enough to the assumed length at maturity. A mean weight was then estimated for each age group. Catch-at-length in numbers and the Japanese longline index of abundance for the 1968-2003 period were used. A catchability coefficient that was constant over time was assumed for relating the Japanese longline index to abundance. A Beverton-Holt stock-recruitment relationship was assumed, where steepness was fixed at a value of 0.9, and only virgin recruitment was estimated.

76. The population trends detected by this model were in general agreement with those of the ASPM: a stable or slightly declining SSB until the early 1970s, when the decline of adult biomass started. Recruitment (in the form of its proxy here of the abundance of age 0 and 1 fish) appeared stable until recent years. Even with a very weak SR relationship, the current level of exploitation of the stock appears to start having an impact on recruitment, albeit a minor one.

77. The model predicted that ongoing catches at the level of those in 2003 are not sustainable in the short or medium term. A constant catch scenario at the levels of 2003, and incorporating the uncertainty in the estimate of SSB, and an alternative were catches of both ages are reduced by 25% in weight were presented.

CATAGE

78. CATAGE-TREND is a multi-fleet statistical catch-at-age model which includes both observation error and process error on both catchabilities and selectivities for each fleet. The process error model for catchabilities combines a random walk that allows for slow trends in fishing power and a robust error that allows for high frequency random variability in annual catchabilities. The model uses a Bayesian approach that allows for the use of prior probability distributions for parameters such as natural mortality and recruitment variability. The likelihood approach used enables different levels of model complexity to be compared and permits the extraction of the maximum amount of information from the data. A Monte Carlo Markov Chain (MCMC) algorithm is used to integrate the posterior density function of the model and to provide the posterior probability distributions for model parameters (e.g. natural mortality, abundances and fishing mortalities) and derived parameters of interest (e.g. reference points and projections).

79. Results of applying CATAGE-TREND to yellowfin tuna data covering the period 1953-2003 are presented in IOTC-2005-WPTT-33. Estimated trends in SSB and recruitment matched those of the other models, especially the declines in recent decades. The apparent jump in recruitment in the 1998-99 was discussed with respect to its possible contribution to the high catches observed in 2003. However, it was noted that the five year gap was too long to realise the sizes of fish observed in the 2003 catches, even considering the uncertainty in growth and aging. Estimates of catchability for the longline fleets showed strong decreasing trends for the first 20 – 30 years of the fishery and then increases since 1990. For the purse-seine fleets, there were strong increases in estimated catchabilities since the early to mid-1980s.

PROCEAN

80. PROCEAN (PROduction Catch/Effort ANalysis) is a multi-fleet non-equilibrium Pella and Tomlinson model which includes both observation error and process error on both the carrying capacity of the stock and the catchability for each fleet. The process error model for catchabilities combines a random walk that allows for slow trends in fishing power and a robust error that allows for high frequency random variability in annual catchabilities. PROCEAN uses a Bayesian approach that allows for the use of prior probability distributions for the biomass at time zero (B_0) and other model parameters such as the intrinsic growth rate (r), the shape parameter (m), and the carrying capacity (K), or alternatively on the MSY and F_{MSY}. A Monte Carlo Markov Chain (MCMC) algorithm is used to integrate the posterior density function of the model and to calculate posterior probability distributions for the estimated model parameters, derived parameters (e.g. F_{MSY}, MSY), and other variables of interest (e.g. reference points, projections, etc). The objective of the model is not to propose a very realistic representation of the fishery. Rather, it is a tool to explore data sets and extract the maximum amount of information from the data set by structuring it according to a simple and well established theoretical model.

81. Results of applying PROCEAN to yellowfin tuna data covering the period 1953-2003 are presented in IOTC-2005-WPTT-33. Estimates of catchability for the longline fleets showed strong decreasing trends for the first 20 – 30 years of the fishery and then slower increases since the mid-1980s. For the purse-seine fleets, there were strong increases in estimated catchabilities since the early to mid-1980s. In the runs conducted, the data were well fitted by the model. The fishery is estimated to be below F_{MSY} although the current position relative to F_{MSY} is poorly determined. The 2003 catch was above the MSY, but the mean catch for the five previous years was in the vicinity of the MSY.

Summary of model results

82. Although there were differences in the details of results from the different assessments, the overall picture they presented was consistent, particularly in terms of estimated trends in stock biomass and fishing mortality rates. Estimates of catchability using the PROCEAN and CATAGE trend methods, which allow for time-varying catchability, show a strong increasing trend since the mid-1980s for both the longline fleets and the purse-seine fleets. The assessment runs considered at this meeting consistently indicated that fishing mortality rates between 1992 and 2002 have been close to or at levels of F corresponding to the F_{MSY} estimated by the most plausible ASPM assessment. Catches during this period were in the vicinity of, or possibly above, the MSY levels estimated by PROCEAN and the most plausible ASPM assessment. Estimated catches in 2003 and 2004 were well above

those MSY levels, and projections carried out indicate that these are not sustainable unless supported by very high recruitments.

83. There remain strong uncertainties in each of the assessments conducted. In particular, none are yet able to consistently explain the trends in standardized CPUEs in the early years of the fishery without using trends in catchabilities or recruitment for which there is no evidence. Consequently, the implications drawn from them regarding current stock status are also uncertain.

4.4. Technical advice on yellowfin tuna

84. A comprehensive assessment was attempted for yellowfin tuna in 2005 by the WPTT and the Executive Summary of the status of the yellowfin tuna resource was updated. The Management Advice section of the executive summary is reproduced below. The complete Executive Summary is given in Appendix V.

Considering all the stock indicators and assessments, as well as the recent trends in effort and total catches of yellowfin, the Scientific Committee considered that:

1) Fishing mortality rates between 1999 and 2002 were probably slightly below or around Fmsy, and total catches during that period, at an average level of 347,000 t, were probably close to, or possibly above MSY. Total catches in 2003 and 2004 were substantially above MSY; see below for interpretation of the possible reasons for and possible effects of these catches. In these circumstances, any further increase in both effective fishing effort and catch above average levels in 1999 - 2002 should be avoided.
2) The current fishing pressure on juvenile yellowfin by both purse seiners fishing on floating objects and artisanal fisheries is likely to be detrimental to the stock if it continues, as fish of these sizes are well below the optimum size for maximum yield per recruit estimated in 2002.
3) The Scientific Committee also noted that juvenile yellowfin tuna are caught in the purse-seine fishery that targets primarily skipjack tuna. Some measures to reduce the catches of juvenile yellowfin tuna in the FAD fishery will be accompanied by a decrease in the catches of skipjack tuna.

While there was greater consistency in the assessment results considered at this meeting than in 2002, the Scientific Committee emphasized that there remain considerable uncertainties in the assessments, as none as yet are able to fully explain the observed trends in standardized longline CPUEs over the duration of the fishery.

In interpreting the high catches of 2003 and 2004, the Scientific Committee noted that if the hypothesis of one or two high recruitments entering the adult stock is correct, the increased catches from these year classes are unlikely to be detrimental to the stock, but these catches would not be sustainable in the longer term unless supported by continued high recruitments.

On the other hand, there could be serious consequences if the hypothesis that there was an increased catchability during 2003 and 2004 is correct. In this case, the very large catches would represent a much higher fishing mortality and certainly would not be sustainable. Furthermore, they could lead to a sudden decline of the existing adult biomass of yellowfin tuna, potentially reducing the stock to below MSY levels. If such is the case, management action might be needed to reduce catches and fishing mortality to below the levels prevailing in 1999 – 2002 to allow the stock to recover.

If, as the Scientific Committee believes, the most likely cause of the exceptional catches is a combination of these factors, then some reduction of stock biomass is to be expected in the future. However, the extent of any such reduction will only become apparent in several years following detailed stock assessments.

5. Research Recommendations and priorities

85. At the 9th Session of the IOTC, the Commission requested (via IOTC Resolution 05/01 On conservation and management measure for bigeye tuna) that the Scientific Committee be tasked to provide advice on;

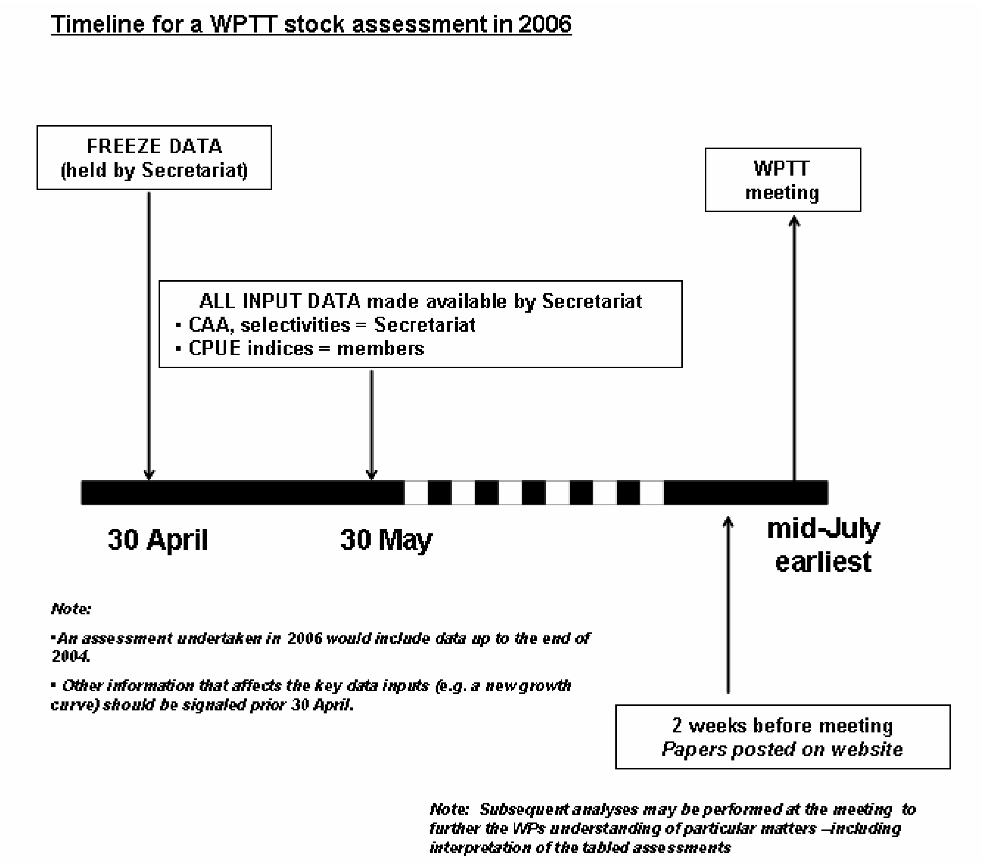
- the effects of different levels of catch on the SSB (in relation to MSY or other appropriate reference point)
- the impact of misreported and illegal catch of bigeye tuna on the stock assessment and required levels of catch reduction
- evaluation of the impact of different levels of catch reduction by main gear types.

86. The WPTT agreed that that ASPM model, as used by Japan in 2004 would be re-run using updated fisheries data and the biological and fisheries parameters used in 2004. The results of this assessment will be made available to WPTT prior to the Scientific Committee meeting in November 2005 and new technical advice on bigeye would be prepared for the Commission by the Scientific Committee based on the results of the up-dated assessment. The WPTT requested that the Secretariat coordinate the delivery of the assessment in conjunction with Japanese scientists.

6. Other business

Timeline for future stock assessments

87. Concerns were raised by members about the short amount of time that was available in which to produce stock assessments and/or review the results of comprehensive assessments prior to the meeting . The WPTT agreed that the main problem lay with the unavailability of the key data inputs until near the start of the meeting. To improve the situation in 2006, the WPTT recommended that the Secretariat works closer to the those member scientists that provide the various datasets and ultimately be responsible for providing the basic data including catch at size and catch at age data –estimated using standard- agreed procedures. The WPTT concluded adherence to the timeline below should greatly benefit the work of the Working parties in 2006 and future years.



Election of WPTT chair

88. The WPTT noted with regret that the current WPTT chair (Dr. Pilar Pallarés) would not be available for consideration for re-election for 2006 and 2007. On behalf of the WPTT, the Chair of the SC, thanked the Dr Pallarés for her expert guidance over the last biennium and her considerable contribution to the success of the WP process over that time. The meeting noted that a new WPPT chair needed to be elected and agreed that this matter should be addressed at the Scientific Committee meeting in November 2005.

Update on tuna tagging activities in the Indian Ocean

89. Document IOTC-2005-WPTT-25 described the small scale and pilot tagging projects involving IOTC being carried out in Maldives, Mayotte and India, and progress to-date at the start of the Regional Tuna Tagging Project.

7. Adoption of the report

90. The Report of the Seventh Session of the Working Party on Tropical Tunas as reviewed by correspondence between 10 and 26 August. This final version reflects the comments received from that review.

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APPENDIX II. AGENDA OF THE MEETING

1. REVIEW OF THE DATA

Review of the statistical data available for the tropical tuna species

2. REVIEW OF NEW INFORMATION ON THE STATUS OF YELLOWFIN

Investigations on the cause of the extraordinary large catches on YFT in 2003, 2004

Data for input into stock assessments:

- Catch and effort
- Catch at size
- Growth curves and revised age-length key
- Catch at age
- CPUE

Stock assessments

Selection of Stock Status indicators

3. NEW INFORMATION ON BIOLOGY AND STOCK STRUCTURE OF TROPICAL TUNAS

Review new information on the biology, stock structure of tropical tunas, their fisheries and associated environmental data

4. DEVELOP TECHNICAL ADVICE ON THE STATUS OF THE STOCKS

Yellowfin

5. **RESEARCH RECOMMENDATIONS AND PRIORITIES**

6. **OTHER BUSINESS**

APPENDIX III. LIST OF DOCUMENTS PRESENTED TO THE MEETING

DOCUMENTS	TITLES
IOTC-2005-WPTT-01	WPTT 2005 Agenda
IOTC-2005-WPTT-02	WPTT List of documents
IOTC-2005-WPTT-03	Status of IOTC databases for Tropical Tunas. *IOTC Secretariat*
IOTC-2005-WPTT-04	Revised catch estimates for tuna and tuna-like species caught by artisanal boats in Yemen *Secretariat*
IOTC-2005-WPTT-05	Biological data on tuna and tuna-like species gathered at the IOTC Secretariat *Secretariat*
IOTC-2005-WPTT-06	Preliminary results of the multilateral catch monitoring programme on fresh-tuna longliners operating from ports in Indonesia. *DGCF, RCCF, CSIRO, ACIAR, IOTC, OFCF*.
IOTC-2005-WPTT-07	Fresh tuna longline fishery in Thailand. *Praulai Nootmorn*
IOTC-2005-WPTT-08	Availability of size frequency data for yellowfin tuna and bigeye tuna from the major longline fleets operating in the Indian Ocean. *Secretariat*
IOTC-2005-WPTT-09, add1	Stock assessment of yellowfin tuna (*Thunnus albacares*) resources in the Indian Ocean by the age structured production model(ASPM) analyses. *Tom Nishida and Hiroshi Shono*
IOTC-2005-WPTT-10	Korean tuna longline fishery in the Indian Ocean. *Won Seok Yang*
IOTC-2005-WPTT-11	Recent trend of Japanese longline fishery in the Indian Ocean with special reference to the targeting. *Hiroaki Okamoto*
IOTC-2004-WPTT-12	Estimation of longline gear configuration using species composition in the operations of which the gear structure are already known. *Hiroaki Okamoto, Kotaro Yokawa and Shui-Kai Chang*
IOTC-2004-WPTT-13	Thai Tuna Fishery by Mook Andaman Longliners in the Indian Ocean during 2000-2004. *Sampan Panjarat, Praulai Nootmorn, Smith Thummachua*
IOTC-2004-WPTT-14	Reproductive Biology of Yellowfin Tuna in the Eastern Indian Ocean. *Praulai Nootmorn*
IOTC-2005-WPTT-15	Standardised CPUE for yellowfin tuna (*Thunnus albacares*) of the Japanese longline fishery in the Indian Ocean up to 2003 by generalised linear models (GLM (1960-2003). *Hiroshi Shono, Hiroaki Okamoto, Tom Nishida*
IOTC-2005-WPTT-16	Standardization of CPUE for yellowfin tuna caught by Taiwanese longline fishery in the Indian Ocean using generalised linear model (Draft). *Sheng-Ping Wang and Shui-Kai Chang*
IOTC-2005-WPTT-17	Standardized catch rates for yellowfin (*Thunnus albacares*) for the European purse seine fleets (1982-2003) *Soto M., D. Gaertner, A. Fonteneau, J. Dorizo, P. Pallarés1, A. Delgado de Molina and J. Ariz*
IOTC-2005-WPTT-18	Statistics of the purse seine Spanish fleet in the Indian Ocean (1984-2004) *Delgado de Molina, A., P. Pallares, J.J. Areso and J. Ariz 4*
IOTC-2005-WPTT-19	Preliminary analysis on biological features of yellowfin tuna (*Thunnus albacares*) based on observers' data in the Indian Ocean. *Xu Liuxiong and Zhu Guoping*.
IOTC-2005-WPTT-20	Preliminary yellowfin tuna sex-ratio analysis from observer data obtained during the experimental cruise on Spanish longliners in the Southwestern Indian Ocean. *J.Ariz , A. Delgado de Molina, Mª L. Ramos and P.Pallarés*
IOTC-2005-WPTT-21	An overview of yellowfin tuna stocks, fisheries and stock status worldwide. *Alain Fonteneau*
IOTC-2005-WPTT-22	French purse-seine tuna fisheries statistics in the Indian Ocean, 1981-2003. *Pianet R., V. Nordstrom and P.Dewals*.
IOTC-2005-WPTT-23	Statistics of the main purse seine fleets fishing in the Indian Ocean (1981-2003). *Pianet R., P. Pallares, A. Delgado de Molina, V. Nordstrom, P. Dewals and V. Lucas*
IOTC-2005-WPTT-24	Stock assessment of Indian Ocean yellowfin tuna using a Bayesian implementation of a two-age structured model. *Iago Mosqueira & Richard Hillary.*
IOTC-2005-WPTT-25	Summary of the different tagging activities of the Indian Ocean tuna tagging programme (IOTTP). *Secretariat*

IOTC-2005-WPTT-26	Developing a index of area suitable for recruitment. *Olivier Maury*
IOTC-2005-WPTT-27	Did ecological anomalies cause 1993 and 2003-2004 high catches of yellowfin tuna (*Thunnus albacares*) in the western Indian Ocean? And - review of other possible causes (strong recruitments, high catchabilities and excess fishing efforts). *Tom Nishida, Hiroshi Matsuura, Yukiko Shiba, Miyako Tanaka, Masahiko Mohri and Shui-Kai Chang*
IOTC-2005-WPTT-28	Report of the predation survey by the Japanese commercial tuna longline fisheries (September, 2000 – December, 2004). *Tom Nishida and Yukiko Shiba*
IOTC-2005-WPTT-29	Study on affect of Japanese tuna prices on targeting practices and CPUE of tuna longline fisheries - Case study for yellowfin tuna (*Thunnus albacares*) & bigeye tuna (*Thunnus obesus*) in the Indian Ocean. *Tom Nishida, Arata Izawa and Shui-Kai Chang*
IOTC-2005-WPTT-30	Recent trend in fad fishing activities by purse seiners licensed to fish inside of the Seychelles EEZ. *V. Lucas, and J. Dorizo*
IOTC-2005-WPTT-31	Preliminary result of the CAPPES (CAPturabilité des grands PElagiques exploités à la palangre dérivante dans la Zone Economique Exclusive des Seychelles) research program. *V. Lucas and P. Bach*
IOTC-2005-WPTT-32	Study of the growth of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean based on length frequency data from 2000 to 2004. *Antony Viera*
IOTC-2005-WPTT-33	Outputs from CATAGE-TREND (statistical catch at age analysis program -Maury 2000). *Olivier Maury*
IOTC-2005-WPTT-34	PROCEAN results. *Olivier Maury*
IOTC-2005-WPTT-35	Examining environmental factors and yellowfin catch rates in the Indian Ocean. *Marco Garcia.*
IOTC-2005-WPTT-INF01	Spatial and Temporal Distribution Patterns of Bigeye Tuna (*Thunnus obesus*) in the Indian Ocean. *Pei-Fen Lee, I-Ching Chen and Wann-Nian Tzeng*
IOTC-2005-WPTT-INF02	Incorporating spatial autocorrelation into the general linear model with an application to the yellowfin tuna (*Thunnus albacares*) longline CPUE data. *Tom Nishida and Ding-Geng Chen*
IOTC-2005-WPTT-INF03	Tuna price statistics in Japan. *Tom Nishida and Arata Izawa*
IOTC-2005-WPTT-INF04	The Indian Ocean yellowfin stock and fisheries in 2003: overview and discussion of the present situation. *Alain Fonteneau, Javier Ariz, Jean Pierre Hallier, Vincent Lucas, Pilar Pallares and Michel Potier*
IOTC-2005-WPTT-INF05	Processing of YFT catch by size data (06/2005). *V. Nordstrom*
IOTC-2005-WPTT-INF06	On accuracy of the estimated fish school weights by sonar specialists. *H. Shono and T. Nishida*

APPENDIX IV. REPORT OF THE BIOLOGICAL PARAMETER TASK FORCE

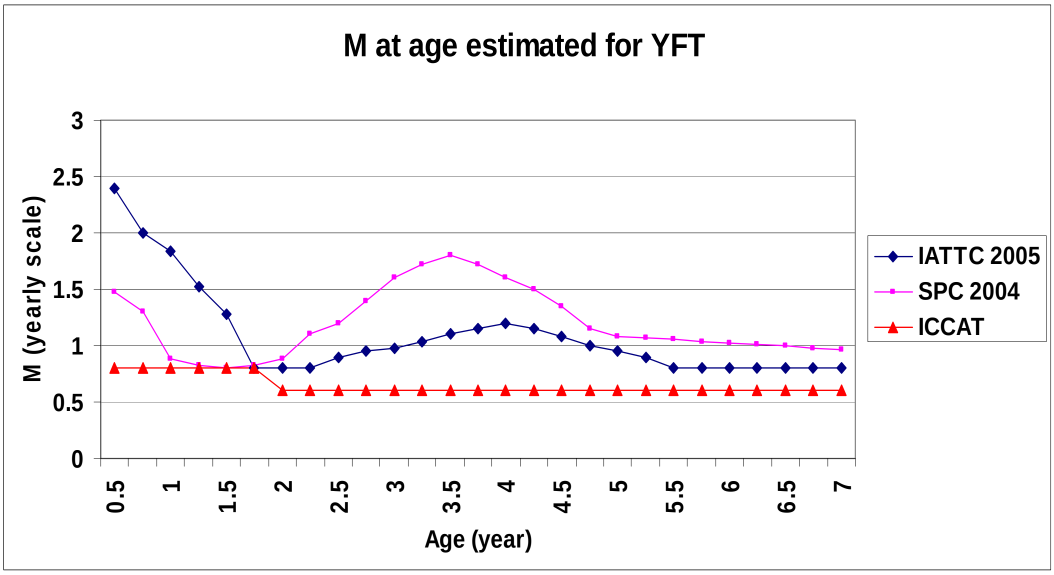
The *ad hoc* Task Force on the biological parameters to be used by the WPTT in its stock assessment held its meeting after the abalone dinner. Its work has been targeting on 2 key parameters used in analytical stock assessment.

(1) Natural mortality at age

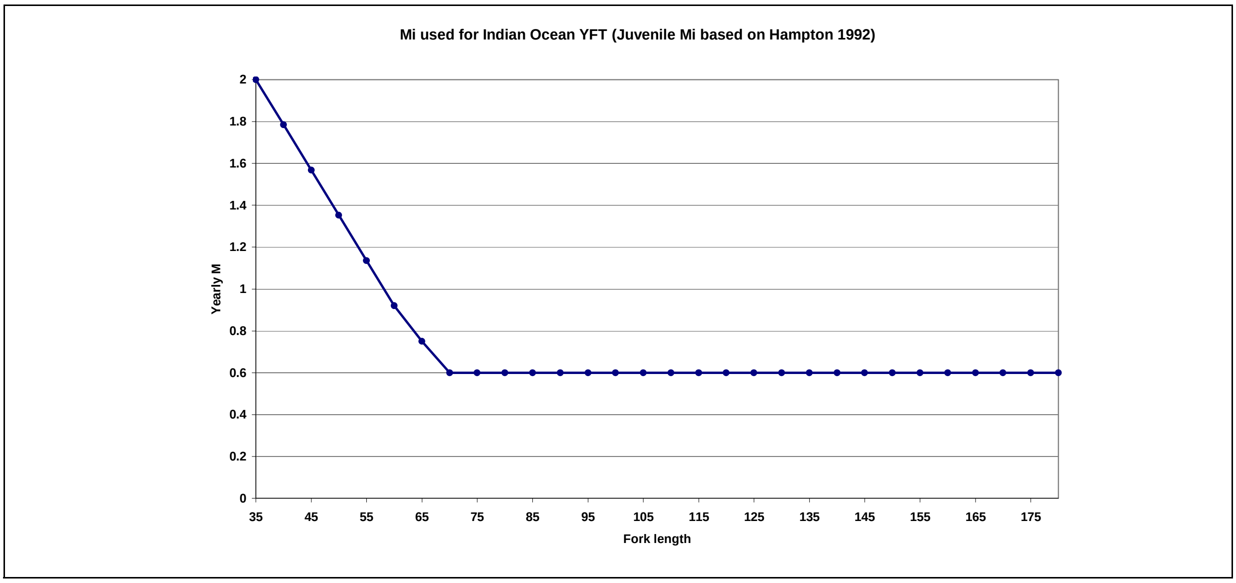
This parameter tend to be of key importance in all analytical stock assessment, when it remains widely uncertain. The WG made a comparison between various M at age vectors used nowadays by other tuna commissions and by the IOTC. A summary of these vector is shown by figure 1.

After an extensive discussion the group reached a consensus that age structure production models could well use the 3 types of hypothetical Mi, a single vector of Mi should be selected in analytical models.

The group reached the conclusion that a vector Mi combining the initial shape and level of



The Mi at size estimated by Hampton 2001, showing a pattern that is very similar to the IATTC Mi, was selected as being the best Mi to be used in the 2005 stock assessment, followed by a low ICCAT type Mi at 0.6; The change between the high and low M would be fixed at a given size of 70 cm, e. g. at 6.5 kg, this age would be variable as a function of the age estimated at this 70 cm size, as shown by figure 2 (see the discussion on growth).

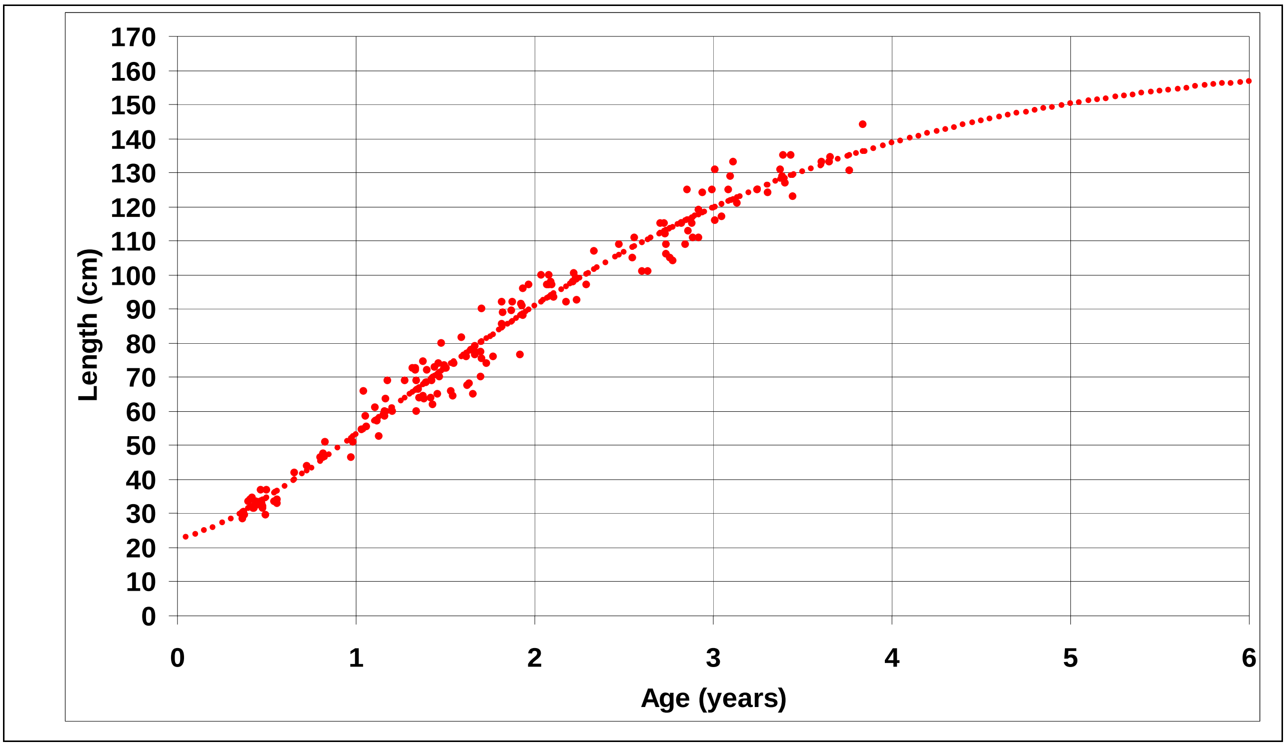


(2) Growth

The WG made a comparison of the various growth models available in the Indian Ocean (based on modal progressions such as the Lumineau 2002 and Viera 2005 models, and based on otolith readings such as the Stequert 1998 models), comparing them to models used in other oceans for YFT stock assesments.

The conclusion by the WG was that if the age reading done by Stequert were highly valuable, his growth parameters using his best fit of an L infinity at 2.60 m should not be used in a stock assessment. The WG reprocessed the Stequert data, and it was found that alternative growth model fitted to a Gascuel et al 1992 model with an L infinity fixed at a realistic biological level of 1,65 m (e.g. at the 99% highest sizes taken by the historical LL fisheries). The fit of this new growth curve was nearly identical in statistical terms to the original Stequert curve;

This new growth curve fitted to the Stequert 1998 data with a L infinity = 1.65 m using a 2 stanza model will be later kept as the revised Stequert growth curve.



This new growth curve also shows at sizes over 70 cm a good agreement in its growth pattern with the growth obtained from modal progression (Lumineau 2002 or Viera 2005)

However, the WG could not reach a consensus upon growth of YFT <70 cm as various studies in all oceans, and including in the IO, have shown that these young YFT are showing a slower growth than preadults, and a much slower growth than expected from the Von Bertalanffy model.

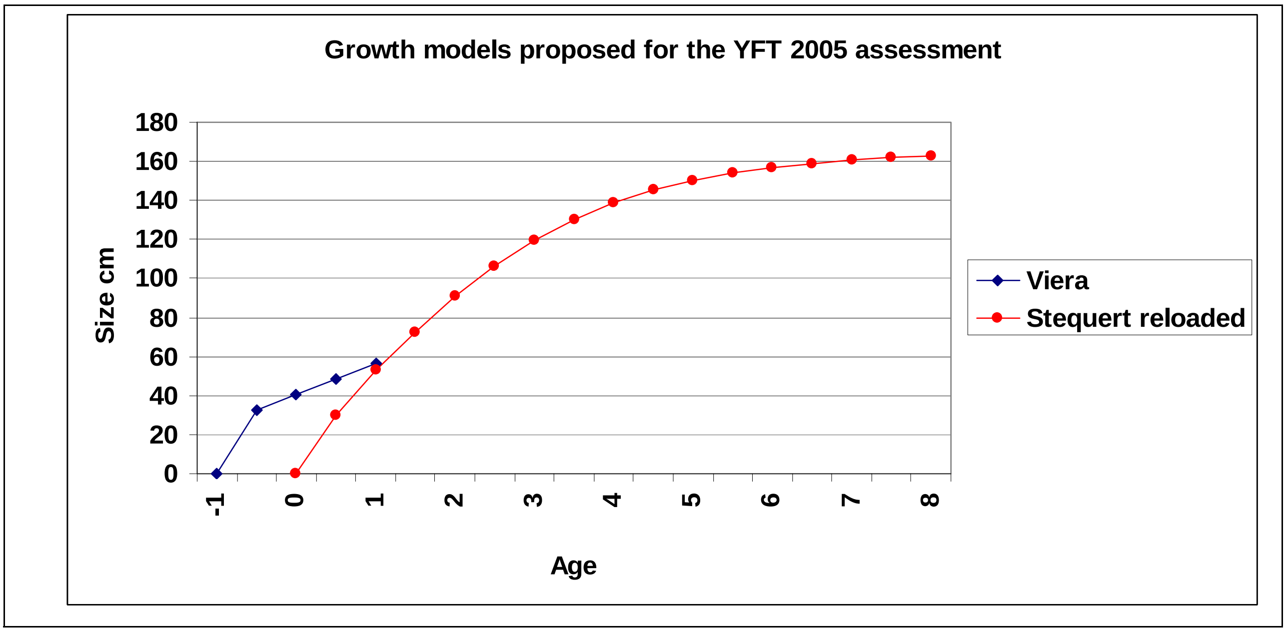
In the Indian Ocean such slow growth pattern has been repeatedly and strongly suggested by the slow modal progressions analysed by Lumineau 2002 and Viera 2005.

The final conclusion by the WG was to use:

(3) 2 alternate growth curves should be used for YFT <60 cm: Stequert reloaded and Viera (noting that there is a difference of 12 month or 1 year in the absolute age of the 60 cm fishes).

(4) the Stequert reloaded growth curve should solely be used for YFT over 60 cm

These 2 recommended assessment growth curves are summarised by the following figure.



NB: an important point should also be noted in the further analysis of the subsequent catch at age matrices obtained following these 2 growth curves: in both cases, the catches of YFT the year of recruitment in the fisheries at age 0, are taken at sizes greater than 30 cm, then starting both at an age of about 6 month and during a duration of only 6 months during this first year (e.g. a half year interval, when all the other catches are taken during entire full years). Therefore the catch equations working during this age "zero" should be processed in an ad hoc correct semi annual way.

The corresponding table of Mi to be used in subsequent analytical studies are given in the following table:

Age	0	1	2	3	4	5	6
Stequert	1.6	0.6	0.6	0.6	0.6	0.6	0.6
Viera/Stequert	1.8	1.3	0.6	0.6	0.6	0.6	0.6

APPENDIX V. EXECUTIVE SUMMARY OF THE STATUS OF THE YELLOWFIN TUNA RESOURCE

BIOLOGY

Yellowfin tuna is a cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three major oceans, where it forms large schools. The sizes exploited in the Indian Ocean range from 30 cm to 180 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack 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 are seldom taken in the industrial fisheries, but are abundant in some artisanal fisheries, mainly in the Arabian Sea.

Stock structure is unclear, and a single stock with complete mixing is usually assumed for stock assessment purposes. Longline catch data indicates that yellowfin are distributed continuously throughout the entire tropical Indian Ocean, but some more detailed analysis of fisheries data suggests that the stock structure may be more complex and that mixing may be incomplete. A study of stock structure using DNA was unable to detect whether there were subpopulations of yellowfin tuna in the Indian Ocean.

Spawning seems to occur mainly from December to March in the equatorial area (0-10°S), with the main spawning grounds between 50° and 70°E. However, secondary spawning grounds are known to exist, for instance off Sri Lanka and the Mozambique Channel and in the eastern Indian Ocean off Australia. Yellowfin size at first maturity has been estimated at around 100 cm, and recruitment occurs predominantly in July. 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 150 cm (this is also the case in other oceans).

A new growth study fitting a two-stanza growth curve to length frequency data was presented to the WPTT. In addition, the Working Party refitted a two-stanza growth curve to the Stequert otolith data. Both growth curves suggested similar growth rates for fish over 70 cm, but growth rates differed substantially for smaller fish. The two growth curves are illustrated in Figure 7.

There are no direct estimates of natural mortality (M) for yellowfin in the Indian Ocean. In stock assessments, new estimates of M at length based on those from other oceans have been used. These were then converted to estimates of M at age using the two growth curves. This indicated a higher M on juvenile fish than for older fish.

There is little information on yellowfin movement patterns in the Indian Ocean, and what information there is comes from analysis of fishery data, which can produce biased results because of their uneven coverage. However, there is good evidence that medium sized yellowfin concentrate for feeding in the Arabian Sea. Feeding behaviour is largely opportunistic, with a variety of prey species being consumed, including large concentrations of crustacea that have occurred recently in the tropical areas and small mesopelagic fishes which are abundant in the Arabian Sea.

FISHERY

Catches by area, gear, country and year from 1950 to 2003 are shown in Table 1 and illustrated in Figure 1. Contrary to the situation in other oceans, the artisanal fishery component in the Indian Ocean is substantial, taking approximately 20-25% of the total catch.

The geographical distribution of yellowfin tuna catches in the Indian Ocean in recent years by the main gear types (purse-seine, longline and artisanal) is shown in Figure 2. Most yellowfin tuna are caught in Indian Ocean north of 12°S and in the Mozambique Channel (north of 25°S).

Although some Japanese purse seiners have fished in the Indian Ocean since 1977, the purse seine 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 although a larger proportion of the catches is made of adult fish, when compared to the case of the bigeye tuna purse-seine catch. Purse seine catches of yellowfin with fork lengths between 30 and 180 cm increased rapidly to around 131,000 t in 1993. Subsequently, they have fluctuated around that level, until 2003 when they increased substantially to 227,000 t.

The purse seine fishery is characterized by the use of two different fishing modes: the fishery on floating objects (FADs), which catches large numbers of small yellowfin in association with skipjack and juvenile bigeye, and a fishery on free swimming schools, which catches larger yellowfin on mixed or pure 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 took 36-63% of the yellowfin catch by weight (59-76% of the total catch). Since 1997, the proportion of log sets has steadily decreased from 66% to 48%.

The longline fishery started in the beginning of the 1950's and expanded rapidly over the whole Indian Ocean. It catches mainly large fish, from 80 to 160 cm fork length, although smaller fish in the size range 60 cm – 100 cm 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 and bigeye being the main target species in tropical waters. The longline fishery can be subdivided into an industrial component (deep-freezing longliners operating on the high seas from Japan, Korea and Taiwan, China) and an artisanal component (fresh tuna longliners). The total longline catch of yellowfin reached a maximum in 1993 (196,000 t). Since then, it has declined, and in 2003 was 83,500 t.

Artisanal catches, taken by bait boat, gillnet, troll, hand line and other gears have increased steadily since the 1980s. In 2003, the total artisanal yellowfin catch was 51,000 t, while the catch by gillnets (the dominant artisanal gear) was 79,000 t.

Yellowfin catches in the Indian Ocean were much higher than previous levels during 2003 and 2004, while skipjack and bigeye catches remained at their average levels. Purse seiners currently take the bulk of the yellowfin catch — mostly from the western Indian Ocean. In 2003, their total catch was 227,000 t — over 48% more than the previous largest purse seine catch, which was recorded in 1995. Artisanal yellowfin catches were also near their highest level in 2003. Japanese longliners also recorded higher than normal catches in the tropical western Indian Ocean in 2003. Preliminary data suggest that purse seine and longline catches during 2004 are even higher than 2003.

Yellowfin catches in number by gear (purse seine, longline and bait boat) are reported in Figure 3. Current estimates of annual mean weights of yellowfin caught by different gears and by the whole fishery are shown in Figure 4. After an initial decline, mean weights in the whole fishery remained quite stable from the 1970s to the early 1990s. Since 1993, mean weights in the catches in the industrial fisheries have declined. Prior to 2003, although total catch in biomass has been stable for several years, catches in numbers have continued to increase, as there has been more fishing effort directed towards smaller fish. As described above, this situation changed during 2003 and 2004; where most of the very large catches were obtained from fish of larger sizes.

AVAILABILITY OF INFORMATION FOR ASSESSMENT PURPOSES

The reliability of the estimates of the total catch has continued to improve over the past few years, and the Secretariat conducted several reviews of the nominal catch databases during 2004. This has led to marked increases in estimated catches of yellowfin tuna since the early 1970s. A comparison of time series of estimates of total catches made by the Secretariat in 2004 and in 2005 is given in Figure 5. In particular, the estimated catches for the Yemen artisanal fishery have been revised upwards sharply, based on new information, but they still remain highly uncertain. In 2005, Taiwan, China provided size data for yellowfin tuna by IOTC area for 1980 – 2003, thereby substantially improving the information available to estimate catches by size.

Estimates of annual catches at size for yellowfin were calculated using the best available information prior to the 2005 WPTT meeting. A number of papers dealing with fisheries data, biology, CPUE trends and assessments were discussed by the WPTT in 2005, and additional data analyses were performed during that meeting. Estimated catches at age were calculated (Figure 6) using the catch-at-size data and two alternative growth curves (a refitted Stequert growth curve and a new two-stanza growth model) are shown in Figure 7. The two growth curves were used to develop two sets of natural mortality at age, maturity at age and average weight at age schedules. M was assumed to be higher on juvenile than adult fish.

Standardized CPUE series for both Japanese and Taiwanese longline data were presented and used during the assessments. Standardised purse seine CPUE analyses were also presented and discussed, but these were not used during the assessments because it was believed that they still did not fully account for the increases in purse seine catching efficiency over time.

The two standardized longline CPUE series showed similar trends, with an initial steep decline, over a period when catches were relatively low and stable, followed by stable standardized CPUEs since the late 1970s, a period during which catches have increased strongly following the development of the purse seine fishery (Figure 8). The observed pattern of standardised longline CPUEs does not correspond well with the expected response of CPUE to changes in catch and biomass, if standardized CPUE is directly proportional to the abundance of the part of the stock exploited by the gear concerned. There are several possible explanations for this, such as changes in catchability or behaviour, or the population existing in two fractions with differential availability to purse seine and longline gears, or a substantial decrease in the accumulated biomass in the oldest age groups in the early years. However, current analyses are unable to distinguish which, if any, of these explanations is correct.

STOCK ASSESSMENT

A full assessment was attempted for yellowfin tuna in 2005 by the WPTT. Two papers presenting assessment results were presented, one using the age structured production model (ASPM) method and one using a new Bayesian two-age-class production model. Additional assessments were carried out during the WPTT meeting using agreed data sets and the following methods: the PROCEAN method, the CATAGE trend (statistical catch at age analysis) method, ASPM, and the Bayesian two-age-class production model.

Although there were differences in the details of results from the different assessments, the overall picture they presented was consistent, particularly in terms of estimated trends in stock biomass and fishing mortality rates. Estimated trends in the fishing mortality rates are shown in Figure 9. Estimates of catchability using the PROCEAN and CATAGE methods show a strong increasing trend since the mid-1980s for both the longline fleets and the purse-seine fleets (Figure 10). The assessment runs considered at this meeting consistently indicated that fishing mortality rates between 1992 and 2002 have been close to or at levels of F corresponding to the Fmsy estimated by the most plausible ASPM assessment. Catches during this period were in the vicinity of, or possibly above, the MSY levels estimated by PROCEAN and the most plausible ASPM assessment. Estimated catches in 2003 and 2004 were well above those MSY levels, and projections carried out indicate that these are not sustainable unless supported by very high recruitments.

The Scientific Committee emphasized, however, that there remain strong uncertainties in each of the assessments conducted. In particular, none are yet able to consistently explain the trends in standardized CPUEs in the early years of the fishery without using trends in catchabilities or recruitment for which there is no evidence. Consequently, the implications drawn from them regarding current stock status are also uncertain.

Since the early-1980s there has also been an increase in both purse seine fishing on floating objects and artisanal fisheries which has led to a rapid increase in the catch of juvenile yellowfin. The rapid expansion, particularly on juvenile fish, is cause for concern, since it displays all the symptoms of a potentially risky situation. The increases in catches in general has not been as a result of geographic expansion to previously unfished areas, but rather as a result of increased fishing pressure on existing fishing grounds.

EXCEPTIONAL CATCHES DURING 2003 AND 2004

Yellowfin catches in the Indian Ocean were very high during 2003 and 2004. The total catch in 2003 was substantially higher than the previous highest catch (in 1993) and 33% higher than the average catch in the previous

5 years. Preliminary indications are that the 2004 catch will be substantially higher still. These anomalous catches occurred all over the western Indian Ocean, in particular in a small area off eastern Africa, although the anomaly extended over a much wider area, from the Arabian Sea to South Africa, in both industrial (purse seine on free-swimming schools and longline) and artisanal fisheries. The fish caught were of large sizes (100-150 cm FL).The Scientific Committee discussed two possible hypotheses explaining the observed high catches, noting that it is possible that a combination of factors was responsible for this event. There are two main categories of factors:

Increase in the biomass of the population:

According to this hypothesis, several large recruitments to the population in the late 1990's or early 2000's could be responsible for the large increase in yellowfin catches. In these years, environmental conditions favourable to good recruitment may have occurred in the Indian Ocean. But recruitment is not the only process by which the biomass could increase. Additional explanations could be reduced natural mortality during some critical life stage and/or increased growth rates related to favourable environmental conditions.

The Scientific Committee noted there is no evidence from existing data of unusually large numbers of small fish being caught in the surface fisheries in the early 2000's. This could indicate that either the juveniles from these large cohorts were present, but outside the normal purse seine fishing grounds (e.g. in the eastern Indian Ocean), or that the recent cohorts were only at average levels.

An increase in catchability due to a concentration of the resource and/or an increase in the fishing efficiency:

It is also possible that during 2003 and 2004, the catchability of large yellowfin tuna had increased. Possible factors that could have caused this include aggregation of large yellowfin tuna over a relatively small area and/or depths that made it easier for purse seiners and longliners to catch them in large quantities and technological improvements on purse-seiners that could have the schools more vulnerable to fishing. No technological improvements have been reported for industrial longliners during this period.

While these factors might explain the high catches of industrial fisheries in a small area off eastern Africa, there are also reports of exceptionally high catches by the commercial and artisanal fisheries from Yemen, Oman, Iran, South Africa and Maldives.

Large concentrations of the shallow water crustacean *Natosquilla investigatoris* and swimming crab *Portunus trituberculatus*, were reported to have occurred in 2003 and 2004 in the western Indian Ocean, and yellowfin tuna were observed feeding voraciously on them. New information on anomalies in the thermocline depth and primary productivity in 2003 also supported the hypothesis that there may have been an increased catchability due in some part to environmental factors.

By the end of 2002, most purse seine vessels had new sonar equipment installed. These devices potentially enable skippers to locate schools at distances up to 5 km, both night and day. This could make schools more vulnerable to fishing, and catches could be expected to increase. However, there is no indication of similar increases in efficiency in the Atlantic Ocean, where vessels were also fitted with the same equipment. In addition, higher catches also occurred in artisanal and longline fisheries for which there is no indication of recent technological advances.

The Scientific Committee agreed that it was most likely that the increased catches were due to a combination of these two sets of factors, increased recruitment in the early 2000s and increased catchability of large yellowfin tuna during 2003 and 2004.

MANAGEMENT ADVICE

Considering all the stock indicators and assessments, as well as the recent trends in effort and total catches of yellowfin, the Scientific Committee considered that:

1) Fishing mortality rates between 1999 and 2002 were probably slightly below or around Fmsy, and total catches during that period, at an average level of 347,000 t, were probably close to, or possibly above MSY. Total catches in 2003 and 2004 were substantially above MSY; see below for interpretation of the possible reasons for and possible effects of these catches. In these circumstances, any further increase in both effective fishing effort and catch above average levels in 1999 - 2002 should be avoided.
2) The current fishing pressure on juvenile yellowfin by both purse seiners fishing on floating objects and artisanal fisheries is likely to be detrimental to the stock if it continues, as fish of these sizes are well below the optimum size for maximum yield per recruit estimated in 2002.
3) The Scientific Committee also noted that juvenile yellowfin tuna are caught in the purse-seine fishery that targets primarily skipjack tuna. Some measures to reduce the catches of juvenile yellowfin tuna in the FAD fishery will be accompanied by a decrease in the catches of skipjack tuna.

While there was greater consistency in the assessment results considered at this meeting than in 2002, the Scientific Committee emphasized that there remain considerable uncertainties in the assessments, as none as yet are able to fully explain the observed trends in standardized longline CPUEs over the duration of the fishery.

In interpreting the high catches of 2003 and 2004, the Scientific Committee noted that if the hypothesis of one or two high recruitments entering the adult stock is correct, the increased catches from these year classes are unlikely to be detrimental to the stock, but these catches would not be sustainable in the longer term unless supported by continued high recruitments.

On the other hand, there could be serious consequences if the hypothesis that there was an increased catchability during 2003 and 2004 is correct. In this case, the very large catches would represent a much higher fishing mortality and certainly would not be sustainable. Furthermore, they could lead to a sudden decline of the existing adult biomass of yellowfin tuna, potentially reducing the stock to below MSY levels. If such is the case, management action might be needed to reduce catches and fishing mortality to below the levels prevailing in 1999 – 2002 to allow the stock to recover.

If, as the Scientific Committee believes, the most likely cause of the exceptional catches is a combination of these factors, then some reduction of stock biomass is to be expected in the future. However, the extent of any such reduction will only become apparent in several years following detailed stock assessments.

YELLOWFIN TUNA SUMMARY

Maximum Sustainable Yield (MSY)	Approximately 300,000 - 350,000 t
Current (2003) Catch	458,000 t
Mean catch over previous five years (1998 – 2002)	343,000 t
Current Replacement Yield	
Relative Biomass B_{cur}/ Bmsy	
Relative Fishing Mortality F_{cur}/Fmsy	
Management Measures in Effect	None

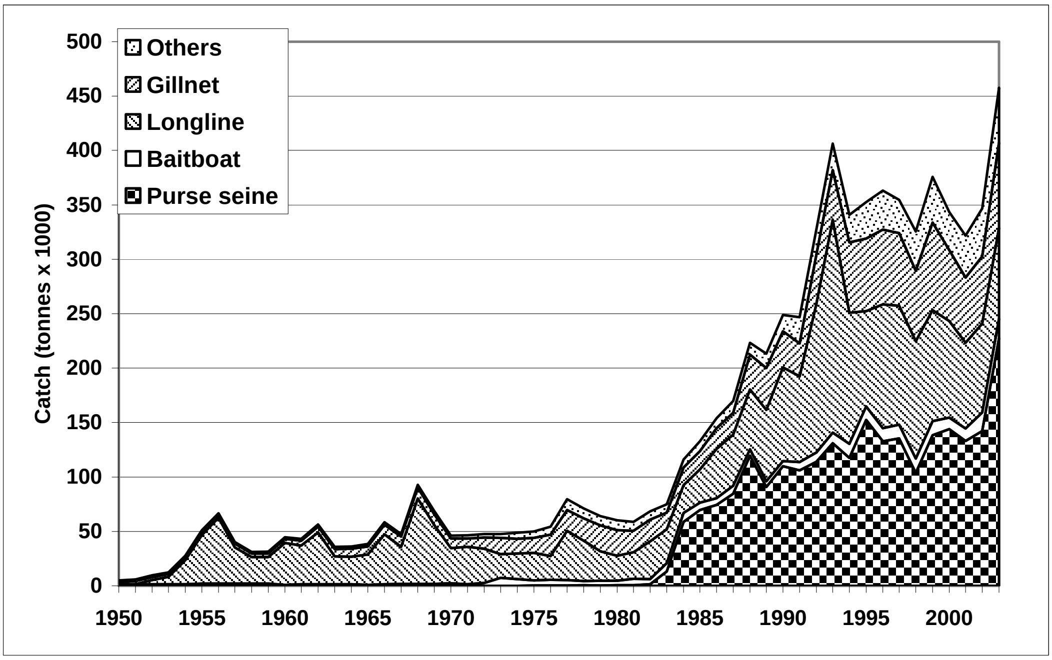
Table 1. Catches of yellowfin tuna by gear and main fleets for the period 1966 to 2003. 2004 is provisional data only.

YFT

Gear	Fleet	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
Purse seine	Total									0.0	0.0	0.0									0.1	0.2	0.2	0.3	0.5	0.4	0.5
Baitboat	Maldives	2.0	2.0	2.0	2.0	2.0	1.0	1.5	1.5	1.5	1.5	1.0	1.5	1.7	1.7	1.8	2.3	1.4	2.5	6.9	5.0	4.6	5.2	4.9	3.8	4.4	4.4
	Other Fleets	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	1.2	0.2	0.0	0.0	0.0	0.0	0.0
	Total	2.0	2.0	2.0	2.0	2.0	1.0	1.5	1.5	1.5	1.5	1.0	1.5	1.7	1.7	1.8	2.3	1.4	2.6	7.4	6.2	4.8	5.2	4.9	3.8	4.4	4.4
Longline	China																										
	Taiwan,China	0.7	1.1	1.3	1.8	2.4	2.2	2.9	3.5	3.4	2.9	2.2	4.4	3.4	22.7	21.1	14.9	11.9	11.8	5.7	4.4	4.6	3.4	8.1	4.2	3.7	3.8
	Indonesia																			0.1	0.3	0.7	1.0	1.3	1.3	1.4	2.1
	Japan	44.2	59.5	31.9	22.6	22.2	36.1	32.7	44.2	22.0	22.2	24.9	40.8	30.2	48.3	23.1	10.3	13.4	7.9	3.9	4.9	6.4	2.8	2.1	4.6	3.3	3.2
	Korea, Republic of											0.1	0.1	0.4	5.3	9.1	5.2	7.4	10.3	10.8	13.1	13.3	13.7	33.1	26.5	18.0	13.2
	Other Fleets	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.5	0.1	2.3	0.6	1.9	1.6	1.5	1.1	0.7	0.2	1.1	0.9	0.2	0.4	0.5
	Total	44.9	60.6	33.1	24.5	24.6	38.3	35.6	47.7	25.4	25.3	27.7	45.7	34.0	78.6	53.9	32.3	34.3	31.5	21.7	23.5	25.3	21.9	45.4	37.0	26.9	22.8
Gillnet	Sri Lanka	0.7	0.8	1.0	1.1	1.2	1.5	1.8	2.7	3.5	3.4	3.2	3.6	4.1	4.5	5.0	3.9	2.8	4.4	5.3	4.7	3.8	6.9	6.3	6.7	7.4	8.2
	Oman	0.7	0.5	0.5	0.5	0.7	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.9	2.9	3.4	3.8	4.0	4.4	4.1	5.0
	Pakistan	0.6	0.5	1.4	0.7	0.7	0.9	0.8	1.2	1.8	2.5	2.7	3.6	3.5	3.5	3.2	2.9	2.4	2.8	2.2	3.0	3.3	3.1	2.8	1.6	2.8	1.3
	Indonesia	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.6	0.6	1.1	1.1	1.0	1.1	1.6	3.3	4.2	4.7	4.3
	Other Fleets	0.3	0.4	0.3	0.3	0.3	0.5	0.7	0.2	0.4	0.3	0.3	0.3	0.4	0.4	0.3	0.7	1.3	1.3	5.4	1.8	2.2	4.3	2.7	3.5	4.8	4.7
	Total	2.7	2.7	3.6	3.1	3.2	3.8	4.3	5.2	6.9	7.4	7.6	8.9	9.4	9.9	10.1	8.8	7.9	10.4	14.9	13.4	13.8	19.7	19.0	20.6	23.9	23.5
Line	Yemen	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.7	0.8	0.9	1.0	1.0	1.0	1.1
	Comoros																0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
	Indonesia	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.3	0.6	0.7	0.5
	Other Fleets	0.2	0.3	0.3	0.3	0.3	0.4	0.5	0.7	0.9	0.8	0.8	0.9	1.1	1.2	1.3	1.3	1.3	1.6	1.8	1.8	1.5	2.3	4.9	3.3	3.0	3.2
	Total	0.6	0.6	0.6	0.7	0.7	0.7	0.8	1.0	1.2	1.2	1.2	1.3	1.5	1.7	1.8	1.8	1.8	2.2	2.4	2.9	2.8	3.9	6.3	5.1	4.7	4.9
All	Total	50.1	65.9	39.4	30.2	30.5	43.8	42.3	55.5	35.1	35.4	37.5	57.4	46.7	91.9	67.7	45.2	45.4	46.6	46.4	46.0	46.9	50.9	75.9	66.9	60.3	56.0

Gear	Fleet	Av00/04	Av55/04	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04
Purse seine	Spain	62.1	19.3				11.5	18.4	20.0	26.3	44.9	41.1	43.7	44.0	37.8	47.8	43.1	65.1	59.4	61.0	38.6	51.9	49.4	47.7	53.4	79.0	80.8
	France	47.0	17.5	0.2	1.0	10.5	36.7	39.1	43.3	46.8	59.9	38.4	45.3	38.1	45.3	39.5	35.8	39.6	35.6	31.2	22.4	30.8	37.7	34.1	36.4	63.3	63.5
	Seychelles	24.6	2.9											0.4	0.2					2.8	7.4	9.8	11.6	12.9	16.6	33.3	48.8
	NEI-Other	20.0	6.3			0.7	8.4	9.4	6.3	5.2	7.9	4.5	11.9	11.9	8.1	15.5	19.7	19.3	16.7	21.9	20.3	25.8	27.1	19.4	19.1	24.5	10.1
	NEI-Ex-Soviet Union	8.5	2.3										0.8		5.2	8.7	5.8	14.6	11.7	9.8	5.3	11.8	10.9	9.8	6.8	15.1	
	Other Fleets	7.8	3.9	0.4	0.6	2.1	2.3	2.6	4.7	6.4	6.7	6.7	8.0	11.8	17.4	19.5	13.0	13.8	9.4	8.8	9.6	8.1	7.2	9.1	10.0	12.3	0.3
	Total	170.0	52.1	0.6	1.6	13.2	58.9	69.5	74.3	84.7	119.5	90.7	109.7	106.2	114.0	131.0	117.5	152.5	132.9	135.5	103.6	138.2	143.9	133.0	142.2	227.4	203.5
Baitboat	Maldives	10.9	5.7	5.6	4.5	7.7	8.2	6.9	6.2	7.4	5.9	5.5	4.9	7.0	8.0	9.3	12.4	11.8	11.5	12.2	13.0	12.6	10.0	11.1	16.3	17.2	
	Other Fleets	0.6	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.5	0.6	0.5	0.6	0.6	0.4
	Total	11.5	5.9	5.9	4.6	7.7	8.2	6.9	6.2	7.4	5.9	5.5	4.9	7.5	8.5	9.8	12.8	12.2	12.0	12.7	13.4	13.1	10.6	11.6	16.9	17.8	0.4
Longline	China																										
	Taiwan,China	26.2	14.9	4.1	4.7	5.6	5.8	7.3	16.2	22.3	22.7	22.4	31.6	30.7	56.0	88.2	34.1	23.1	27.9	18.4	23.4	17.7	17.4	18.9	27.7	24.8	42.3
	Indonesia	23.5	7.0	2.6	2.7	0.8	0.8	0.8	0.7	1.3	2.3	3.8	4.6	5.5	9.3	10.8	14.8	16.7	31.8	38.2	35.7	41.7	29.6	28.4	24.2	20.2	15.0
	Japan	16.4	16.4	4.9	7.3	7.8	7.9	9.5	10.7	8.3	9.3	4.6	6.3	4.4	5.7	5.7	9.7	8.0	12.8	15.6	16.8	14.7	15.5	13.9	14.0	17.3	21.3
	NEI-Fresh Tuna	8.4	4.6									11.9	16.6	14.4	16.7	16.5	23.7	17.1	17.7	21.2	16.6	14.8	13.0	7.9	7.4	8.3	5.4
	NEI-Deep-freezing	3.3	2.5					0.1	1.1	1.2	3.4	3.2	6.7	5.9	8.9	23.8	9.9	6.9	12.1	5.9	9.8	7.4	6.6	3.2	4.0	2.6	
	Korea, Republic of	2.0	7.0	12.4	19.3	16.2	10.2	12.5	15.4	13.2	14.1	8.7	7.5	3.2	4.4	4.3	4.0	2.7	4.0	4.2	2.6	1.0	2.0	1.5	0.3	2.1	4.1
	NEI-Indonesia Fresh Tuna	0.0	2.0						0.1		2.7	10.3	12.6	12.9	15.6	12.6	16.3	8.9	3.7	4.0	0.3	0.0					
	Other Fleets	4.7	2.5	0.4	0.4	0.7	0.7	0.3	1.1	0.7	0.5	0.5	0.1	1.9	20.1	33.7	8.2	4.2	3.8	1.9	2.6	4.6	4.6	4.7	4.2	8.1	2.1
	Total	84.6	56.8	24.4	34.5	31.1	25.5	30.4	45.3	47.0	55.0	65.3	86.1	78.8	136.7	195.7	120.7	87.6	113.8	109.2	107.8	101.9	88.7	78.6	81.9	83.5	90.1
Gillnet	Sri Lanka	24.9	10.1	9.4	9.2	8.9	6.3	6.8	7.0	7.3	7.6	8.2	9.4	11.5	13.7	16.4	21.3	18.6	23.4	29.2	28.9	36.7	33.3	27.8	29.9	33.5	
	Iran, Islamic Republic	16.0	4.9									1.0	2.3	3.2	12.1	13.3	19.5	22.5	28.5	20.0	18.0	24.3	13.5	18.0	19.0	29.5	
	Oman	5.5	5.1	4.8	3.5	1.6	4.6	2.3	2.5	5.9	15.6	16.2	14.4	9.0	13.5	11.5	19.2	21.4	11.6	9.9	11.3	7.4	7.1	6.3	5.3	8.8	
	Pakistan	3.8	2.8	2.0	2.5	0.8	0.9	1.5	2.6	2.4	3.8	8.6	3.3	4.9	3.9	2.6	2.4	2.1	3.2	3.9	3.9	9.4	5.3	4.0	3.3	3.5	3.2
	Indonesia	2.7	1.9	2.5	3.2	3.1	3.3	4.3	6.2	2.7	4.2	3.3	2.2	0.9	0.9	0.8	1.3	1.3	1.1	2.7	1.5	1.8	5.0	3.1	3.1	2.3	
	Other Fleets	1.0	1.3	0.9	1.5	0.7	1.0	1.9	0.9	1.4	0.8	1.2	1.7	0.9	1.0	0.9	0.9	0.8	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.1	0.8
	Total	53.9	25.9	19.5	20.0	15.1	16.0	16.7	19.1	19.8	32.0	38.5	33.2	30.4	45.2	45.6	64.6	66.7	68.7	66.7	64.5	80.5	65.3	60.0	61.5	78.5	4.1
Line	Yemen	27.2	6.0	0.8	0.8	1.5	2.3	3.1	3.9	4.6	5.4	6.2	6.9	7.7	8.5	7.6	8.3	13.2	15.0	17.0	19.1	21.1	23.1	25.2	27.2	29.2	31.3
	Comoros	4.6	1.6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	3.7	3.7	3.7	5.0	5.0	5.9	5.9	5.8	5.6	5.6	5.4	5.9	5.4	5.8	6.1	
	Indonesia	3.3	2.3	0.1	0.5	0.4	0.3	1.7	1.1	2.3	1.5	0.2	0.9	9.1	6.5	8.3	7.9	11.2	11.9	4.9	8.9	12.3	1.5	2.3	4.3	8.3	
	Other Fleets	4.8	2.3	3.9	3.4	2.9	2.3	2.2	2.1	2.2	2.4	2.3	2.6	3.0	3.4	3.3	3.0	3.1	3.0	3.0	2.7	3.0	4.5	5.4	6.9	7.0	0.4
	Total	39.9	12.2	5.0	4.9	5.1	5.1	7.1	7.3	9.4	9.5	12.4	14.1	23.5	23.3	24.2	25.1	33.4	35.7	30.5	36.3	41.9	35.0	38.3	44.2	50.5	31.7
Other	Total	0.0	0.0								0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	0.0	
All	Total	359.9	153.0	55.5	65.6	72.2	113.7	130.8	152.2	168.2	222.0	212.4	248.1	246.4	327.7	406.2	340.7	352.4	363.0	354.6	325.6	375.6	343.5	321.6	346.7	457.8	329.9

(a)



(b)

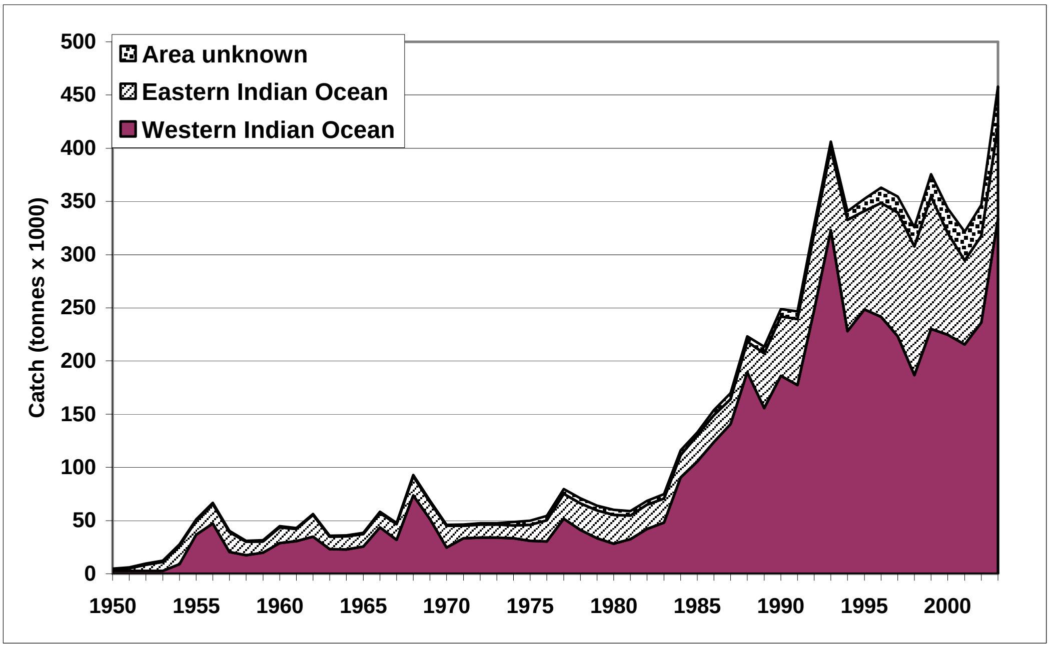


Figure 1. Yearly catches (tonnes x 1000) of yellowfin by (a) gear and (b) area from 1960 to 2003.

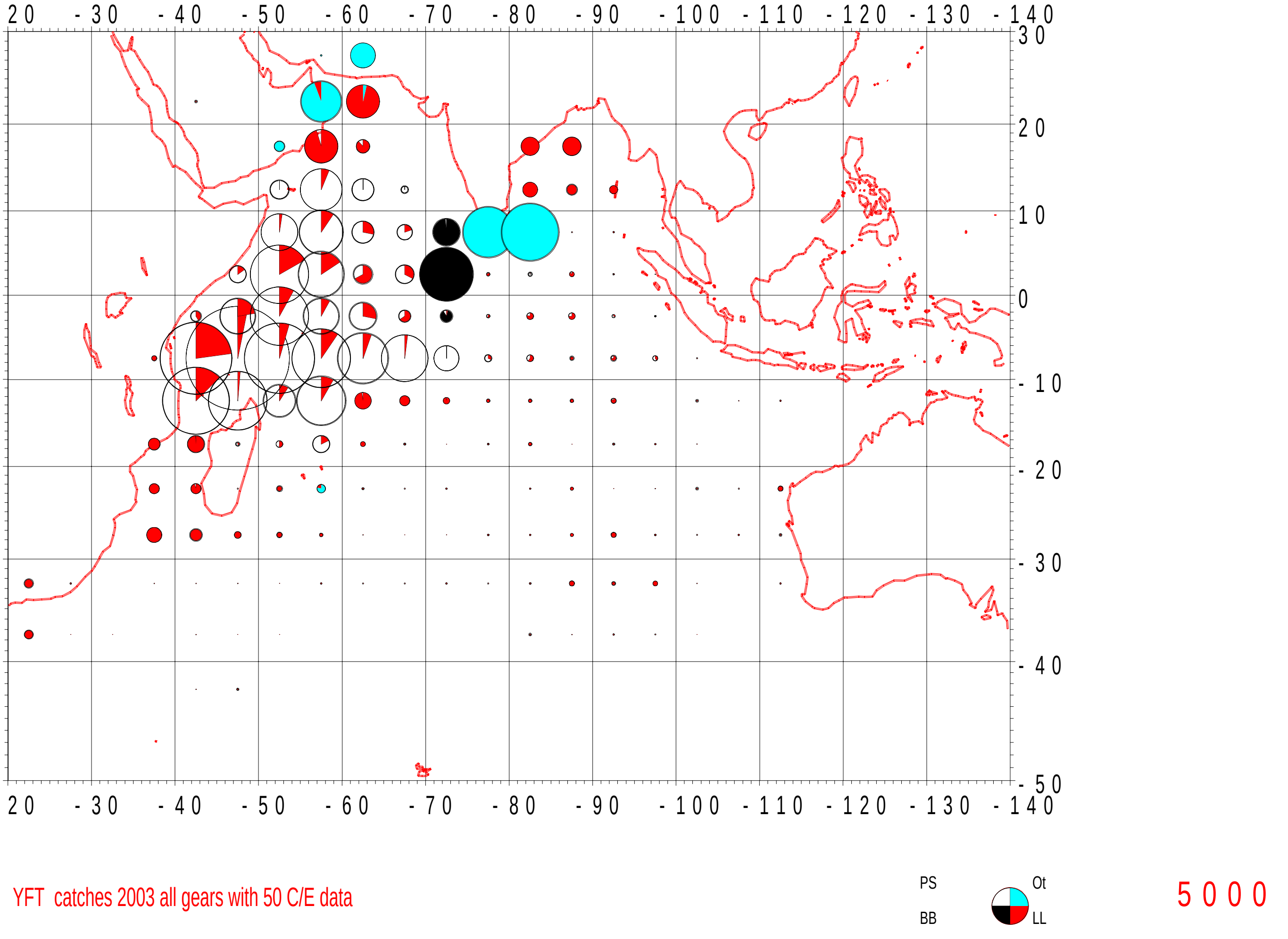


Figure 2. Location of yellowfin catches taken in the Indian Ocean in 2003. Legend circle equivalent to 5000 tonnes.

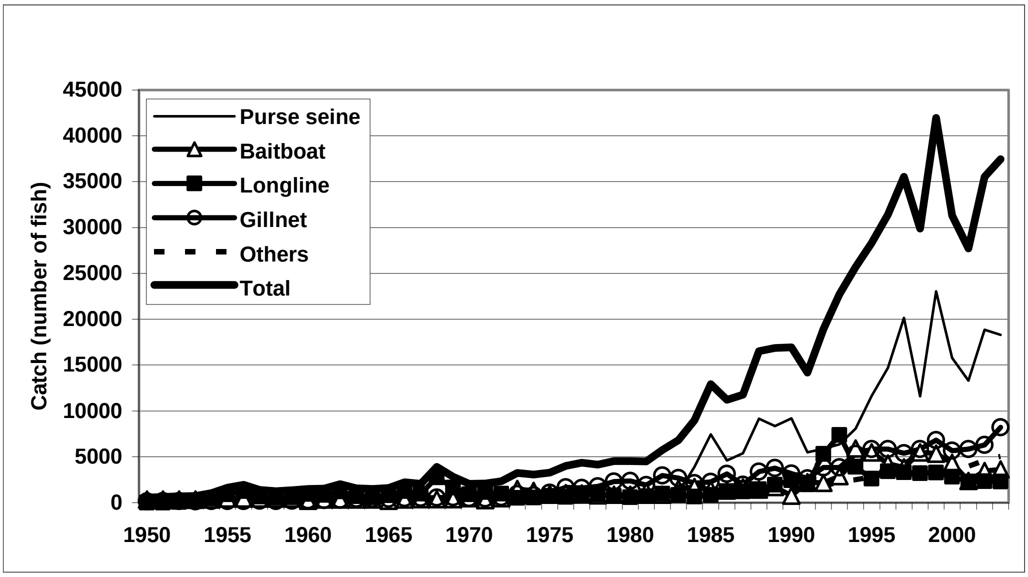


Figure 3. Numbers of yellowfin caught by gear-type.

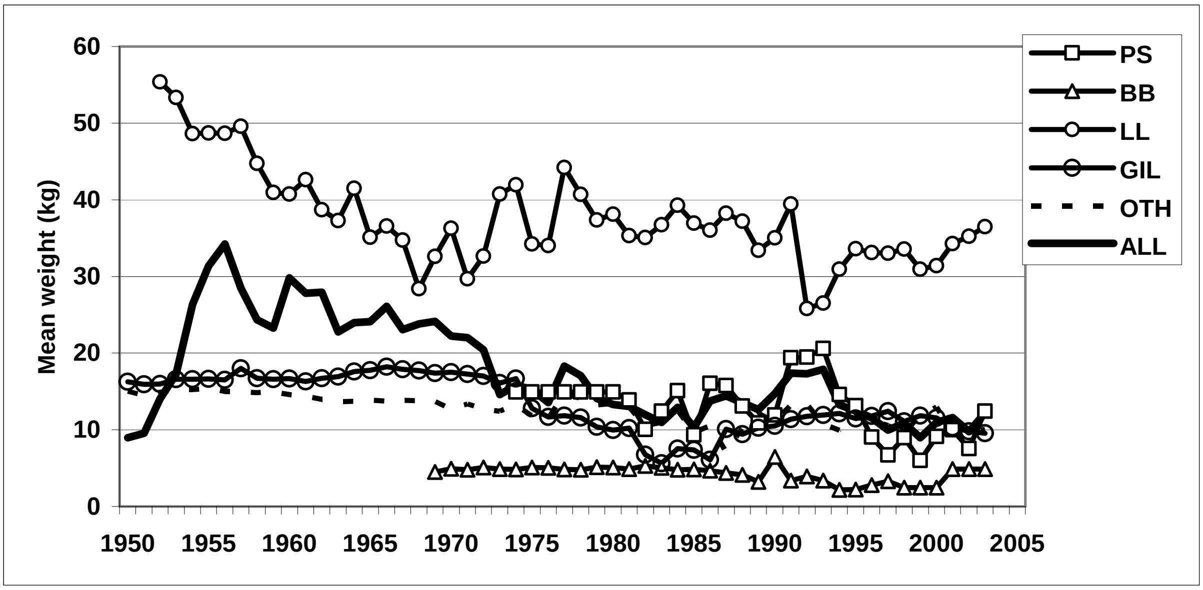


Figure 4. Mean weight (kg) of yellowfin individuals in the catch by gear and for all gear-types (estimated from the total catch at size). PS: purse seine, BB: bait boat, LL: longline, GIL: gillnet, OTH: other.

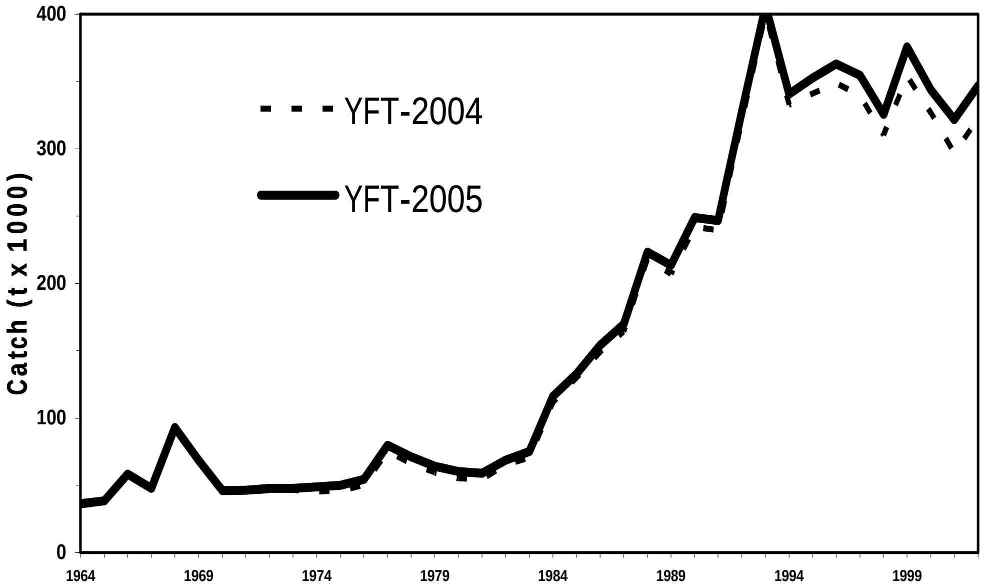


Figure 5: Yellowfin tuna catch estimates in 2005 following a review of the data by the IOTC Secretariat versus catch estimates in 2004 (1964-2002)

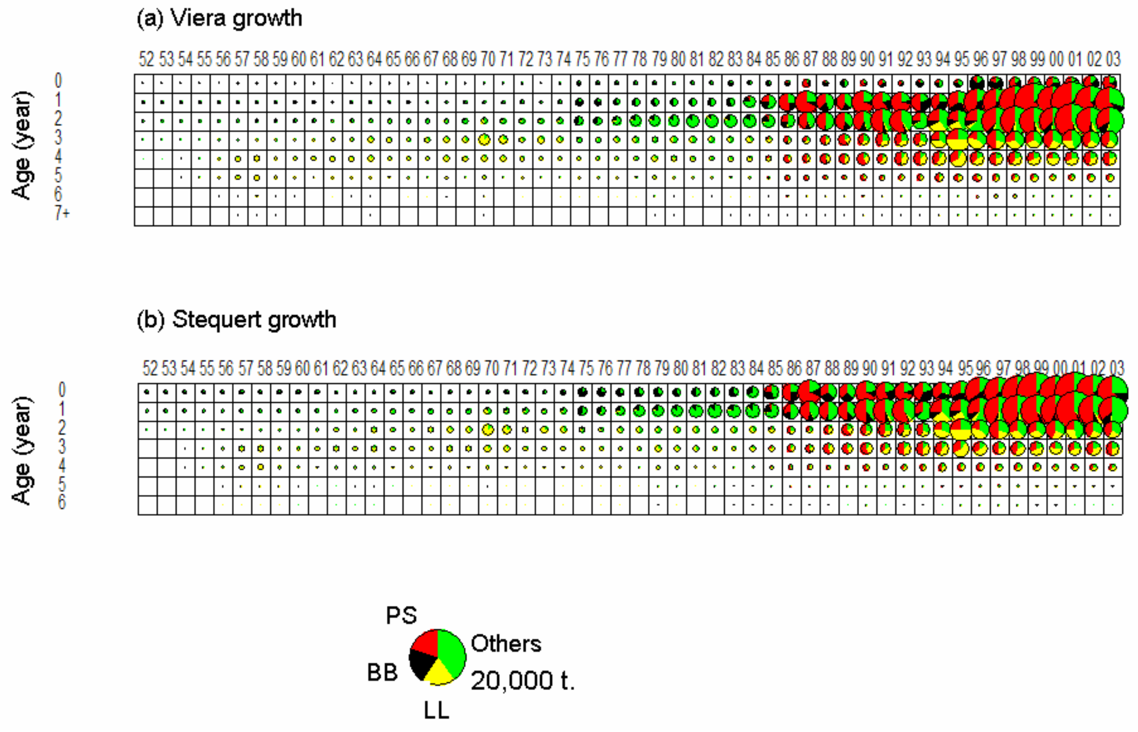


Figure 6. Catch at age (tonnes) for yellowfin tuna caught in the Indian Ocean (a) estimated using the revised Viera growth curve (b) estimated using the revised Stequert growth curve. PS: purse seine; BB: bait boat; LL: longline fishing.

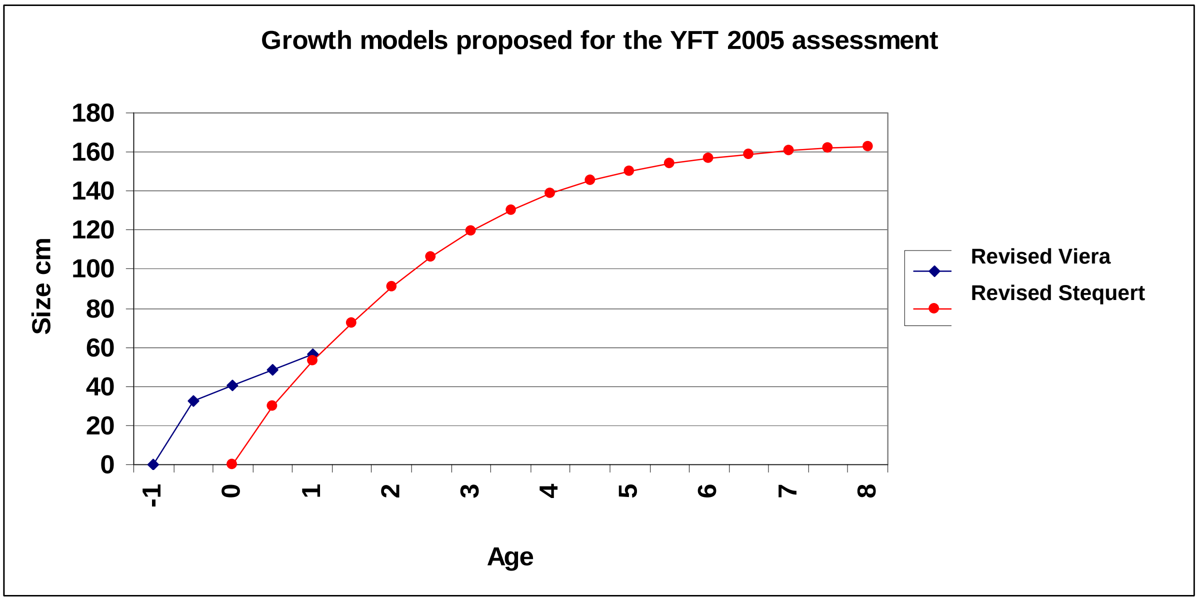


Figure 7. Yellowfin tuna growth curves used in the 2005 stock assessments.

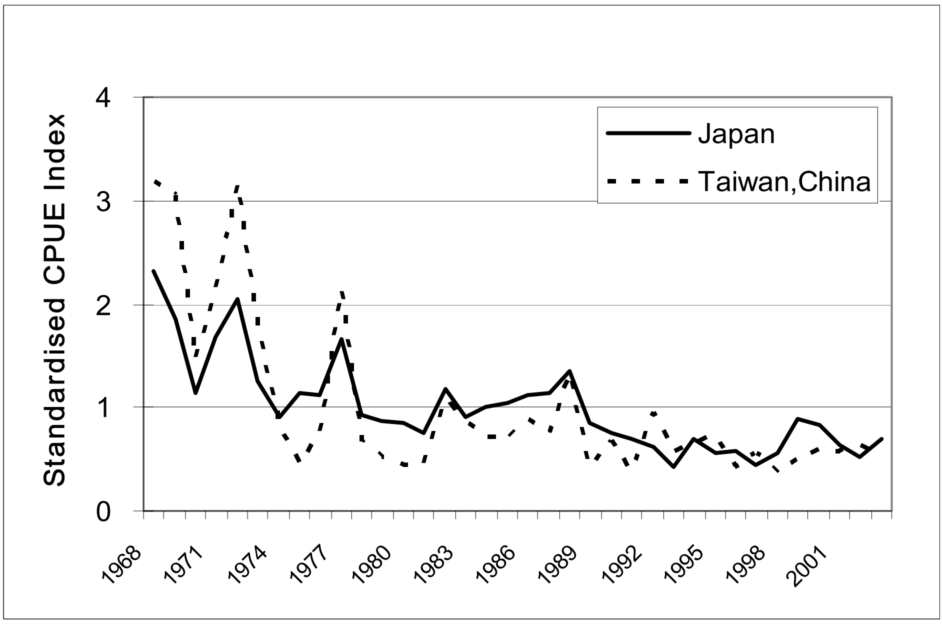


Figure 8. Yearly standardised CPUE indices for yellowfin tuna based on the Japanese and Taiwan,China longline catch rates in the Indian Ocean

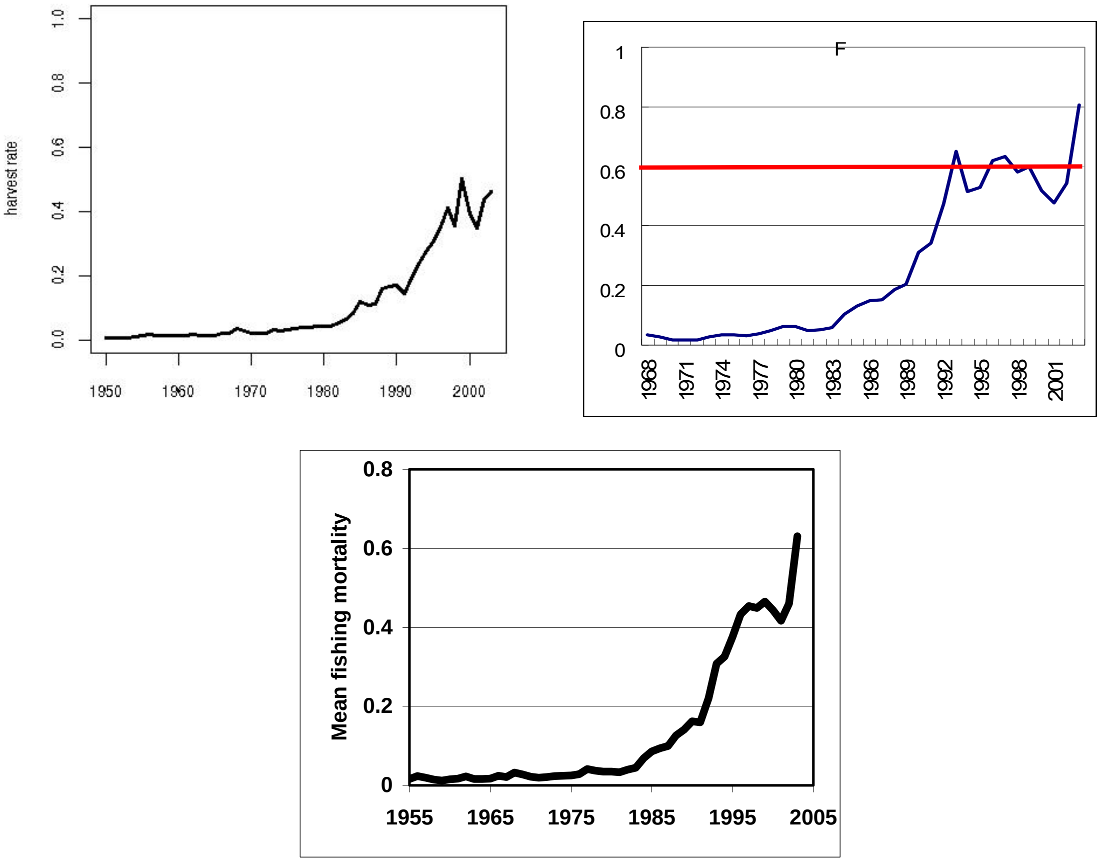


Figure 9. Yellowfin fishing mortality rate trends from each of the models in 2005. Bayesian (top left), ASPM (top right) and CATAGE (bottom).

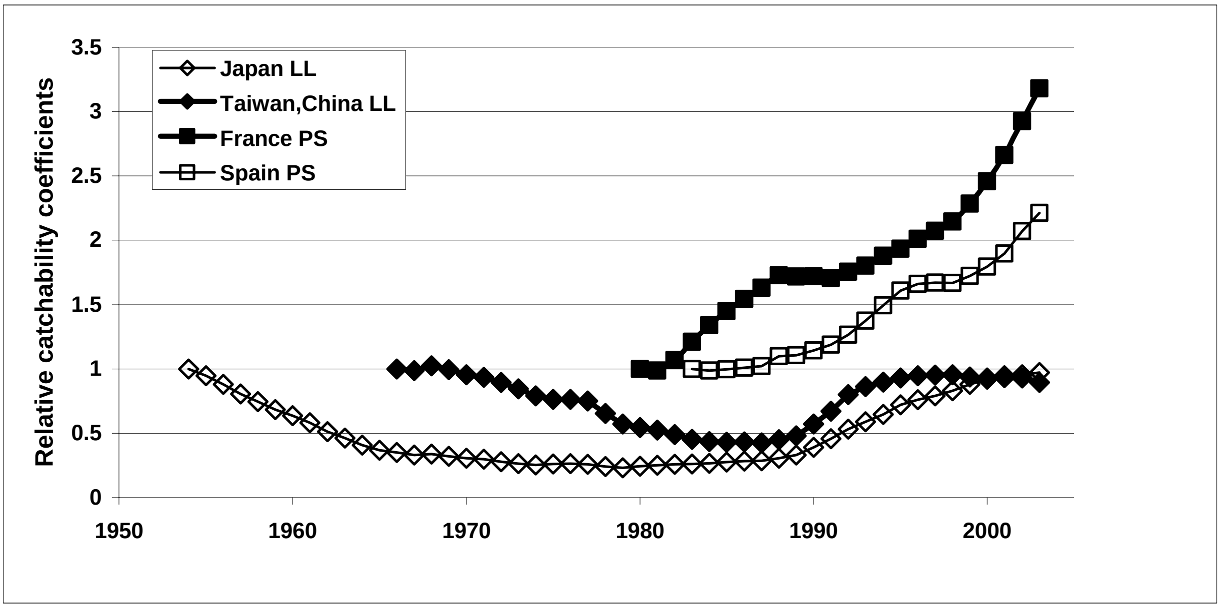


Figure 10. Mean yearly relative catchability coefficients estimated from CATAGE for Japanese longline (LL), Taiwan,China longline, French purse seine (PS) and Spanish purse seine.

附件三

Report of the First Session of the IOTC Working Party on Bycatch

Phuket, Thailand, 20 July, 2005

DRAFT for WPBy comments v7Aug05

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1. Opening of the Meeting and Adoption of the Agenda

1. The First Meeting of the Working Party on Bycatch (WPBy) was opened on 20 July 2005 in Phuket, Thailand, by the Chair of the IOTC Scientific Committee, Dr. Geoffrey Kirkwood, who welcomed the participants (Appendix I).
2. The working party members unanimously elected Mr Kevin Mcloughlin (Australia) as Chair of the WPBy for next biennium (2005 and 2006).

3. The Agenda for the Meeting was adopted as presented in Appendix II. And the list of documents presented to the meeting is given in Appendix III.

2. Review of the data

2.1. Status of IOTC databases

Data currently available on bycatch species **(IOTC-2005-WPBy-03b)**

4. According to the IOTC Data Summary No 24 (an excerpt is given as document IOTC-2005-WPBy-03b), the statistical data systems in place for both, industrial and artisanal tuna fisheries up to the end of 2003, did not account well for the collection of statistics on non-tuna species. While the amount of discards by artisanal fisheries is probably very low, given the experiences in other oceans, it could be assumed that the amount of non-tuna bycatch discarded by industrial fisheries in the Indian Ocean is significant. To-date the Secretariat has been requesting information on both IOTC and non-IOTC species via IOTC Form 1 on retained catches i.e. total catches per fleet (flag country-type of vessel-gear used) year, IOTC Area (East or West) and species (both IOTC and other) and IOTC Form 2 i.e. total amounts discarded per year per fleet and species (both). Also catch-and-effort and size data. However, the catch of non-tuna species has not been well reported and it is not possible to estimate reliable levels of bycatch because the existing data are highly incomplete and there is little information at the species level. Figure 1 illustrates one of the apparent discrepancies in the current data. In this case catches of non-tuna species have not increased proportionally to the catches of tuna species as might be expected.

5. Notwithstanding the limitations of the data currently available, the non-tuna, tuna-like species caught by fleets targeting IOTC species includes, sharks, rays and skates ; various finfish, including dolphinfish, rainbow runner, oilfish, escolar, triggerfish, barracuda ; mammals such as dolphins ; seabirds such as albatrosses and sea turtles.

6. Table 1 shows the non-tuna species having catches recorded in the IOTC Database and proportion that the catches of each group make up of the total catches of non-tunas. Sharks are the dominant bycatch species in this respect.

Figure 1. Catches of non-tuna species *versus* catches of tuna species in the IOTC nominal catches database

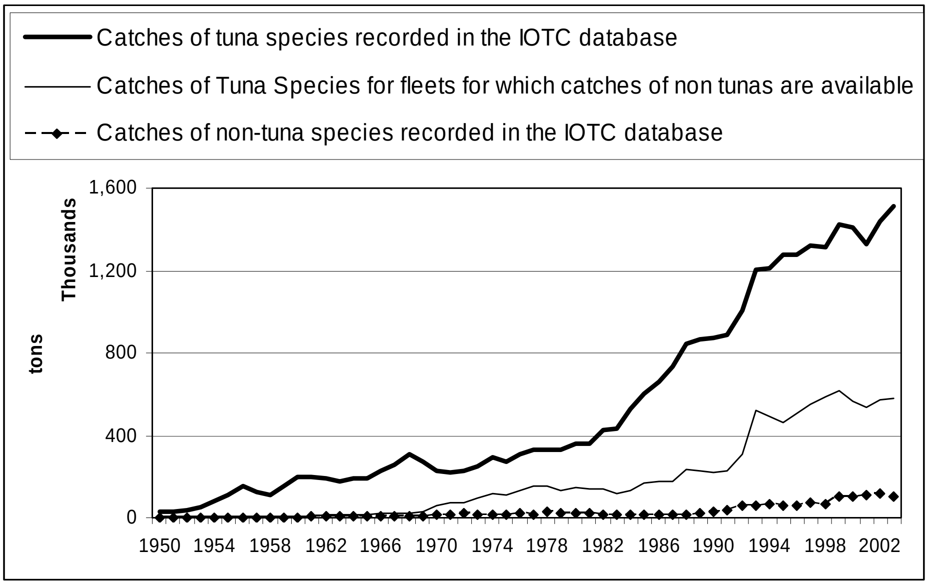

Table 1. Non-tuna species having catches recorded in the IOTC Database and proportion that the catches of each group make up of the total catches of non-tunas

Gear	Group	Species	Espece	%93-02
PS	Other / Autres	Non targeted, associated and dependent species	Espèces non ciblées, associées et dépendantes	0.01
LL	Sharks / Requins	Blue shark	Peau bleue	9.01
		Broadnose sevengill shark	Platnez	
		Copper shark	Requin cuivre	
		Dogfishes nei	Aiguillats nca	
		Hammerhead sharks nei	Requins marteau nca	
		Longfin mako	Petite taupe	
		Oceanic whitetip shark	Requin océanique	
		Porbeagle	Requin-taupe commun	
		Requiem sharks nei	Requins nca	
		Sharks nei other than oceanic whitetip shark and blue shark	Requins nca hors requin océanique et peau bleue	
		Sharks various nei	Requins divers nca	
		Shortfin mako	Taupe bleue	
		Silky shark	Requin soyeux	
		Smooth hammerhead	Requin marteau commun	
		Smooth-hound	Emissole lisse	
		Thresher sharks nei	Renards de mer nca	
		Tiger shark	Requin tigre commun	
		Tope shark	Requin-hâ	
	Other / Autres	Butterfly kingfish	Thon papillon	0.71
		Common dolphinfish	Coryphène commune	
		Dogtooth tuna	Bonite à gros yeux	
		Mackerels Indian, nei	Maquereaux (Indo-pacif.) nca	
		Non targeted, associated and dependent species	Espèces non ciblées, associées et dépendantes	
		Other non tuna-like fishes nei	Poissons non du type thon nca	
		Rays, stingrays, mantas nei	Raies, pastenagues, mantes nca	
BB	Other / Autres	Blue mackerel	Maquereau tacheté	8.04
		Dogtooth tuna	Bonite à gros yeux	
		Mackerels Indian, nei	Maquereaux (Indo-pacif.) nca	
		Other non tuna-like fishes nei	Poissons non du type thon nca	
		Striped bonito	Bonite oriental	
GILL	Sharks / Requins	Blue shark	Peau bleue	65.44
		Hammerhead sharks nei	Requins marteau nca	
		Oceanic whitetip shark	Requin océanique	
		Requiem sharks nei	Requins nca	
		Sharks mackerel, porbeagles nei	Requins taupe nca	
		Sharks various nei	Requins divers nca	
		Shortfin mako	Taupe bleue	
		Silky shark	Requin soyeux	
		Thresher sharks nei	Renards de mer nca	
	Other / Autres	Dogtooth tuna	Bonite à gros yeux	1.44
		Indian mackerel	Maquereau des Indes	
		Mackerels Indian, nei	Maquereaux (Indo-pacif.) nca	
		Non targeted, associated and dependent species	Espèces non ciblées, associées et dépendantes	
		Other non tuna-like fishes nei	Poissons non du type thon nca	
		Striped bonito	Bonite oriental	
LINE	Sharks / Requins	Blacktip reef shark	Requin pointes noires	0.82
		Blue shark	Peau bleue	
		Broadnose sevengill shark	Platnez	
		Copper shark	Requin cuivre	
		Dusky shark	Requin de sable	
		Hammerhead sharks nei	Requins marteau nca	
		Sharks mackerel, porbeagles nei	Requins taupe nca	
		Sharks various nei	Requins divers nca	
		Shortfin mako	Taupe bleue	
		Smooth-hound	Emissole lisse	
		Thresher sharks nei	Renards de mer nca	
		Tope shark	Requin-hâ	
	Other / Autres	Common dolphinfish	Coryphène commune	4.24
		Dogtooth tuna	Bonite à gros yeux	
		Mackerels Indian, nei	Maquereaux (Indo-pacif.) nca	
		Other non tuna-like fishes nei	Poissons non du type thon nca	
		Striped bonito	Bonite oriental	
OTHER	Sharks / Requins	Sharks various nei	Requins divers nca	8.96
	Other / Autres	Blue mackerel	Maquereau tacheté	1.34
		Dogtooth tuna	Bonite à gros yeux	
		Indian mackerel	Maquereau des Indes	
		Mackerels Indian, nei	Maquereaux (Indo-pacif.) nca	
		Non targeted, associated and dependent species	Espèces non ciblées, associées et dépendantes	
		Other non tuna-like fishes nei	Poissons non du type thon nca	
		Striped bonito	Bonite oriental	

7. Acknowledging that there was likely to be more information available on bycatch than is held by the IOTC Secretariat, the Secretariat sent out a call for any information on data on non-tuna catches in the Indian Ocean tuna fisheries. The data listed indicated in the catalogue of data on non-tuna catches in the Indian Ocean tuna fisheries listed in Appendix IV are in most cases not currently held by the Secretariat. Participants at the meeting commented that there are additional data sets to those listed in Appendix IV.

Improvements to data on bycatch species

8. In 2005, a range of new IOTC Resolutions and Recommendations call for information on catches of sharks (Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC*), sea turtles (Recommendation 05/08 *On sea turtles*) and seabirds (Recommendation 05/09 *On incidental mortality of seabirds*).

2.2. Information from bycatch studies in the IOTC area

Distribution of albatrosses and petrels in the Southern Indian Ocean and the overlap with IOTC longline fisheries (IOTC-2005-WPBy-05)

9. Document IOTC-2005-WPBy-05 compared albatross and petrel distribution with longline effort for the oceans between 30-50° S. The IOTC area includes 21% of the global breeding distribution of albatrosses (Table 2). Fishing effort below 30°S (and hence overlapping with albatross distribution) is greatest in the 2nd & 3rd quarters of each year. This also coincides with the periods of greatest densities of non-breeding albatrosses within the area (e.g. Shy albatrosses from the Auckland Islands, New Zealand, and Black-browed, Grey-headed and Atlantic Yellow-nosed albatrosses from the Atlantic). Non-breeding birds are less tied to proximity of breeding colonies, and are often found further north, closer to the South African coast and with greater overlap with the pelagic longline fisheries. The document indicated that around 300,000 seabirds and 100,000 albatrosses are killed each year, and 19 out of the 21 species of albatross are considered to be threatened with extinction. The life history characteristics of albatrosses i.e. they are long-lived, have delayed sexual maturity, slow breeding and small populations mean that mortality due to fishing could be a major risk to the species. The Birdlife representative expressed interest in collaborating with the IOTC to produce an assessment of seabirds interactions in the IOTC area.

Table 2. Top RFMOs in relation to breeding albatross distribution (% time), and longline fishing effort below 30°S (area of overlap) managed by each RFMO.

	Ocean	Breeding albatross distribution (%)	Longline fishing effort below 30°S
CCSBT	All, 30-50º S	67 %	120-130 million hooks
WCPFC	West Pacific	46 %	Approx. 30 million hooks[1]
IOTC	Indian	21 %	75-100 million hooks
ICCAT	Atlantic	17 %	Approx.100 million hooks
CCAMLR	Southern	16 %	100-120 million hooks

Incidental mortality of seabirds, turtles and sharks: A review of data collected east of 20 degrees by South African observers (IOTC-2005-WPBy-06)

10. This document described the incidental mortality of seabirds, turtles and sharks from observer data collected by sea-fisheries observers on board South African flagged pelagic longline vessels from 2000 to 2003 and a range of for mitigation measures for bycatch reduction of these species. The southwest Indian Ocean is important for albatross, particularly for the Critically Endangered Amsterdam albatross and the Endangered Indian yellow-nosed albatross. Five species of turtles are reported to occur within the area (loggerhead, leatherback, green, hawksbill and Olive Ridley) all of which are Endangered (IUCN redlist). Thirty six species of sharks that are currently classified as threatened, near-threatened or data-deficient by the IUCN (IUCN redlist) also occur in the area. The South African longline fleet operates partially within the IOTC convention area, in particular in the south western Indian Ocean between 20 and 45° E and 23 and 40° S. A total of 4.1 million hooks were set between 2000 and 2003 by domestic pelagic long-liners within the IOTC convention area. Bycatch (seabirds, turtles and sharks) data were collected from 9% of the hooks set. Less than 1% observer coverage was achieved on the foreign flagged

[1] Unlike the other RFMOs, the WCPFC also has albatross distribution above 30S. Fishing effort shown here indicates only that proportion below 30S, but does not indicate the full extent of overlap with WCPFC longline fisheries.

vessels however seabird bycatch data was collected from 10 trips (1999-2005) which set approximately 350 000 hooks. White-chinned petrels were the most commonly caught species, followed by black-browed, shy and Indian yellow-nosed albatrosses. The catch rate averaged 0.2 birds/1000 hooks for the domestic fleet and 0.8 bird/1000 hooks for foreign vessels. Catch rates differed between areas and seasons. Four species of turtles were caught. Catch rates averaged 0.05 turtles per 1000 hooks. 55% of trips caught no turtles and 25 % of trips caught one turtle. However, there were trips where up to 35 turtles were caught (14 sets) and up to 10 turtles in a single set. In 85 % of cases turtles were alive. The use of appropriate de-hooking and release techniques could improve the survival of turtles returned to the water. Sharks were caught on every set and catch rates averaged 7 sharks/1000 hooks and ranged between 0 and 65 per 1000 hooks. Blue sharks were caught on most (87 %) of sets and catch rates averaged 3.3 Blue Sharks/1000 hooks (range 0-65). Mako catches averaged 1.3/1000 hooks (range: 0-2.1). Blue and Mako sharks comprised 60 % (range 3-100 %) and 15 % (0-100 %) of the shark bycatch respectively. Although blue sharks were the most frequently species caught, they were mainly discarded, often after being finned. The document comments on a range of possible measures to reduce bycatch interactions.

Bycatch from Tuna Purse Seine and Longline Fishing Gears in the Eastern Indian Ocean by MV SEAFDEC (IOTC-2005-WPBy-07)

11. The training and research vessel MV SEAFDEC undertook purse seine and longline fishing in the eastern Indian Ocean between 2001 and 2005. Fifteen families with about 30 species of fishes and one family of Octopus were caught by purse seine. From 54 fishing operations 94% of total catch comprised tuna species namely frigate, skipjack, yellowfin and bigeye. Of the remaining 6 %, rainbow runner made up 46% and triggerfish 15%. Apart of purse seine operation using drifting FADs or Payao, it was found that the net installed for aggregating the target species could also catch some marine animals such as dolphin and sea turtle. The 27 long-line operations targeted and caught yellowfin, bigeye and skipjack tunas and swordfish, marlins and sailfish. Other species caught included mainly sharks (thresher, blue, white-tip, spottail, crocodile and silky) and also stringrays, lancetfish, escolar, snake mackerel, great barracuda, oilfish, common dolphinfish, sickle pomfret and wahoo. Two green turtles were also caught.

Report on the Bycatch from a Korean Observer on the Korean Tuna Longliner in the Indian Ocean in 2004 (IOTC-2005-WPBy-08)

12. This paper provided the summary of bycatch taken by a Korean tuna longliner operating in the Indian Ocean between August and September 2004. The vessel fished around 2400 hooks per day. In addition to tunas, 15 other species of fish were caught (215 fish total) over a 39 day period. Hake was the dominant species comprising 35.4 % of the catch, followed by escolar (20.8 %), oilfish (15.6 %), blue shark (9.9 %), and mako shark (8.0 %). No non-fish bycatch such as sea turtles and sea birds were caught.

Preliminary analyses of catch rate by hook type and bait from observer data obtained during the longline experimental cruise on Spanish longliners in the Southwestern Indian Ocean (IOTC-2005-WPBy-11)

13. This document provided preliminary information about an experimental campaign being carried out by the Spanish Oceanographic Institute (IEO) on two surface longliners in the waters of the south-western Indian Ocean since mid December 2004. These experimental fisheries used several types of hooks and bait, and scientific observers. For each set the observers record catch data (situation, time, species, hook, bait, etc) and biological data (species, size, sex, individual weight, gonadal weight, etc). 14088 fish comprising over 50 species have been caught to July 2005, with swordfish accounting for 37 %, blue shark 24%, and bigeye tuna 7 %; these equated to catch rates of 20, 13 and 3.5 per 100 hooks respectively. These data should be considered provisional and are to be more fully analysed once the pilot work is completed.

***Tropical tuna acoustic selectivity studies and experimental new FADs ecologically designed (reducing by-catch) through experimental cruises in Spanish purse seiners in the Indian Ocean* (IOTC-2005-WPBy-12)**

14. This document described a project that aims to improve the fishing over objects where bigeye and yellowfin tunas and bycatch species maybe adversely affected. It involves four Spanish boats (two purse seiners and two supplies) from ALBACORA S.A. and the Spanish Oceanographic Institute (IEO). Acoustic data is being be collected using sonar and echosounders and will be analysed to determine techniques that will exnable fishers to reduce catches of juveniles tropical tuna (yellowfin, and essentially, bigeye) based on acoustic signatures. At the same time, experiments will be undertaken to test the efficiency of a range of artificial floating objects to reduce bycatch (in particular sea turtles) without reducing catches of target species. Data will be collected for six months, from May to November 2005. There are two teams. Each is allocated to a purse seiner and a support vessel. One team will collect acoustic information to validate with the fishing outcomes of the other purse seiner. Examples of the tuna and bycatch data forms are provided.

***Activity of the Spanish purse seine fleet in the Indian Ocean and by-catch data obtained from observer programmes conducted in 2003 and 2004* (IOTC-2005-WPBy-13)**

15. Data collected by scientific observers accompanying the European purse seine fleet in the Indian Ocean is entered into a National Database Plan (PNDB) which aims to collect information about fishing that cannot be obtained from fishing logs, sampling in ports and at offloads. This preliminary document showed some of the results obtained to-date under the PNDB undertaken by the Spanish Oceanographic Institute (IEO). The data analysed was obtained from 11 campaigns with observers from the PNDB-IEO in 2003 and 2004 and amounted to over 336 observation days. Observer data provides valuable information about different aspects of fisheries. It is essential that such data be analysed with the utmost care, owing to important biases that may occur when coverage is low or extrapolation is performed without bearing in mind strata (space, time, fleet, type of fishery, etc), which minimise these biases through statistical analysis. The results to-date list 56 species, including four species of sea turtles.

***Scientific estimations of bycatch landed by the Spanish surface longline fleet targeting swordfish (Xiphias gladius) in the Indian Ocean: 2001 – 2003 period* (IOTC-2005-WPTT-14)**

16. This paper presented data on the bycatch species landed by the Spanish surface longline fleet targeting swordfish (*Xiphias gladius*) in the Indian Ocean between 2001 and 2003. The species classified as bycatch amounted to 51.9% of the total landings in weight: large pelagic sharks amounted to 43.1%, tunas 6.0%, billfish 0.7% and 'other' species 2.1%. Large pelagic sharks were the most prevalent bycatch with 83.0% of the catch in weight, whereas tunas amounted to 11.6%, billfish 1.3% and 'other' species 4.0%. The three most prevalent species in the catch, *Xiphias gladius*, *Prionace glauca* and I*surus oxyrhinchus* represented 90% of the total landings in weight during this period. *P. glauca* and *I. oxyrhincus* are the most prevalent species in the group of large pelagic sharks, reaching 88.5% and 10.0%, respectively. Preliminary data on accidental catch of turtles and sea birds caught in 555 observed sets, suggest global incidence rates per hook around 3.52903E-05 for turtles (dead + alive),1.60411E-06 for dead turtles and 1.60411E-06 for dead sea birds.

***Scientific monitoring of longline fishing of Western Australia* (IOTC-2005-WPBy-15)**

17. This paper described the observations from scientifically trained independent observers placed on Australian vessels using pelagic longline gear to catch tuna and swordfish off Western Australia. The longliners operated in the open ocean, with trips ranging from a few days to several weeks.. The observers collected biological samples and data from the catches. Observers monitored 13 longline trips from April 2003 to June 2004. The trips involved 104 daily operations, which deployed a total of 134 755 hooks and caught 3593 fish and other animals. The observers identified 46 different species in the longline catches, a diverse mixture of surface- and deep-dwelling fish and other animals. More than half the animals caught were "bycatch". The bycatch included species like stingrays, which do not have markets, and several species, like mahi mahi, which are sold locally. Sharks dominated the bycatch. Blue shark, were the most frequently caught species. Their catch rates, at approximately 6

per 1000 hooks, exceeded those of commercially valuable target species, such as broadbill swordfish and bigeye tuna. The top ten species taken, in order of decreasing catch rate, were blue shark, swordfish, crocodile shark, bigeye tuna, longnosed lancetfish, yellowfin tuna, albacore tuna, escolar, dolphinfish and oilfish.

18. Most bycatch species were alive when longlines were retrieved and the animals were released without being brought on board the vessel. Survival after release will vary with the animal's condition, environmental conditions and the prevalence of scavengers that might attack released animals. The observers reported five turtles. Seabirds, such as shearwaters, petrels and albatrosses, often followed the vessels as they retrieved their longlines. Shearwaters were occasionally snagged in branchlines during hauling. However, they escaped or were released unharmed by crewmembers. No seabirds were reported killed, probably because fishers are not allowed to deploy longlines during the day in southern waters. In those areas seabirds sometimes dive for baits as longlines are being deployed. The pilot scientific monitoring program is to be continued for another year, providing an opportunity to improve spatial coverage and refine data and sample collection.

***By-catches of tuna long lining conducted in the Indian EEZ* (IOTC-2005-WPBy-16)**

19. The Fishery Survey of India carried out tuna fishing surveys in the Indian EEZ along West coast of India and around Andaman and Nicobar Islands from 2000 to 2004. Among the target species of tunas, yellowfin, bigeye and skipjack were commonly caught during the surveys. By-catch belonged to three major categories – fourteen shark species, three marlin, sailfish and swordfish species and other species including seer fish, wahoo, dolphin fish and barracuda. Overall, the hooking rate for the bycatch species combined was found to be higher in Andaman and Nicobar waters than that of in Arabian Sea. The bycatch in general and sharks in particular were observed to be in higher proportion in Andaman and Nicobar waters than in the Arabian Sea, and the catch of bycatch species appeared to be influenced by season.

***Contribution of the IOSEA Marine Turtle Memorandum of Understanding to the compilation of information on marine turtle-fisheries interactions and relevant mitigation measures* (IOTC-2005-WPBy-17)**

20. In March 2005, recognising that some sea turtle stocks are seriously impacted by fishing, the Food and Agriculture Organization of the United Nations (FAO) adopted Guidelines to Reduce Sea Turtle Mortality in Fishing Operations. These voluntary guidelines are meant to apply wherever fisheries interactions with turtles occur or are suspected to occur. FAO member States are encouraged to report biennially on their implementation. The IOSEA Marine Turtle Memorandum of Understanding is an intergovernmental agreement among 22 Signatory States that aims to conserve and manage marine turtles and their habitats of the Indian Ocean and South-East Asia. The IOSEA MoU has developed an innovative online reporting system that will be used to actively monitor application of the FAO Guidelines.

3. WPBy work plan and recommendations to the Scientific Committee

3.1. Workplan

21. Data

- Further develop the IOTC catalogue on non-tuna data holdings (including socio-economic data) by members (to be undertaken by the Secretariat). Cooperation is sought from members to provide the required information on data holdings.
- Comment on the potential of the available bycatch data to develop estimates of bycatch catch rates for the wider Indian Ocean and/or specific regions (to be undertaken by the WPBy for the next meeting)

22. Current state of knowledge

- Review the current state of knowledge (including biology, catches, stock status) on bycatch species/species groups, particularly sharks, seabirds and sea turtles (to be undertaken by the WPBy for the next meeting)
- Ongoing work to identify species/species groups of concern by regions and gear-type (to be undertaken by the WPBy for the next meeting)
- Describe the types of information required to improve knowledge; how such information might be obtained (to be undertaken by the WPBy for the next meeting)
- Encourage further development of pelagic ecosystem models for the Indian Ocean incorporating tuna and key bycatch species and species groups

23. By the 2006 Scientific Committee meeting (as per the Commission's 2005 resolutions and recommendations)

- Develop preliminary advice on status of key shark species and propose a research plan and timeline for a comprehensive stock assessment (see above).
- Review ratios of fin to body weight of sharks

3.2. Recommendations

24. Members are encouraged to submit all relevant data on bycatch to IOTC Secretariat

25. Recognising that the best opportunities for obtaining accurate data on bycatch are likely to come from observer programmes, the WPBy strongly encourages further collaboration between observer programmes and expansion and implementation of new observer programmes for the Indian Ocean.

26. Bycatch species specialists should be encouraged to participate in the WPBy.

27. Noting paragraph 1 of IOTC Recommendation 05/09, the WPBy encourages a collaborative and regional approach to dealing with incidental seabird mortality.

4. Other business

28. No other business was discussed.

5. Adoption of the report

29. The Report of the First Session of the Working Party on Bycatch was reviewed by correspondence and adopted on dd mmm yyyy.

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APPENDIX II. AGENDA OF THE MEETING

1. **REVIEW OF THE DATA**
2. **REVIEW OF REGIONAL POA-Sharks**
3. **RESEARCH RECOMMENDATIONS AND PRIORITIES**
4. **OTHER BUSINESS**

APPENDIX III. LIST OF DOCUMENTS PRESENTED TO THE MEETING

NUMBER	TITLE
IOTC-2005-WPBy-01	WPBy 2005 Agenda
IOTC-2005-WPBy-02	WPBy List of documents
IOTC-2005-WPBy-03	Status of IOTC databases for bycatch. *Secretariat*
IOTC-2005-WPBy-04	Bycatch metadata for the Indian Ocean *Secretariat*
IOTC-2005-WPBy-05	Distribution of albatrosses and petrels in the Southern Indian Ocean and the overlap with IOTC longline fisheries *Cleo Small*
IOTC-2005- WPBy-06	Bycatch of seabirds, turtles and sharks caught by tuna vessels operating in South Africa's pelagic longline fishery *Samantha Petersen*
IOTC-2005-WPBy-07	Bycatch from Tuna Purse Seine and Longline Fishing Gears in the Eastern Indian Ocean by MV SEAFDEC. *Sutee Rajruchithong, Pratakphol Prajakjitt and Somboon Siriraksophon*
IOTC-2005-WPBy-08	Report on the bycatch from a Korean Observer on the Korean tuna longliner in the Indian Ocean in 2004. *Won-Soek Yang, Dae-Yeon Moon, Soon-Song Kim and Jeong Rack Koh*.
IOTC-2005-WPBy-09	Seychelles draft NPOA-Sharks. *Vincent Lucas*
IOTC-2005-WPBy-10	Australia NPOA Sharks – *presented by Kevin McLoughlan* (http://www.daff.gov.au/content/output.cfm?ObjectID=D2C48F86-BA1A-11A1-A2200060B0A00884)
IOTC-2005-WPBy-11	Preliminary analyses of catch rate by hook type and bait from observer data obtained during the longline experimental cruise on Spanish longliners in the Southwestern Indian Ocean. *J. Ariz, A. Delgado de Molina, Mª L. Ramos and P. Pallarés*
IOTC-2005-WPBy-12	Tropical tuna acoustic selectivity studies and experimental new FADs ecologically designed (reducing by-catch) through experimental cruises in Spanish purse seiners in the Indian Ocean. *A. Delgado de Molina , J. Ariz, P. Pallarés, R. Delgado de Molina y S. Déniz.*
IOTC-2005-WPBy-13	Activity of the Spanish purse seine fleet in the Indian Ocean and by-catch data obtained from observer programmes conducted in 2003 and 2004. *Alicia Delgado de Molina2, Javier Ariz1, Roberto Sarralde, Pilar Pallarés and José. Carlos Santana*
IOTC-2005-WPBy-14	Scientific estimations of bycatch landed by the Spanish surface longline fleet targeting swordfish (*Xiphias gladius*) in the Indian Ocean: 2001-2003 period. *B. Garcia-Cortes and J. Mejuto.*
IOTC-2005-WPBy-15	Scientific monitoring of longline fishing off Western Australia. *Peter Ward and Danielle Curran.*
IOTC-2005-WPBy-16	By-catches of tuna long lining conducted in Indian EEZ. *V.S. Somvanshi, S. Varghese, S.A. Rajkumar, P. Chalapati Rao & K. Gopalakrishnan*
IOTC-2005-WPBy17	*Contribution of the IOSEA Marine Turtle Memorandum of Understanding to the compilation of information on marine turtle-fisheries interactions and relevant mitigation measures*. Douglas Hykle
IOTC-2005-WPBy-INF01	Reproductive and distribution parameters of the blue shark *Prionace glauca*, on the basis of on-board observations at sea in the Atlantic, Indian and Pacific Oceans. *Jamie Mejuto and Blanca Garcia-Cortes*
IOTC-2005-WPBy-INF02	Tagging-recapture activities of large pelagic sharks carried out by Spain or in collaboration with the tagging programs of other countries. *Jamie Mejuto, Blanca Garcia-Cortes, Ana Ramos-Cartelle*

APPENDIX IV. Catalogue of Data on Non-tuna catches in Indian Ocean Tuna Fisheries

Catalogue of Data on Non-tuna catches in Indian Ocean Tuna Fisheries

Data set name	Flag	Gear type	Source	Target species	Area	Years	Frequency	Format	Data description				Contact	
									Gear	Species composition	Size	Other	Name	Email
WTBF Pilot Observer Program	Australia	longline	observer	SWO, YFT, BET	south-western Indian Ocean	2003–ongoing	14 trips	MS Excel spreadsheets	longline dimensions, materials, bait, lightsticks	all species identified	length	sex, health	Peter Ward	peter.ward@brs.gov.au
Australian Foreign Longline Observer Program	Japan	longline	observer	YFT, BET, SBT	Western Australian Fishing Zone (AFZ)	1991–97	24 trips	MS Access database	longline dimensions, materials, bait	all species identified	length	sex, health	Peter Ward	peter.ward@brs.gov.au
MRAG Foreign Longline Observer Program		longline	observer	YFT, BET	British Indian Ocean territory								Neil Ansell	n.ansell@ic.ac.uk
YugNIRO tuna surveys	Ukraine	longline	survey (some observer)	tuna, billfish, sharks	Indian Ocean	1961–89	5200 sets		No. hooks, estimated depth range	all species identified	length, weight		Evgeny Romanov	island@crimea.com
Re Union observer program	Re Union	longline	observer	SWO	southern Indian Ocean									
Seychelles observer program	Seychelles		observer	SWO	western Indian Ocean									
	EU	Purse seine	observer											
	Spain	longline	observer											
	Indonesia	small LL	observer											