出國報告(出國類別：其他)

參加 ICCAT 2006 劍旗魚會議報告

服務機關：行政院農業委員會漁業署

姓名職稱：張水鍇 / 科長

派赴國家：西班牙馬德里

出國期間：中華民國 95 年 9 月 2 日至 9 月 10 日

報告日期：中華民國 95 年 10 月 13 日

摘要

北劍旗魚管理建議：近幾年由於配額管理及 90 年代的高補充群，故資源有些恢復，但 MSY 估計爲 13,350 噸，比 2004 年的 TAC（14,000 噸）還低（但比去年產量高），也比上屆會議結果還悲觀。建議總產量限制在 MSY 以下，而若爲達 02-02 之資源重建決議案目標，就必須限制在 10,000 噸以下，直到 2009 年，不然就限制在 12,000 噸，直到 2016 年。

南劍旗魚管理建議：以混獲漁業（台、日）爲主之資源評估結果相當悲觀，但相信受到配額管理及漁業縮減而有誤差，而以專業漁業爲主之評估結果又過度樂觀，相信是一種因採用新漁具提高效率之假象。故小組決定採整合性評估結果，MSY 估計約爲 17,000 噸，比目前產量高，也比 2005 年 TAC（約 16,000 噸）高。建議在未有進一步研究確認資源狀況前，總產量應限制在 MSY 以下。

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壹、 目的

大西洋鮪類資源保育委員會(ICCAT)為保護大西洋鮪類資源而於 1969 年成立之區域性國際組織，該組織下設有秘書處、按海域魚種劃分之任務小組、紀律委員會、永續推動小組等各小組委員會，共同推動會務。

ICCAT 每年均邀請我國以觀察員身份參加相關會議。我國對該組織召開之會議均依其必要性分別派員參加，以在相關會議中維護我國漁業權益。本年度之劍旗魚資源評估小組會議，我國亦派員參加。本報告為本署人員遠洋組張水鍇科長參加此次會議情況及會議結論。

貳、 會議時地、代表

本屆會議於 9 月 4 日至 8 日召開，會議由加拿大籍及巴西籍科學家聯合擔任主席（各負責北、南劍旗魚評估），共美、加、日、巴、迦納、摩洛哥、烏拉圭、西班牙及我國等九國代表參加。首日會議由 ICCAT 秘書長致歡迎辭後開始。主席表示，針對部分議題，如 CPUE 標準化、評估模式等，將另成立任務小組來討論細節。

參、 工作紀要

☞九月四日至九月五日

一、　漁業近況報告：

1、 各國代表介紹及通過議程後，巴西報告接續有多國入漁在其水域作業，且目標魚種多樣化（劍旗魚、鯊、鮪類）。西國代表則建議未來分入漁國報告漁業概況。

2、 加拿大報告 2005 年丟棄量為歷年之最（106 噸），並回應表示近年漁船數下降，但漁民反應漁獲很好。2002 年開始實施 ITQ 制度，並可用 SWO 配額換其他鮪類。

3、 我國代表依簽核內容報告我國漁業概況，由於簽核後 2005 年之總量有再修改，故報告內容亦略作調整，並要求修正 TASK I。

4、 西班牙劍旗魚漁獲量仍相當高，並於會議當場提報 2005 年產量（南北各 5000 餘噸，北劍有增加），但表示尚未經管理單位正式審核。近年 SWO 釣獲率提高，認為是漁撈技術改變及商業因素所致。其回應巴西提問表示，西國與巴西合作船可能因市場在巴西之地利，所以調整作業方式，造成劍旗魚漁獲

組成會特別高，此種現象與西國傳統船不同。回應日本提問表示，是有許多船移往他洋作業，但主要都是從南大西洋移出，且都有重新翻修過或換新船。

5、 日本表示南劍產量持續下降，主因有二：東大西洋大目鮪船由南移北，故努力量下降；以及船數減少。北劍自 2000 年 2 月至 2003 年實施漁獲全部丟棄政策，主要爲補償之前的超捕行爲。2004-05 年政府仍要求業者活魚放生，並提供紀錄，但回報情形很少，故丟棄/放生量及其分佈之估計，係依據每十日之 radio report，再與作業報表比對而取得（與本科日前之估計方式近似）。

日本代表表示，其認爲日本以往提報之 TASK I 有低報，他可以重新估計，但未經官方程序，不可以用來修改 TASK I，問主席要不要。SCRS 主席回應，科學上能取得越真確資料越好，惟要小心處理，故建議採用日本科學家之最佳估值，但另列爲 NEI－Japan。不過美國另一代表及秘書處皆認爲，列 NEI 易引起誤解，故建議列爲小組會議之初估值。

6、 烏拉圭表示自 1980 年代台灣船提供捕魚技術後，就開始了鮪釣漁業，現在已有自己船在作業。

二、 統計資料：

1、 討論 TASK I 時，通過採用西國新提之 2005 年數字，西國代表表示該值雖未經正式管道，但應不會修改。另日本科學家所提之修正，討論後將另列爲會議估值。

2、 我代表要求澄清我國 2005 年數字之修正。主席要求依程序提供書面資料。後與秘書處聯繫，將以 email 具名寄送即可，只要有紀錄就可處理。已依此寄送 TASK I 修正值，並在第二日會議中確認。

3、 SCRS 主席質疑萬那杜未分南北之 2004-05 年 140-200 噸產量，秘書處表示有收到部分報表，將會分析其分佈。另奈及利亞 1994 年高產量有疑異，同意刪除。

4、 有關 TASK II 資料，從秘書處之列表中，可看出台灣是少數有提供全系列資料的國家，也是少數有作 catch at size（CAS）的國家（日本只作北劍的，未作南劍的）。

5、 秘書處表示日本與我國本次提供之 CAS 與 2002 年會議所用的差距很大，秘書處認爲此次我國估計的較可信，但需瞭解差異原因。主席請秘書處先說明製作時取代過程。秘書處半天預備後，說明目前之取代作法，其中許多未提供 CAS 的鮪釣國家，都以我國的取代，經我國詢問後，秘書處也統一將韓

國之 CAS 改以我國 CAS 取代，而不用日本的。主席另將擇期討論差距大之原因。

針對此差距正在與協會討論瞭解中，初步發現有許多體長資料（特小魚及特大魚）都不是我國資料庫所有的，洽秘書處釐清，其發現 2002 年 CAS 為秘書處所作的，且有些不是台灣資料。

三、 **CPUE 標準化：**

1、 就目前已討論的國家的研究結果，整體上除我國及日本外，南、北劍的 CPUE 近幾年都是上升或平緩的。加拿大的北劍趨勢上揚，巴西的南劍趨勢平穩，但 GLM 作法被質疑，將於任務小組中討論。

2、 我代表將核定之南劍研究報告於會場說明，報告時提及 1998 年後之急速下降可能與管理措施有關，該措施使我國產量從 1997 年之約 2600 噸降至 98 年之 1100 噸。另亦表示，由於 1998 年前後之 CPUE 性質不同，建議小組考慮分成兩段處理。

會中對我國報告有很多討論，除技術性問題外，大都集中在 1998 年後系列該如何處理上。巴西詢問管理措施可能造成之影響，我方回應為因應配額大量縮減，有些業者會改變 fishing strategy，據瞭解亦有業者有將活魚放生，以減輕配額壓力，我國觀察員亦曾看過，而這些資料目前無法從作業報表中分析出。

美國代表要求確認該段 CPUE 代表的是留在船上的漁獲量。巴西再表示 1998 年後台灣業者可能改變作業方式、也可能有活魚放生，但因為目前沒有資料所以無法校正，並詢問未來是否有可能校正。我方回應肯定巴西之說法，並回應 2004 年起我國新修改的報表有填報欄位（廣義「丟棄」包含放生），另外未來觀察員資料夠多後，就可以嚐試分析漁船作業有何種改變。

巴西接續表示，其研究亦有發現 1998 年管理措施造成之影響，並同意我方建議，將之分成兩段系列處理，不應直接連接一起（否則資源為急速下降）。西班牙雖不完全贊成，要看其他魚種是否也有同樣現象，但表示既然資料所代表的性質不同，建議直接刪除後段結果。我方回應，紅肉、黑皮旗魚也有同樣現象，管理措施的確有某種影響，西國代表點頭。日本接續詢問，1998 年後之作業方式是否穩定，我方回應沒有聽說有何改變，日本因此認為後段系列之性質應是一致的。

日本再詢問我國 1990 年代劍旗魚混獲率明顯增加，是否與 deep longline 漁業的發展有關。我方回應是，日本接續表示，這個現象與日本漁業相同，日本之混獲也主要是 deep longline，而非像其他國家為 surface longline。

主席詢問為何本次結果與 2002 年會議結果不同，我方回應，主要是本次報

告有刪除只報一魚種的作業報表紀錄。主席表示抱歉未注意聽到我代表報告時之說明。

3、 日本報告其南劍標準化 CPUE 持續下降，但表示因日本的劍旗魚漁獲比例持續下降，代表性越來越差，且都局限在特別地區，故對其 CPUE 之代表性表示存疑。巴西對照日本之歷年漁獲量表示，日本漁獲量在 1990 年最高（6708 噸），然後持續下降至 175 噸，而很巧的日本 CPUE 在這段期間也急速下降，認爲日本之結果是否能代表資源指標，的確值得商榷。會議討論後建議作一些分佈圖來檢視。

美國代表則不斷質疑日本北劍之趨勢爲何較 2002 年結果明顯平穩很多。日本最後表示，2002 年會議他在試驗船上，是由其他同事作的。主席決定到任務小組中再討論細節。

4、 美國北劍各齡魚之 CPUE 趨勢呈現平穩或上升，整體上，自 1999 年起即上升並維持平穩。美國丟棄量今年 262 噸，算在配額裡。

5、 巴西發表數篇報告，其中新提以統計方法進行目標魚種畫分之報告，會議中有許多正面回應及建議，日本則提供不少類似方法之經驗。主席對此報告所引起之正面討論表達肯定。巴西此次發表之報告最多，參加的人也最多，據說有意取得南劍之主導地位。

☞九月六日至九月七日

一、 南劍資源：

1、 日本表示，以往西班牙曲線是最重要的指標，但關切今年沒有西班牙標準化結果。西國表示，今年有新資訊，由於不及處理，所以明年才能提供。但由於其指標是向上，對資源狀況之正面印象很重要，故在任務小組時也請其作簡單計算。不過西國代表表示其專注在北劍，無暇作此計算，要任務小組直接引用其 2002 年報告（1988-2001 年）。經比較其標準化及未標準化結果顯示，兩者幾無差異，故任務小組決定直接引用其未標準化結果。日本則不再參加南劍小組，而專注在北劍小組。

2、 會中同意我代表提議，將台灣之 1998 年前後分成兩不同系列處理，以降低管理造成的誤差。惟因日本之下降趨勢太顯著，所以合併兩國代表「混獲指標」的 CPUE 後，趨勢仍被拉下，但仍比原先平穩。

3、 圖一爲我代表負責彙整之南劍各國 CPUE 系列圖，圖二爲 SCRS 主席整理之 GLM 標準化圖。在整理過程發現，其實各國（包括我國）在 1995 年以前之趨勢皆相近，故可以取平均；而在 1995 年之後，可以呈現三種假設：資源不好（台灣＋日本，紅色，混獲漁業系列）；資源重建中（主要爲巴西＋西

班牙，綠色，專業漁業系列）；但也可能資源狀況是在兩者之間，則呈現資源平穩（棕色）。

4、 南劍任務小組向全席會議報告進度時，西國表示，雖然有兩種完全不同趨勢，但很可喜的是，今年混獲系列（deep LL）及專業系列（Surface LL）各自都很一致。我代表建議以漁獲量來加權，以降混獲漁業系列不穩定之影響，巴西附議。日本則強調日本系列下降，係因在南大西洋的努力量持續下降，且漁場範圍也逐漸縮小，故代表性不足，但也不相信代表專業漁業的綠色線會這麼明顯的升高，除非有很高的補充群。

5、 在任務小組討論過程中，由於下降的系列都是在東大西洋（日本及我國），上升的系列都是在西大西洋（以巴西爲主），故巴西及後來加入會議的葡萄牙多次提出是否東、西不同，而東邊的有區域性過漁（local depletion）。（此對台、日漁業相當負面。）巴西並刻意分析日本小區塊資料，證實日本不完全是受作業區域縮小之影響，而是努力量太大造成的。SCRS 主席同意東西邊可能不同，但不希望這次會議討論，以免變複雜，會期內無法完成任務。而在全席討論時，我方提醒日本巴西之看法，日本強烈反駁，認爲日本在西邊仍有很高 SWO 漁獲，CPUE 也下降。

6、 資源評估結果，若以專業系列爲主，MSY 約 20,000 噸；以混獲系列爲主，MSY 只有 2,000-9,000 噸；若取兩者加權平均系列，MSY 在 15,000-18,000 噸間。西國認爲從生物及歷史角度，混獲系列之結果相當不可靠，他相信「真實」是在平均與專業系列結果之間。我代表也提醒，一開始混獲系列之兩國皆指出其 CPUE 在後期可靠性較差，並附議西國看法。

7、 巴西則表示，專業系列（主要爲巴西曲線）可靠性也有問題（沒有考慮目標魚種及漁具改變）。而回到任務小組討論時，巴西表明，即使「真實」可能真在平均與專業系列結果之間，渠仍希望 precautionary 採平均系列之結果，畢竟 TAC 不會降（目前爲 15,000 噸，平均系列結果可能會採 16,000 噸或維持原狀）。日本也表明，其政府不關切 SWO TAC，在目前情況不明時，寧願採維持原狀作法。SCRS 主席則分析，平均系列幾乎與最大漁業國西班牙系列相近，而實際上其系列還可能高估，故渠也同意採 precautionary 看法，維持目前 TAC，若 commissioner 最後提高一點，則可分給沒有配額的迦納。

8、 副秘書長回應我代表提問時表示，今年應該會訂四年配額，所以下次想翻案，就要等到 2010 年。

二、 北劍資源：

1、 北劍漁捕國家中，除日本是下降之外，其餘國家都是平穩或上升。但因日本有兩年沒有資料，之後 2004-05 年 CPUE 就非常低，所以就把整個資源趨勢從 2002-03 年之高點拉下來。討論後建議刪除那兩點再試，結果最近幾年趨

勢雖有一些平緩，但受加拿大早年之異常高 CPUE 影響，以及美國代表之資料處理模式，評估結果仍比上屆會議悲觀。

2、 而另一面，美國代表則表示，由於日本之系列相當長，在資源評估上影響力很大，故日本南、北洋特異之下降趨勢，都引導資源評估結果趨向不樂觀。。

三、 統計資料：

1、 有關我國 CAS，由於確定 2002 年會議時是秘書處使用日本資料來替代，故確定我國 CAS 沒有問題，已用來替代部分其他鮪釣國家的 CAS。

肆、 心得與建議

1、 因應劍旗魚配額管理，重要國家之漁業動態包括：日本因超捕北劍旗魚配額，於 2000 年 2 月至 2003 年 12 月間要求業者所有北劍旗魚皆丟棄，日本至今仍實施活魚放生政策，另因船數減少，捕獲量持續下降。美國在 2001 年實施禁漁期及禁漁區措施。加拿大因應配額減少，鼓勵業者轉捕其他魚種，並在 2002 年實施個別配額轉讓制度等，劍旗魚漁業因而衰退；最近業者則反應漁獲狀況好轉。歐盟許多國家改變漁具漁法，專捕劍旗魚，且漁獲量高，本次會議則對此轉變將衝擊劍旗魚資源而感到憂心。

2、 劍旗魚產量：北大西洋部分，由於配額措施而致部分船移往南大西洋或其他洋區，或者改捕其他價位較高或漁獲率較高之魚種，劍旗魚產量也因而大量下降至約 12,000 萬噸左右（含丟棄量）。南大西洋部分，也由於配額措施而致部分船移往他洋或改變目標魚種，產量因而下降至約 12,800 噸。我國 2005 年產量也在本次會議中向上修正。

3、 管理成效：2005 年南、北劍旗魚之總漁獲量都沒有超過配額；另由於體長資料不足，故小魚漁獲比例之管理成效無法評估；但會中注意到 ICCAT 的配額管理措施已造成北劍旗魚漁獲之丟棄，可能也造成南劍旗魚某種程度的漁獲丟棄，而使得許多科學資料無法一致取得，故本會議嚴重關切這對未來資源評估的影響。

4、 北劍旗魚管理建議：近幾年由於配額管理及 90 年代的高補充群，故資源有些恢復，但 MSY 估計為 13,350 噸，比 2004 年的 TAC（14,000 噸）還低（但比去年產量高），也比上屆會議結果還悲觀。建議總產量限制在 MSY 以下，而若為達 02-02 之資源重建決議案目標，就必須限制在 10,000 噸以下，直到 2009 年，不然就限制在 12,000 噸，直到 2016 年。

5、 南劍旗魚管理建議：以混獲漁業（台、日）爲主之資源評估結果相當悲觀，但相信受到配額管理及漁業縮減而有誤差，而以專業漁業爲主之評估結果又過度樂觀，相信是一種因採用新漁具提高效率之假象。故小組決定採整合性評估結果，MSY 估計約爲 17,000 噸，比目前產量高，也比 2005 年 TAC（約 16,000 噸）高。建議在未有進一步研究確認資源狀況前，總產量應限制在 MSY 以下。

6、 本次會議結論仍將提送 SCRS 劍旗魚小組會議及全席會議討論，故部分內容仍可能修改。另由於今年將重新分配配額，本次結論將提送產業科及參加本年 ICCAT 年會之代表團參。

伍、會議報告

2006 年 ICCAT 劍旗魚資源評估會議之會議紀錄(附件一)
2006 年 ICCAT 劍旗魚資源評估會議之管理摘要報告（附件二）

REPORT OF THE 2006 ATLANTIC SWORDFISH STOCK ASSESSMENT SESSION

(Madrid, September 4 to 8, 2006)

1. Opening, adoption of the Agenda, and introductions

The meeting was held at the ICCAT Secretariat in Madrid. Mr. Driss Meski, ICCAT Executive Secretary, opened the meeting and welcomed participants.

Dr. John Neilson (Canada), meeting Chairman, welcomed meeting participants ("the Group") and thanked the Secretariat for the effort made to prepare the meeting. Dr Neilson proceeded to review the Agenda which was adopted without changes (**Appendix 1**). In reviewing the Agenda, Dr. Neilson reminded participants that it had been prepared to address the objectives presented in the Swordfish Workplan for 2006 (**Appendix 2**).

A list of meeting participants is attached as **Appendix 3** and the list of scientific documents presented at the meeting is attached as **Appendix 4**.

Drs. Travassos (Brazil) and Neilson chaired the sessions for the southern and northern Atlantic stocks, respectively. The following participants served as Rapporteurs for various sections of the report:

Section	*Rapporteurs*
1, 10, 11	P. Pallarés
2	G. Scott
3	J. Neilson, P. Travassos
4	J. Mejuto, K. Yokawa
5	M. Ortiz, S. Paul
6	C. Porch, L. Brooks
7	C. Porch, V. Restrepo, L. Brooks
8	C. Porch, L. Brooks
9	J, Neilson

2. Review of recommendations from the 2006 SWO Stock Structure Workshop

A Workshop on swordfish stock structure took place in Crete in early 2006, in response to Resolution [99-03], at which 13 scientific documents on swordfish biology were presented (SCRS/2006/010). While the delineation between stock boundaries remains imprecise, the results of the research presented gave general support to the stock structure currently assumed for Atlantic Swordfish (Mediterranean and North and South Atlantic stocks). The Workshop agreed that delimitation between these three stocks cannot be improved upon without intensified collaborative and multi-disciplinary research. Similarly, the classification of swordfish caught near the boundaries to their stock of origin is subject to uncertainty and cannot be made accurately without intensified collaborative and multi-disciplinary research taking into account fine-scale (e.g., 1º squares) and quarterly sampling strata. A summary of the available information regarding stock structure is provided in SCRS/2006/010 and repeated in this report in **Table 1**.

Considering these conclusions, the Group concluded that the traditional North and South Atlantic management units would continue to be used as the basis for the current assessments.

3. Biological data, including tagging information

Three papers were presented at the meeting pertaining to this subject. SCRS/2006/119 presented an analysis of the genetic and growth patterns of three swordfish specimens (two males and one female) tagged with traditional tags and later recaptured over a period of time ranging from 2.7 to 5.4 years. Two of these specimens were tagged and recaptured in the NW Atlantic, while the third individual was tagged and recaptured in the NE

Atlantic. These three specimens were genotyped for four microsatellite loci and were analyzed together with additional genotyped specimens from Atlantic and Mediterranean areas using a Bayesian cluster analyses. The results suggest that the three recaptured swordfish have a genetic profile that is characteristic of the Atlantic. The growth patterns were seen to differ in two of the specimens analyzed (male and female): the male was assumed as a single ring pattern, while the female was found to have a mostly double ring pattern. The age estimation of these two specimens according to these observations was consistent with previous growth studies. The third specimen that is known to be a male at least 6 years of age, tagged and recaptured in the NW Atlantic, was not consistent with previous growth studies. The authors concluded that more work is required to document the process and frequency of ring formation. The Group noted that these results, although based on a small sample, seem to imply that different ring formation rates may be found within a single stock of swordfish. If this conclusion is correct, this may further complicate investigations of direct age determination from hard parts of swordfish, a previous recommendation of the Group. The authors recommended improving the protocols for recaptures of tagged Atlantic swordfish made by all fleets to include the routine sampling of tissues and hard parts.

The second document (SCRS/2006/031) was originally intended for presentation at the March 2006 Swordfish Stock Structure Workshop, but the authors were unable to attend. The paper was tabled for the information of the Group. The paper described the artisanal swordfish fishery off the Côte d'Ivoire. The fishery is exploited using drifting gill nets and is located in waters off Abidjan at the limit of the continental shelf. The fishery has been operation for more than 15 years. An analysis of the length composition of fish landed from 1988 to 2004 was done, and indicated that most of the landed catch had not reached the length of first maturity. The authors discuss the implications of this finding in terms of impacts on the population, and compare with other swordfish fisheries employing similar fishing gear.

Document, SCRS/2006/118 provided biological information on size and sex-ratios at size from fishing areas near Uruguay, south of 25º latitude S. The sex-ratio at size observed was characteristic of a "feeding region" as described for other Atlantic regions, with a linear increase of the female percentage over size, confirming previous data and assumption for this region. Sporadic observations of males as large as 290 cm LJFL were also noted.

Concerning tagging, the Secretariat made the updated database available to the Group. The Group recalled that this database had been useful during the stock structure Workshop in Crete. It was noted that the Secretariat should remove tag positions at 0 degrees, which actually correspond with missing data. The resulting inferred linear movements from release-recovery data are given in **Figure 1**.

4. Catch data, including fisheries trends

4.1 Overview

Directed surface longline fisheries from Canada, EC-Spain and the United States have operated since the late 1950s or early 1960s in the North Atlantic. The harpoon fisheries have existed at least since the late 1800s in the NW Atlantic. Other directed swordfish fisheries include longline fleets from Brazil, Morocco, Namibia, EC-Portugal, South Africa, Uruguay, and Venezuela, among other. Additionally, some driftnet activities occur around the Gibraltar areas, such Morocco, and in other Atlantic areas (e.g., off the coast of West Africa).

The primary by-catch or opportunistic fisheries that take swordfish are tuna fleets from Chinese Taipei, Japan, Korea and EC-France. The tuna longline fishery started in 1956 and has operated throughout the Atlantic since then, with substantial catches of swordfish in some years that are produced as a by-catch in their fisheries targeting different tuna species. **Figure 2** shows the geographical distribution of swordfish catches in the Atlantic.

As a result of ICCAT and domestic regulatory recommendations, there were significant recent events during the last decade in the fisheries of some nations. Starting in February 2000, Japanese vessels fishing in the North Atlantic were domestically required to discard all swordfish as the Japanese block quota had been reached. In 2001, U.S pelagic longline fishing was prohibited or restricted in five areas and times to reduce incidental catches including juvenile swordfish and by-catches. The Canadian directed swordfish fishery, which used to continue into October, since 1999 has finished at the end of August due to reduced quota. Finally, a further change in the fishery has resulted from changes in technology, i.e. there has been a change in the type or style of longline gear used by many Spanish vessels that have changed from the traditional multifilament to monofilament gear. The Group noted these recent developments and their potential effect on the available data, its continuity and complexity and therefore its interpretation. Specific research actions concerning these issues are needed in the near future.

The SCRS scientists believe that ICCAT Task I landings data provide minimum estimates because of unreported catch of swordfish made in association with illegal, unreported and unregulated (IUU) fishing activities. However, the amount of NEI swordfish catch by IUU vessels were not estimated during this meeting.

Total Atlantic

The total Atlantic estimated catch of swordfish (North and South, including reported discards) reached 24.830 t in 2005 which represented a significant decrease from the historical peak of 38.624 t in 1995 (**Table 2** and **Figure 3**). As a substantial number of countries have not yet reported their 2005 catches and because of unknown IUU catches, this value should be considered provisional and subject to further revision.

North Atlantic

For the past decade, the North Atlantic estimated catch (landings plus discards) has averaged about 14,200 t per year (**Table 2** and **Figure 3**), although the 2001 reported landings and discards were already reduced to 10.011 t because the ICCAT regulatory recommendations. The reporting of catches in 2005 (including discards) represent a 40% decrease since the 1987 peak in North Atlantic landings (20,236 t), in response to ICCAT recommendations. These reduced landings have also been attributed in the past to shifts in fleet distributions, including the movement of some vessels years to the South Atlantic or out of the Atlantic. In addition, some fleets, including at least the United States, EC-Spain, EC-Portugal and Canada, have changed operating procedures to opportunistically target tuna and/or sharks, taking advantage of market conditions and higher relative catch rates of theses species previously considered as by-catch in some fleets.

South Atlantic

The historical trend of catch (landings plus discards) can be divided in two periods: before and after 1980. The first one is characterized by relatively low catches, generally less than 5,000 t (with an average value of 2,300 t). After 1980, landings increased continuously up to a peak of 21,780 t in 1995, levels that match the peak of North Atlantic harvest (20,236 t). This increase of landings was, in part, due to progressive shifts of fishing effort to the South Atlantic, primarily from the North Atlantic, as well as other waters. Expansion of fishing activities by southern coastal countries, such as Brazil and Uruguay, also contributed to this increase in catches. The reduction in catch following the peak in 1995 resulted from regulations and partly due to a shift to other oceans and target species. In 2004, the 12,902 t reported catches were about 40% lower than the 1995 reported level. The reported 2005 catch is 12,687 t, and should be considered provisional and probably an underestimate.

4.2. Recent developments

Because of the broad geographical of distribution of the Atlantic swordfish in coastal and offshore areas, generally ranging from 45ºN to 45ºS, this species is available to a large number of fishing countries (see **Table 2** for details). However, information about fishing activities and new developments is only available for some fishing countries and reported to this working group. Argentina has provided information about minor fishing activities in the South Atlantic during recent years, suggesting fishing activity since the 1980 probably incompletely reported during some periods. Vanuatu has also reported recent catches in the North Atlantic for 2004 and 2005. The Group notes that the summaries below are limited to those reported directly to the meeting. The reports received represent XX% of the total N. and S. Atlantic landings for recent years (((Secretariat to calculate)))

Brazil: Up to 1979, swordfish were caught as by-catch in the tuna longline fishery and annual catches in general did not exceed 500 t. During the eighties some opportunistic catches were taken in directed swordfish fishing, which resulted in increased catches that, in some years, were around 1,000 t.

Up to 1990 the majority of foreign chartered longliners were Japanese flagged vessels that started operations in 1977 targeting yellowfin and moved to bigeye. From 1991 through 1994, Chinese Taipei flagged vessels comprised the major part of the chartered fleet and albacore replaced bigeye as the target species. In more recent years, this fleet has been comprised mainly of medium-sized vessels that operated targeting either yellowfin or bigeye to supply the fresh tuna market.

It was only in 1992 that direct swordfish fishery was introduced in Brazilian waters, by foreign flagged chartered vessels using monofilament longline. Starting in 1994, Brazilian longliners began to change to the monofilament longline and the major part of the Brazilian longline fleet is now targeting this species. In 1996, Spanish flagged leased vessels started operations in Brazilian waters targeting swordfish.

As a result of an increased number of vessels conducting directed swordfish fisheries and due to the expansion of the fishing area to offshore waters, swordfish catches increased continuously until 1999 when the highest catch of 4,721 t was recorded. Since then, some chartered vessels targeting swordfish stopped operations and catches have shown a decreasing trend levelling off around 3,000 between 2002 and 2004. In 2005, longline catches increased again, up to 3,785 t, showing an increase of about 30% in relation to 2004. This increase in swordfish catches was mainly the result of an increase of the fishing effort.

Canada: Canadian swordfish landings in 2005 were 1,558 tons, taken by longline (1,364 t) and harpoon (193 t). Based on data from at-sea observers, an estimated 106 t were discarded dead from the longline fleet. Only 48 of the 77 licensed longline vessels landed fish in 2005, a significant decrease relative to the mid-1990s when all, or nearly all, of the swordfish longline licenses were active. The reduced effort in recent years is a result of a combination of factors including reduced quota, increased opportunities for fishing other species, relatively low market value, and the introduction of an Individual Transferable Quota (ITQ) management system in 2002. Prior to the inception of ITQ's in 2002, pelagic longliners targeted "tunas" early and late in the season, before and after the swordfish quota was caught. Under the ITQ system, longliners use their quota for swordfish or use it for by-catch to target the tunas. This has resulted in a longer fishing season for swordfish than in previous years, ending in November, rather than September.

Chinese Taipei: The Chinese Taipei longline fishery started its operation in the Atlantic Ocean in the 1960s and has fished widely throughout the Atlantic, targeting mostly on albacore, bigeye or yellowfin tunas in the 1990s. Swordfish was mainly a by-catch to the tuna fishery, although some small longliners had been targeting the species for fresh fish market and some large longliners had access in the past to fishing in the Brazilian waters for swordfish seasonally. For the northern stock, the annual catch was less than 300 t in the 1980s and increased to 400-600 t during 1991-1997. The increase was mainly due to the development of deep longline operations in the tropical area for bigeye and yellowfin tunas. Due to an additional catch reduction regulation by ICCAT, the catch decreased to a level of 300 t. The catch was further decreased to a preliminary estimate of 140 t in 2005. For the southern stock, the annual catch was about 200-800 t in the 1980s, but increased to 850-2,900 t in the 1990s accompanied by an increase of deep longline operations. Due to the enhanced catch regulation, the catch was then reduced to around 1,100 t in 1998. The catch was further decreased to a preliminary estimate of 744 t in 2005.

EC-Portugal 2006: There have been a few changes in the Portuguese swordfish longline fisheries in recent years, further to those produced by regulations. The North Atlantic fleet has become more of a multi-species fishery, mostly due to changes in the market (increases in the price of other species like sharks). Additionally, many vessels have changed fishing gear, from traditional multifilament to monofilament gear (Florida style). Swordfish landings in 2005 amounted to 900 t in the North Atlantic and 493 t in the South Atlantic.

EC-Spain: An extensive description of the recent fishery, catch, effort and nominal CPUEs, is found in SCRS/2006/150, including North and South nominal catch per effort information for the period 1986-2004, as well as in documents previously presented. Landings in the North during 2005 were 5,521 t, a 21% decline from the peak landings reported in 1995. There were some changes in the Spanish fisheries in most recent years, additionally to those produced by regulations. As it was already reported over the past few years, the North Atlantic fleet has kept a multi-species fishery due to changes in the market (increases in the price of other species) and to a shift of some vessels out of the Atlantic. Additionally, most of the vessels have already gone from the traditional multifilament to monofilament gear. In the South Atlantic reported catches for 2005 were 5,402 t, a 52% decline from the peak catches in 1995 (11,290 t).

*Ghana :*Swordfish are caught primarily from small drifting nets employed from large dugout canoes used off the central and western shores of Ghana. Swordfish are not targeted specifically but occur among other billfishes including the sailfish (I*stiophorus albicans*), blue marlin (*Makaira nigricans)* and white marlin (*Tetrapturus albidus*). Traditionally, fishermen living along the coast have been engaged in the fishery since its inception in 1974. There are currently over 400 drift gill net canoes operating with catches fluctuating annually between 50 to 700 t. No major developments have occurred in the fishery since it was introduced.

Japan: North Atlantic Japanese longliners discarded/released all their swordfish catch in the period between February 2000 and December 2003 because of domestic regulations. Though the Japanese government requested all Japanese longliners to submit their dead discarded and live released swordfish in the same format as the logbook, availability of these data from the reporting system is quite low (Yokawa, 2006).The number of dead discarded and live released swordfishes was reported every 10 day period although no information for the location of these catches was provided. This information was used in the estimation to the total catch. The Japanese government requested Japanese longliners to continue releasing their live swordfish catch after 2003 until the present. The amount of these live released catch was also estimated using the data from the radio reporting system. The estimated total catch (including live release) decreased from 1090 tons in 2000 to 396 tons in 2003, increased in 2004 to 926 tons, and decreased in 2005 to 324 tons. The estimated decreasing trend of the total catch in the 2000-2003 period was caused, at least in part, by the increase of the reporting ratio of swordfish to the radio reporting system. The ratio of vessels reported swordfish catches in 2000-2003 were largely lower than those in 2004 and 2005, when Japanese longliners are allowed to retain their dead swordfish catch. Japanese longliners are required to report their landings in the logbook system. The data of the radio reporting system in 2004 and 2005 are supposed to be more reliable than those in 2000-2003, as they require consistency between the data in the log-book and the radio reporting system. The observed decrease in the catch in 2005 is mainly due to the decrease of the number of longliners.

The South Atlantic swordfish catch of Japanese longliners fluctuated between 123 tons and 339 tons in the period of 2000-2005. This is mainly due to the yearly shift of the main fishing ground of Japanese longliners targeting bigeye tunas in the eastern tropical Atlantic laying across the boundary of the north and south stock units of swordfish. The effort of Japanese longliners in the recent years tends to be more concentrated in the upwelling areas where they can catch higher quality of bigeye tuna. This supposed to give the negative impact on the swordfish catches as the catch ratio of swordfish in these upwelling areas is generally lower than adjacent areas.

Morocco: A description of the fishery is provided in SCRS/2006/125. In Morocco, swordfish fish is currently carried out by a coast comprised of about 340 vessels, of which 20 operate in the Atlantaic. These vessels use driftnet and surface longline as the major fishing gears.

However, in the Moroccan South Atlantic, swordfish have also been targeted in the last three years by a freezer longline fleet, with vessels measuring from 20 to 27 m in length. These vessels use surface longline as the fishing gear and they mostly land at the port of Dakhla. While their number does not exceed 10, these vessels fish mainly off the coast and their sets last from 10 to 20 days.

The major fishing zones are located in the area of the influence of the Strait of Gibraltar (5-30 nautical miles from the coast) anda long the Moroccan South Atlantic coasts. Swordfish fishing is carried jout during the two periods of passage of this recourse along the Moroccan coasts. These two periods are usually from April to November.

The Atlantic catches of swordfish have fluctuated in the last ten years between 114 t and 462 t. These have, however, shown a stable trend at about 325 t in the last three years. The catches taken by longline have increased slightly since 2003 and amounted to 325 t in 2005. It is important to note here that the geographic breakdown of the catches of this species is done according to the fishing zone where the catch is made, which is imperatively indicated in the ICCAT Statistical Document established to this effect. According to the Moroccan administrative sub-division, the catches made in the Strait of Gibraltar are included in the Mediterranean catches.

The size of the swordfish caught in the Strait of Gibraltar and in the Moroccan North Atlantic zone varies in a range from 85 to 260 cm. The average sizes in these areas are on the order of 146 cm and 137 cm fork length, respectively.

United States: For 2005, the provisional estimate of U.S. vessel landings and dead discards of swordfish was 2,424 t (2,162 landed North Atlantic and 262 dead discards NATL). This estimate is 10% lower than the estimate of 2,670 t for 2004.

Swordfish landings are monitored in-season from reports submitted by dealers, vessel owners and captains, NMFS port agents, and mandatory daily logbook reports submitted by U.S. vessels permitted to fish for swordfish. This fishery is also being monitored via a scientific observer sampling program, instituted in 1992. Approximately 8% of the longline fleet-wide fishing effort is randomly selected for observation during the fishing year. The observer sampling data, in combination with logbook reported effort levels, support estimates of approximately 19,559 fish discarded dead in 2005, representing an estimated 262 t of swordfish, overall. For the North Atlantic, the estimated tonnage discarded dead in 2005 is 262 t, of which 252 is estimated due to longline gear. Overall, the estimates of dead discarded catch declined by 5% (13 t) compared to the 2004 level. This fishery is still subject to domestic management actions including time-area closures and others implemented in 2000. During the year 2001, U.S pelagic longline fishing was prohibited or restricted in the five areas and times shown in **Figure 4**. The three southern areas, (Charleston Bump, Florida East Coast, and Desoto Canyon), were selected, at least in part, to reduce the catch of swordfish <125 cm and other by-catch. The bluefin tuna area was closed primarily to reduce the catch of bluefin smaller than legal size for sale by U.S. fishers. Longline vessels were allowed to fish in the Northeast Distant Area if they participated in a turtle study and carried an observer. The number of longline vessels in the U.S. fishery targeting swordfish has declined steadily since the mid-1990s. Reported effort (hooks) declined initially but has remained fairly stable since 1998. Some of the effort previously reported from the Florida East Coast fishing area appears to have redistributed into the Gulf of Mexico and up to the South Atlantic and Mid-Atlantic Bight.

Uruguay: Document provides information on the Uruguayan fishery between 2001 and 2005 from its nacional observer program. The reported catches for 2005 from the South Atlantic were 843 t. Surface longline fishing started in 1969 in Uruguay with a tuna vessel that operated until 1974. There were no tuna vessels in operation from 1974 to 1981. In 1981 the activity was reinitiated with fishing by a longline fleet. In the 1981 to 1991 period this fleet, comprised of vessels of Japanese origin and fishing methods, was directed mainly at swordfish, yellowfin tuna and bigeye tuna, except for some some Chinese vessels that operated approximately one year and trageted albacore. These vessels ceased operations in 1992, with the introduction of a fleet of longliners of American and Spanish origin, with the corresponding change in the fishing method. Currently, the vessels that fish are almost all "fresqueros" which use an American type drift monofilament longline and their main target species is swordfish and, to a lesser degree, bigeye tuna and yellowfin tuna, as well some shark species. The major fishing area during the entire period has been the Uruguayan Exclusive Economic Zone and adjacent international waters, between 30º and 38º latitude South. However, during the initial period some vessels fished in extensive areas of the Atlantic Ocean. During the first stage (1981-1991), the fleet reached 13 vessels, all of them large freezer vessels. Since 1991 only one vessel has operated, although currently the fleet has reached 12 vessels, mostly less than 24 m. The catches for the 1982-2005 period varied between 156 t (1991) and 1,927 t. (1984), fluctuating at about 800 t in the last 10 years.

4.3 Catch data

The Secretariat presented summarized catch tables by gear and country (**Table 2**). The Group noted that many fleets had not submitted data in time for the assessment. For the purposes of the analyses used in the assessment, data for 2005 were carried over from the previous years for those fleets that did not submit data. Affected countries in the North were Barbados, Phillipines, St. Vincent and the Grenadines, Senegal, and UK Bermuda. In the South, a roll-over of landings from 2004 to 2005 was necessary only for the Phillipines (1 t).

Vanuatu also reported landings in 2004 and 2005, representing the first time that country reported North Atlantic swordfish landings. The catch of Vanuatu and Saint Vincent and the Grenadines which had been reported as unclassified areas were assigned to the North Atlantic. Further, the Group reviewed the landings of Nigeria (south Atlantic), and considered the issue raised in the 2002 assessment of an unusually large catch (857 t) reported in 1994. Given that there were no landings of that magnitude in adjacent years for that country, and based on further information received by the Secretariat, a decision was made to omit this value from the catch table.

The size information and the catch data available during the meeting were reviewed by the Group. The Secretariat noted that the majority of the 2005 information was submitted after the deadline, and consequently some delay was encountered in the work to assimilate and disseminate the data. For the Northern stock, updated catch at size or size-sampling information data since the last assessment were reported for the following nations/fleets and years:

- Japan 1998-2005
- USA 2001-2005
- Spain 2001-2004
- Canada 2001-2005
- Chinese Taipei 1981- 2004
- Morocco gillnet 2001-2005
- Portugal longline 2001-2005

- Venezuela gillnet 2001
- Mexico longline 2001

For the Southern stock:

- Chinese Taipei 1981-2004
- Spain 2001-2004
- Brazil longline 2001 to 2005
- Namibia for 2001 and 2005
- South Africa 2001 to 2005
- Portrugal 2002 and 2005
- Côte d'ivoire 2003 and 2004
- Japan 2001 to 2004

To update the catch at size created during the last assessment in 2002, the Secretariat presented the substitution table for the years 2001 to 2005 for the North and the South Atlantic stock (**Tables 3** and **4** provide details of the substitutions made for years 2001-2005 for the north and south stocks, respectively). With some small changes, the Group accepted the proposals made by the Secretariat to create the catch at size. The Group further recommended that this table become the template for further updates of the catch at size information for these stocks. Following the procedures of the 2002 stock assessment, the "unisex" Gompertz growth curve adopted by the Group since 1989 was used to convert catch at size to catch at age using the AGEIT program. The resulting catches at age matrices are shown in **Table 5** and **6** for the north and south stocks, respectively.

5. Relative abundance indices

5.1 Relative abundance indices – North

Indices of abundance by age combined sex for north Atlantic swordfish stock show consistent patterns for all ages (2-5+) between the different target fisheries, only the by-catch fisheries show a divergent trend. For ages 3 to 5+, indices indicated an increase in biomass since 2000 for age 3, and since 1998 for age 5+ (**Figure 5**). In contrast, for age 2 indices show a decline in recent years compared to 1999. No updated index was available for age 1 recruits in the recent period. The biomass index that included all major fisheries shows a slightly increasing trend from 1998 through 2005 (**Table 8 and Figure 6**).

The biomass index for the North Atlantic swordfish stock was created during the meeting (SCRS/2006/129). Data from Canada, Japan, USA, Portugal and Spain were submitted by their scientists, and from those 5 series, the data from Canada, Japan, USA, and Spain were standardized using a GLM assuming a delta lognormal distribution (**Table 7** and **Figure 5**). Concerns regarding the reliability of the Japanese catch data since 2000 were raised by the Japanese scientist due to the low reporting of discarded and released swordfish. The Group recommended excluding the information from 2000 to 2005 from the standardization of catch rates. Following the 2002 assessment, the biomass index was restricted to the periods 1963 to 1970 and 1975 to 2005. In the past, only positive swordfish catch records were included, and although the proportion of zero catch is low (less than 5%), it was considered by the authors appropriate to use a delta lognormal model rather than excluding data. Other modifications of the standardization model included the re-categorization of the target factor. In the past, this factor considered 10 levels (10% increments of the percentage from 0 to 100%), while in the present analysis the target variable was defined in 4 groups, as 25% percentiles increments. This change gives a more balanced input matrix and reduces the number of parameters estimated. Further discussion with the Group indicated that data from the Spanish fleet may require further revision, in particular for the classification of the gear type. It was decided by the Group to exclude the data classified as gear "multifilament" from 2001 forward from the Spain input data from the current analyses.

Standardized, age-specific catch rate information for the North Atlantic swordfish stock from the Canadian (SCRS/2006/116) and US (SCRS/2006/124) longline fisheries were updated through 2005 using previously presented analyses. Age-specific CPUE of swordfish caught by Japanese longliners in the North Atlantic was presented for the period 1975-2005 (SCRS/2006/021), standardized using the methods from the 1999 assessment (Anon., 2000). For the period February 2002 through December 2003, Japanese longliners discarded all their swordfish catch, and continuing from 2003 to the current period, Japanese longliners continue releasing their live swordfish catches. Data from the radio reporting system, which report the number of live and dead swordfish releases in 10 day intervals (without information for the location of these catches), was used in the estimation of live and dead discards. Standardized CPUE showed unrealistic drops for the period 2000-2003 for all age groups, coinciding with a period of low reporting. This strongly indicates that the estimated abundance index values in 2000-2003 underestimated the level of the stock. Thus, the Group resolved not to use these values in the stock assessment. The available standardized CPUE from the Spanish longline fleet was from the 2002 stock assessment, updated to 2001 (Anon., 2003).

Table 7 and **Figure 5** present scaled age-specific standardized catch rates available for the VPA assessment of the North Atlantic stock.

According with the 2006 Workplan and because not all fisheries have age- and -sex specific indices, it was agreed that VPA analyses would be restricted to age-specific, combined sex evaluations. The Canadian age-specific, combined sex index used in the VPA was estimated at the meeting by adding the standardized CPUE of males and females of each age class (age 2-5+) and the variance of this pooled index was estimated as the sum of the variance estimates for each sex.

The Group observed that indices of abundance for swordfish by age and sex, or age combined sex, were calculated using different growth models. It was recommended that future evaluations used consistent growth models for standardization purposes but also for the methods of sizing and ageing the catch information.

5.2 Relative abundance indices – South

For the 2006 assessment, there was improvement in the information level available from fisheries harvesting southern Atlantic stock swordfish **(Table 9) Figure 7)**. Nominal and standardized catch rate patterns from several fisheries were provided and fell into two general patterns, generally reflecting targeted and by-catch fisheries (**Figures 8** and **9**). Although the by-catch and targeted fisheries patterns were similar in the early part of the available time-series, the patterns diverged starting in the mid 1990's and without additional research it will not be possible to resolve if either pattern best reflects the total biomass trend. It was noted that there was little overlap in fishing area and strategies between the by-catch and targeted fleets used for estimating CPUE pattern, and that the by-catch and targeted fisheries CPUE trends could track different components of the population. This view was supported to some degree by the limited size-frequency information for southern stock swordfish catch, but much additional research and data collection would also be required to test this hypothesis.

5.2.1 Swordfish targeted fisheries

Two standardized CPUE indices from Brazilian swordfish targeting fleets were presented at the meeting. Document SCRS/2006/126 presented results from a cluster analysis to investigate changes in target species and fishing strategy of the Brazilian longline fleet (chartered and national) from 1978 to 2005. The cluster analysis successfully grouped the longline sets by the target species, clearly reflecting the differences among fleets as well as in the fishing strategies. The database generated by that analysis was then used to standardize the CPUE of swordfish caught by the Brazilian longline fishery from 1978-2005 (SCRS/2006/127). Results suggest that the use of cluster analysis to previously group the longline sets as a way to take into account the targeting strategy might be an important tool to generate standardized CPUE series by the GLM method, particularly in the case of a fishery, such as the Brazilian tuna longline fishery, made up by several fleets, with a high degree of variance in the fishing strategy over time. It was recognized, however, that one potential bias of that method is that the cluster analysis will not consider a set as targeting swordfish if swordfish catches are null or if its proportion is considerably lower than those obtained for other fish species in the same set, a flaw that could result in artificially higher CPUEs. This bias, however, may have been minimized by including all clusters as a factor in the GLM analysis. It was also noted that the use of aggregated data by fleet, for instance, not considering the proportion of catches in each set, may cause an opposite bias, since a variable part of the fishing effort deployed by it might not have been directed to the expected target species, thus artificially lowering its relative abundance.

Discussion of this approach resulted in a recommendation to investigate the method through simulation to permit evaluating the potential sources of bias in approach. Such simulations have been carried out for simpler methods which use catch of other species to index the degree of targeting (SCRS/00/21). That set of simulations found that certain approaches using catch of other species could lead to serious bias in measures of relative abundance. The Group was concerned that the methods may have introduced a positive bias in the inferred relative abundance trend and believes that the pattern resulting may be an overly optimistic representation of the recent trend in southern Atlantic swordfish biomass.

The Group suggested a comparison of standard CPUE estimates derived from cluster analysis against estimates using the proportion of swordfish catch to other species catch, a common approach used in other standardization models. The Group also suggested the application of the cluster analysis in the summary of trip data. It was argued that within a trip, the likelihood of shifting fishery tactics is smaller compared to different trips, as captains have economic objectives that determined the objective of their trip. This may be applied primarily to oceanic trips, rather than coastal-short trips where normally the catch is more opportunistic. In general, the Group recognized the importance of evaluating catch rates as a function of the catch composition. Whether using cluster analysis, proportions of catch or direct measurements of targeting, this factor has shown to be very important in standardization analyses.

Catch and effort data (1971-2005) of swordfish caught off southern Brazil by the tuna fleet based in Santos were also standardized using a GLM approach, and AIC and deviance analysis to select the relevant factors (SCRS/2006/117). The final standardized index showed fluctuations without a clear trend for the whole period. This is generally associated to changes in fishery strategies, but the use of data aggregated by month does not allow the model to clearly explain the target. The result suggests that the swordfish from the south Atlantic stock is not strongly affected by the fishery. However this interpretation must be carefully analyzed due to the low fishing effort of Santos longliners and the small area of operation. It was suggested by the Group to split the series at the period of the longline type change. The Group also noted that the recent declining tendency in the Santos standardized CPUE was opposite in direction from the pattern modeled in SCRS/2006/127, especially if the time-series was separated to deal with the transition from multifilament to monofilament longline gear, which may have resulted in substantially higher per hook catch rates for swordfish (and other species), as seen in other fleets. Further research into methods to control for this feature was recommended.

A nominal CPUE index for Uruguay was presented in document SCRS/2006/118. Swordfish catch and size information was collected by the *Programa Nacional de Observadores de la Flota Atunera*-PNOFA (National Observer Program of the Tuna Fleet) and catch from logbooks of the pelagic longline fleet of Uruguay from 2001-2005 were presented. The percent of covarage was 7% and 35% of the total effort of the fleets, respectively. Preliminary analyses focus on the spatio-temporal distribution of effort and catch by size. A total of 9,604 fish were measured (66-455 LJFL cm). In addition, ratios of sex by size were evaluated and compared to other areas. It was observed the increase of female proportion in function of size. Catch rates were analyzed by size categories, < 125 LJFL cm, 125-160 LJFL cm, and > 160 LJFL cm, and by area and season. Results indicate that smaller fish concentrate near the coast in the fall-spring time, while large animal show a more oceanic distribution with an apparent trophic migration between northern and southern areas following main pray species.

The Group suggested that attempts be made to standardize the Uruguayan catch rate data to permit more direct comparison with the results from other swordfish fleets in the region.

SCRS/2006/128 used GRASP (Generalized Regression Analysis and Spatial Prediction) to map the spatial distribution of swordfish in the south Atlantic, based on generalized additive models (GAMs) relating catch to environmental predictor variables. Catch information from 38,000 Brazilian pelagic longline sets from 1980 to 2000 and size frequency data from 5,000 longline sets from 1982 to 2000 were obtained from ICCAT database. The results highlighted the importance of environmental variables for the fishery and for the spatial distribution of different size classes of swordfish (small, intermediate and large). The distribution of swordfish was closely associated with convergence zones (inter-tropical and sub-tropical), especially in the months of greatest intensity. Spatial distribution patterns differed for the three studied size classes. The smallest size classes were found mainly in coastal zones and in areas with a shallow mixed layer (< 20 m). In contrast, intermediate sized swordfish were mostly associated with the inter-tropical convergence and mixed layers of more than 20 m depth, while large swordfish was more common in the vicinity of the sub-tropical convergence zone.

In addition, a nominal CPUE series was available from EC-Spain (1988-2004, see SCRS/2006/115), a pattern which was also generated at the meeting based on ICCAT Task II data. In the future, a standardization of these data should be attempted, taking into account the transition to monofilament gear.

5.2.2 Non-swordfish targeted (by-catch) fisheries

Two documents on standardized by-catch swordfish CPUE from the pelagic longline, non-targeted fisheries of Japan and Chinese Taipei were presented.

The CPUE index (number/1000 hooks) of swordfish caught by Japanese longliners in the South Atlantic was standardized by a delta lognormal model, using set by set data for the period between 1967 and 2005 (SCRS/2006/021). The biomass index of the south Atlantic swordfish was also estimated using the values of standardized CPUE in number and the calculated average weight of the catch in each year. In recent years, effort has declined and has been concentrated in the northeastern part of the south Atlantic where lower catch rates of swordfish have been observed due to the influences of strong up-welling. It is difficult to believe that the model used in the CPUE standardization can fully adjust for the effects of these shifts of the fishing effort. The Group considered the estimated abundance/biomass indices are underestimating the current stock level to some extent.

Document SCRS/2006/120 describes the standardized by-catch CPUE from Chinese Taipei. Catch rates were developed by applying a GLM approach assuming a delta lognormal error distribution, with main explanatory variables of bi-month, geographical area and fishing target species. Three sets of area definitions were considered in the standardization runs with north boundary assumptions of the south stock at 5ºN and 15ºN and the results are almost identical. A sharp decrease was noted since 1997/98 towards 2003 when the ICCAT Recommendation 96-08 and 97-07 on swordfish catch reduction were in effect. The Group discussed the ways to deal with this part of underestimated series including either drop that series or treat it as a separate series and agreed on the latter option.

In addition, nominal CPUE series were made available from Ghana for the years 1990-2004.

Table 9 and **Figure 7** show the various catch rate patterns available to the Group for the south Atlantic swordfish stock.
The Brazilian, Spanish, and Uruguayan data showed a similar trend of increasing CPUE for recent years (1996 on, although at differing rates). The Brazilian CPUE series provided the most optimistic scenario, a trend, however, that might be, at least partly, due to the standardization method used, which considered the target species, selected by a cluster analysis, as one of the explanatory variables in the model. Japanese and Taiwanese CPUE trends, however, showed an opposite trend, with CPUE continuously declining in recent years. The most pessimistic scenario was provided by the Japanese and Taiwanese fleets. The Japanese CPUE series might be biased downward due to the strong reduction of the fishing effort in the South Atlantic from 1985 to 2005, with a consequent shrinking of the fishing area, with a significant reduction of the effort in the areas of higher abundance of swordfish. The Japanese fishing effort not only declined over time, but also moved closer to the eastern side of the Atlantic.

For the 2006 assessment there was some improvement in the information level available from fisheries harvesting southern Atlantic stock swordfish. CPUE series from the targeted fisheries of Brazil and EC-Spain and from the by-catch fisheries of Japan and Chinese Taipei were applied in characterization of stock status (**Figure 8**). The Group also decided to consider a Composite index that utilized both target and by-catch datasets. The three catch rate patterns were constructed through a GLM Least Square Mean prediction (SAS code and inputs held in the ICCAT assessment archive) for each year in the time-series controlling for the source of the information and using the appropriate catch rate patterns rescaled to the respective time-series mean values for the period of common overlap (1989-2003). These input streams for GLM analysis are provided in **Table 10** and the output results in **Table 11**. In the case of the Chinese Taipei time-series, the catch rate pattern was divided into two periods (separated after 1997) to account for the likely impact of constraining quotas on the fleet not controlled for in the standardization procedure applied in SCRS/2006/120. The patterns estimated were based on equal weighting between the series used.

Selection of indices for the model runs:

The decision to use the Composite CPUE pattern for the base case was seen as a compromise way forward in the short term. In the medium term, the Group should investigate alternative forms of analyses that can better accommodate both the By-catch and Target patterns, such as age- and spatially-structured models.

6. Methods and other data relevant to the assessment

6.1 Methods – North

6.1.1 Production model

In applying production models to North Atlantic swordfish, the Group used an updated version of the dynamic (non-equilibrium) model (ASPIC v5.05) adopted previously by the SCRS for several species including swordfish. This version of ASPIC is parameterized in terms of MSY, K, and B(first year)/K, whereas the version of ASPIC used in the 2002 assessment (v3.82) parameterized the model in terms of r, K, and B(first year)/BMSY. The model was formulated as in the 1994, 1996, 1999, and 2002 assessments, with the 1950 (starting) biomass constrained to equal 0.875*K (equivalent to 1.75*BMSY). Least squares minimization was used. At previous assessments, numerous sensitivity analyses were conducted to evaluate sensitivity to this and other factors. Those trials indicated that the results of the assessment were largely unaffected by this assumption.

The data used in ASPIC production modeling and in the sensitivity analyses were the total North Atlantic reported catch from 1950 to 2005 including estimated dead discards (**Table 2**) and the CPUE biomass index described in section 5.1 (**Table 7** and **Figure 5**). At this assessment, several sensitivity analyses were conducted to evaluate the effect on the model of the different data filtering performed in the construction of the combined CPUE index. Those trials indicated that the results of the assessment were largely unaffected by the data filtering.

As ASPIC v5.05 permits fitting a generalized production model, a sensitivity analysis was conducted where the shape parameter (BMSY/K) was fixed to the value of the Fox exponential yield model ($1/e \approx 0.367$). A comparison of AICc values between the Schaefer and Fox fits did not provide convincing evidence that the Fox model should be preferred over the Schaefer fit. Therefore, the base model remains the Schaefer form (BMSY/K=0.5), although the relative stock status results from bootstrapping the Fox model are plotted with the Schaefer estimates for comparison.

As for further sensitivity analyses, the Group also applied the Bayesian statistical approach for stock assessment with a surplus production function described in SCRS/1999/085. These models were discrete time step models with harvesting occurring at the beginning of each year. The prior distribution for parameter r from SCRS/1999/085 was applied as the baseline prior for the North stock with a median value for r of 0.42 and CVs of 0.49. The baseline prior for the starting biomass in the North stock run had the same mean value as was assumed in the baseline ASPIC runs and a CV of 0.25. The same baseline catch and catch rate data used in the ASPIC runs was applied in the Bayesian estimation.

It should be emphasized that the lumped biomass production models assume that the input CPUE series are proportional to biomass with some degree of random variation and both can give misleading results when this assumption is violated. The indices of biomass were assumed to be lognormally distributed.

6.1.2 Virtual population analyses

Virtual population analyses were conducted for the North Atlantic stock using program VPA-2BOX (see ICCAT catalog). Catch-at-age data were derived for 1978-2005 from catch-at-size using the unisex Gompertz growth equation (see **Table 5**). Only 5 age groups (age 1 to 5+) were used owing to the inability to reliably age older male fish. The VPA was calibrated using 17 age-specific, unisex catch rate indices (**Table 7, Figure 5**) developed for Canada (ages 2-5+), Japan (ages 3-5+), Spain (ages 1-5+) and United States (ages 1-5+). The indices were assumed to be lognormally distributed with identical coefficients of variation (equally weighted). The natural mortality rate was fixed at 0.2 yr-1. The fishing mortality rates in the last year were estimated for every age except the last (which is modeled by the F-ratio). The F-ratio (ratio of the fishing mortality rate on the oldest age to that of the next younger age) was estimated for two blocks of years (1978-1982 and 1983-1987) and fixed to 1.0 for the remaining years as was done in the previous assessment to account for changes in the transition of the fishery from coastal to oceanic waters. A sensitivity run was conducted where the F-ratio for the last time period was estimated rather than fixed.

In order to evaluate the variability of the fit to the indices to the catch at age through the VPA model, a bootstrapping analysis was performed in which the deviations of the log-transformed index data points and their predictions were randomly selected to generate 500 sets of new index points. The VPA was then applied to each of the 500 new data sets and the median values with their 80% confidence intervals computed.

6.2 Methods – South

For the 2006 assessment there was some improvement in the information level available from fisheries harvesting southern Atlantic stock swordfish. CPUE series from the targeted fisheries of Brazil and EC-Spain and from the by-catch fisheries of Japan and Chinese Taipei were applied in characterization of stock status (**Figure 8**). The group also decided to consider a Composite index that utilized both target and by-catch datasets.

Version 5.05 of the ASPIC production model software, which is in the ICCAT software catalogue, was used. Initially, 12 runs were made using combinations of these three indices, two model formulations (Logistic or Fox/Gompertz), and two initial conditions (estimate the ratio B_{1970}/K or fix it at 1.0). Least squares minimization was used.

7. Stock status results

7.1 Stock status – North

7.1.1 Production models

Results from the North Atlantic Base Case ASPIC model, which the Group considered to be the best estimate, are shown in **Table 12** and **Figure 10**. The estimated relative biomass trend shows a consistent increase since 2001. The bias corrected deterministic outcome indicates that the stock is almost at B_{MSY} (**Figure 11**). The relative trend in fishing mortality shows that the level of fishing is less than in 2001, and has consistently been below F_{MSY} since 2001. The estimate of stock status in 2005 is improved compared to the estimated status from the 2002 assessment, and suggests that the stock is almost fully recovered. Overall the stock was estimated to be somewhat less productive than the previous assessment, with the intrinsic rate of increase, r, estimated at 0.49 compared to 0.56 in 2002 (**Figure 12**). The combined biomass index shows a consistent upturn from the estimated 2001 value, and the index values for the most recent years are near the level estimated in the early 1990s (**Figure 13**). The high value in 1963 is not well fit.

The estimated stock status results from applying the BSP model sensitivity are shown in **Table 13**, and they are very similar to the base ASPIC estimates. The stock is estimated to be at BMSY, and current fishing mortality is estimated to be less than FMSY. The posterior distributions for MSY and B2006/BMSY are also similar to the ASPIC bootstrap distribution, while the mode of the distribution of F2005/F2006 is slightly less than the ASPIC bootstrap distribution (**Figure 10**). As in 2002, the posterior distribution for r is less than the ASPIC bootstrap distribution (**Figure 12**), however the distributions from both models are closer to each other than in 2002. The fit to the combined index, and the residuals, are shown in **Figure 14**. As in ASPIC, the fitted CPUE underestimates values in early 2000 and overestimates values in 2003-2005, and the high value in 1963 is not well fit.

A comparison of production model runs in 2006 versus 2002 is shown in **Table 14**. Both production models gave similar results during the assessments, but between 2002 and 2006, the estimated stock productivity (r) in ASPIC was less in 2006 while for the BSP it was slightly greater.

Figure 15 shows scatterplots of bootstrapped estimates of the biomass and F ratios. The spread of the Logistic fits suggest some probability that current F is exceeding Fmsy and/or that current B is less than B_{MSY}, whereas most of the bootstraps from the Fox fit suggest that current B is greater than B_{MSY} and current F is less than F_{MSY}. The fit of the Fox model was not better than the Logistic model.

7.1.2 Virtual population analyses

The Base Case estimates of abundance, fishing mortality and biomass are given by age in **Tables 15, 16** and **17**, respectively. In general, the estimates are similar to the results for the 2002 base case. The estimates of recruitment (age 1) generally fluctuate between 400,000 and 700,000 fish except for 2005, when recruitment is estimated to be over 800,000 (**Figure 16**). The 2005 estimate, however, is highly uncertain. The estimates of the abundance of age 2 follow a pattern similar to that exhibited by age 1 with a 1-year lag (**Figure 17**). The estimates of spawning biomass (age 5+) indicate a strong decreasing trend with a recent upswing since 1999. Although somewhat variable, the estimated fishing mortality rates for all ages show an increasing trend until 1996, after which they decrease substantially (**Figure 17**).

The VPA fits to the indices of abundance are given in **Figure 18.** In general, the VPA results appear to be adequately averaging the variations in the indices (given the relatively low contrast in each of the CPUE time series). The median estimates of the bootstrap analysis were very similar to the original maximum likelihood predictions. Therefore, it does not appear that the model output is seriously biased with respect to the data. It is important to note however that the bootstrap analyses only account for the imprecision of the indices of abundance and do not account for uncertainties in the natural mortality rate, non-reporting of catches and other potential biases.

Yield per recruit and spawning biomass per recruit calculations for the base case were made using PRO-2BOX (see ICCAT catalog). The per-recruit and projection analyses used the same inputs so that the management advice from each would be consistent. Selectivity vectors were derived from the Base Case VPA using the geometric mean of the fishing mortality rates from the most recent three years. The geometric mean fishing mortality rates were then normalized by dividing by the highest value across all ages. Weight at age was derived from the 2005 catch at age for ages 1-4 and from the growth curve and average age of the plus group for age 5+ (as described in the documentation for PRO-2BOX). Future recruitment was assumed fluctuate around the levels estimated by the model between 1978 and 2004.

The estimated per-recruit statistics results are summarized in **Table 18**. The fishing mortality rate at which yield per recruit was maximized (Fmax) was 0.28, F0.1 was 0.15 and the fishing mortality rate estimated to result in an SPR of 30% (F30%) was 0.15. It should be noted that, in the case of constant recruitment (as assumed here), the MSY-related statistics are the same as those corresponding to maximum yield per recruit (e.g., FMSY= Fmax , SSBMSY = SSBmax).

7.2 Stock status – South

Table 19 provides summary results for the 12 initial runs of ASPIC. The following general conclusions were drawn from this exercise:

- In terms of fitting, for each of the three CPUE datasets, the Fox (Gompertz) production function gave better results, especially for the By-catch and Composite patterns.
- As expected, the By-catch pattern data resulted in more pessimistic estimates of current stock status and productivity than did the Target pattern data. The Composite data resulted in intermediate estimates.
- Whether the ratio of initial biomass to K was fixed or estimated did not greatly affect estimates of current status.

Figure 19 shows the trends in estimated biomass and fishing mortality, as well as the fits to CPUE data, corresponding to the runs assuming a Fox model and estimating the initial biomass.

The Group noted that for the By-catch and Composite pattern CPUE data, the software had difficulty in fitting the 1967 CPUE which was much lower than the values in the years immediately following. The Group made a sensitivity run with equivalent specifications to R3Av, but with LAV (Least Absolute Values) minimization instead of least squares. The LAV procedure is often espoused as being robust to outliers. A comparison of these two runs gave almost identical estimates of MSY, current F and current biomass; however, the initial biomass ratio estimates differed considerably (B_{1970}/K=0.0003 for the least squares option, and =0.695 for the LAV option).

The Group carried out bootstrap analyses of the three runs that gave the best fits to each dataset. **Figure 20** gives the resulting frequency distributions for the estimates of MSY, and current biomass and fishing mortality ratios.

The Group considered the available results in order to draw conclusions that would be useful to the Commission. There was general agreement that the results based on By-catch pattern CPUE and those based on Target pattern CPUE were likely unrealistic. Especially in the case of the By-catch data, it was pointed out that the estimates of MSY and intrinsic growth rate obtained could not be supported by current knowledge of swordfish population dynamics and historical catch levels. On the other hand, the Group believed that the recent increase in the Target pattern CPUE was more likely due to changes in catchability than it was to an increase in abundance, possibly leading to an overestimation of the intrinsic growth rate. In conclusion, the Group decided to base its advice on the results obtained with the Composite CPUE data.

Although the by-catch and targeted fisheries patterns were similar in the early part of the available time-series, the patterns diverged starting in the mid 1990’s and without additional research it will not be possible to resolve if either pattern best reflects the total biomass trend. It was noted that there was little overlap in fishing area and strategies between the by-catch and targeted fleets used for estimating CPUE pattern, and that the by-catch and targeted fisheries CPUE trends could track different components of the population. Therefore, the decision to use the Composite CPUE pattern for the base case was seen as a compromise way forward in the short term. In the medium term, the Group should investigate alternative forms of analyses that can better accommodate both the By-catch and Target patterns, such as age- and spatially-structured models.

Figure 21 shows scatterplots of bootstrapped estimates of the biomass and F ratios, obtained from the Composite data analyses using the Fox and Logistic models. Both sets of results are similar in central tendencies, although the spread of the Logistic fits suggest a greater probability that current F is exceeding Fmsy. The goodness of fit of the Fox model was superior and the Group decided to use these results in the summary table.

Table 20 summarizes the estimates obtained with the Fox model. The bias-corrected estimate of MSY is close to 17,000 t (range 14,100 - 18,100). The estimated ratio B_{2006}/Bmsy is 1.57 and the estimated ratio F_{2005}/Fmsy is 0.42, suggesting that the stock is in good condition.

In summary, if the available CPUE information is used in a simple production model, two different conclusions are reached about the status of southern Atlantic swordfish. Using by-catch fishery data leads to overly-pessimistic results, while using target fishery data leads to optimistic results. The Group believes that neither of these alternatives is defensible, given the current state of knowledge of swordfish biology and the nature of the fisheries from which the CPUE patterns were obtained. As a result, the Group has based its base case analyses on a Composite CPUE pattern that has been constructed from both types of fisheries. Recognizing that further research is required in order to make better use of the available data, the results obtained indicate that the stock is in good condition: The current fishing mortality rate is below that which would produce MSY, and the current biomass is above that which would result from fishing at Fmsy in the long term. The estimated MSY (about 17,000 t) is 33% higher than current landings.

8. Projections

8.1 Projections – North

8.1.1 Production models

Both production models were projected to the year 2010 under constant TAC scenarios of 9000 t, 10 000 t, 10 400 t, 11 000 t, 12 000 t, 13 000 t, 14 000 t, and 15 000 t. Catch in year 2006 was assumed to be the same as that reported for year 2005 (12 143 t).

Bootstrapped projections were run for ASPIC, and the bias corrected medians for all TAC scenarios are plotted in **Figure 22**. As the current relative biomass (2006) suggests that the stock is practically rebuilt, all projected TACs except 15 000 t (which exceeds MSY) maintain the stock at or above B_{MSY} through 2010. TACs above the estimated MSY (14,100 t) would project a decline in stock status. The same TAC scenarios were used for projecting the BSP model. Results from the BSP model suggest that a constant TAC of up to 13 000 t maintains at least a 50% probability of the stock remaining at or above BMSY by 2010 (**Figure 23**). The BSP model estimated a slightly lower MSY compared to ASPIC (13 700 versus 14 100 t), so that TACs greater than MSY led to the stock dropping below B_{MSY} by 2010.

8.1.2 VPA Projections and recovery scenarios

Bootstrap projections were conducted using the Base Case unisex VPA results. Future selectivity was computed from the geometric mean of the fishing mortality rate estimates for 2003-2005. The weights for each age other than the plus group were assumed to be equal to the average weights from the catch observed in 2005 (consistent with the yield per recruit analyses). The average weight of the plus group was computed from the average age of the plus group using the unisex growth curve. The average age of the plus group in 2005 was inferred from the observed weight at age by inverting the growth curve (see documentation for PRO-2BOX). The observed 2005 catch (12,143 t) and 2005 TAC (14,000 t) were used for the first two years of the projections (i.e., 2006 and 2007, respectively). After that, future catches were set to one of the constant catch scenarios defined above for the production models. Future recruitments (age 1) were randomly drawn from the estimated values for 1978-

2004 (‘average’ recruitment scenario). Because 2005 recruitment was not well estimated by the VPA models, the recruitment in 2005 was replaced by a random draw as well.

All projections indicate a short term increase in the median trajectory of spawning stock biomass from a little more than half of SSBMSY in 2005 with the exception of the 15,000 t case (**Figures 24, 25**). Only TAC levels of less than 9,000 t were expected to achieve at least a 50% probability of the stock rebuilding to Bmsy by 2009. These projections are somewhat less optimistic than the corresponding projections from 2002, largely owing to the somewhat lower estimates of recent recruitment.

The Group noted that the recruitment estimates from the VPA model for 1997-2001 were lower than the corresponding values from the Spanish longline index for age 1 by a factor of about 1.8 (**Figure 26**), suggesting the possibility that future recruitment might be considerably higher than was assumed in the projections above. Accordingly, deterministic projections were run assuming that recruitment from 2001 onward was equal to the average from 1978-2004 multiplied by 1.8 (971,412). The Group recognized that this value is greater than any that has ever been estimated for this stock and suggested it be regarded as a possible upper limit. Replacing the estimated recruitments for 2001-2005 also implies that the VPA is in fact underestimating the recruitment during those years. As expected, the high-recruitment projections are much more optimistic than the average recruitment scenario (**Figure 27**). Under this assumption, all TAC scenarios, including 15,000 t, are estimated to permit the stock to recover above SSBmax by 2009 and above SSB30% shortly thereafter.

An additional sensitivity run was made where the F-ratio (F5+/F4) for the last time period was estimated rather than fixed to 1. Unlike the previous assessment, the estimated value of 0.51 was statistically significant. The group did not offer any explanations for why the fishing mortality rate on age 4 fish might differ from that on older fish, but could not deny the possibility. It was recommended that this be explored further, particularly as the potential for recovery appears to be greater with this model than the base case (**Figure 28**).

8.2 Projections – South

The Group did not carry out projections for this stock.

9. Recommendations

9.1 Research and statistics

Stock structure. The Draft Report of the Swordfish Stock Structure workshop (Heraklion, March 2006) recommended intensified collaborative and multi-disciplinary research. In particular, the classification of swordfish caught near the boundaries to their stock of origin is subject to uncertainty and cannot be made accurately without intensified collaborative and multi-disciplinary research taking into account fine-scale (e.g., 1º squares) and quarterly sampling strata.

Catch. All countries catching swordfish (directed or by-catch) should report catch, catch-at-size (by sex) and effort statistics by a small an area as possible, and by month. These data must be reported by the ICCAT deadlines, even when no analytical stock assessment is scheduled. Historical data should also be provided.

Ageing. The computer codes used for ageing swordfish in the Atlantic should be updated. The new sex-specific growth curves (SCRS/02/31) should be incorporated, and its impact in terms of the catch-at-age estimation, as well as its consistency with the tagging data should be evaluated before a new set of growth curves is formally adopted by the Group.

Discards. Information on the number of undersized fish caught, and the numbers discarded dead and released alive should be reported so that the effect of discarding and releasing can be fully included in the stock assessment. Observer sampling should be sufficient to quantify discarding in all months and areas in both the swordfish directed fisheries and the tuna fisheries that take swordfish as by-catch. Studies should be conducted to improve estimation of discards and to identify methods that would reduce discard mortality of swordfish. Studies should also be conducted to estimate the subsequent mortality of swordfish discarded alive; these are particularly important given the level of discarding due to the minimum size regulatory recommendation.

Target species. All fleets should record detailed information on log records to quantify which species or species-group is being targeted. Compilation of detailed gear characteristics and fishing strategy information (including time of set) are very strongly recommended in order to improve CPUE standardization. The recommendations made by the 2002 Methods WG meeting for looking at diagnostics in this context should be followed. The Group recommended the investigation of alternative forms of analyses in the south that deal with both the By-catch and Target patterns, such as age- and spatially-structured models.

Further, at-sea Observers should collect more detailed information on fishing strategy and target species. Finally, the Group recommended an investigation into the cluster analysis approach used to determine targeting in the Brazilian CPUE series through simulation to permit evaluating the potential sources of bias in the approach. It was also recommended to revise the standardization procedures for the Santos Brazil, catch and effort series to deal with the transition from multifilament to monofilament longline gear. Further research into methods to control for this feature was recommended.

Tagging. The Group recommended development of an experimental design for specific tagging applications such as estimating fishing mortality rates and/or migration patterns. An experimental design could be especially useful in evaluating the potential of applying traditional and pop-up tags to evaluate the exchange rates between Mediterranean and Atlantic stocks. In addition, the continuation of industry tagging on board commercial vessels should also be encouraged as the sample sizes are considerable, and there are clear benefits in terms of reporting rates and quality of recaptured tags.

Microconstituent analyses. A pilot microconstituent analysis study with a number of individuals collected from widely separated areas should be carried out to examine the potential resolution of this technique for delineation of stock subdivision and mixed stock composition in the Atlantic Ocean, Mediterranean Sea, and Indian Ocean.

CPUE. The Group is concerned that many of the age-specific indices of abundance show strong year-effects. It has been recommended that future CPUE analyses should focus on developing additional methods to explicitly incorporate environmental variability into the model. Consideration should be given to aggregating the CPUE trends by sex ratio-at-size area (rather than the current method of aggregating by nation). Investigations of the appropriateness of obtaining age-specific indices of abundance from independent analyses should be conducted, CVs should be presented with the analyses, and model outputs should be made comparable (e.g., from random and fixed effects models). Some attempt should be made to use stock assessment methods that can reconcile the contradictory trends in the target and by-catch CPUE series for the south (e.g., age/spatially-structured models). For the biomass indices, the influence of the level of aggregation of data should be examined. The United States should take steps to maintain the time series of CPUE data in their closed areas in order to maintain continuity in the monitoring of the fishery.

The Group recommended standardizing the Uruguayan and Spanish nominal catch rates.

Stock assessment methods. It is recommended that methods that better characterize and communicate uncertainty (e.g., Bayesian approaches) continue to be explored. In addition, future assessments should continue to move towards models that have more flexibility in fitting the data as originally collected. It is also recommended that models more fully incorporate biological information and the uncertainties associated with biological inputs.

Biomass Index. The Group recommended that Canadian longline biomass index in the 1960's showed a rapid decreasing trend, which was not consistent with anecdotal information from the Japanese longline fishery which, during those years, was broadly distributed throughout the North Atlantic. Given the importance of the Canadian series in establishing the history of the population, it is recommended that the early data be re-validated, if possible.

9.1 Management

The Group had not recommendations on management.

10. Other matters

The Group agreed to recommend that the next swordfish stock assessment be conducted in at least three years time (not sooner than 2009) in order to advance basic research and assessment methods. It should be noted that the data required for that session should be up to and including the year prior to the meeting.

11. Adoption of the report and closure

The Group thanked Drs Travassos and Neilson for the excellent work done during the meeting. The Group also recognized the helpful work of the Secretariat. A complete review of the report was made during the meeting and substantive issues dealt with in plenary. The detailed report was adopted during the SCRS Species Group meeting.

References

ANON. 2000. Report of the ICCAT SCRS Atlantic Swordfish Stock Assessment Session (Madrid, Spain, September 27-October 4, 1999). Col. Vol. Sci. Pap. ICCAT, 51(4): 1001-1208.

ANON. 2003. Report of the ICCAT SCRS Atlantic Swordfish Stock Assessment Session (Madrid, September 9 to 13, 2002). Col. Vol. Sci. Pap. ICCAT, 55(4): 1289-1415.

Table 1. Summary of available information on the Atlantic and Mediterranean swordfish stock structure. The text in parenthesis indicates the conclusions reached by SCRS in 1994. (Source: SCRS/2006/010).

Stock Hypotheses	*CPUE by age*	*Catch Distribution (Major Fleets)*	*Mark/ Recapture*	*Length/ Weight*	*Spawning Areas*	*Genetics*	*Biological Markers*
Mediterranean Single Stock (different from Atlantic)	Inconclusive	Inconclusive	Yes	Inconclusive	Yes	(Yes) Yes[4]	Yes
North Atlantic single stock	(Yes) Yes[1]	(Yes) Yes	[2]	(Yes) Yes	(?) Yes	([5]) ?	
North (E + W) separate stocks	(No) No[1]	(No) No	[2]	(No) No	(?) No	([5]) ?	
North + South single stock	No info	(Yes) ?	No[3]	No info	Inconclusive	(?) No[6]	

[1] Based on trends in CPUE reported by country (2002 stock assessment).
[2] Interpretation of the conventional mark/recapture studies are complicated by variable reporting rates among fleets, and distribution of releases and recapture effort.
[3] Three tags have shown evidence of movement from the North to the northern limit of the southern stock, but need to be verified.
[4] Papers presented dealing with this hypothesis were unanimous. Some evidence of population heterogeneity within the Mediterranean also presented. There is evidence of mixed zones in the area off the west coast of Gibraltar and along the northern coast of Morocco.
[5] SCRS earlier failed to reject either the null or alternate hypotheses of homogeneity/heterogeneity. New evidence indicates possibility of overlapping stocks, but the extent of overlap is uncertain.
[6] Several independent studies now support the conclusion, but the location of the management boundary remains uncertain.

Table 2. Estimated catches (t) of swordfish by major area, gear and flag.

			1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
TOTAL			3746	2781	3193	3503	3134	3602	3359	4802	4996	6403	4287	5397	6111	11608	13288	11230	11301	10684	11620	13684	14921	7432	7346	9152	9115
	AT.N		3646	2581	2993	3303	3034	3502	3358	4578	4904	6232	3828	4381	5342	10190	11258	8652	9349	9107	9172	9203	9495	5266	4766	6074	6362
	AT.S		100	200	200	200	100	100	1	224	92	171	459	1016	769	1418	2030	2578	1952	1577	2448	4481	5426	2166	2580	3078	2753
Landings	AT.N	Longline	1445	966	966	1203	305	619	374	1010	875	1428	1042	2060	3202	9193	10833	7759	8503	8679	8985	9003	9197	5208	4469	5519	5139
		Other surf.	2201	1615	2027	2100	2729	2883	2984	3568	4029	4804	2786	2321	2140	997	425	893	846	428	187	200	298	58	297	555	1223
	AT.S	Longline	0	0	0	0	0	0	1	124	92	71	359	816	769	1418	2030	2578	1952	1577	2348	4281	5426	2164	2580	3078	2753
		Other surf.	100	200	200	200	100	100	0	100	0	100	100	200	0	0	0	0	0	0	100	200	0	2	0	0	0
Discards	AT.N	Longline	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
		Other surf.	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
	AT.S	Longline	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
		Other surf.	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
Landings	AT.N	Barbados	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
		Brasil	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
		Canada	1290	1523	1890	1990	2573	2722	2761	3102	3219	4014	2328	1913	2092	7482	7099	4674	4433	4794	4393	4257	4800	0	0	0	2
		China P.R.	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
		Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	48	99	150	283	304	294	168	316	265
		Cuba	0	0	0	0	0	0	0	0	0	300	300	300	400	125	134	171	175	336	224	97	134	160	75	248	572
		Dominica	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
		EC.Denmark	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
		EC.España	1445	966	966	1203	305	619	374	1000	832	1100	722	1700	2300	1000	1800	1433	2999	2690	3551	3502	3160	3384	3210	3833	2893
		EC.France	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
		EC.France (based in Martinique)	0	0	0	0	0	0	0	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EC.Ireland	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
		EC.Italy	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
		EC.Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0
		EC.Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	6	15	11	12	11	8	11	21	37	92
		EC.United Kingdom	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
		FR-Saint Pierre et Miquelon	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
		Faroe Islands	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
		Grenada	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
		Iceland	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
		Japan	0	0	0	0	0	0	0	10	43	28	20	54	106	311	700	1025	658	280	262	130	298	914	784	518	1178
		Korea, Republic of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	27	46	24	22	40	159	155	374	152
		Liberia	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
		Maroc	0	0	0	0	0	0	0	0	0	0	0	6	12	6	118	100	61	34	43	20	17	33	43	18	15
		Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	3
		NEI	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
		Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300	300	200	600	400	200	0	0	0
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	171	24
		Philippines	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
		Rumania	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
		S. Vincent and Grenadines	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
		Senegal	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
		Seychelles	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
		Sierra Leone	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
		Sta. Lucia	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
		Trinidad and Tobago	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
		U.S.A.	911	92	137	110	156	161	223	366	710	690	458	408	424	1250	1384	1227	614	474	274	170	287	35	246	406	1125
		U.S.S.R.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	8	22	21	11	24	24	28	26	17
		UK.Bermuda	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
		UK.British Virgin Islands	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
		Vanuatu	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
		Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	8	13	12	8	11	21	18	100	23	52	27	23	24
	AT.S	Angola	100	200	200	200	100	100	0	100	0	100	100	200	0	0	0	0	0	0	0	0	0	0	0	0	0
		Argentina	0	0	0	0	0	0	0	0	0	0	281	111	196	400	508	400	200	79	259	500	400	63	100	48	10
		Belize (Observed by Sta. Helena)	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
		Benin	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
		Brasil	0	0	0	0	0	0	0	0	0	0	0	440	251	125	125	125	125	62	100	181	162	154	121	161	465
		Bulgaria	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
		Cambodia	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
		China P.R.	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
		Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	1	5	3	1	95	166	488	828	1281	779	807	1104	802
		Cuba	0	0	0	0	0	0	0	0	0	0	0	0	0	63	101	164	122	559	410	170	148	74	66	221	509
		Côte D'Ivoire	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
		EC.España	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
		EC.France+España	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
		EC.Lithuania	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
		EC.Portugal	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
		EC.United Kingdom	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
		Gabon	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
		Ghana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	200	0	0	0	0	0
		Guinea Ecuatorial	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
		Honduras (observed by Sta. Helena)	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
		Japan	0	0	0	0	0	0	1	124	92	71	78	265	321	825	1288	1845	1300	474	859	2143	2877	664	1023	480	191
		Korea, Republic of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	54	79	77	370	382	256	249	602	563
		Liberia	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
		NEI-1	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
		Namibia	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
		Nigeria	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
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	274	90
		Philippines	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
		S. Tomé e Príncipe	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
		Seychelles	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
		South Africa	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
		Sta. Helena	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
		Togo	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
		U.S.A.	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
		U.S.S.R.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	39	56	158	155	89	176	176	202	188	123
		Uruguay	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
Discards	AT.N	Canada	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
		Japan	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
		U.S.A.	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
	AT.S	U.S.A.	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

Table 2 (cont.)

		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
TOTAL		11901	9508	9264	14601	15231	18881	15155	19662	19929	21930	23969	24380	26266	32469	34098	32796	28647	29027	32659	34247	38624	33324	31432	26101	27001	27047	25019	23703	23990	25167	24830
	AT.N	8839	6696	6409	11835	11937	13558	11180	13215	14527	12791	14383	18486	20236	19513	17250	15672	14934	15394	16717	15475	16844	15172	12997	12195	11590	11439	10011	9654	11464	12265	12143
	AT.S	3062	2812	2855	2766	3294	5323	3975	6447	5402	9139	9586	5894	6030	12956	16848	17124	13713	13633	15942	18772	21780	18152	18435	13906	15410	15608	15008	14049	12526	12902	12687
Landings	AT.N	7078	5234	5458	11123	11177	12831	10549	13019	14023	12664	14240	18269	20022	18927	15348	14026	14208	14288	15641	14309	15765	13787	12186	10783	10449	9642	8423	8654	9986	11498	11163
		1761	1462	951	712	760	727	631	196	504	127	143	217	214	586	1902	1646	511	723	669	458	553	797	360	928	612	659	687	385	855	447	612
	AT.S	3062	2812	2840	2749	3265	5179	3938	6344	5307	8920	8863	4951	5446	12404	16398	16705	13287	13173	15547	17365	20806	17799	18239	13720	14819	15448	14302	13641	11725	12445	12596
		0	0	15	17	29	144	37	103	95	219	723	943	584	552	450	419	426	460	395	1407	974	352	175	176	586	159	706	408	801	456	91
Discards	AT.N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	215	383	408	708	526	562	439	476	525	1137	896	607	618	313	358
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	12	9	4	1	6	8	5	7	10
	AT.S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	21	10	6	1	0	0	0	1	
		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	
Landings	AT.N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	16	16	12	13	19	10	10	10	10
		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	117	0	0	0	0	
		21	15	113	2314	2970	1885	561	554	1088	499	585	1059	954	898	1247	911	1026	1547	2234	1676	1610	739	1089	1115	1119	968	1079	959	1285	1203	1558
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	73	86	104	132	40	337	304	22	102	90	316	56	108
		272	471	246	164	338	134	182	260	272	164	152	157	52	23	17	270	577	441	127	507	489	521	509	286	285	347	299	310	257	30	140
		280	283	398	281	128	278	227	254	410	206	162	636	910	832	87	47	23	27	16	50	86	7	7	7	7	0	0	10	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	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	
		3747	2816	3309	3622	2582	3810	4014	4554	7100	6315	7441	9719	11135	9799	6648	6386	6633	6672	6598	6185	6953	5547	5140	4079	3993	4595	3968	3957	4586	5376	5521
		0	0	0	0	0	5	4	0	0	1	4	4	0	0	0	75	75	75	95	46	84	97	164	110	104	122	0	74	169	102	178
		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	
		3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	15	132	81	35	17	5	12	1	1
		0	0	0	8	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	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		58	32	38	17	29	15	13	11	9	14	22	468	994	617	300	475	773	542	1961	1599	1617	1703	903	773	777	732	735	766	1032	1320	900
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	5	11	0	2	1	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	10	39	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	5	4	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	56	5	1	2	3	13	0	1	4	15	15	42	84	0	54	88	73	56
		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	0	0	0	0	
		2462	1149	793	946	542	1167	1315	1755	537	665	921	807	413	621	1572	1051	992	1064	1126	933	1043	1494	1218	1391	1089	161	0	0	0	554	302
		172	335	541	634	303	284	136	198	53	32	160	68	60	30	320	51	3	3	19	16	16	19	15	0	0	0	0	0	0	0	51
		0	0	0	0	0	5	38	34	53	0	24	16	30	19	35	3	0	7	0	0	0	0	0	0	0	0	0	0	0	0	
		15	12	7	11	208	136	124	91	129	81	137	181	197	196	222	91	110	69	39	36	79	462	267	191	119	114	523	223	329	335	334
		0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	14	0	0	14	28	24	37	27	34	32	44	41
		0	0	0	0	0	0	12	0	0	0	0	14	3	207	302	714	43	35	111	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	0	0	0	0	0	0	
		25	91	22	76	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	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	4	44	5	5
		0	0	0	1	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	0	0	0	0	0	0	3	0	3	23	0	4	3	1	0	1	0	22	22	7	7	7
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	6	0	0	0	0	0	0	0	0	0	0	0	108	108
		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	10	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	2	2	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	3
		0	0	0	0	0	0	0	0	21	26	6	45	151	42	79	66	71	562	11	180	150	158	110	130	138	41	75	92	78	83	91
		1700	1429	912	3684	4619	5625	4530	5410	4820	4749	4705	5210	5247	6171	6411	5519	4310	3852	3783	3366	4026	3559	2987	3058	2908	2863	2217	2384	2513	2380	2162
		32	19	15	23	10	21	0	69	0	16	13	18	4	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	0	0	1	1	5	5	3	3	2	0	0	1	1
		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	4	4
		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	200	141
		52	43	15	46	182	192	24	25	35	23	51	84	86	2	4	9	75	103	73	69	54	85	20	37	30	30	21	34	45	53	55
	AT.S	0	0	0	0	0	0	0	0	0	26	228	815	84	84	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		10	111	132	4	0	0	0	20	0	0	361	31	351	198	175	230	88	88	14	24	0	0	0	0	38	0	5	10	8	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	17	8	0	0	0	0	
		0	0	0	0	0	0	18	24	0	86	90	39	13	19	26	28	28	26	28	25	24	24	10	0	3	0	0	0	0	0	
		514	365	396	372	521	1582	655	1019	781	468	562	753	947	1162	1168	1696	1312	2609	2013	1571	1975	1892	4100	3847	4721	4579	4082	2910	2920	2998	3785
		0	0	3	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	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	29	534	344	200	423	353	278	91
		935	745	675	625	1292	702	528	520	261	199	280	216	338	798	610	900	1453	1686	846	2829	2876	2873	2562	1147	1168	1303	1149	1164	1254	745	744
		248	317	302	319	272	316	147	432	818	1161	1301	95	173	159	830	448	209	246	192	452	778	60	60	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	10	10	10	10	12	7	8	18	13	14	20	19	26	18	25	26	20	19	19	43	29	31
		0	0	0	0	0	0	0	0	0	0	0	66	0	4393	7725	6166	5760	5651	6974	7937	11290	9622	8461	5832	5758	6388	5789	5741	4527	5483	5402
		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	4	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	794	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	0	380	389	441	384	381	392	393	380	354	345	493
		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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	
		0	0	0	0	0	110	5	55	5	15	25	13	123	235	156	146	73	69	121	51	103	140	44	106	121	117	531	372	734	343	55
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	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	6	4	5	2	8	0	0	0	0	0	
		805	105	514	503	782	2029	2170	3287	1908	4395	4613	2913	2620	4453	4019	6708	4459	2870	5256	4699	3619	2197	1494	1186	775	790	685	897	937	646	175
		279	812	699	699	303	399	311	486	409	625	917	369	666	1012	776	50	147	147	198	164	164	7	18	7	0	10	0	2	24	70	36
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	26	28	28	28	28	28	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	856	439	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	0	0	0	730	469	751	504	191	549	832
		0	0	0	0	0	0	0	0	83	69	0	0	0	0	0	0	0	3	0	0	0	9	0	0	0	0	0	0	0	0	
		40	219	28	83	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	105	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	6	1	8	1	1
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	14	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	6	0	0	
		0	0	0	0	28	31	9	3	7	0	8	5	5	4	0	0	5	9	4	1	4	1	1	240	143	328	547	649	293	295	199
		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	20	4	0	0	
		0	0	0	0	0	0	0	0	0	0	6	32	1	0	2	3	5	5	8	14	14	64	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	6	171	396	160	179	142	43	200	21	15	
		231	138	106	161	70	154	40	26	46	158	60	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	92	575	1084	1927	1125	537	699	427	414	302	156	210	260	165	499	644	760	889	650	713	789	768	850	1105	843
Discards	AT.N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	52	35	50	26	33	79	45	106
		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	598	567	319	263	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	215	383	408	708	526	588	446	433	494	490	308	263	282	275	262
	AT.S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	21	10	6	1	0	0	0	1	

Table 3. Substitutions scheme for the swordfish North Atlantic stock.

Taski							Size daata							
Year	**Flag**	**Gear**	**Area**	**Type**	**Taski**	**RF**	**Year**	**Flag**	**Area**	**Gear**	**Mean length**	**wgt**	**N.Fish**	**Action**
2001	Barbados	LLHB	NW	L	19	0.0115	2001	U.S.A.	ANW	LLHB	150	1658	36124	sub-raise
2001	Canada	GILL	NW	L	0	0.0000								ignore
2001	Canada	HARP	NW	L	121	0.9977	2001	Canada	ANW	HARP	198	121	1158	OK
						0.9977	2001	Canada	ANC	HARP	212	0	1	OK
2001	Canada	LL	NW	D	26	3.6875	2001	Canada	ANW	LLD	102	5	330	raise
						3.6875	2001	Canada	ANC	LLD	108	2	132	raise
2001	Canada	LLHB	NW	L	957	0.9995	2001	Canada	ANC	LLHB	168	338	5134	OK
						0.9995	2001	Canada	ANW	LLHB	171	620	8972	OK
2001	China P.R.	LL	NORT	L	102	0.3411	2001	Chinese Taipei	ANC	LLFB	174	230	3227	sub-raise
						0.3411	2001	Chinese Taipei	ANE	LLFB	159	68	1184	sub-raise
						0.3411	2001	Chinese Taipei	ANW	LLFB	118	7	362	sub-raise
2001	Chinese Taipei	LLFB	NORT	L	299	1.0029	2001	Chinese Taipei	ANC	LLFB	174	230	3227	OK
						1.0029	2001	Chinese Taipei	ANE	LLFB	159	68	1184	OK
						1.0029	2001	Chinese Taipei	ANW	LLFB	118	7	362	OK
2001	Dominica	UNCL	WTRO	L	1	0.1025	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2001	EC.España	LLHB	NE	L	2274	0.9392	2001	EC.España	ANE	LLHB	137	2421	65271	OK
2001	EC.España	LLHB	NWC	L	1694	0.9670	2001	EC.España	ANC	LLHB	138	1751	47844	OK
2001	EC.España	BB	CANA	L	1	0.0003	2001	EC.España	ANE	LLHB	137	2421	65271	sub-raise
2001	EC.Ireland	GILL	NE	L	14	0.0058	2001	EC.España	ANE	LLHB	137	2421	65271	sub-raise
2001	EC.Ireland	MWTD	NE	L	3	0.0013	2001	EC.España	ANE	LLHB	137	2421	65271	sub-raise
2001	EC.Portugal	LL	MDRA	L	6	0.0303	2001	EC.Portugal	ANE	LLHB	124	208	7703	sub-raise
2001	EC.Portugal	LL	NE	L	17	0.0799	2001	EC.Portugal	ANE	LLHB	124	208	7703	sub-raise
2001	EC.Portugal	LLHB	AZOR	L	235	1.1318	2001	EC.Portugal	ANE	LLHB	124	208	7703	
2001	EC.Portugal	LLHB	NE	L	158	0.7621	2001	EC.Portugal	ANE	LLHB	124	208	7703	sub-raise
2001	EC.Portugal	LLHB	NWC	L	63	0.3036	2001	EC.Portugal	ANE	LLHB	124	208	7703	sub-raise
2001	EC.Portugal	PS	NE	L	3	0.0144	2001	EC.Portugal	ANE	LLHB	124	208	7703	sub-raise
2001	EC.Portugal	SURF	NE	L	252	1.2114	2001	EC.Portugal	ANE	LLHB	124	208	7703	sub-raise
2001	EC.Portugal	TRAP	NE	L	0	0.0000								ignore
2001	Japan	LLHB	NORT	D	567	0.6910	2001	Japan	ANC	LLHB	169	204	2990	OK
						0.6910	2001	Japan	ANE	LLHB	176	617	7474	OK
						0.6910	2001	Japan	ANW	LLHB	180	317	4155	OK
2001	Maroc	GILL	NE	L	243	0.1903	2001	Maroc	ANE	GILL	143	1277	30819	raise
2001	Maroc	LL	NE	L	264	0.1091	2001	EC.España	ANE	LLHB	137	2421	65271	sub-raise
2001	Maroc	PS	NE	L	9	0.0070	2001	Maroc	ANE	GILL	143	1277	30819	sub-raise
2001	Maroc	TRAP	NE	L	7	0.0055	2001	Maroc	ANE	GILL	143	1277	30819	sub-raise
2001	Mexico	LL	GOFM	L	27	1.1222	2001	Mexico	ANW	LL	144	24	531	raise
2001	Philippines	LL	NW	L	1	0.2016	2001	Chinese Taipei	ANW	LLFB	118	7	362	sub-raise
2001	Sierra Leone	LL	NE	L	2	0.0349	2001	Chinese Taipei	ANE	LLFB	159	68	1184	sub-raise
2001	Trinidad and Tobag	LLHB	NORT	L	75	7.6874	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2001	U.S.A.	HAND	GOFM	L	0	0.0449	2001	U.S.A.	ANW	HAND	164	7	117	sub-raise
2001	U.S.A.	HAND	NW	L	9	1.2108	2001	U.S.A.	ANW	HAND	164	7	117	raise
2001	U.S.A.	HARP	NW	L	7	0.9893	2001	U.S.A.	ANW	HARP	204	8	67	raise
2001	U.S.A.	LL	GOFM	L	426	0.2569	2001	U.S.A.	ANW	LLHB	150	1658	36124	raise
2001	U.S.A.	LL	NW	L	1036	0.6246	2001	U.S.A.	ANW	LLHB	150	1658	36124	sub-raise
2001	U.S.A.	LL	WTRO	L	332	0.2000	2001	U.S.A.	ANW	LLHB	150	1658	36124	sub-raise
2001	U.S.A.	LL	NWC	L	402	0.6927	2001	U.S.A.	ANC	LLHB	162	580	10090	raise
2001	U.S.A.	RR	NW	L	2	0.1997	2001	U.S.A.	ANW	HARP	204	8	67	sub-raise
2001	U.S.A.	TRAW	NW	L	3	0.9084	2001	U.S.A.	ANW	TROL	168	3	42	raise
2001	U.S.A.	UNCL	NW	L	1	0.4073	2001	U.S.A.	ANW	TROL	168	3	42	sub-raise
2001	U.S.A.	LL	GOFM	D	69	0.0414	2001	U.S.A.	ANW	LLHB	150	1658	36124	sub-raise
2001	U.S.A.	LL	NW	D	185	0.1116	2001	U.S.A.	ANW	LLHB	150	1658	36124	sub-raise
2001	U.S.A.	LL	WTRO	D	15	0.0092	2001	U.S.A.	ANW	LLHB	150	1658	36124	sub-raise
2001	U.S.A.	LL	NWC	D	19	0.0323	2001	U.S.A.	ANC	LLHB	162	580	10090	sub-raise
2001	U.S.A.	PSLB	GOFM	D	5	0.0029	2001	U.S.A.	ANW	LLHB	150	1658	36124	sub-raise
2001	U.S.A.	UNCL	NW	D	1	0.0004	2001	U.S.A.	ANW	LLHB	150	1658	36124	sub-raise
2001	UK.Bermuda	UNCL	NW	L	2	0.0012	2001	U.S.A.	ANW	LLHB	150	1658	36124	sub-raise
2001	Venezuela	GILL	NW	L	9	0.9122	2001	Venezuela	ANW	GILL	127	10	335	raise
2001	Venezuela	LL	NW	L	12	1.2095	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2002	Barbados	LLHB	NW	L	10	0.0060	2002	U.S.A.	ANW	LLHB	148	1719	38531	sub-raise
2002	Canada	HARP	NW	L	38	1.0126	2002	Canada	ANW	HARP	205	37	321	OK
2002	Canada	LL	NW	D	30	0.0380	2002	Canada	ANW	LLHB	173	775	10601	sub-raise
2002	Canada	LL	NWC	D	3	0.0218	2002	Canada	ANC	LLHB	163	147	2462	sub-raise
2002	Canada	LLHB	NW	L	921	0.9993	2002	Canada	ANW	LLHB	173	775	10601	OK
						0.9993	2002	Canada	ANC	LLHB	163	147	2462	OK
2002	Canada	TRAW	NW	L	0	0.0000								ignore
2002	China P.R.	LL	NORT	L	90	0.2880	2002	Chinese Taipei	ANC	LLFB	158	162	3117	sub-raise
						0.2880	2002	Chinese Taipei	ANE	LLFB	159	151	2784	sub-raise
						0.2880	2002	Chinese Taipei	ANW	LLFB	171	8	123	sub-raise
2002	Chinese Taipei	LLFB	NORT	L	310	0.9899	2002	Chinese Taipei	ANC	LLFB	158	162	3117	OK
						0.9899	2002	Chinese Taipei	ANE	LLFB	159	151	2784	OK
						0.9899	2002	Chinese Taipei	ANW	LLFB	171	8	123	OK

Table 3. (cont.)

2002	Cuba	LL	NWC	L	10	0.0057	2002	U.S.A.	ANW	LLHB	148	1719	38531	sub-raise
2002	EC.España	LLHB	NE	L	2041	0.9353	2002	EC.España	ANE	LLHB	137	2182	57529	OK
2002	EC.España	LLHB	NWC	L	1913	1.0070	2002	EC.España	ANC	LLHB	138	1900	51711	OK
2002	EC.España	BB	CANA	L	3	0.0015	2002	EC.España	ANE	LLHB	137	2182	57529	sub-raise
2002	EC.France	MWT	NE	L	74	0.0339	2002	EC.España	ANE	LLHB	137	2182	57529	sub-raise
2002	EC.Ireland	MWTD	NE	L	5	0.0023	2002	EC.España	ANE	LLHB	137	2182	57529	sub-raise
2002	EC.Portugal	LL	MDRA	L	8	9.2032	2002	EC.Portugal	ANE	LL	130	1	27	
2002	EC.Portugal	LL	NE	L	11	0.0751	2002	EC.Portugal	ANE	LLHB	134	152	4420	sub-raise
2002	EC.Portugal	LLHB	NE	L	127	0.8392	2002	EC.Portugal	ANE	LLHB	134	152	4420	
2002	EC.Portugal	LLHB	NW	L	39	1.2720	2002	EC.Portugal	ANC	LLHB	129	31	1073	sub-raise
2002	EC.Portugal	LLHB	NWC	L	210	6.8068	2002	EC.Portugal	ANC	LLHB	129	31	1073	
2002	EC.Portugal	LLMB	NE	L	235	1.5459	2002	EC.Portugal	ANE	LLHB	134	152	4420	sub-raise
2002	EC.Portugal	PS	NE	L	0	0.0000								ignore
2002	EC.Portugal	SURF	NE	L	134	152.4778	2002	EC.Portugal	ANE	LL	130	1	27	sub-raise
2002	EC.Portugal	TRAP	NE	L	0	0.0000								ignore
2002	FR.St Pierre et Miq	UNCL	NW	L	10	0.0131	2002	Canada	ANW	LLHB	173	775	10601	sub-raise
2002	Grenada	LL	NW	L	54		2002	Chinese Taipei	ANW	LLFB	171	8	123	sub-raise
2002	Japan	LLHB	NORT	D	319	0.6389	2002	Japan	ANC	LLHB	172	62	869	OK
						0.6389	2002	Japan	ANE	LLHB	175	438	5513	OK
						0.6389	2002	Japan	ANW	LLHB	167	215	3275	OK
2002	Maroc	GILL	NE	L	64	?								sub-raise
2002	Maroc	LL	NE	L	154	0.0706	2002	EC.España	ANE	LLHB	137	2182	57529	sub-raise
2002	Maroc	PS	NE	L	1	?								sub-raise
2002	Maroc	TRAP	NE	L	4	?								sub-raise
2002	Mexico	LL	GOFM	L	34	1.4191	2001	Mexico	ANW	LL	144	24	531	sub-raise
2002	Philippines	LL	NW	L	4	0.5281	2002	Chinese Taipei	ANW	LLFB	171	8	123	sub-raise
2002	Trinidad and Tobag	LLHB	NORT	L	92	9.4299	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2002	U.S.A.	GILL	NW	L	0	0.0000								ignore
2002	U.S.A.	HAND	GOFM	L	3	0.3455	2002	U.S.A.	ANW	HAND	158	9	163	sub-raise
2002	U.S.A.	HAND	NW	L	9	1.0365	2002	U.S.A.	ANW	HAND	158	9	163	OK
2002	U.S.A.	HARP	NW	L	3	1.0762	2002	U.S.A.	ANW	HARP	200	3	27	raise
2002	U.S.A.	LL	GOFM	L	452	0.2629	2002	U.S.A.	ANW	LLHB	148	1719	38531	sub-raise
2002	U.S.A.	LL	NW	L	1003	0.5834	2002	U.S.A.	ANW	LLHB	148	1719	38531	sub-raise
2002	U.S.A.	LL	WTRO	L	312	0.1815	2002	U.S.A.	ANW	LLHB	148	1719	38531	sub-raise
2002	U.S.A.	LL	NWC	L	576	0.8580	2002	U.S.A.	ANC	LLHB	168	671	10213	
2002	U.S.A.	RR	NW	L	22	2.5336	2002	U.S.A.	ANW	HAND	158	9	163	sub-raise
2002	U.S.A.	TRAP	WTRO	L	0	0.0000								ignore
2002	U.S.A.	TRAW	NW	L	4	1.1136	2002	U.S.A.	ANW	TROL	196	4	33	
2002	U.S.A.	LL	GOFM	D	97	0.3446	2002	U.S.A.	ANW	LLD	96	281	23743	
2002	U.S.A.	LL	NW	D	130	0.0756	2002	U.S.A.	ANW	LLHB	148	1719	38531	sub-raise
2002	U.S.A.	LL	WTRO	D	17	0.0099	2002	U.S.A.	ANW	LLHB	148	1719	38531	sub-raise
2002	U.S.A.	LL	NWC	D	11	0.6892	2002	U.S.A.	ANC	LLD	110	16	919	
2002	U.S.A.	UNCL	GOFM	D	6	3.4666	2002	U.S.A.	ANW	UNCD	103	2	119	
2002	U.S.A.	UNCL	NW	D	2	1.1555	2002	U.S.A.	ANW	UNCD	103	2	119	sub-raise
2002	U.S.A.	UNCL	WTRO	D	0	0.1156	2002	U.S.A.	ANW	UNCD	103	2	119	ignore
2002	U.S.A.	UNCL	NWC	D	0	0.1156	2002	U.S.A.	ANW	UNCD	103	2	119	ignore
2002	UK.Bermuda	UNCL	NW	L	0	0.0000								ignore
2002	Venezuela	GILL	NW	L	9	0.9430	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2002	Venezuela	LL	NW	L	25	2.5215	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2003	Barbados	LLHB	NORT	L	10	0.0055	2003	U.S.A.	ANW	LLHB	146	1805	42577	sub-raise
2003	Canada	HARP	NW	L	147	1.0016	2003	Canada	ANW	HARP	203	147	1326	OK
2003	Canada	LL	NW	D	79	0.1082	2003	Canada	ANW	LLHB	169	726	10943	sub-raise
2003	Canada	LLHB	NW	L	1137	1.0021	2003	Canada	ANW	LLHB	169	726	10943	OK
						1.0021	2003	Canada	ANC	LLHB	159	409	7567	OK
2003	Canada	RR	NW	L	0	0.0000								ignore
2003	Canada	TL	NW	L	0	3.4180	2003	Canada	ANW	TL	151	0	1	
2003	China P.R.	LL	NORT	L	316	1.1860	2003	Chinese Taipei	ANC	LLFB	158	110	2105	sub-raise
						1.1860	2003	Chinese Taipei	ANE	LLFB	161	151	2530	
						1.1860	2003	Chinese Taipei	ANW	LLFB	160	5	92	
2003	Chinese Taipei	LLFB	NORT	L	257	0.9652	2003	Chinese Taipei	ANC	LLFB	158	110	2105	
						0.9652	2003	Chinese Taipei	ANE	LLFB	161	151	2530	
						0.9652	2003	Chinese Taipei	ANW	LLFB	160	5	92	
2003	EC.España	LLHB	NE	L	1866	0.9247	2003	EC.España	ANE	LLHB	139	2018	52214	OK
2003	EC.España	LLHB	NWC	L	2719	0.9922	2003	EC.España	ANC	LLHB	140	2740	73644	OK
2003	EC.España	BB	CANA	L	1	0.0005	2003	EC.España	ANE	LLHB	139	2018	52214	sub-raise
2003	EC.France	MWT	NE	L	138	0.0681	2003	EC.España	ANE	LLHB	139	2018	52214	sub-raise
2003	EC.France	UNCL	NE	L	32	0.0156	2003	EC.España	ANE	LLHB	139	2018	52214	sub-raise
2003	EC.Ireland	MWTD	NE	L	9	0.0045	2003	EC.España	ANE	LLHB	139	2018	52214	sub-raise
2003	EC.Ireland	TRAW	NE	L	3	0.0015	2003	EC.España	ANE	LLHB	139	2018	52214	sub-raise

Table 3. (cont.)

2003	EC.Portugal	LLSWO	AZOR	L	309	1.1095	2003	EC.Portugal	ANE	LLHB	134	279	8019	sub-raise
2003	EC.Portugal	LL	MDRA	L	9	13.8885	2003	EC.Portugal	ANE	LL	128	1	21	
2003	EC.Portugal	LL	NE	L	10	0.0344	2003	EC.Portugal	ANE	LLHB	134	279	8019	sub-raise
2003	EC.Portugal	LLALB	NE	L	3	0.0107	2003	EC.Portugal	ANE	LLHB	134	279	8019	sub-raise
2003	EC.Portugal	LLHB	NE	L	315	1.1320	2003	EC.Portugal	ANE	LLHB	134	279	8019	
2003	EC.Portugal	LLHB	NORT	L	49	1.1931	2003	EC.Portugal	ANE	LLHB	145	41	929	
2003	EC.Portugal	LLHB	NW	L	2	2.9906	2003	EC.Portugal	ANE	LL	128	1	21	sub-raise
2003	EC.Portugal	PS	NE	L	0	0.0000								ignore
2003	EC.Portugal	SURF	NE	L	335	1.2031	2003	EC.Portugal	ANE	LLHB	134	279	8019	sub-raise
2003	FR.St Pierre et Miq	LL	NW	L	3	0.0039	2003	Canada	ANW	LLHB	169	726	10943	sub-raise
2003	FR.St Pierre et Miq	UNCL	NW	L	36	0.0491	2003	Canada	ANW	LLHB	169	726	10943	sub-raise
2003	Grenada	LL	NW	L	88	17.6781	2003	Chinese Taipei	ANW	LLFB	160	5	92	sub-raise
2003	Japan	LLHB	NORT	D	263	0.5296	2003	Japan	ANC	LLHB	168	23	328	
						0.5296	2003	Japan	ANE	LLHB	185	356	3821	
						0.5296	2003	Japan	ANW	LLHB	170	119	1799	
2003	Maroc	GILL	NE	L	98									
2003	Maroc	LL	NE	L	223	0.1105	2003	EC.España	ANE	LLHB	139	2018	52214	raise
2003	Maroc	PS	NE	L	1	?								sub-raise
2003	Maroc	TRAP	NE	L	7	?								sub-raise
2003	Mexico	LL	GOFM	L	32	1.3478	2001	Mexico	ANW	LL	144	24	531	sub-raise
2003	Philippines	LL	NW	L	44	8.8391	2003	Chinese Taipei	ANW	LLFB	160	5	92	sub-raise
2003	St. Vincent and Gre	LLFB	NW	L	7		2003	Chinese Taipei	ANW	LLFB	160	5	92	sub-raise
2003	Sta. Lucia	TROL	NW	L	0	0.0000								ignore
2003	Trinidad and Tobag	LLHB	NW	L	78	7.9675	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2003	U.S.A.	HAND	GOFM	L	10	1.0877	2003	U.S.A.	ANW	HAND	150	9	202	sub-raise
2003	U.S.A.	HAND	NW	L	11	1.1973	2003	U.S.A.	ANW	HAND	150	9	202	raise
2003	U.S.A.	HAND	WTRO	L	0	0.0000								ignore
2003	U.S.A.	LL	GOFM	L	430	0.2381	2003	U.S.A.	ANW	LLHB	146	1805	42577	sub-raise
2003	U.S.A.	LL	NW	L	1167	0.6466	2003	U.S.A.	ANW	LLHB	146	1805	42577	raise
2003	U.S.A.	LL	WTRO	L	271	0.1501	2003	U.S.A.	ANW	LLHB	146	1805	42577	sub-raise
2003	U.S.A.	LL	NWC	L	613	0.8323	2003	U.S.A.	ANC	LLHB	171	737	10590	raise
2003	U.S.A.	RR	GOFM	L	0	0.0000								ignore
2003	U.S.A.	RR	NW	L	6	0.0033	2003	U.S.A.	ANW	LLHB	146	1805	42577	sub-raise
2003	U.S.A.	TRAP	NW	L	0	0.0000								ignore
2003	U.S.A.	TRAP	WTRO	L	0	0.0000								ignore
2003	U.S.A.	TRAW	NW	L	6	1.2452	2003	U.S.A.	ANW	TRAW	166	5	78	raise
2003	U.S.A.	LL	GOFM	D	78	0.0432	2003	U.S.A.	ANW	LLHB	146	1805	42577	sub-raise
2003	U.S.A.	LL	NW	D	175	0.0967	2003	U.S.A.	ANW	LLHB	146	1805	42577	sub-raise
2003	U.S.A.	LL	WTRO	D	4	0.0020	2003	U.S.A.	ANW	LLHB	146	1805	42577	sub-raise
2003	U.S.A.	LL	NWC	D	20	0.0268	2003	U.S.A.	ANC	LLHB	171	737	10590	sub-raise
2003	U.S.A.	UNCL	GOFM	D	3	0.0019	2003	U.S.A.	ANW	LLHB	146	1805	42577	sub-raise
2003	U.S.A.	UNCL	NW	D	2	0.0009	2003	U.S.A.	ANW	LLHB	146	1805	42577	sub-raise
2003	U.S.A.	UNCL	WTRO	D	0	0.0000								ignore
2003	U.S.A.	UNCL	NWC	D	0	0.0000								ignore
2003	UK.Bermuda	UNCL	NW	L	0	0.0000								ignore
2003	Venezuela	GILL	NW	L	16	1.5990	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2003	Venezuela	LL	NW	L	25	2.5522	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2003	Venezuela	LLHB	NW	L	4	0.4305	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2004	Canada	HARP	NW	L	87	1.0009	2004	Canada	ANW	HARP	209	87	722	OK
2004	Canada	LL	NW	D	45	0.0586	2004	Canada	ANW	LLHB	172	764	11105	sub-raise
2004	Canada	LLHB	NW	L	1116	1.0002	2004	Canada	ANW	LLHB	172	764	11105	OK
						1.0002	2004	Canada	ANC	LLHB	171	352	5143	OK
2004	Canada	TRAW	NW	L	0	1.2870	2004	Canada	ANC	TRAW	142	0	5	
2004	China P.R.	LL	NORT	L	56	1.7941	2004	Chinese Taipei	ANC	LLFB	166	7	123	sub-raise
						1.7941	2004	Chinese Taipei	ANE	LLFB	164	24	396	sub-raise
2004	Chinese Taipei	LLFB	NORT	L	30	0.9639	2004	Chinese Taipei	ANC	LLFB	166	7	123	OK
						0.9639	2004	Chinese Taipei	ANE	LLFB	164	24	396	OK
2004	Dominica	TROL	NW	L	0	0.0000								ignore
2004	EC.España	BB	CANA	L	3	0.0011	2004	EC.España	ANE	LLHB	140	2393	59233	sub-raise
2004	EC.España	LLHB	NE	L	2261	0.9446	2004	EC.España	ANE	LLHB	140	2393	59233	OK
2004	EC.España	LLHB	NWC	L	3113	1.0019	2004	EC.España	ANC	LLHB	138	3107	86601	OK
2004	EC.France	UNCL	NE	L	102	0.0425	2004	EC.España	ANE	LLHB	140	2393	59233	sub-raise
2004	EC.Ireland	MWTD	NE	L	1	0.0006	2004	EC.España	ANE	LLHB	140	2393	59233	sub-raise
2004	EC.Portugal	LLSWO	AZOR	L	193	0.5387	2004	EC.Portugal	ANE	LLHB	142	358	8396	sub-raise
2004	EC.Portugal	LL	MDRA	L	6	17.0627	2004	EC.Portugal	ANE	LL	128	0	8	
2004	EC.Portugal	LL	NE	L	31	1.0655	2004	EC.Portugal	ANE	LLHB	161	29	461	
2004	EC.Portugal	LLHB	NE	L	672	1.8778	2004	EC.Portugal	ANE	LLHB	142	358	8396	
2004	EC.Portugal	LLHB	NW	L	418	6.7058	2004	EC.Portugal	ANC	LLHB	133	62	2015	
2004	EC.Portugal	PS	NORT	L	0	0.0000								ignore
2004	EC.Portugal	TRAP	NE	L	0	0.0000								ignore
2004	Grenada	LL	WTRO	L	73	10.0831	2004	Chinese Taipei	ANC	LLFB	166	7	123	sub-raise
2004	Japan	LLHB	NORT	L	554	0.4758	2004	Japan	ANC	LLHB	164	175	2880	
						0.4758	2004	Japan	ANE	LLHB	169	529	7326	
						0.4758	2004	Japan	ANW	LLHB	170	460	6763	

Table 3. (cont.)

2004	Maroc	GILL	NE	L	76	?								raise
2004	Maroc	LL	NE	L	255	0.1066	2004	EC.España	ANE	LLHB	140	2393	59233	sub-raise
2004	Maroc	PS	NE	L	1	?								sub-raise
2004	Maroc	TRAP	NE	L	3	?								sub-raise
2004	Mexico	LL	GOFM	L	44	1.8555	2001	Mexico	ANW	LL	144	24	531	sub-raise
2004	Philippines	LL	NE	L	5	0.1885	2004	Chinese Taipei	ANE	LLFB	164	24	396	sub-raise
2004	Philippines	LL	NW	L	0	0.0000								ignore
2004	Senegal	UNCL	NE	L	108	0.0450	2004	EC.España	ANE	LLHB	140	2393	59233	sub-raise
2004	Sta. Lucia	TROL	WTRO	L	2	0.0822	2004	U.S.A.	ANW	HAND	147	19	470	sub-raise
2004	Trinidad and Tobag	LLHB	NW	L	83	8.4729	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2004	U.S.A.	GILL	NW	L	0	0.0000								ignore
2004	U.S.A.	HAND	GOFM	L	4	0.2033	2004	U.S.A.	ANW	HAND	147	19	470	sub-raise
2004	U.S.A.	HAND	NW	L	19	0.9611	2004	U.S.A.	ANW	HAND	147	19	470	raise
2004	U.S.A.	HAND	WTRO	L	0	0.0000								ignore
2004	U.S.A.	HARP	NW	L	1	0.9753	2004	U.S.A.	ANW	HARP	226	1	4	raise
2004	U.S.A.	LL	GOFM	L	452	0.2570	2004	U.S.A.	ANW	LLHB	149	1760	39191	sub-raise
2004	U.S.A.	LL	NW	L	999	0.5675	2004	U.S.A.	ANW	LLHB	149	1760	39191	raise
2004	U.S.A.	LL	WTRO	L	278	0.1582	2004	U.S.A.	ANW	LLHB	149	1760	39191	sub-raise
2004	U.S.A.	LL	NWC	L	593	0.9343	2004	U.S.A.	ANC	LLHB	175	635	8468	
2004	U.S.A.	RR	GOFM	L	1	0.0271	2004	U.S.A.	ANW	HAND	147	19	470	sub-raise
2004	U.S.A.	RR	NW	L	24	1.2483	2004	U.S.A.	ANW	HAND	147	19	470	sub-raise
2004	U.S.A.	RR	WTRO	L	0	0.0000								ignore
2004	U.S.A.	TRAW	NW	L	8	1.1419	2004	U.S.A.	ANW	TRAW	159	7	128	raise
2004	U.S.A.	LL	GOFM	D	73	0.0414	2004	U.S.A.	ANW	LLHB	149	1760	39191	sub-raise
2004	U.S.A.	LL	NW	D	171	0.0972	2004	U.S.A.	ANW	LLHB	149	1760	39191	sub-raise
2004	U.S.A.	LL	WTRO	D	17	0.0099	2004	U.S.A.	ANW	LLHB	149	1760	39191	sub-raise
2004	U.S.A.	LL	NWC	D	6	0.0102	2004	U.S.A.	ANC	LLHB	175	635	8468	sub-raise
2004	U.S.A.	UNCL	GOFM	D	3	0.0017	2004	U.S.A.	ANW	LLHB	149	1760	39191	sub-raise
2004	U.S.A.	UNCL	NW	D	4	0.0022	2004	U.S.A.	ANW	LLHB	149	1760	39191	sub-raise
2004	U.S.A.	UNCL	NWC	D	0	0.0000								ignore
2004	U.S.A.	UNCL	WTRO	D	0	0.0000								ignore
2004	UK.Bermuda	UNCL	NW	L	1	0.0003	2004	U.S.A.	ANW	LLHB	149	1760	39191	sub-raise
2004	Venezuela	GILL	NW	L	7	0.7513	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2004	Venezuela	LL	NW	L	46	4.7260	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2005	Canada	GILL	NW	L	0	0.0000								ignore
2005	Canada	HARP	NW	L	193	1.0002	2005	Canada	ANW	HARP	206	193	1658	OK
						1.0002	2005	Canada	ANC	HARP	184	0	2	OK
2005	Canada	LL	NW	D	79	0.4101	2005	Canada	ANW	HARP	206	193	1658	sub-raise
2005	Canada	LL	NWC	D	27	0.1417	2005	Canada	ANW	HARP	206	193	1658	sub-raise
2005	Canada	LLHB	NW	L	1364	1.0000	2005	Canada	ANW	LLHB	171	812	12169	OK
						1.0000	2005	Canada	ANC	LLHB	169	553	8382	OK
2005	Canada	RR	NW	L	0	0.5040	2005	Canada	ANW	UNCL	176	0	6	raise
						0.5040	2005	Canada	ANC	UNCL	172	0	6	raise
2005	China P.R.	LL	NORT	L	108	3.4683	2004	Chinese Taipei	ANC	LLFB	166	7	123	sub-raise
						3.4683	2004	Chinese Taipei	ANE	LLFB	164	24	396	sub-raise
2005	Chinese Taipei	LLFB	NORT	L	83	2.6669	2004	Chinese Taipei	ANC	LLFB	166	7	123	sub-raise
						2.6669	2004	Chinese Taipei	ANE	LLFB	164	24	396	sub-raise

Table 3. (cont.)

2005	EC.España	BB	CANA	L	10.3	0.0043	2004	EC.España	ANE	LLHB	140	2393	59233	sub-raise
2005	EC.España	LLHB	NORT	L	5511	1.1582	2003	EC.España	ANE	LLHB	139	2018	52214	sub-raise
						1.1582	2003	EC.España	ANC	LLHB	140	2740	73644	sub-raise
2005	EC.France	UNCL	NE	L	178	0.0881	2003	EC.España	ANE	LLHB	139	2018	52214	sub-raise
2005	EC.Ireland	MWTD	NE	L	1	0.0005	2004	EC.España	ANE	LLHB	140	2393	59233	sub-raise
2005	EC.Portugal	LLSWO	AZOR	L	293	29.6192	2005	EC.Portugal	ANE	LL	143	10	223	sub-raise
2005	EC.Portugal	LL	MDRA	L	15	1.5525	2005	EC.Portugal	ANE	LL	143	10	223	raise
2005	EC.Portugal	LL	NE	L	24	2.4017	2005	EC.Portugal	ANE	LL	143	10	223	sub-raise
2005	EC.Portugal	LLHB	AZOR	L	123	1.3421	2005	EC.Portugal	ANC	LLHB	131	91	2949	raise
2005	EC.Portugal	LLHB	CVER	L	20	11.9747	2005	EC.Portugal	ANE	LLJAP	186	2	18	sub-raise
2005	EC.Portugal	LLHB	MDRA	L	5	3.1072	2005	EC.Portugal	ANE	LLJAP	186	2	18	raise
2005	EC.Portugal	LLHB	NW	L	260	1.1505	2005	EC.Portugal	ANE	LLHB	132	226	6582	raise
2005	EC.Portugal	LL-surf	NW	L	161	9.2155	2005	EC.Portugal	ANE	LLHB	139	17	429	raise
2005	Grenada	LL	WTRO	L	56	7.6581	2004	Chinese Taipei	ANC	LLFB	166	7	123	sub-raise
2005	Japan	LLHB	NORT	L	302	0.7287	2005	Japan	ANC	LLHB	154	49	966	
						0.7287	2005	Japan	ANE	LLHB	168	227	3171	
						0.7287	2005	Japan	ANW	LLHB	161	138	2351	
2005	Korea, Republic of	LLHB	NW	L	51	7.0336	2004	Chinese Taipei	ANC	LLFB	166	7	123	sub-raise
2005	Maroc	GILL	NE	L	9	?								?
2005	Maroc	LL	NE	L	325	0.1358	2004	EC.España	ANE	LLHB	140	2393	59233	sub-raise
2005	Mexico	LL	GOFM	L	41	1.7440	2001	Mexico	ANW	LL	144	24	531	sub-raise
2005	Sta. Lucia	TROL	WTRO	L	3	0.0783	2005	U.S.A.	ANW	HAND	147	34	796	sub-raise
2005	Trinidad and Tobag	LLHB	NW	L	91	9.3067	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2005	U.S.A.	HAND	GOFM	L	0	0.0000								ignore
2005	U.S.A.	HAND	NW	L	33	0.9803	2005	U.S.A.	ANW	HAND	147	34	796	sub-raise
2005	U.S.A.	LL	GOFM	L	412	0.2712	2005	U.S.A.	ANW	LLHB	148	1519	34400	raise
2005	U.S.A.	LL	NW	L	967	0.6367	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	LL	WTRO	L	130	0.0859	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	LL	NWC	L	550	0.9137	2005	U.S.A.	ANC	LLHB	172	602	8455	raise
2005	U.S.A.	RR	GOFM	L	1	0.0010	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	RR	NW	L	53	0.0350	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	RR	WTRO	L	7	0.0043	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	TRAW	NW	L	8	1.0426	2005	U.S.A.	ANW	TRAW	150	8	178	
2005	U.S.A.	LL	GOFM	D	80	0.0524	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	LL	NW	D	155	0.1021	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	LL	NWC	D	4	0.0074	2005	U.S.A.	ANC	LLHB	172	602	8455	sub-raise
2005	U.S.A.	LL	WTRO	D	13	0.0085	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	UNCL	GOFM	D	4	0.0025	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	UNCL	NW	D	4	0.0028	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	UNCL	NWC	D	1	0.0008	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	U.S.A.	UNCL	WTRO	D	1	0.0004	2005	U.S.A.	ANW	LLHB	148	1519	34400	sub-raise
2005	Venezuela	GILL	NW	L	7	0.6963	2001	Venezuela	ANW	GILL	127	10	335	sub-raise
2005	Venezuela	LL	NW	L	48	4.9022	2001	Venezuela	ANW	GILL	127	10	335	sub-raise

Table 4. Substitutions scheme for the swordfish South Atlantic stock.

Taski							Size daata							
Year	Flag	Gear	Area	Type	Taski	RF	Year	Flag	Area	Gear	Mean length	wgt	N.Fish	Action
2001	Argentina	TRAW	SW	L	5	0.05	2001	Brasil	ASW	LLHB	171	109	1452	subs-raise
2001	Brasil	LL	SW	L	1739	15.90	2001	Brasil	ASW	LLHB	171	109	1452	raise
2001	Brasil	UNCL	SW	L	7	0.06	2001	Brasil	ASW	LLHB	171	109	1452	subs-raise
2001	Brasil	LLFB	SW	L	40	0.37	2001	Brasil	ASW	LLHB	171	109	1452	subs-raise
2001	Brasil	LLFB	SW	L	1454	0.39	2001	EC.España	ASW	LLHB	152	3737	79691	subs-raise
2001	Brasil	LLFB	SW	L	11	0.10	2001	Brasil	ASW	LLHB	171	109	1452	subs-raise
2001	Brasil	LLFB	SW	L	66	0.60	2001	Brasil	ASW	LLHB	171	109	1452	subs-raise
2001	Brasil	LLFB	SW	L	30	0.27	2001	Brasil	ASW	LLHB	171	109	1452	subs-raise
2001	Brasil	LLFB	SW	L	43	0.18	2001	Chinese Taipei	ASW	LLFB	153	242	5461	subs-raise
2001	Brasil	LLFB	SW	L	74	0.67	2001	Brasil	ASW	LLHB	171	109	1452	subs-raise
2001	Brasil	LLFB	SW	L	52	1.24	2001	U.S.A.	ASW	LLHB	157	42	865	subs-raise
2001	Brasil	LLFB	SW	L	568	5.19	2001	Brasil	ASW	LLHB	171	109	1452	subs-raise
2001	China P.R.	LL	SOUT	L	200	0.17	2001	Chinese Taipei	ASE	LLFB	157	918	17255	subs-raise
						0.17	2001	Chinese Taipei	ASW	LLFB	153	242	5461	subs-raise
2001	Chinese Taipei	LLFB	SOUT	L	1149	0.99	2001	Chinese Taipei	ASE	LLFB	157	918	17255	raise
						0.99	2001	Chinese Taipei	ASW	LLFB	153	242	5461	raise
2001	Côte D'Ivoire	SURF	SE	L	19	0.92	2001	Côte D'Ivoire	ASE	GILL	140	21	464	raise
2001	EC.España	LLHB	SE	L	2019	0.94	2001	EC.España	ASE	LLHB	159	2155	37290	OK
2001	EC.España	LLHB	SW	L	3770	1.01	2001	EC.España	ASW	LLHB	152	3737	79691	OK
2001	EC.Portugal	LLHB	SE	L	330	0.15	2001	EC.España	ASE	LLHB	159	2155	37290	subs-raise
2001	EC.Portugal	LLHB	SW	L	63	0.02	2001	EC.España	ASW	LLHB	152	3737	79691	subs-raise
2001	Ghana	GILL	SE	L	531	2.63	1999	Ghana	ASE	SURF	162	202	3167	subs-raise
2001	Japan	LLHB	SOUT	L	685	46.51	2001	Japan	ASE	LLHB	154	9	180	raise
						46.51	2001	Japan	ASW	LLHB	147	6	136	raise
2001	Korea, Republic of	LLFB	SE	L	0	0.00								ignore
2001	Namibia	BB	SE	L	144	66.67	2001	Namibia	ASE	BB	131	2	75	raise
2001	Namibia	LL	SE	L	607	7.18	2001	Namibia	ASE	LL	151	85	1675	raise
2001	Philippines	LL	SW	L	6	0.02	2001	Chinese Taipei	ASW	LLFB	153	242	5461	subs-raise
2001	South Africa	LL	SE	L	543	2.61	2001	South Africa	ASE	LL	174	208	2759	subs-raise
2001	South Africa	LLHB	SE	L	4	0.02	2001	South Africa	ASE	LL	174	208	2759	subs-raise
2001	U.S.A.	LL	SW	L	43	0.28	2001	U.S.A.	ASW	LLHB	157	42	865	raise
						0.28	2001	U.S.A.	ASE	LLHB	170	113	1626	raise
2001	U.S.A.	LL	SW	D	0.1	0.00	2001	U.S.A.	ASW	LLHB	157	42	865	subs-raise
2001	U.S.A.	UNCL	SW	D	0.1	0.00	2001	U.S.A.	ASW	LLHB	157	42	865	subs-raise
2001	UK.Sta Helena	LL	SE	L	20	0.24	2001	Namibia	ASE	LL	151	85	1675	subs-raise
2001	Uruguay	LLHB	SW	L	789	22.11	1998	Uruguay	ASW	LLHB	160	36	668	subs-raise
2002	Brasil	BB	SW	L	7	0.28	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLHB	SW	L	1913	75.64	2002	Brasil	ASW	LLHB	159	25	474	raise
2002	Brasil	LLFB	SW	L	24	0.94	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLFB	SW	L	54	2.13	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLFB	SW	L	27	1.07	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLFB	SW	L	312	0.08	2002	EC.España	ASW	LLHB	152	4041	84345	subs-raise
2002	Brasil	LLFB	SW	L	23	0.89	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLFB	SW	L	115	4.53	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLFB	SW	L	7	0.29	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLFB	SW	L	136	5.38	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLFB	SW	L	53	1.92	2002	EC.Portugal	ASW	LLHB	154	28	581	subs-raise
2002	Brasil	LLFB	SW	L	70	0.31	2002	Chinese Taipei	ASW	LLFB	155	224	4676	subs-raise
2002	Brasil	LLFB	SW	L	6	0.25	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLFB	SW	L	28	0.53	2002	U.S.A.	ASW	LLHB	151	52	1200	subs-raise
2002	Brasil	LLFB	SW	L	120	4.76	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	Brasil	LLFB	SW	L	16	0.63	2002	Brasil	ASW	LLHB	159	25	474	subs-raise
2002	China P.R.	LL	SOUT	L	423	0.36	2002	Chinese Taipei	ASE	LLFB	156	953	18077	subs-raise
						0.36	2002	Chinese Taipei	ASW	LLFB	155	224	4676	subs-raise
2002	Chinese Taipei	LLFB	SOUT	L	1164	0.99	2002	Chinese Taipei	ASE	LLFB	156	953	18077	raise
						0.99	2002	Chinese Taipei	ASW	LLFB	155	224	4676	raise
2002	Côte D'Ivoire	GILL	SE	L	19	0.94	2002	Côte D'Ivoire	ASE	GILL	142	20	449	raise
2002	EC.España	LLHB	SE	L	1494	0.95	2002	EC.España	ASE	LLHB	154	1567	29499	OK
2002	EC.España	LLHB	SW	L	4247	1.05	2002	EC.España	ASW	LLHB	152	4041	84345	OK
2002	EC.Portugal	LLHB	SE	L	174	18.57	2002	EC.Portugal	ASE	LLHB	157	9	167	raise
2002	EC.Portugal	LLHB	SW	L	206	7.47	2002	EC.Portugal	ASW	LLHB	154	28	581	raise
2002	EC.United Kingdom	GILL	SW	L	0	0.00								ignore
2002	Ghana	GILL	SE	L	372	1.84	1999	Ghana	ASE	SURF	162	202	3167	subs-raise
2002	Japan	LLHB	SOUT	L	897	14.56	2002	Japan	ASE	LLHB	152	21	402	raise
						14.56	2002	Japan	ASW	LLHB	153	41	902	raise
2002	Korea, Republic of	LLHB	SE	L	2	0.07	2002	Japan	ASE	LLHB	152	21	402	subs-raise
2002	Namibia	LL	SE	L	504	5.96	2001	Namibia	ASE	LL	151	85	1675	subs-raise
2002	Philippines	LL	SW	L	1	0.00	2002	Chinese Taipei	ASW	LLFB	155	224	4676	subs-raise
2002	Seychelles	LL	SE	L	6	0.01	2002	South Africa	ASE	LL	155	416	7361	subs-raise
2002	South Africa	LL	SE	L	649	1.56	2002	South Africa	ASE	LL	155	416	7361	
2002	U.S.A.	LL	SW	L	200	3.87	2002	U.S.A.	ASW	LLHB	151	52	1200	
2002	U.S.A.	LL	SW	D	0.3	0.48	2002	U.S.A.	ASW	LLD	103	1	46	
2002	UK.Sta Helena	LL	SE	L	4	0.05	2001	Namibia	ASE	LL	151	85	1675	subs-raise
2002	Uruguay	LLHB	SW	L	768	21.52	1998	Uruguay	ASW	LLHB	160	36	668	subs-raise

Table 4. (cont.)

2003	Brasil	LL	SW	L	13	1.07	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	5	0.42	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	356	8.93	2003	Brasil	ASW	LLHB	162	40	720	raise
2003	Brasil	HAND	SW	L	3	0.20	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	815	65.91	2003	Brasil	ASW	LLHB	159	12	245	raise
2003	Brasil	LL	SW	L	44	3.54	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	419	40.72	2003	Brasil	ASW	LLHB	163	10	174	raise
2003	Brasil	LL	SW	L	14	1.10	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	642	0.26	2003	EC.España	ASW	LLHB	152	2428	51828	subs-raise
2003	Brasil	LL	SW	L	28	0.01	2003	EC.España	ASW	LLHB	152	2428	51828	subs-raise
2003	Brasil	LL	SW	L	6	0.47	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	97	7.86	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	29	2.35	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	107	8.70	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	13	1.04	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	87	7.08	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	14	1.15	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	117	0.05	2003	EC.España	ASW	LLHB	152	2428	51828	subs-raise
2003	Brasil	LL	SW	L	29	2.36	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	18	1.44	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	13	0.66	2003	U.S.A.	ASW	LLHB	158	20	390	subs-raise
2003	Brasil	LL	SW	L	41	3.30	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	Brasil	LL	SW	L	11	0.88	2003	Brasil	ASW	LLHB	159	12	245	subs-raise
2003	China P.R.	LL	SOUT	L	353	0.28	2003	Chinese Taipei	ASE	LLFB	162	1071	18274	subs-raise
						0.28	2003	Chinese Taipei	ASW	LLFB	159	196	3894	
2003	Chinese Taipei	LLFB	SOUT	L	1254	0.99	2003	Chinese Taipei	ASE	LLFB	162	1071	18274	
						0.99	2003	Chinese Taipei	ASW	LLFB	159	196	3894	
2003	Côte D'Ivoire	GILL	SE	L	43	1.11	2003	Côte D'Ivoire	ASE	GILL	147	39	713	
2003	EC.España	LLHB	SE	L	2059	0.92	2003	EC.España	ASE	LLHB	153	2235	42410	OK
2003	EC.España	LLHB	SW	L	2468	1.02	2003	EC.España	ASW	LLHB	152	2428	51828	OK
2003	EC.Portugal	LLHB	SE	L	261	0.12	2003	EC.España	ASE	LLHB	153	2235	42410	subs-raise
2003	EC.Portugal	LLHB	SW	L	93	0.04	2003	EC.España	ASW	LLHB	152	2428	51828	subs-raise
2003	Gabon	TRAW	SE	L	9	0.04	1999	Ghana	ASE	SURF	162	202	3167	subs-raise
2003	Ghana	GILL	SE	L	734	3.64	1999	Ghana	ASE	SURF	162	202	3167	subs-raise
2003	Japan	LLHB	SOUT	L	937	34.15	2003	Japan	ASE	LLHB	171	14	197	
						34.15	2003	Japan	ASW	LLHB	172	13	213	
2003	Korea, Republic of	LLHB	SE	L	24	1.70	2003	Japan	ASE	LLHB	171	14	197	subs-raise
2003	Namibia	BB	SE	L	4	2.03	2001	Namibia	ASE	BB	131	2	75	subs-raise
2003	Namibia	LL	SE	L	187	2.21	2001	Namibia	ASE	LL	151	85	1675	subs-raise
2003	Philippines	LL	SW	L	8	0.04	2003	Chinese Taipei	ASW	LLFB	159	196	3894	subs-raise
2003	South Africa	BB	SE	L	0.1	0.00								ignore
2003	South Africa	LL	SE	L	293	6.88	2003	South Africa	ASE	LL	164	43	674	raise
2003	South Africa	LLFB	SE	L	0.3	0.00								ignore
2003	U.S.A.	LL	SW	L	21	1.03	2003	U.S.A.	ASW	LLHB	158	20	390	OK
2003	U.S.A.	LL	SW	D	0.4	0.02	2003	U.S.A.	ASW	LLHB	158	20	390	subs-raise
2003	Uruguay	LLHB	SW	L	850	23.82	1998	Uruguay	ASW	LLHB	160	36	668	subs-raise
2004	Argentina	UNCL	SW	L	0.1	0.00								ignore
2004	Brasil	LL	SW	L	26	0.05	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	SURF	SW	L	69	0.15	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	383	0.80	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	SURF	SW	L	15	0.03	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	949	1.98	2004	Brasil	ASW	LLHB	163	478	8527	raise
2004	Brasil	SURF	SW	L	1	0.00	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	14	0.03	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	213	0.45	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	20	0.04	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	233	0.07	2004	EC.España	ASW	LLHB	155	3314	66991	subs-raise
2004	Brasil	LL	SW	L	657	0.20	2004	EC.España	ASW	LLHB	155	3314	66991	subs-raise
2004	Brasil	LL	SW	L	235	0.49	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	25	0.05	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	16	0.03	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	33	0.07	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	68	0.14	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	10	0.02	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise
2004	Brasil	LL	SW	L	16	1.08	2004	U.S.A.	ASW	LLHB	159	15	288	subs-raise
2004	Brasil	LL	SW	L	16	0.03	2004	Brasil	ASW	LLHB	163	478	8527	subs-raise

Table 4. (cont.)

2004	China P.R.	LL	SOUT	L	278	0.37	2004	Chinese Taipei	ASE	LLFB	164	647	10671	subs-raise
						0.37	2004	Chinese Taipei	ASW	LLFB	162	105	2019	subs-raise
2004	Chinese Taipei	LLFB	SOUT	L	745	0.99	2004	Chinese Taipei	ASE	LLFB	164	647	10671	OK
						0.99	2004	Chinese Taipei	ASW	LLFB	162	105	2019	OK
2004	Côte D'Ivoire	GILL	SE	L	29	1.06	2004	Côte D'Ivoire	ASE	GILL	136	27	652	raise
2004	EC.España	LLHB	SE	L	2154	0.93	2004	EC.España	ASE	LLHB	150	2325	47428	OK
2004	EC.España	LLHB	SW	L	3329	1.00	2004	EC.España	ASW	LLHB	155	3314	66991	OK
2004	EC.Portugal	LLHB	SE	L	73	0.03	2004	EC.España	ASE	LLHB	150	2325	47428	subs-raise
2004	EC.Portugal	LLHB	SW	L	272	0.08	2004	EC.España	ASW	LLHB	155	3314	66991	subs-raise
2004	Ghana	GILL	SE	L	343	1.70	1999	Ghana	ASE	SURF	162	202	3167	subs-raise
2004	Japan	LLHB	SOUT	L	646	227.38	2004	Japan	ASE	LLHB	136	1	29	raise
						227.38	2004	Japan	ASW	LLHB	168	2	31	raise
2004	Korea, Republic of	LLHB	SE	L	70	65.55	2004	Japan	ASE	LLHB	136	1	29	subs-raise
2004	Namibia	LL	SE	L	549	6.50	2001	Namibia	ASE	LL	151	85	1675	subs-raise
2004	Philippines	LL	SW	L	1	0.01	2004	Chinese Taipei	ASW	LLFB	162	105	2019	subs-raise
2004	South Africa	LL-Shrk	SE	L	0.2	0.00								ignore
2004	South Africa	LLSWO	SE	L	81	37.11	2004	South Africa	ASE	LLSWO	180	2	26	raise
2004	South Africa	LLSWO	SE	L	40	6.42	2004	South Africa	ASE	LLSWO	177	6	78	raise
2004	South Africa	LLFB	SE	L	2	0.38	2004	South Africa	ASE	LLSWO	177	6	78	subs-raise
2004	South Africa	LLFB	SE	L	0.0	0.00								ignore
2004	South Africa	LLSWO	SE	L	107	17.16	2004	South Africa	ASE	LLSWO	177	6	78	subs-raise
2004	South Africa	LLSWO	SE	L	63	10.10	2004	South Africa	ASE	LLSWO	177	6	78	subs-raise
2004	U.S.A.	LL	SW	L	15	1.03	2004	U.S.A.	ASW	LLHB	159	15	288	raise
2004	U.S.A.	LL	SW	D	1	0.05	2004	U.S.A.	ASW	LLHB	159	15	288	subs-raise
2004	Uruguay	LLHB	SW	L	1105	30.96	1998	Uruguay	ASW	LLHB	160	36	668	subs-raise
2005	Brasil	LL	SW	L	117	1.03	2005	Brasil	ASW	LLHB	105	114	7904	subs-raise
2005	Brasil	LL	SW	L	364	3.19	2005	Brasil	ASW	LLHB	105	114	7904	subs-raise
2005	Brasil	LL	SW	L	765	6.71	2005	Brasil	ASW	LLHB	105	114	7904	subs-raise
2005	Brasil	SURF	SW	L	5	0.05	2005	Brasil	ASW	LLHB	105	114	7904	subs-raise
2005	Brasil	LL	SW	L	23	0.20	2005	Brasil	ASW	LLHB	105	114	7904	subs-raise
2005	Brasil	LL	SW	L	366	3.21	2005	Brasil	ASW	LLHB	105	114	7904	raise
2005	Brasil	LL	SW	L	118	0.57	2005	Brasil	ASW	LL	143	66	1718	raise
						0.57	2005	Brasil	ASE	LL	152	122	2342	raise
						0.57	2005	Brasil	ASE	LL	154	17	332	raise
2005	Brasil	LL	SW	L	1376	6.99	2005	Brasil	ASW	LL	148	93	2115	raise
						6.99	2005	Brasil	ASE	LL	154	78	1469	raise
						6.99	2005	Brasil	ASE	LL	152	26	473	raise
2005	Brasil	LL	SW	L	58	0.62	2005	Brasil	ASW	LL	148	93	2115	subs-raise
2005	Brasil	LL	SW	L	36	0.32	2005	Brasil	ASW	LLHB	105	114	7904	subs-raise
2005	Brasil	LL	SW	L	154	2.07	2005	Brasil	ASE	LL	185	31	355	raise
						2.07	2005	Brasil	ASE	LL	165	44	701	subs-raise
2005	Brasil	LL	SW	L	147	1.98	2005	Brasil	ASE	LL	185	31	355	subs-raise
						1.98	2005	Brasil	ASE	LL	165	44	701	subs-raise
2005	Brasil	LL	SW	L	2	0.03	2005	Brasil	ASE	LL	185	31	355	subs-raise
						0.03	2005	Brasil	ASE	LL	165	44	701	subs-raise
2005	Brasil	LL	SW	L	4	0.04	2005	Brasil	ASW	LLHB	105	114	7904	subs-raise
2005	Brasil	LL	SW	L	39	0.34	2005	Brasil	ASW	LLHB	105	114	7904	subs-raise
2005	Brasil	LL	SW	L	4	0.05	2005	Brasil	ASW	LL	154	78	1438	subs-raise
						0.05	2005	Brasil	ASE	LL	158	9	162	subs-raise
2005	Brasil	LL	SW	L	162	1.86	2005	Brasil	ASW	LL	154	78	1438	subs-raise
						1.86	2005	Brasil	ASE	LL	158	9	162	subs-raise
2005	Brasil	LL	SW	L	43	0.43	2005	EC.Portugal	ASW	LLHB	146	99	2498	subs-raise
2005	China P.R.	LL	SOUT	L	91	0.12	2004	Chinese Taipei	ASE	LLFB	164	647	10671	subs-raise
						0.12	2004	Chinese Taipei	ASW	LLFB	162	105	2019	subs-raise
2005	Chinese Taipei	LLFB	SOUT	L	431	0.57	2004	Chinese Taipei	ASE	LLFB	164	647	10671	subs-raise
						0.57	2004	Chinese Taipei	ASW	LLFB	162	105	2019	subs-raise
2005	Côte D'Ivoire	GILL	SE	L	31	1.15	2004	Côte D'Ivoire	ASE	GILL	136	27	652	subs-raise
2005	EC.España	LLHB	SOUT	L	5402	0.96	2004	EC.España	ASE	LLHB	150	2325	47428	subs-raise
						0.96	2004	EC.España	ASW	LLHB	155	3314	66991	subs-raise
2005	EC.Portugal	LLHB	SE	L	30	0.31	2005	EC.Portugal	ASW	LLHB	146	99	2498	subs-raise
2005	EC.Portugal	LLHB	SW	L	462	4.68	2005	EC.Portugal	ASW	LLHB	146	99	2498	raise
2005	Ghana	GILL	SE	L	55	0.27	1999	Ghana	ASE	SURF	162	202	3167	subs-raise
2005	Japan	LLHB	SOUT	L	175	61.60	2004	Japan	ASE	LLHB	136	1	29	subs-raise
						61.60	2004	Japan	ASW	LLHB	168	2	31	subs-raise
2005	Korea, Republic of	LLHB	SE	L	12	4.22	2004	Japan	ASE	LLHB	136	1	29	subs-raise
2005	Korea, Republic of	LLHB	SW	L	24	4.22	2004	Japan	ASW	LLHB	168	2	31	subs-raise
2005	Namibia	LL	SE	L	832	6.17	2005	Namibia	ASE	LL	152	135	2510	raise
2005	South Africa	LL-Shrk	SE	L	1	0.03	2005	South Africa	ASE	LLSWO	167	54	803	subs-raise
2005	South Africa	LLSWO	SE	L	193	3.56	2005	South Africa	ASE	LLSWO	167	54	803	raise
2005	South Africa	LLFB	SE	L	4	0.47	2005	South Africa	ASE	LLFB	200	8	69	raise
2005	South Africa	LLFB	SE	L	1	0.18	2005	South Africa	ASE	LLFB	200	8	69	subs-raise
2005	Uruguay	LLHB	SW	L	843	23.62	1998	Uruguay	ASW	LLHB	160	36	668	subs-raise

Table 5. Catch at age (in numbers of fish) for North Atlantic swordfish using unisex growth model, all fleets combined.

Atlantic Swordfish
NUMBER CAUGHT

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	1324	1210	3434	3144	3945	4317	5681	5197	14702	22916	22860	7912
1	6666	10379	25851	15003	21290	29487	29913	33342	48287	77214	84838	76759
2	19186	27563	45973	35289	33295	54800	52798	59003	94844	117777	131608	115176
3	36093	34452	49628	41738	45309	56326	56368	67306	88723	108535	98630	91808
4	35165	32340	39256	34686	41819	47771	43954	52019	66710	73457	60653	59573
5	66474	66103	68300	54873	66913	68644	55654	58987	73000	76170	59824	59153
total	164908	172047	232442	184733	212570	261346	244367	275855	386266	476069	458411	410380

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	14634	15274	14583	12447	18236	16292	29246	28073	11399	12141	13663	7095
1	48421	47182	44145	56289	62087	52853	58553	67389	50643	46912	48041	31883
2	116784	84007	95534	102141	106537	116984	101575	83458	113670	109404	108997	80543
3	91926	98485	83720	95063	79426	100582	99151	65919	69444	78306	75364	62987
4	50619	52567	53660	55812	48339	53820	54737	39434	37188	35391	38412	31895
5	52212	49699	55539	60593	52759	52726	49862	44522	37695	33353	36190	36329
total	374596	347214	347180	382344	367383	393257	393124	328795	320039	315508	320667	250732

AGE	2002	2003	2004	2005
0	8241	4491	7005	7315
1	34943	29290	39950	39093
2	75937	91716	86780	83108
3	57487	75774	75597	70806
4	30699	37155	42719	40313
5	33035	35629	42383	38911
total	240343	274056	294434	279545

Table 6. Catch at age (in numbers of fish) for South Atlantic swordfish using unisex growth model, all fleets combined.

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	58	54	127	476	305	70	1240	795	235	150	3782	2969
1	397	457	908	3543	4079	1918	6570	7883	4538	3046	16245	26861
2	1272	3384	3600	5602	14105	10836	20418	23036	12888	11721	29788	51355
3	1203	7441	8556	6784	20820	16415	29234	26987	16945	14915	57611	77941
4	2064	5657	12924	7514	17757	14610	27160	36335	16384	16300	40280	71610
5	3924	5994	9557	7378	14649	14379	19901	25259	14813	14328	27858	39730
6	4983	3841	11494	5404	10455	11266	12526	13195	9422	11879	15749	17908
7	2927	2845	7835	3733	5662	3753	7596	5367	5835	6221	7396	8820
8	1107	1776	2639	2024	2767	2436	3721	3201	2419	2072	5444	3997
9	1372	1828	1640	1631	1553	715	1951	1766	1813	1328	2119	1708
10	911	1408	909	1115	1096	844	1454	966	1303	678	1311	795
11	534	1002	305	662	539	253	862	446	623	522	606	414
12	271	193	300	368	341	110	504	259	368	313	531	213
13	305	140	295	215	221	127	265	289	162	302	461	262
14	276	318	183	181	269	235	268	199	154	107	252	118
15	2895	1046	1246	3283	1721	981	2293	2768	1366	1756	1852	1278
total	**24499**	**37383**	**62518**	**49915**	**96338**	**78948**	**135965**	**148753**	**89269**	**85636**	**211283**	**305977**

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	2554	1907	2656	4123	5864	6431	2149	1714	1839	2102	6762	2355
1	11237	9876	9146	13078	21309	25629	18343	21672	12547	21310	28181	18897
2	35195	33900	29082	28026	60819	74589	64382	54104	50470	63997	70018	61551
3	77244	69702	81790	66941	95453	109722	100023	80198	80551	92752	109274	79768
4	72378	58113	69542	52867	76736	84478	73030	75408	60305	62606	62761	52661
5	42625	32038	25862	33636	40887	42511	42443	45318	26662	30356	27302	27676
6	18974	14539	14219	20420	21897	20646	20887	21265	11264	13744	13004	15169
7	8752	5507	7201	13244	10727	11110	11251	10097	5550	7054	6665	7309
8	3488	2772	3508	7078	6440	7177	6061	5237	2785	3653	3761	3982
9	2257	1599	1863	4857	4158	4842	2497	2830	1652	2107	2122	2628
10	1278	932	1123	2936	2069	3392	2066	2082	919	1405	1313	1324
11	312	466	735	733	1043	2076	1359	1234	641	770	744	1182
12	311	266	399	655	715	912	538	840	480	460	602	572
13	372	198	240	582	393	974	581	671	280	324	378	326
14	266	181	165	397	343	281	253	488	239	347	385	313
15	5593	3854	1931	4684	6419	7258	4203	5826	2620	2999	2876	5580
total	**282836**	**235848**	**249461**	**254258**	**355273**	**402030**	**350065**	**328984**	**258803**	**305986**	**336147**	**281294**

Table 7. Standardized catch rates by age for North Atlantic swordfish.

		Canada		USA		Japan		EC-Spain	
Age	Year	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
0	1981			0.979	0.887				
	1982			0.967	0.750				
	1983			0.684	0.440				
	1984			0.409	0.277				
	1985			0.447	0.262				
	1986			1.000	0.489				
	1987			0.699	0.332				
	1988			0.626	0.295				
	1989			0.583	0.273				
	1990			0.548	0.260				
1	1981			0.975	1.250				
	1982			0.784	0.836				
	1983			0.632	0.548			0.270	0.096
	1984			0.607	0.494			0.266	0.095
	1985			0.499	0.391			0.264	0.077
	1986			0.987	0.718			0.424	0.054
	1987			0.844	0.583			0.549	0.061
	1988			1.000	0.678			0.626	0.050
	1989			0.910	0.621			0.546	0.051
	1990			0.791	0.540			0.325	0.053
	1991							0.300	0.049
	1992							0.329	0.045
	1993							0.381	0.045
	1994							0.363	0.042
	1995							0.378	0.040
	1996							0.371	0.041
	1997							0.788	0.041
	1998							0.683	0.042
	1999							0.782	0.055
	2000							0.752	0.096
	2001							0.569	0.164
2	1981			1.000	1.328				
	1982			0.553	0.571				
	1983			0.483	0.417			0.633	0.067
	1984			0.532	0.435			0.523	0.064
	1985			0.515	0.401			0.718	0.054
	1986			0.642	0.468			0.743	0.039
	1987			0.679	0.469			0.976	0.046
	1988	0.929	0.346	0.753	0.512			0.916	0.039
	1989	0.941	0.332	0.602	0.412			1.070	0.039
	1990	1.462	0.411	0.639	0.437			1.247	0.040
	1991	0.671	0.228					0.950	0.037
	1992	1.312	0.326					0.920	0.035
	1993	0.899	0.235					0.849	0.034
	1994	0.602	0.176					0.884	0.032
	1995	0.676	0.184					1.080	0.030
	1996	0.340	0.130					0.669	0.031
	1997	0.470	0.158					0.782	0.032
	1998	0.946	0.239					1.105	0.032
	1999	1.312	0.285					1.266	0.042
	2000	0.806	0.226					1.601	0.068
	2001	0.618	0.187					1.166	0.110
	2002	0.704	0.205						
	2003	0.836	0.232						
	2004	0.649	0.195						
	2005	0.629	0.190						

Table 7. (cont.)

3	1975					0.613			
	1976					0.716			
	1977					1.469			
	1978					0.801			
	1979					1.696			
	1980					1.116			
	1981			1.000	0.850	1.396			
	1982			0.764	0.494	1.317			
	1983			0.380	0.223	0.772		1.044	0.062
	1984			0.531	0.284	1.131		1.037	0.057
	1985			0.611	0.311	1.861		1.086	0.049
	1986			0.546	0.262	1.149		0.964	0.036
	1987			0.595	0.262	0.595		1.067	0.043
	1988	0.731	0.286	0.661	0.286	0.649		0.976	0.036
	1989	0.749	0.276	0.546	0.238	1.963		0.863	0.036
	1990	0.994	0.316	0.530	0.233	0.668		1.213	0.037
	1991	0.850	0.241	0.706	0.303	0.547		1.306	0.034
	1992	0.776	0.232	0.595	0.251	0.231		1.174	0.032
	1993	0.814	0.207	0.535	0.225	0.446		0.951	0.032
	1994	0.434	0.138	0.516	0.218	1.135		0.776	0.030
	1995	0.543	0.152	0.560	0.235	1.557		1.013	0.028
	1996	0.328	0.118	0.517	0.218	0.880		0.709	0.029
	1997	0.534	0.158	0.609	0.256	0.477		0.568	0.030
	1998	0.724	0.195	0.573	0.242	0.815		0.603	0.030
	1999	1.207	0.257	0.702	0.297	0.582		0.826	0.039
	2000	0.887	0.221	0.720	0.305			1.252	0.063
	2001	0.758	0.195	0.646	0.275			1.247	0.102
	2002	0.920	0.217	0.664	0.283				
	2003	1.077	0.245	0.732	0.313				
	2004	0.960	0.221	0.735	0.317	0.407			
	2005	1.161	0.241	0.702	0.305	0.765			
4	1975					1.220			
	1976					0.674			
	1977					1.439			
	1978					0.871			
	1979					0.965			
	1980					1.261			
	1981			1.000	0.727	1.375			
	1982			0.626	0.354	1.187			
	1983			0.346	0.177	0.872		1.038	0.060
	1984			0.429	0.200	0.901		1.060	0.055
	1985			0.464	0.196	1.349		1.042	0.048
	1986			0.458	0.183	0.973		0.801	0.035
	1987			0.410	0.149	0.755		0.785	0.042
	1988	0.669	0.272	0.428	0.152	1.170		0.705	0.035
	1989	0.529	0.232	0.391	0.141	1.752		0.631	0.036
	1990	0.817	0.286	0.365	0.133	1.275		0.681	0.036
	1991	0.700	0.219	0.483	0.170	0.781		0.816	0.034
	1992	0.643	0.212	0.428	0.147	0.398		0.828	0.031
	1993	0.535	0.167	0.392	0.134	0.586		0.634	0.032
	1994	0.338	0.122	0.380	0.131	1.068		0.515	0.029
	1995	0.367	0.126	0.387	0.133	0.854		0.562	0.028
	1996	0.252	0.105	0.363	0.125	0.928		0.423	0.029
	1997	0.459	0.148	0.456	0.156	0.636		0.349	0.030
	1998	0.576	0.173	0.421	0.145	0.710		0.326	0.031
	1999	0.720	0.197	0.534	0.183	0.703		0.356	0.039
	2000	0.657	0.192	0.514	0.177			0.593	0.061
	2001	0.657	0.179	0.517	0.178			0.786	0.105
	2002	0.801	0.202	0.506	0.175				
	2003	0.789	0.210	0.480	0.167				
	2004	0.849	0.207	0.531	0.185	0.351			
	2005	1.099	0.235	0.534	0.187	0.484			

Table 7. (cont.)

5+	1975					1.460			
	1976					1.065			
	1977					1.738			
	1978					1.282			
	1979					0.735			
	1980					1.082			
	1981			1.000	1.689	1.403			
	1982			0.750	0.960	1.336			
	1983			0.396	0.444	0.741		1.054	0.064
	1984			0.404	0.439	0.959		1.116	0.059
	1985			0.443	0.455	1.215		1.009	0.051
	1986			0.293	0.293	1.088		0.824	0.038
	1987			0.272	0.251	0.735		0.721	0.045
	1988	0.923	0.321	0.270	0.244	1.267		0.643	0.038
	1989	0.915	0.305	0.292	0.265	1.189		0.553	0.038
	1990	1.753	0.421	0.255	0.232	1.077		0.559	0.039
	1991	1.269	0.293	0.346	0.308	1.042		0.634	0.036
	1992	1.188	0.290	0.292	0.255	0.662		0.710	0.034
	1993	0.984	0.228	0.264	0.231	1.071		0.574	0.034
	1994	0.810	0.190	0.238	0.209	0.669		0.460	0.031
	1995	0.795	0.184	0.242	0.212	0.610		0.467	0.030
	1996	0.591	0.161	0.206	0.182	0.603		0.357	0.032
	1997	0.815	0.195	0.268	0.235	0.524		0.285	0.033
	1998	1.105	0.241	0.257	0.226	0.446		0.293	0.034
	1999	1.279	0.263	0.346	0.304	0.423		0.236	0.043
	2000	1.042	0.239	0.363	0.319			0.448	0.065
	2001	1.462	0.268	0.330	0.291			0.600	0.106
	2002	1.698	0.297	0.362	0.320				
	2003	1.265	0.266	0.311	0.277				
	2004	1.526	0.277	0.321	0.287	0.294			
	2005	1.848	0.303	0.350	0.315	0.311			

Table 8. Nominal and standard combined biomass CPUE for the north Atlantic swordfish stock from the main fisheries; Canada, Japan, Spain and US fisheries 1963-2005.

Year	N Obs	Nominal CPUE	Standard	Low	Upp	coeff var	std error
1963	95	3537.6	1052.1	870.9	1271.0	9.5%	99.7
1964	247	1211.3	380.1	329.9	437.9	7.1%	26.9
1965	192	765.0	239.8	206.1	279.0	7.6%	18.2
1966	197	753.4	228.7	196.8	265.8	7.5%	17.2
1967	208	967.5	277.8	239.6	322.2	7.4%	20.6
1968	286	665.2	219.9	191.8	252.2	6.9%	15.1
1969	263	617.4	196.5	170.9	226.0	7.0%	13.7
1970	182	739.3	219.2	188.0	255.6	7.7%	16.9
1971	.	.	.			.	.
1972							
1973							
1974							
1975	524	56.6	350.1	313.0	391.6	5.6%	19.6
1976	440	46.9	308.9	274.3	347.8	5.9%	18.3
1977	296	67.3	337.2	295.7	384.6	6.6%	22.2
1978	330	98.9	445.0	380.8	520.1	7.8%	34.7
1979	641	902.3	315.8	279.2	357.2	6.2%	19.5
1980	1056	562.8	252.2	226.1	281.4	5.5%	13.8
1981	810	170.4	230.6	204.9	259.5	5.9%	13.6
1982	942	271.6	283.4	254.7	315.2	5.3%	15.1
1983	699	327.7	222.3	199.2	248.1	5.5%	12.2
1984	821	286.7	212.6	191.7	235.9	5.2%	11.1
1985	1066	278.2	203.3	184.2	224.3	4.9%	10.0
1986	1301	341.4	195.3	177.6	214.8	4.8%	9.3
1987	1507	383.2	177.2	161.4	194.5	4.7%	8.3
1988	1725	411.9	178.2	162.8	195.1	4.5%	8.1
1989	2026	277.7	171.1	156.6	187.0	4.4%	7.6
1990	1990	289.5	167.3	153.1	182.9	4.4%	7.4
1991	2422	294.2	172.5	158.0	188.3	4.4%	7.6
1992	2915	266.6	152.4	139.7	166.2	4.3%	6.6
1993	3247	256.6	137.0	125.8	149.3	4.3%	5.9
1994	3924	235.4	124.2	114.0	135.2	4.3%	5.3
1995	4310	225.1	135.1	124.1	147.1	4.3%	5.8
1996	3560	148.1	109.0	99.9	118.8	4.3%	4.7
1997	3315	165.5	115.9	106.4	126.4	4.3%	5.0
1998	3003	149.5	117.7	107.9	128.4	4.4%	5.1
1999	2465	177.0	139.8	128.0	152.6	4.4%	6.2
2000	1626	262.1	156.9	143.2	171.8	4.6%	7.1
2001	1824	342.7	144.4	131.9	158.0	4.5%	6.5
2002	1589	378.6	156.1	142.5	171.0	4.6%	7.1
2003	1390	389.4	146.2	133.3	160.4	4.6%	6.8
2004	1430	371.2	153.5	140.0	168.4	4.6%	7.1
2005	1172	431.5	168.3	153.2	184.8	4.7%	7.9

Table 9. Catch rates presented to the 2006 stock assessment meeting.. Type code: S=Standardized, N=Nominal, A abundance, B biomass Nominal and standard combined biomass CPUE for the North Atlantic swordfish stock from the main fisheries; Canada Japan Spain and US fisheries 1963-2005.

Year	JPN_A	JPN_B	SPN_2002	TWN	BRZ	Ury	SPN_nominal	Santos	Ghana
1967	0.61	31.88							
1968	0.83	59.49		1.80					
1969	1.23	49.92		1.54					
1970	1.26	73.49		2.05					
1971	0.85	55.63		1.63				198	
1972	0.93	59.58		1.51				234	
1973	0.98	56.81		1.58				265	
1974	0.86	55.34		1.31				537	
1975	0.87	90.33		1.32				567	
1976	1.08	86.10		0.38				282	
1977	1.18	154.51		0.54				312	
1978	0.94	122.06		0.67	0.57			148	
1979	1.09	101.80		1.30	0.58			241	
1980	1.20	111.26		0.93	0.81			956	
1981	1.18	128.46		1.00	1.09			350	
1982	1.22	89.49		0.92	1.04	0.64		382	
1983	1.13	90.23		0.94	0.68	0.40		195	
1984	1.48	124.97		1.11	0.46	0.46		125	
1985	1.64	130.17		0.94	0.55	0.12		182	
1986	1.31	113.63		0.82	0.66	0.35		216	
1987	1.16	100.09		0.75	0.75	0.57		239	
1988	1.14	89.23		0.86	0.55	0.57	1.31	430	
1989	0.93	59.96	1.45	0.73	0.29	0.64	1.31	271	
1990	1.19	95.47	1.07	0.64	0.72	0.61	0.99	309	5.6
1991	0.73	60.38	1.04	0.74	0.40	0.46	1.00	179	3.9
1992	0.67	51.88	0.95	1.08	0.21	0.47	0.95	167	4.2
1993	0.68	56.58	0.83	0.79	0.53	0.95	0.83	157	3.6
1994	0.62	50.75	0.95	0.89	0.35	0.70	0.98	334	2.6
1995	0.53	50.12	1.07	0.73	0.31	2.07	1.18	613	1.7
1996	0.54	33.24	0.95	0.88	0.35	1.11	1.12	932	11.8
1997	0.46	29.70	0.88	0.59	0.42	1.24	0.93	658	2.4
1998	0.39	25.60	0.85	0.41	0.75	1.29	0.77	638	2.1
1999	0.36	25.05	0.87	0.35	0.32	1.25	0.81	643	2.2
2000	0.28	18.75	1.08	0.39	0.40	1.23	1.15	583	2.3
2001	0.24	16.26		0.43	0.47	1.39	1.09	250	17.9
2002	0.26	17.72		0.36	0.43	1.30	1.35	375	4.3
2003	0.20	13.14		0.31	0.97	0.46	0.98	358	28.4
2004	0.19	12.27			0.76	0.71	1.19	258	9.2
2005	0.17	10.35			0.84			283	
Type	S, A	S,B	S, B	S, B	S, A	N, A	N, B	S, B	N,B

Table 10. Inputs for GLM analysis to construct by-catch, targeted, and composite relative abundance patterns for characterizing the status of southern Atlantic swordfish.

Mean of 1989-2003	0.55	0.64	0.48	1.05
	Scaled Relative to mean of overlap			
	JPN_A	TWN	BRZ	SPN_nominal
1967	1.11			
1968	1.50	2.83		
1969	2.22	2.43		
1970	2.27	3.22		
1971	1.54	2.57		
1972	1.68	2.37		
1973	1.78	2.49		
1974	1.55	2.05		
1975	1.58	2.07		
1976	1.94	0.60		
1977	2.13	0.86		
1978	1.70	1.05	1.18	
1979	1.96	2.05	1.20	
1980	2.17	1.46	1.67	
1981	2.13	1.57	2.25	
1982	2.20	1.45	2.15	
1983	2.04	1.48	1.40	
1984	2.68	1.75	0.95	
1985	2.97	1.48	1.14	
1986	2.36	1.30	1.36	
1987	2.10	1.17	1.55	
1988	2.06	1.35	1.14	1.24
1989	1.69	1.15	0.60	1.24
1990	2.15	1.01	1.49	0.94
1991	1.31	1.16	0.83	0.95
1992	1.21	1.70	0.43	0.90
1993	1.22	1.25	1.09	0.79
1994	1.11	1.40	0.72	0.93
1995	0.96	1.15	0.64	1.12
1996	0.98	1.38	0.72	1.06
1997	0.83	0.93	0.87	0.88
1998	0.71	0.64	1.55	0.73
1999	0.65	0.54	0.66	0.77
2000	0.51	0.61	0.83	1.09
2001	0.43	0.68	0.97	1.03
2002	0.46	0.56	0.89	1.28
2003	0.36	0.48	2.00	0.93
2004	0.35		1.57	1.13
2005	0.31		1.74	

Table 11. GLM average patterns used to characterize different hypotheses about recent southern stock SWO biomass pattern.

Hypothesis Composite		Hypothesis Bycatch		Hypothesis Targeted	
year	cpue	year	cpue	year	cpue
1967	0.818	1967	1.071	1967	
1968	1.976	1968	2.219	1968	
1969	2.136	1969	2.379	1969	
1970	2.556	1970	2.799	1970	
1971	1.866	1971	2.109	1971	
1972	1.836	1972	2.079	1972	
1973	1.946	1973	2.189	1973	
1974	1.611	1974	1.854	1974	
1975	1.636	1975	1.879	1975	
1976	1.081	1976	1.324	1976	
1977	1.306	1977	1.549	1977	
1978	1.263	1978	1.429	1978	1.151
1979	1.690	1979	2.059	1979	1.171
1980	1.720	1980	1.869	1980	1.641
1981	1.937	1981	1.904	1981	2.221
1982	1.887	1982	1.879	1982	2.121
1983	1.593	1983	1.814	1983	1.371
1984	1.747	1984	2.269	1984	0.921
1985	1.817	1985	2.279	1985	1.111
1986	1.627	1986	1.884	1986	1.331
1987	1.560	1987	1.689	1987	1.521
1988	1.448	1988	1.759	1988	1.236
1989	1.170	1989	1.474	1989	1.178
1990	1.398	1990	1.634	1990	1.075
1991	1.063	1991	1.289	1991	0.946
1992	1.060	1992	1.509	1992	0.762
1993	1.088	1993	1.289	1993	0.873
1994	1.040	1994	1.309	1994	0.915
1995	0.968	1995	1.109	1995	1.069
1996	0.963	1996	1.234	1996	1.024
1997	0.982	1997	0.806	1997	0.887
1998	1.012	1998	0.601	1998	1.062
1999	0.759	1999	0.521	1999	0.723
2000	0.864	2000	0.486	2000	0.986
2001	0.882	2001	0.481	2001	1.010
2002	0.902	2002	0.436	2002	1.158
2003	1.047	2003	0.346	2003	1.356
2004	1.060	2004	0.311	2004	1.294
2005	1.114	2005	0.271	2005	1.711

Table 12. Summary base case assessment results for northern Atlantic swordfish. Estimates and confidence limits are bias-corrected based on 1000 bootstrap results. Y(2005) is the Task I catch for 2005, while Y(2006) is the model estimated replacement yield available in 2006.

Parameter	**Estimate**	**Lower 80%**	**Upper 80%**
Y(2005)	12140		
Y(2006)	14438	13410	14740
MSY	14133	12800	14790
B./Bmsy	0.99	0.87	1.27
F./Fmsy	0.86	0.65	1.04

Table 13. Means and CVs of the marginal posterior distributions of management parameters from the BSP model. Values for K, MSY, B. and yield are in metric tons.

Parameter	Mean	CV
K	1.33E+05	0.19
r	0.43	0.24
MSY	1.37E+04	0.04
B2005	6.52E+04	0.18
B2005/K	0.50	0.15
B1950	1.16E+05	0.25
B2005/B1950	0.58	0.23
C2005/MSY	0.89	0.04
F2005/Fmsy	0.92	0.19
B2005/Bmsy	1.00	0.15
C2005/rep-y	0.90	0.05
Bmsy	6.64E+04	0.19
rep.yield	1.35E+04	0.05

Table 14. Comparison of results of production model runs in 2006 versus 2002.

Parameter	**ASPIC-2006**	**ASPIC2002**	**BSP2006**	**BSP2002**
MSY	1.41E+04	1.43E+04	1.37E+04	1.40E+04
B./Bmsy	0.99	0.94	1.00	0.97
F./Fmsy	0.86	0.75	0.92	0.78
r	0.49	0.56	0.43	0.41

Table 15. Base Case VPA estimates of the abundance of North Atlantic swordfish at the beginning of the year. The abundance of age 1 at the beginning of 2006 is not estimated by the VPA and therefore is not shown. Note that these results include years 2004-2005 data for JLL.

	age				
Year	1	2	3	4	5+
1978	453367	313630	220550	162504	249997
1979	499312	365167	239468	148075	246399
1980	426861	399431	274111	165027	234519
1981	432225	326160	285592	179759	230531
1982	491298	340332	235227	196229	255382
1983	521935	383026	248620	151820	272028
1984	546343	400716	264233	152913	242487
1985	636238	420316	280509	165642	234237
1986	657317	490819	290975	169169	227728
1987	674459	494607	316513	158622	199779
1988	683403	482606	299093	161857	159645
1989	679686	483073	276937	156441	155338
1990	564896	487293	291987	144421	148966
1991	571189	418828	294000	156600	148056
1992	559328	425097	267334	152413	157750
1993	612362	418120	262147	143772	156088
1994	572799	450603	250538	129470	141308
1995	487046	413001	273163	133880	131158
1996	483992	351115	233111	133559	121664
1997	562911	343493	196292	102207	115394
1998	509507	400142	206224	101614	102999
1999	496770	371489	225560	106587	100450
2000	494155	364420	205957	114495	107872
2001	527537	361264	200548	101118	115176
2002	591493	403143	223359	107693	115888
2003	550140	452743	261733	131227	125837
2004	449322	423984	288171	146271	145121
2005	819176	331848	269070	168030	162186
2006		635402	197019	156695	199154

Table 16. Base Case VPA estimates of the fishing mortality rates on North Atlantic swordfish.

	Age				
Year	1	2	3	4	5+
1978	0.016	0.07	0.198	0.271	0.345
1979	0.023	0.087	0.172	0.274	0.349
1980	0.069	0.135	0.222	0.303	0.385
1981	0.039	0.127	0.175	0.238	0.303
1982	0.049	0.114	0.238	0.267	0.339
1983	0.064	0.171	0.286	0.423	0.324
1984	0.062	0.157	0.267	0.379	0.29
1985	0.059	0.168	0.306	0.422	0.323
1986	0.084	0.239	0.407	0.564	0.433
1987	0.135	0.303	0.471	0.703	0.539
1988	0.147	0.355	0.448	0.527	0.527
1989	0.133	0.303	0.451	0.539	0.539
1990	0.099	0.305	0.423	0.484	0.484
1991	0.095	0.249	0.457	0.458	0.458
1992	0.091	0.283	0.42	0.487	0.487
1993	0.107	0.312	0.505	0.552	0.552
1994	0.127	0.301	0.427	0.525	0.525
1995	0.127	0.372	0.516	0.579	0.579
1996	0.143	0.382	0.625	0.594	0.594
1997	0.141	0.31	0.458	0.548	0.548
1998	0.116	0.373	0.46	0.511	0.511
1999	0.11	0.39	0.478	0.452	0.452
2000	0.113	0.397	0.511	0.458	0.458
2001	0.069	0.281	0.422	0.424	0.424
2002	0.067	0.232	0.332	0.375	0.375
2003	0.06	0.252	0.382	0.372	0.372
2004	0.103	0.255	0.339	0.386	0.386
2005	0.054	0.321	0.341	0.306	0.306

Table 17. Base Case VPA estimates of begin-year biomass (t) of North Atlantic swordfish.

	Age					
Year	1	2	3	4	5+	total
1978	6801	8468	9484	9913	28250	62915
1979	7490	9129	10058	9033	27843	63552
1980	6403	10385	11513	10067	26032	64399
1981	6483	8480	11995	10965	25589	63513
1982	7369	8849	9880	12166	28092	66356
1983	7829	9959	10691	9413	28563	66454
1984	8195	10819	11098	9328	25219	64659
1985	9544	10928	11781	10104	24361	66718
1986	9860	12761	12221	10150	23684	68676
1987	10117	12860	13294	9517	20377	66165
1988	9568	12065	12562	9873	16443	60511
1989	10195	12077	11354	9386	15844	58857
1990	8473	12670	11971	8665	15046	56825
1991	7997	10890	12348	9396	15102	55732
1992	8390	11053	10961	8992	16091	55486
1993	9185	10871	10748	8626	16077	55508
1994	8019	11716	10272	7768	14696	52471
1995	7306	10738	11200	7899	13772	50914
1996	6776	9129	9324	7880	12531	45641
1997	7881	8587	8048	6030	12809	43355
1998	7643	10004	8249	5995	10815	42705
1999	6458	9287	9022	6289	10447	41503
2000	6918	9111	8238	6755	11111	42133
2001	7386	9032	8022	5966	11978	42383
2002	8281	10079	9158	6354	12168	46039
2003	8252	11319	10469	7742	13213	50995
2004	6740	11024	11527	8630	15238	53158
2005	13107	8628	10763	9914	17030	59441

Table 18. Benchmark measures from unisex yield per recruit and spawner per recruit analyses (assuming the 'average' recruitment scenario for SSB computations) with 80% bootstrap confidence limits. The reference to MLE refers to the maximum likelihood estimates from the VPA, whereas mean and median refer to the bootstrap results.

	LOWER CL	MEDIAN	UPPER CL	MEAN	MLE	STD. DEV.
F at max. Y/R	0.28	0.29	0.31	0.29	0.28	0.011
Y/R maximum	25.02	25.39	25.81	25.40	25.41	0.313
S/R at Fmax	42.32	43.07	43.64	43.02	43.03	0.515
SPR at Fmax	0.13	0.13	0.13	0.13	0.13	0.002
SSB at Fmax	23321	23664	24017	23665	23640	277
F0.1	0.15	0.15	0.16	0.15	0.15	0.005
Y/R at F0.1	23.09	23.38	23.72	23.39	23.40	0.243
S/R at F0.1	99.99	100.70	101.25	100.67	100.58	0.497
SPR at F0.1	0.30	0.30	0.30	0.30	0.30	0.001
SSB at F0.1	54452	55294	56371	55385	55251	753
F at 20% SPR	0.21	0.21	0.22	0.22	0.21	0.007
Y/R at 20% SPR	24.60	24.95	25.35	24.96	24.97	0.293
S/R at 20% SPR	67.20	67.37	67.55	67.37	67.24	0.124
SSB at 20% SPR	36551	37023	37617	37065	36938	431
F at 30% SPR	0.15	0.15	0.16	0.15	0.15	0.005
Y/R at 30% SPR	23.05	23.37	23.73	23.37	23.36	0.264
S/R at 30% SPR	100.65	100.93	101.20	100.93	101.28	0.199
SSB at 30% SPR	54744	55486	56364	55529	55635	643
F at 40% SPR	0.11	0.11	0.12	0.11	0.11	0.004
Y/R at 40% SPR	20.80	21.08	21.40	21.08	21.05	0.232
S/R at 40% SPR	134.09	134.46	134.87	134.47	134.96	0.280
SSB at 40% SPR	72968	73920	75095	73982	74138	852

Table 19. Summary estimates for 12 initial runs of the ASPIC production model applied to south Atlantic swordfish using data for 1970-2005. Bmsy=Bmax and Fmsy=Fmax.

Run	Model	B_{1970}/K	MSY	K	Fmsy	B_{2006} /Bmsy	F_{2005} /Fmsy	ObjFun
Target pattern CPUE								
R1Hi	Logistic	Estimate	18570	52470	0.7078	1.548	0.4432	1.288036
R2Hi	Logistic	Fix=1	18570	26240	0.7077	1.548	0.4433	1.288036
R3Hi	Fox	Estimate	21420	20520	1.044	2.015	0.295	1.280371
R4Hi	Fox	Fix=1	21430	20520	1.044	2.015	0.295	1.280371
Bycatch pattern CPUE								
R1Lo	Logistic	Estimate	4127	1167000	0.003535	0.02932	89.47	1.341002
R2Lo	Logistic	Fix=1	2810	175300	0.01603	0.1882	20.56	1.378469
R3Lo	Fox	Estimate	9317	74200	0.1256	0.2473	4.736	1.292628
R4Lo	Fox	Fix=1	8103	84240	0.09618	0.2711	5.046	1.353556
Composite pattern CPUE								
R1Av	Logistic	Estimate	15740	45710	0.3443	1.252	0.6558	1.463906
R2Av	Logistic	Fix=1	15740	45670	0.3447	1.253	0.6552	1.463946
R3Av	Fox	Estimate	16950	43500	0.3897	1.6	0.4738	1.410395
R4Av	Fox	Fix=1	16980	43600	0.3895	1.604	0.4718	1.451442

Table 20. Summary base case assessment results for southern Atlantic swordfish. Estimates and confidence limits are bias-corrected based on 1000 bootstrap results. Bmsy=Bmax and Fmsy=Fmax.

Par.	Estimate	Lower 80%	Upper lower
Y(2005)	12690		
MSY	16982	14100	18130
B_{2006}/Bmsy	1.57	1.29	1.74
F_{2005}/Fmsy	0.42	0.40	0.69

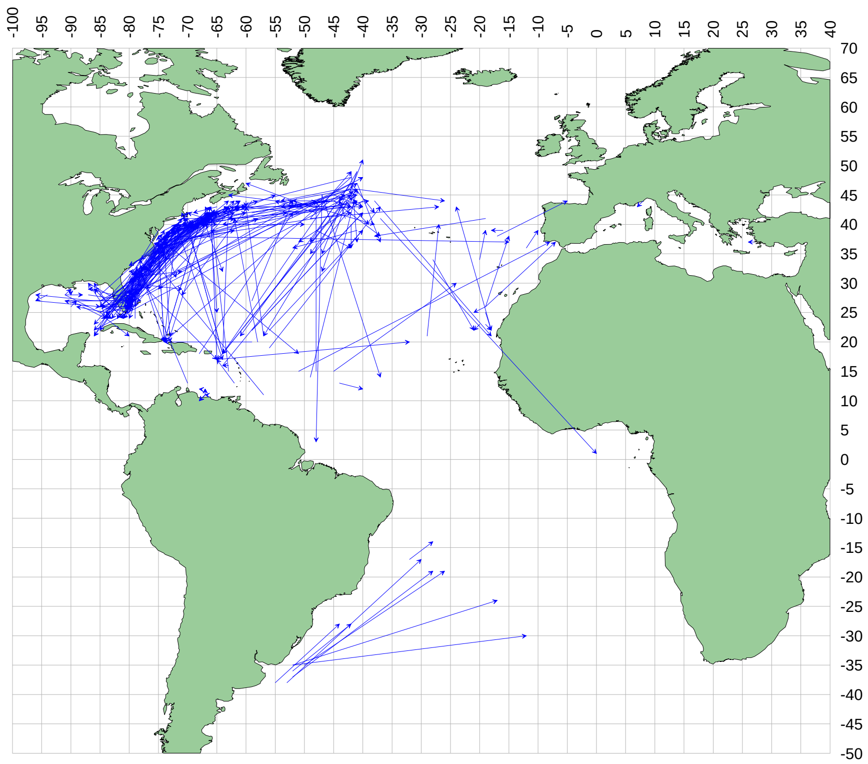

Figure 1. Atlantic swordfish linear movements inferred from ICCAT release-recovery data base, current to September 2006.

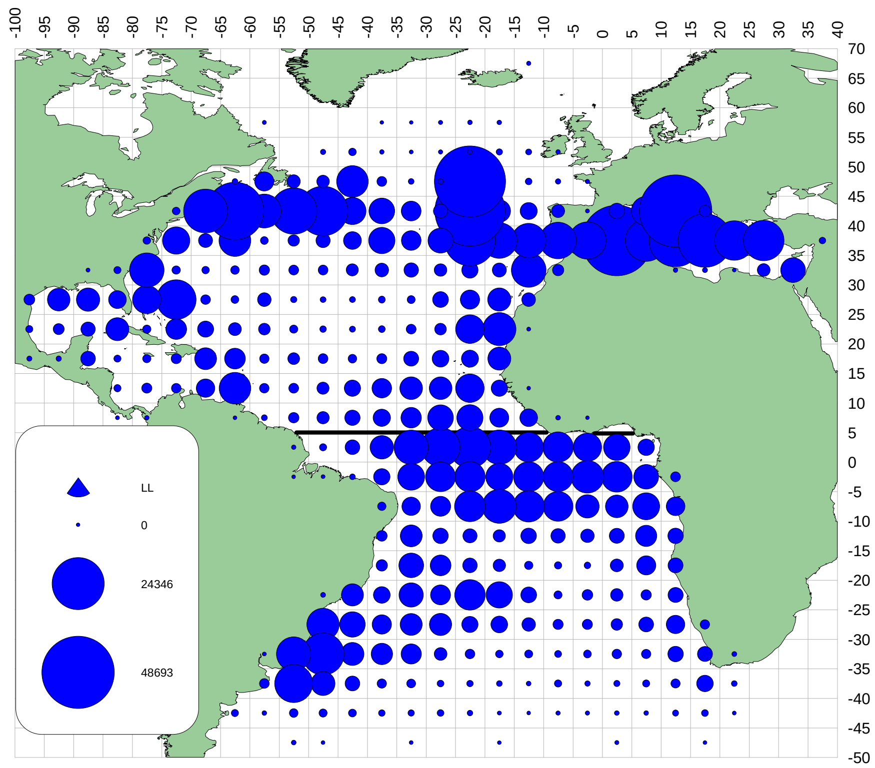

Figure 2. Geographical distribution of cumulative SWO catch (tons) by longline, for the period 1950-2004 in the ICCAT Convention Area.

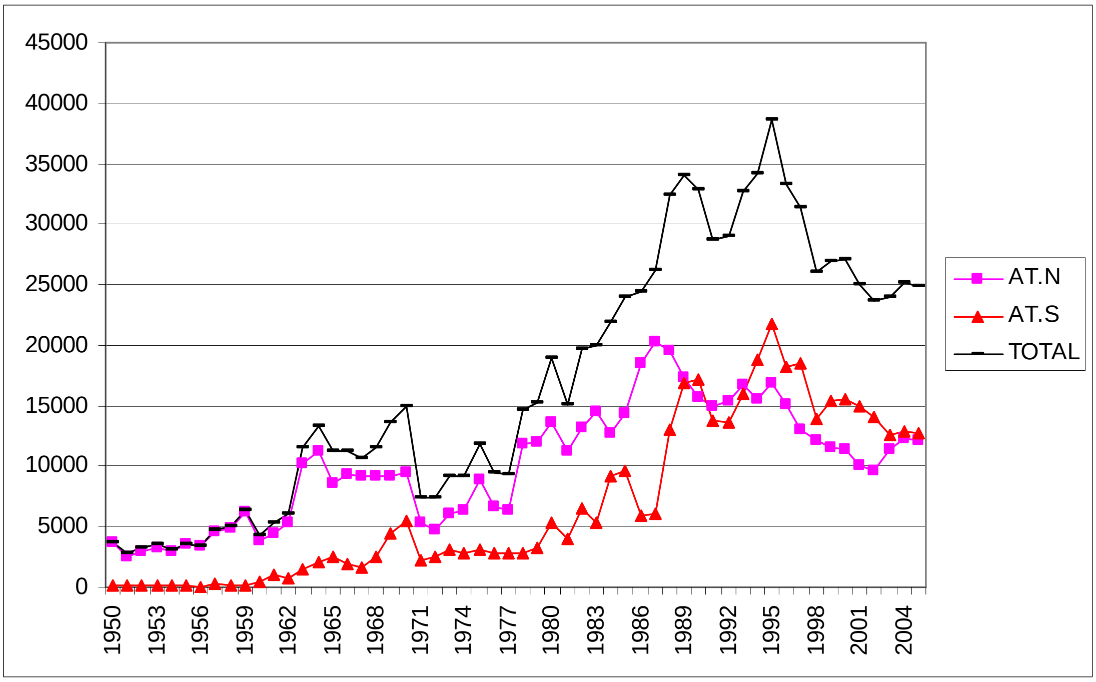

Figure 3. Swordfish catches (in t) for North, South and total Atlantic, for the period 1950-2005.

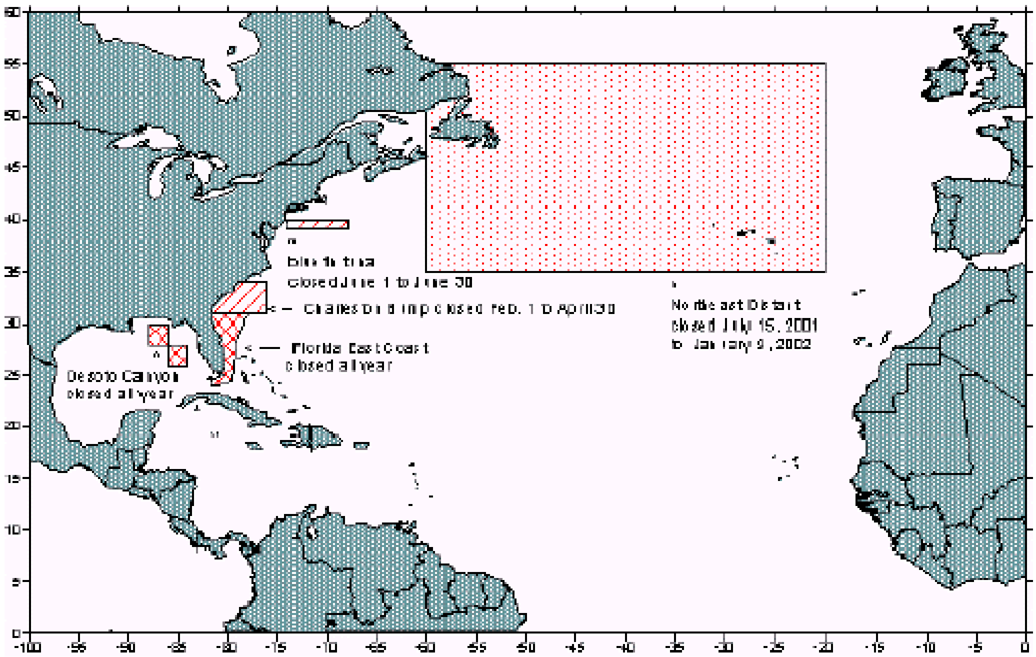

Figure 4. Time-area closures implemented in year 2001 affecting the U.S. longline fishery.

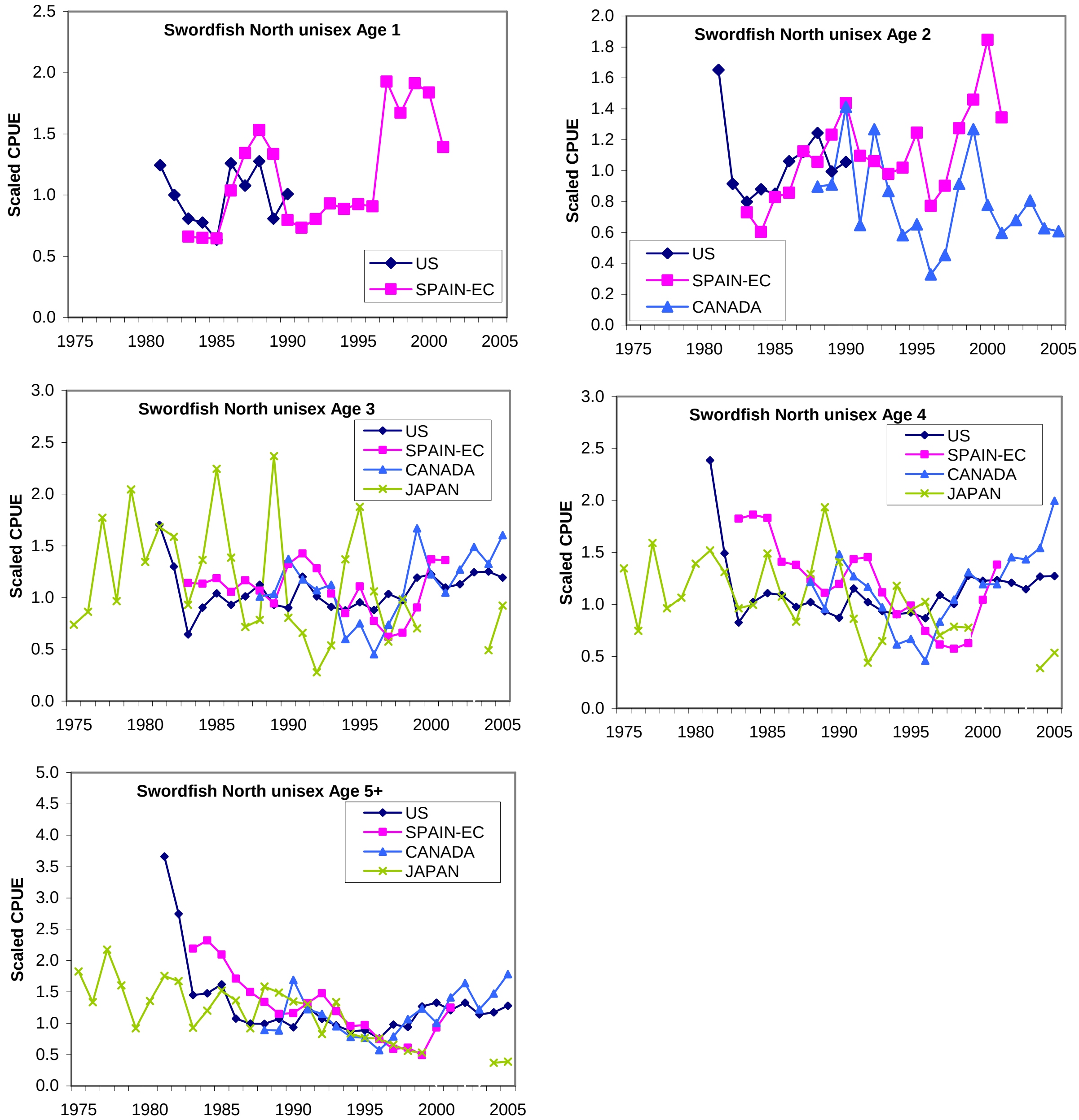

Figure 5. North Atlantic swordfish standardized catch rates by age (combined sexes). CPUE series are scaled to their mean for the overlapping years.

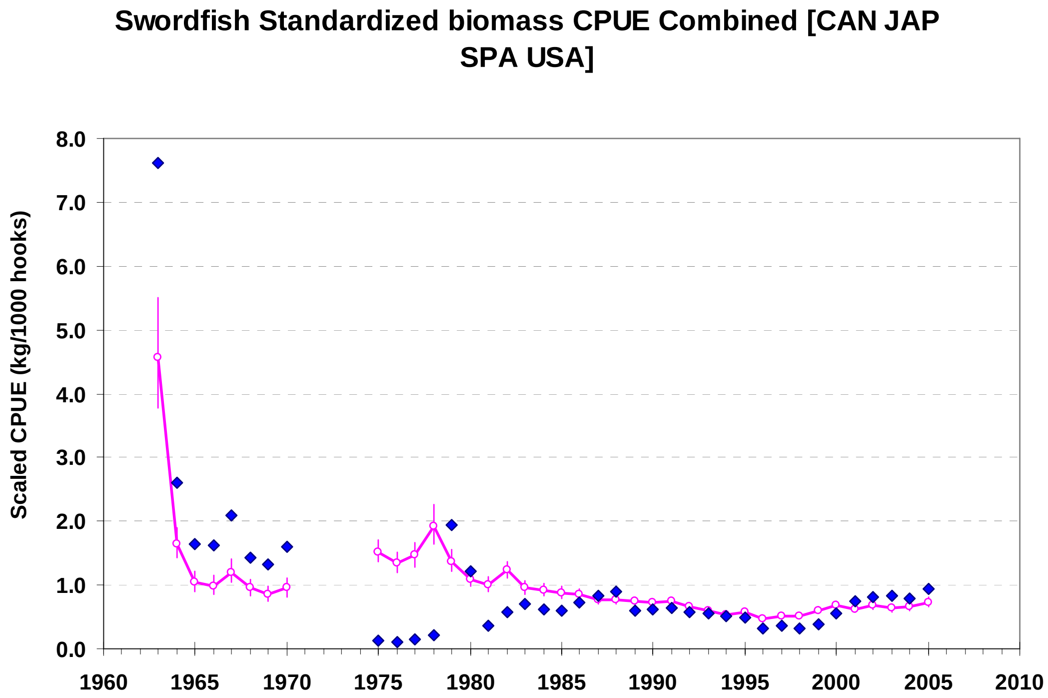

Figure 6. Nominal (solid diamonds) and standardized combined biomass CPUE for the North Atlantic swordfish stock from the main longline fisheries; Canada, Japan, Spain and USA.

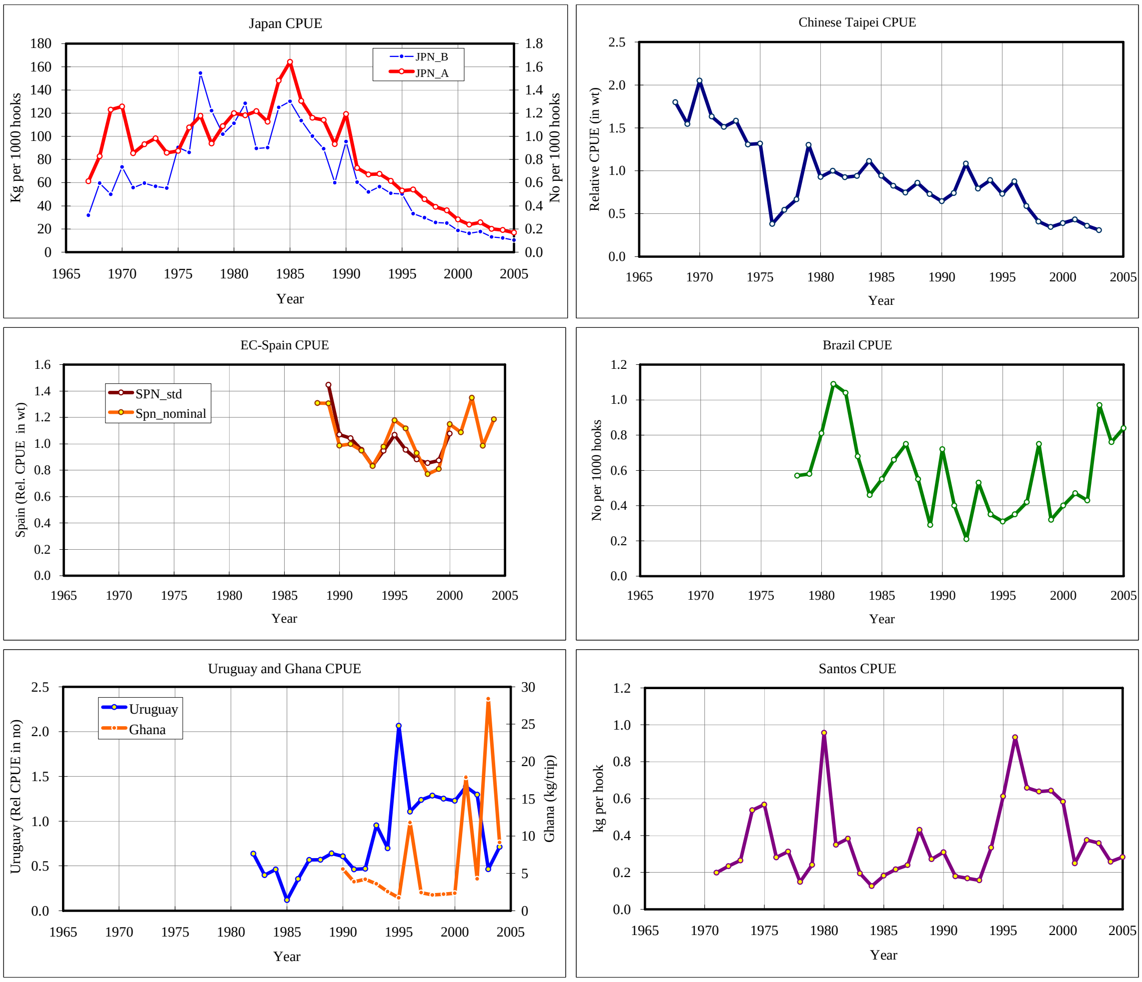

Figure 7. South Atlantic swordfish nominal and standardized catch rates of the main fisheries (see Table 9).

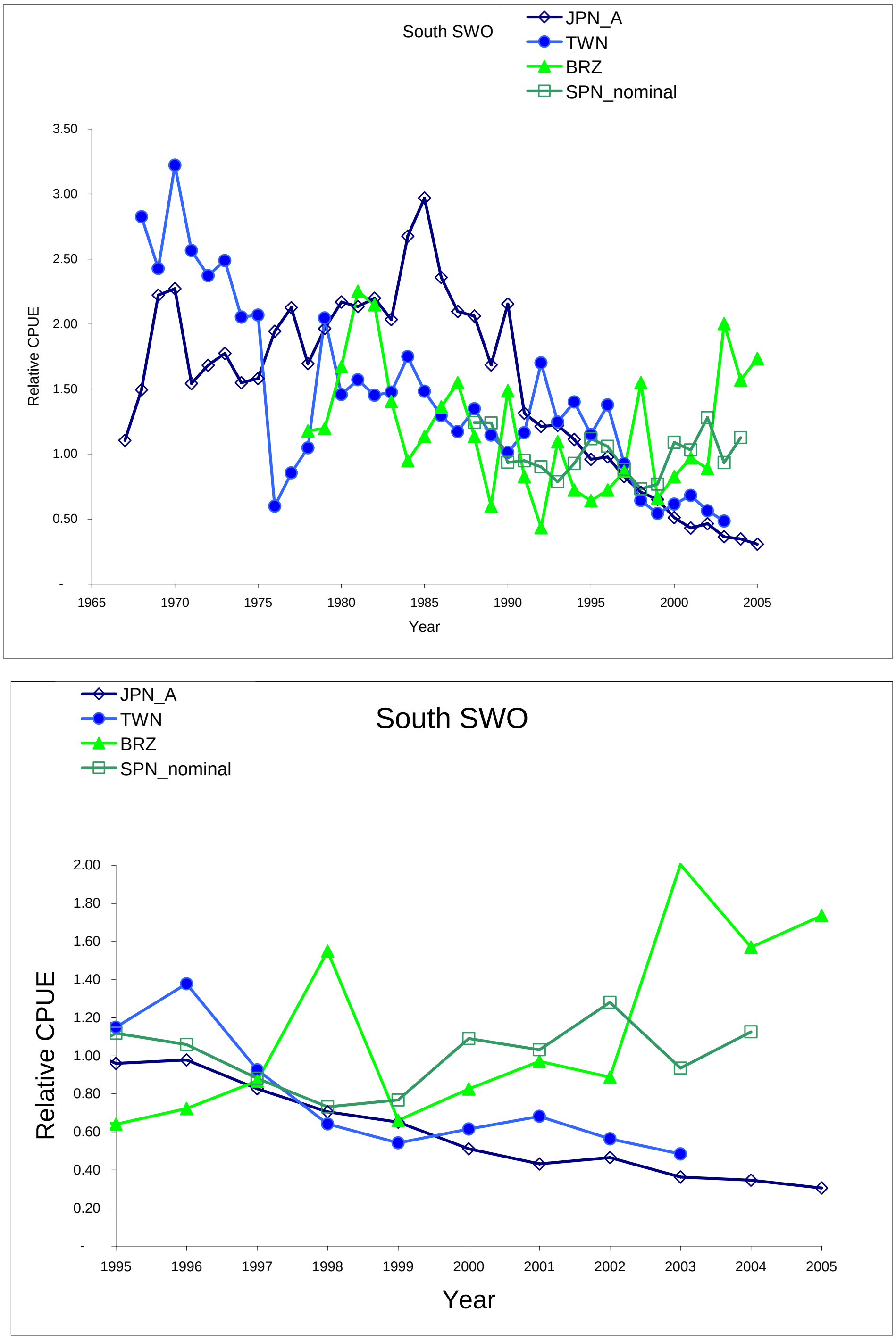

Figure 8. The patterns in catch rates for southern Atlantic swordfish across time from two by-catch fisheries and from two targeting fisheries, as indicated over the entire time series and since the mid-1990s where divergence in trend started.

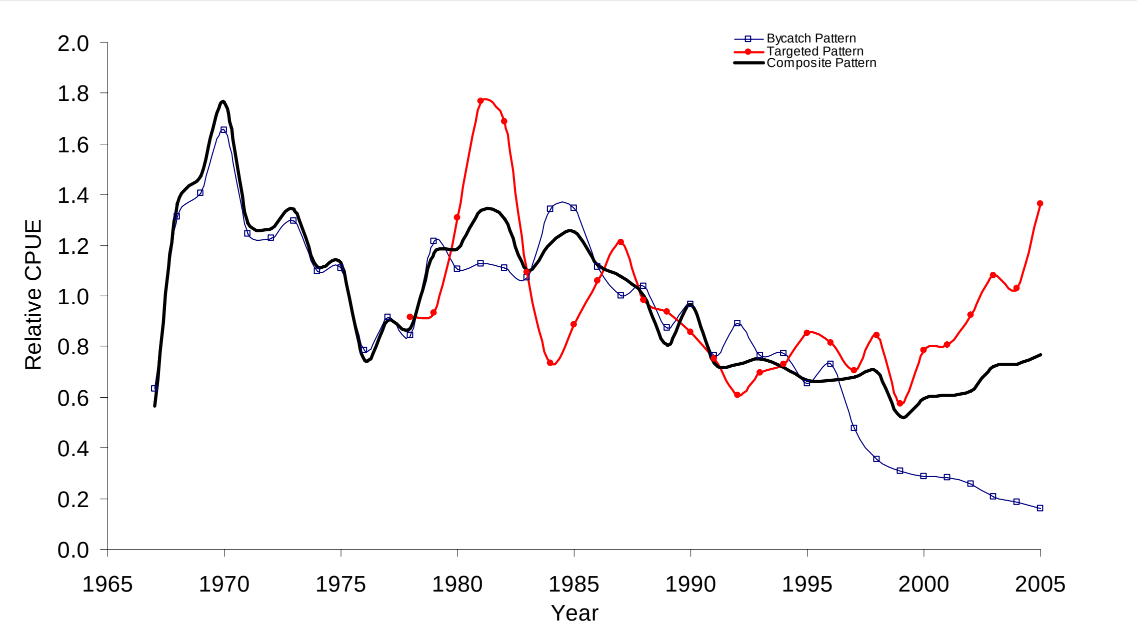

Figure 9. The by-catch fishery, the targeted fishery, and the averaged pattern used to characterize recent trends in the southern stock of swordfish.

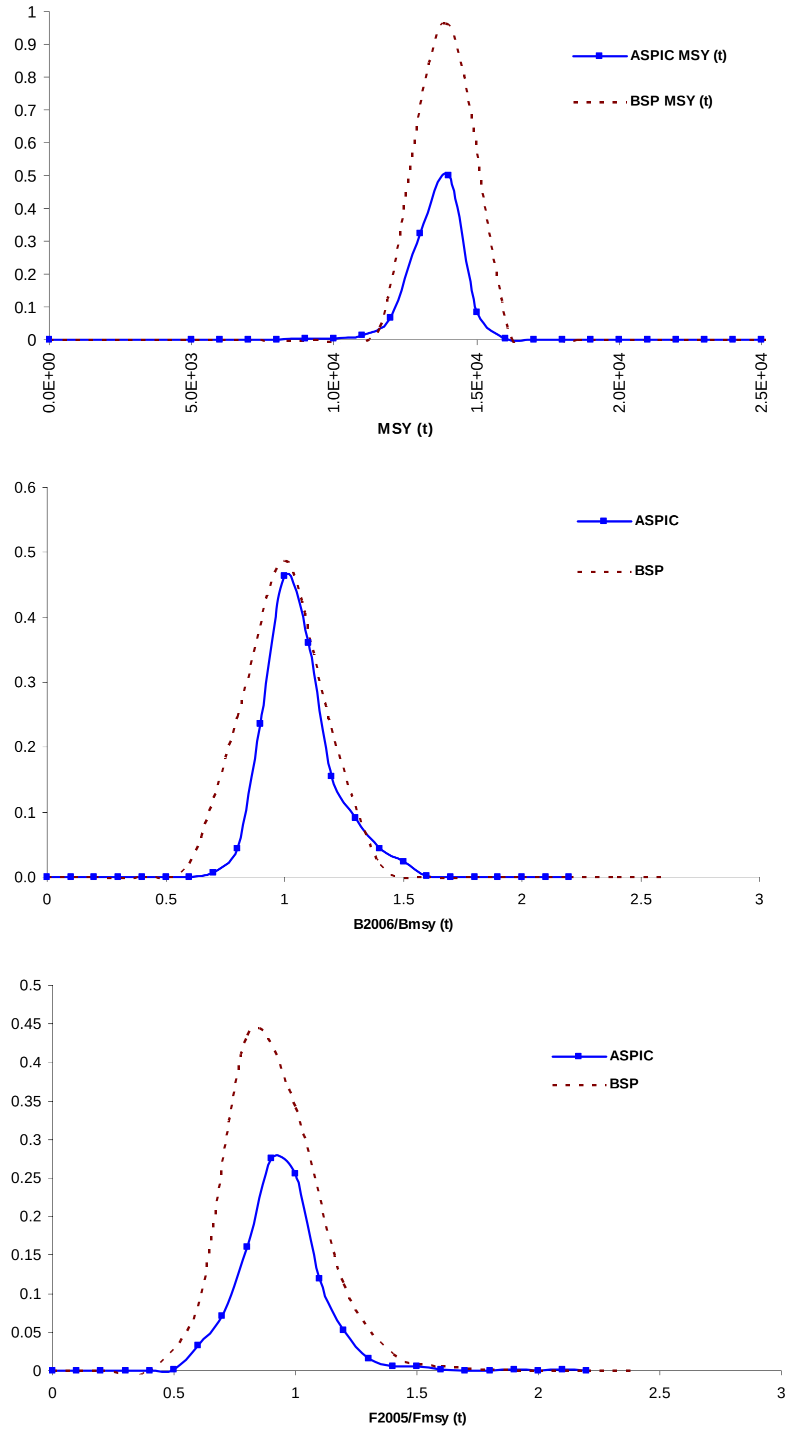

Figure 10. Distributions of the estimates of MSY (top), current biomass ratio (middle) and current fishing mortality ratio (bottom) from the two production models applied to the northern stock. The ASPIC results (solid line) were obtained by bootstrapping the production model fit assuming the Schaefer form; the BSP results (dashed line) are Bayesian posteriors.

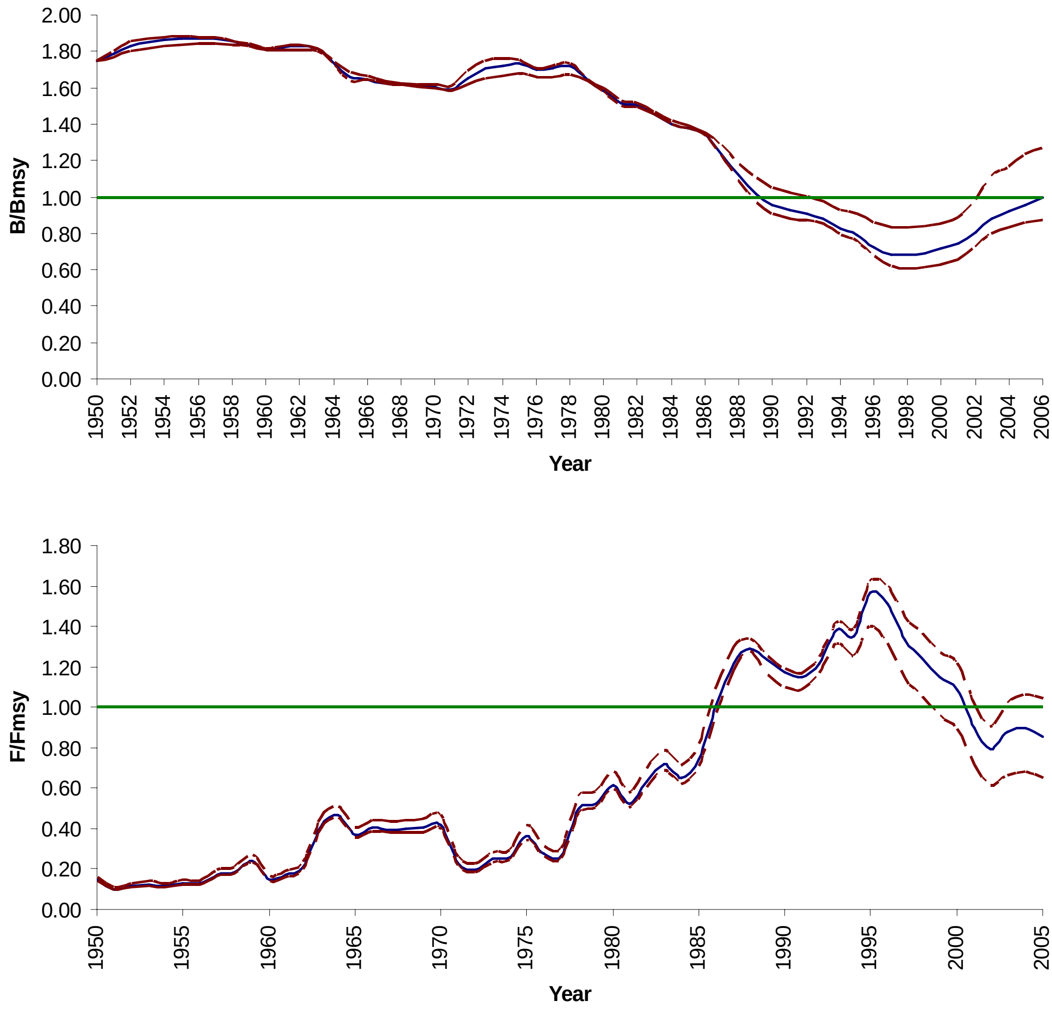

Figure 11. Bias corrected medians and 80% confidence limits for relative biomass (top) and relative fishing mortality (bottom) for the northern stock as estimated by ASPIC.

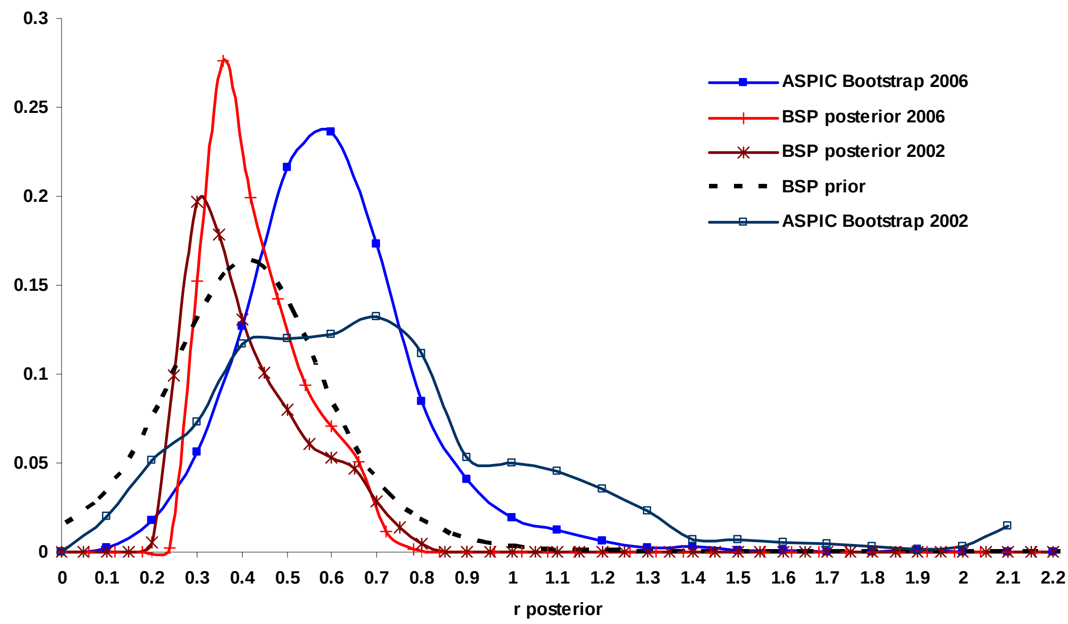

Figure 12. Distributions of the estimates of r from the two production models applied to the northern stock. The ASPIC results were obtained by bootstrapping the production model fit assuming the Schaefer form; the Bayesian Surplus Production model (BSP) results are Bayesian posteriors. The dashed black line is the prior inputted to the BSP model.

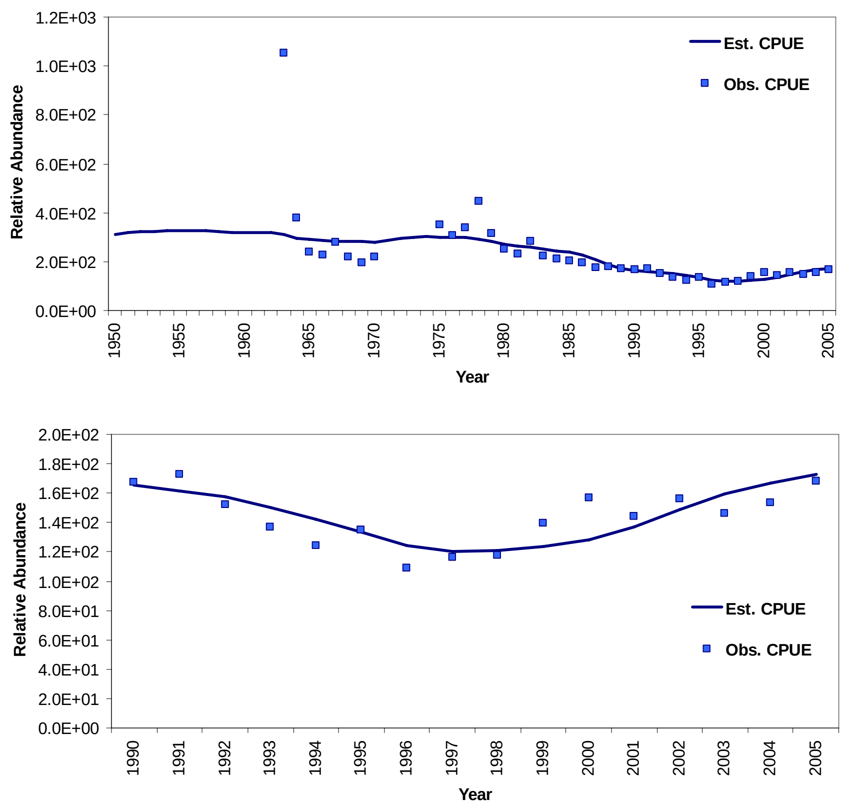

Figure 13. Fit from ASPIC to the combined biomass index for the northern stock.

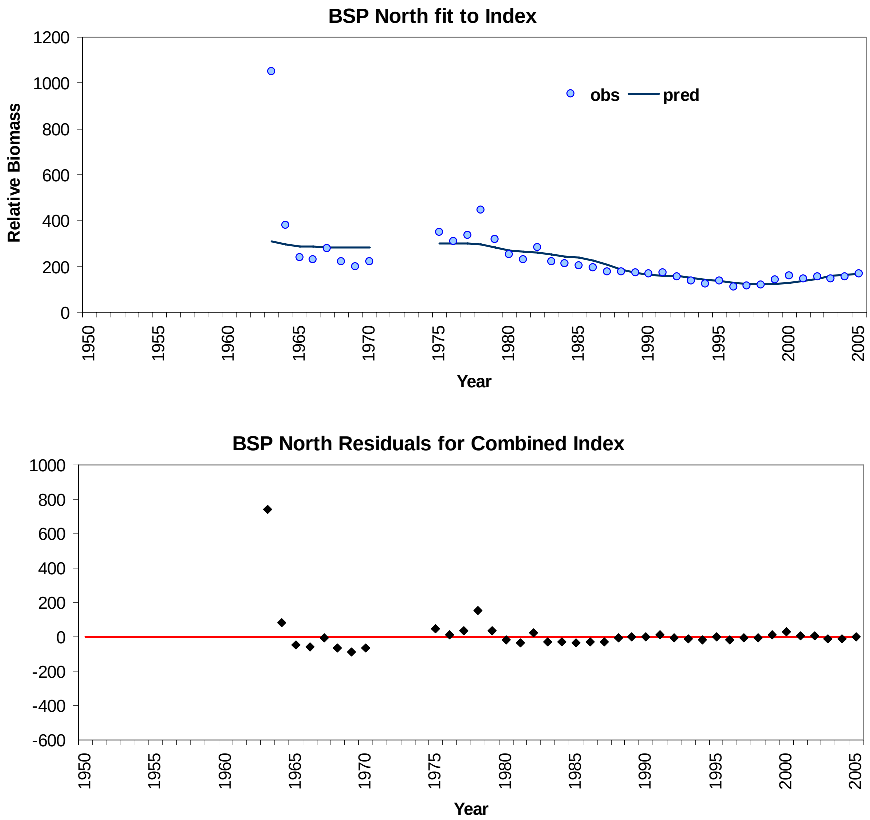

Figure 14. Fit from BSP to the combined biomass index (top) and residuals (bottom) for the northern stock.

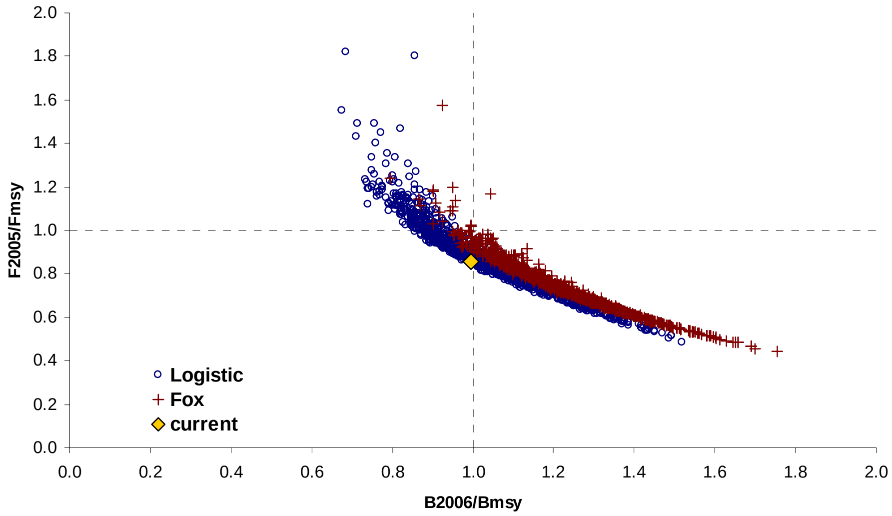

Figure 15. Scatterplot of the estimated pairs of current biomass and fishing mortality ratios for northern Atlantic swordfish. The pairs were obtained from 1000 bootstraps of the production model fit to the Composite CPUE data, assuming a Logistic model (open circles) or a Fox model (crosses). A solid diamond symbol indicates the current estimate.

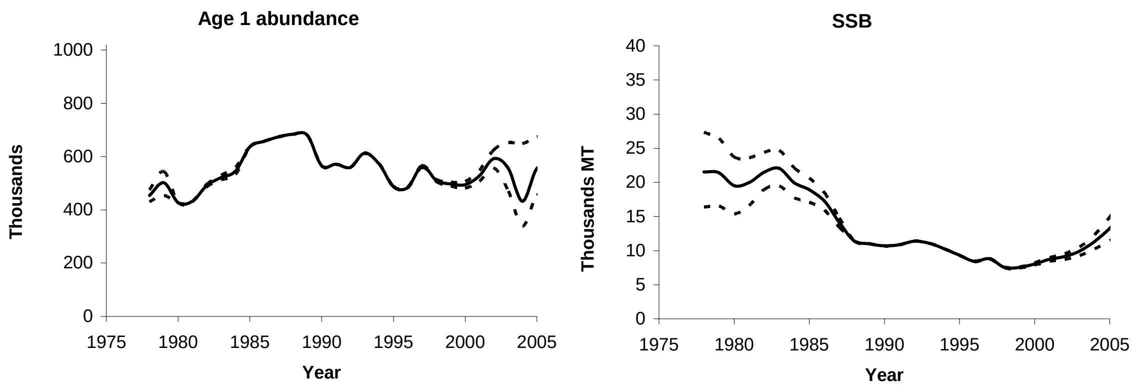

Figure 16. Base VPA estimates of North Atlantic swordfish recruitment and mid-year spawning biomass (solid lines) with 80 percent bootstrap confidence limits (dashed lines).

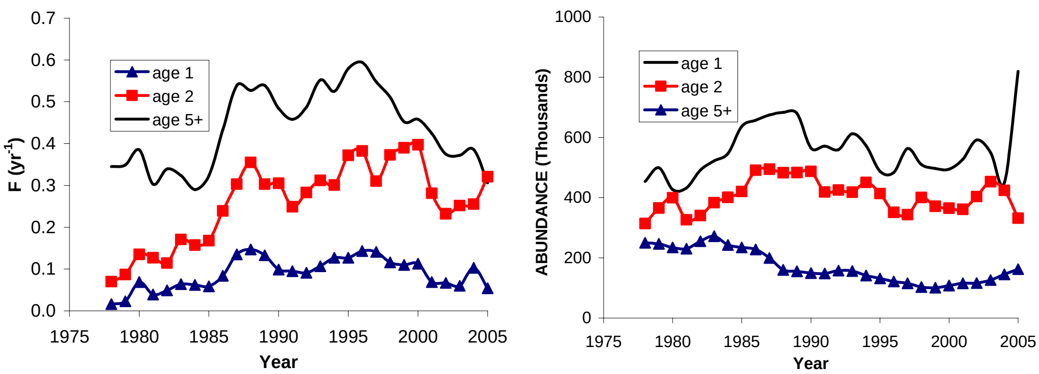

Figure 17. Estimates of fishing mortality rate and abundance of age 1, 2 and 5+ North Atlantic swordfish from base VPA.

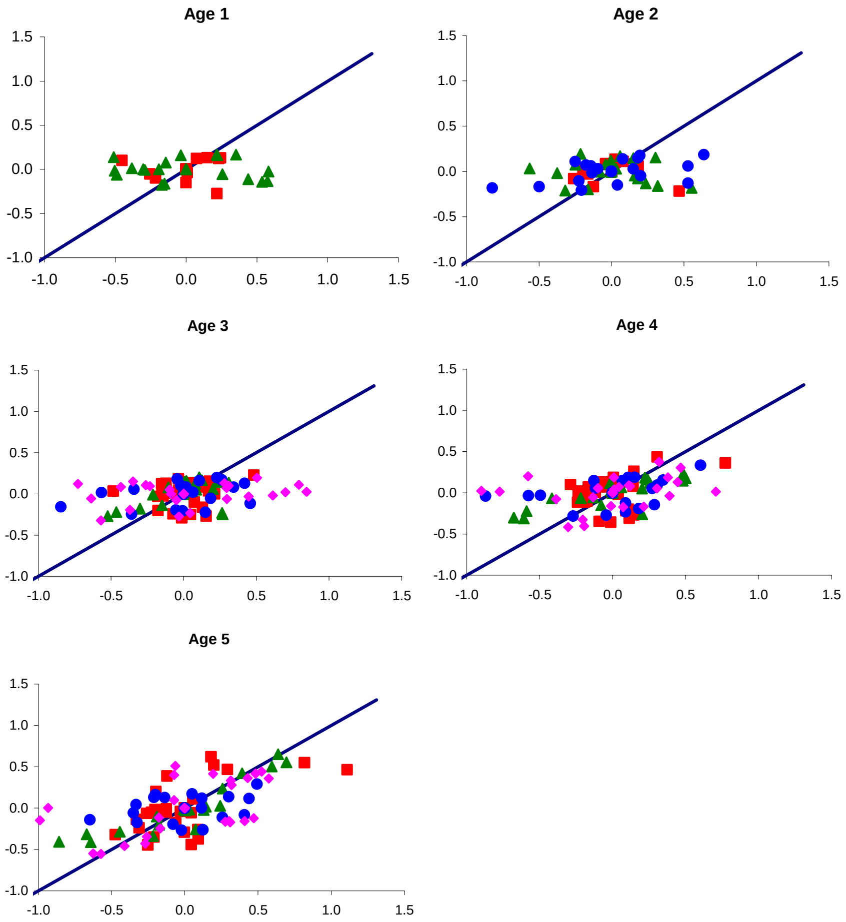

Figure 18. Predicted versus observed values of indices (divided by their respective series means) on logarithmic scale. Squares, triangles, circles and diamonds represent indices from the United States, Spain, Canada and Japan.

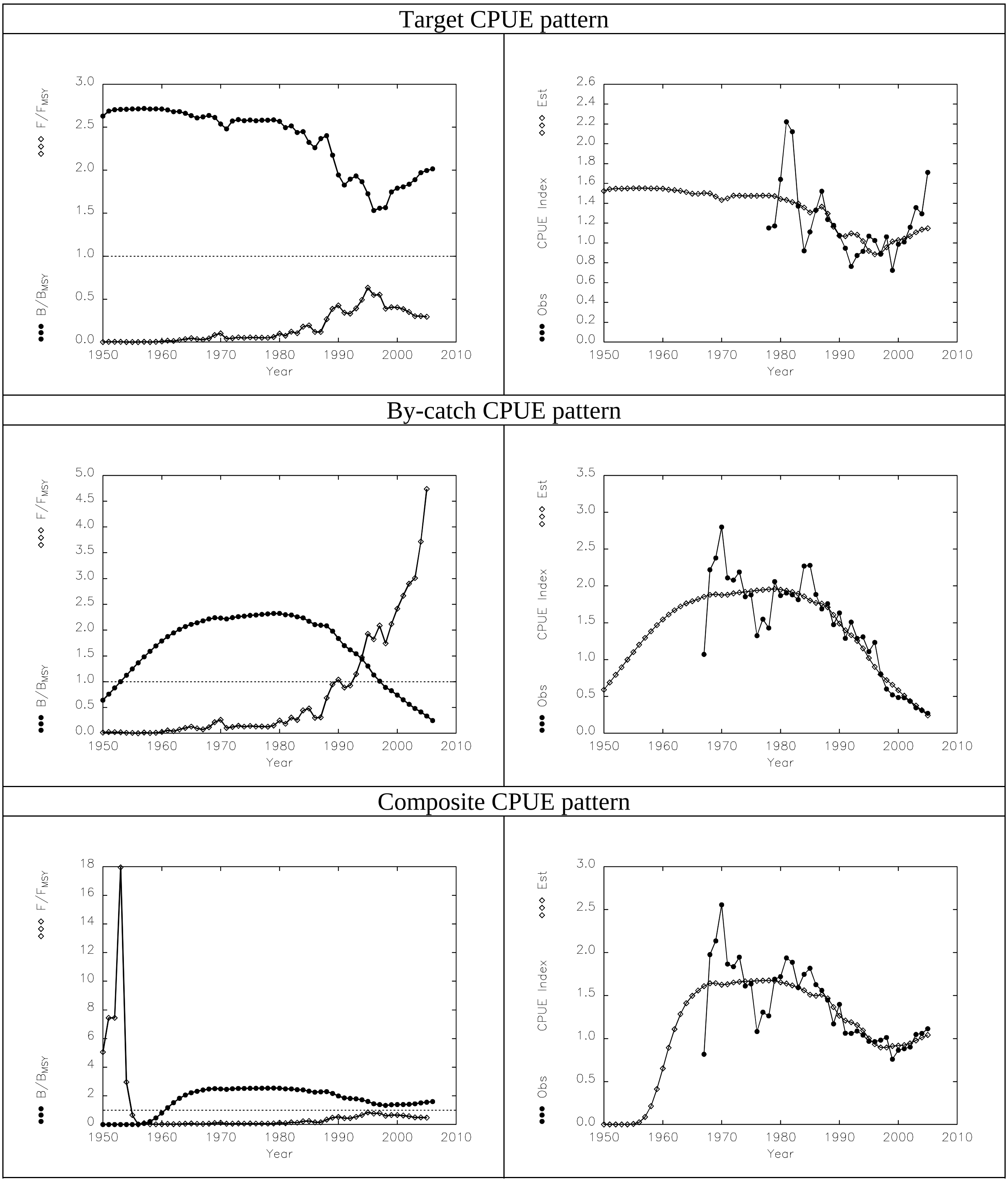

Figure 19. Example initial results obtained by fitting a production model to three datasets for southern Atlantic swordfish. Fits were obtained assuming a Fox model and estimating the biomass in 1950.

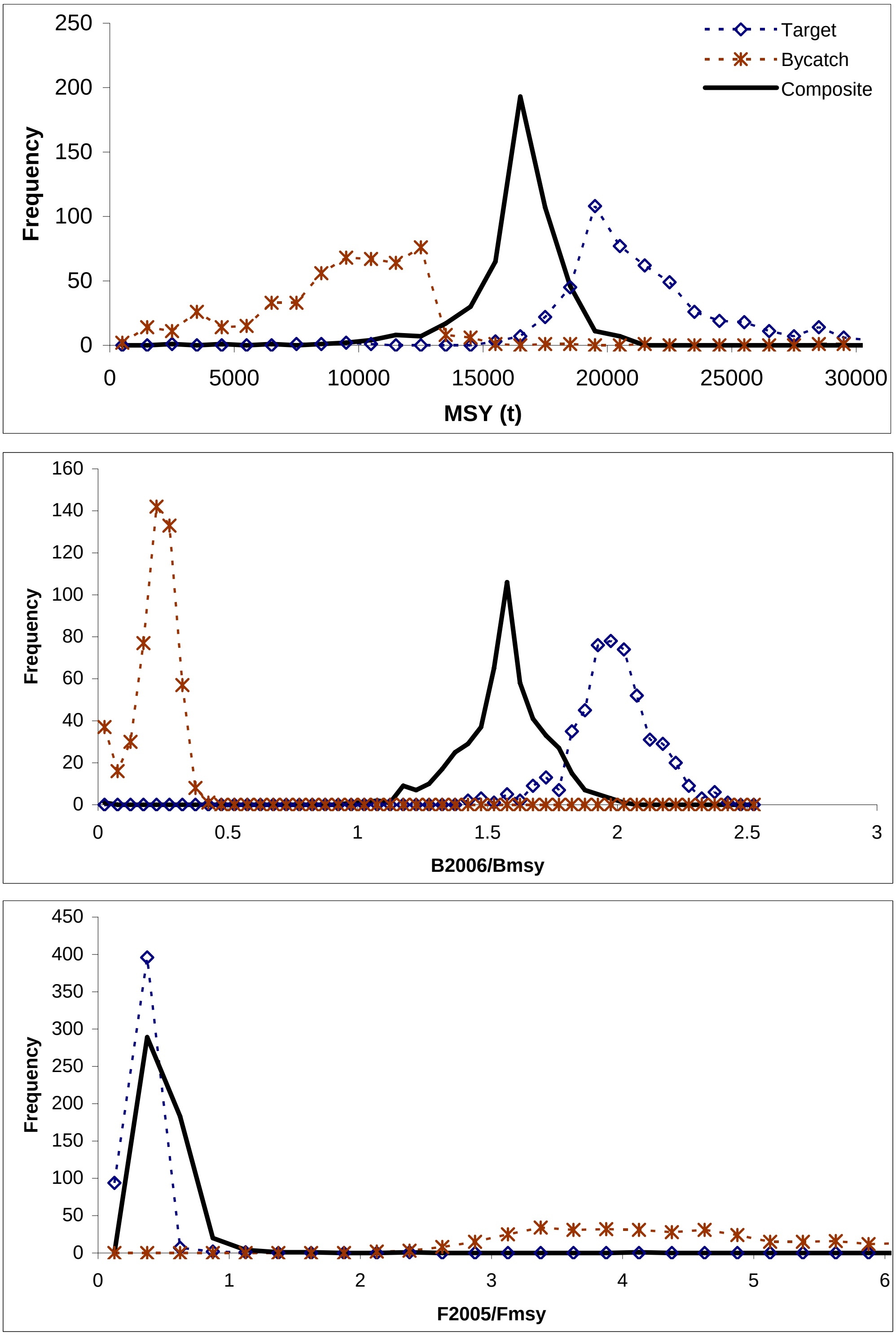

Figure 20. Distributions of the estimates of MSY (top), current biomass ratio (middle) and current fishing mortality ratio (bottom) obtained by bootstrapping the production model fits for three data sets: Target CPUE pattern (broken lines with diamonds), By-catch CPUE pattern (broken line with asterisks) and a Composite CPUE pattern (solid line). The fits were obtained assuming a Fox production function.

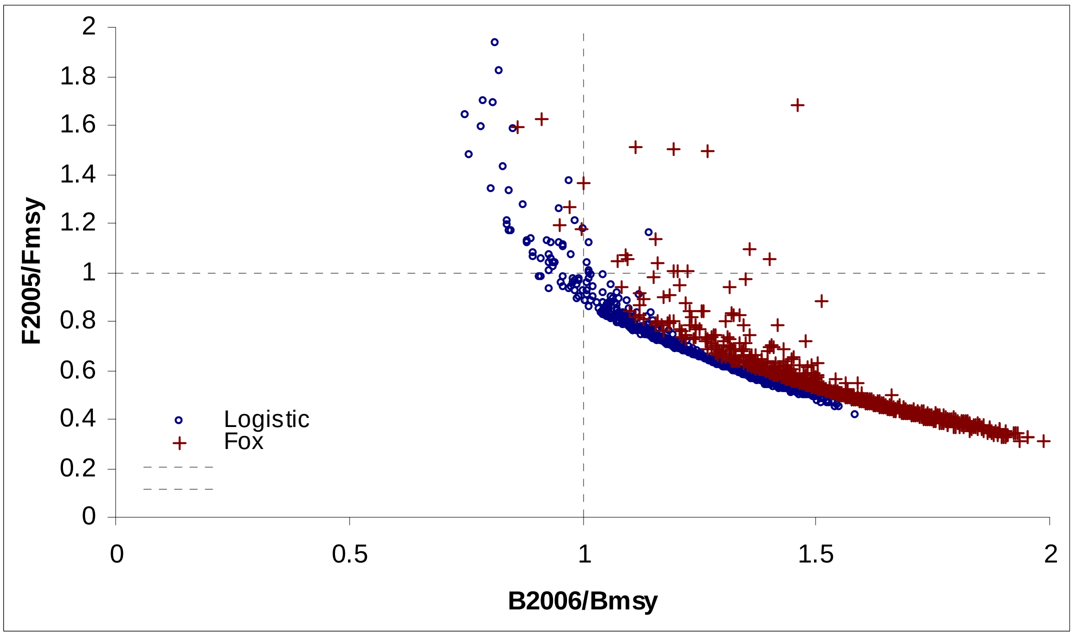

Figure 21. Scatterplot of the estimated pairs of current biomass and fishing mortality ratios for southern Atlantic swordfish. The pairs were obtained from 1000 bootstraps of the production model fit to the Composite CPUE data, assuming a Logistic model (open circles) or a Fox model (crosses).

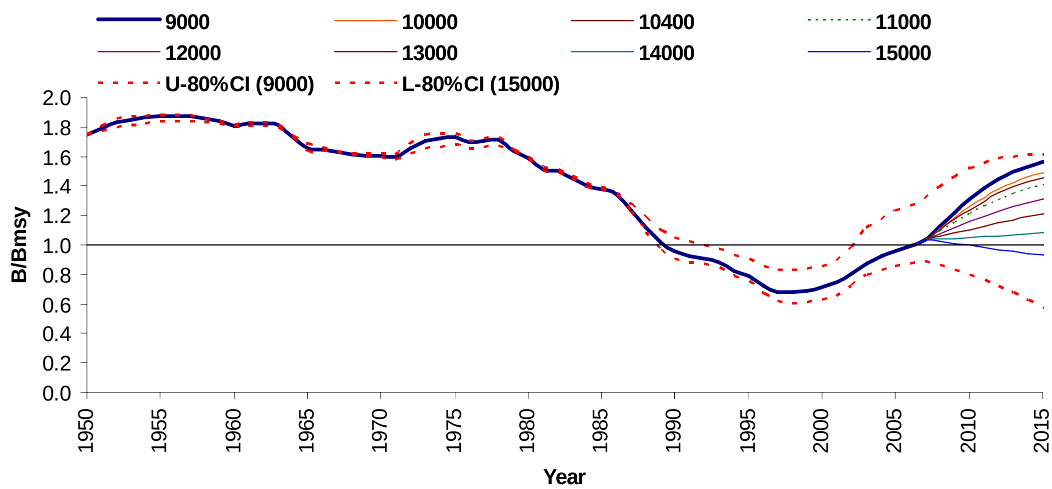

Figure 22. Projections from bootstrapped ASPIC model in the northern Atlantic. The upper 80% CI is from the 9000 TAC and the lower 80% CI is from the 15000 TAC.

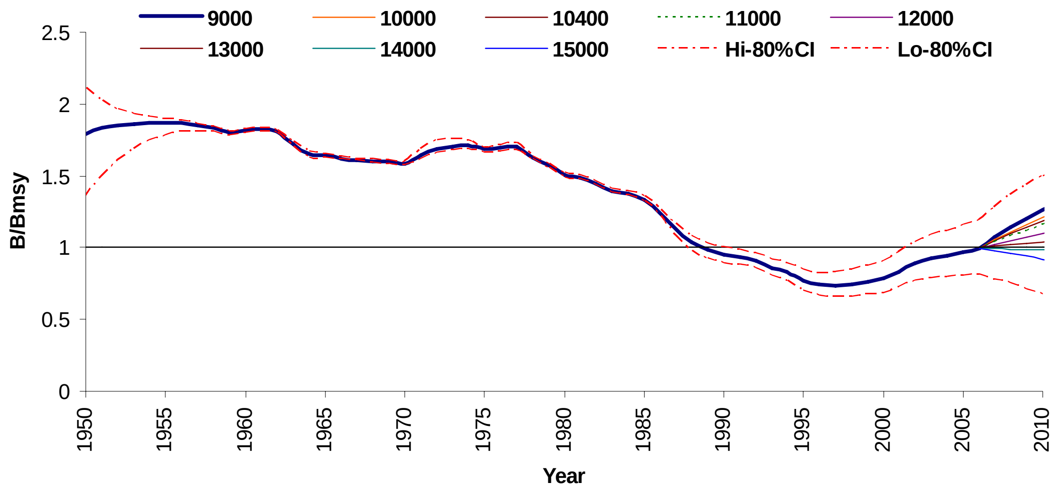

Figure 23. Projections from BSP model in the northern Atlantic. The upper 80% CI is from the 9000 TAC and the lower 80% CI is from the 15000 TAC.

Figure 24. Bootstrapped estimates and projections of the recruitment and spawning biomass of North Atlantic swordfish under the 'average' and 'recent' recruitment scenarios assuming future catches near the present TAC (14,000 MT). Dashed lines are 80% confidence limits.

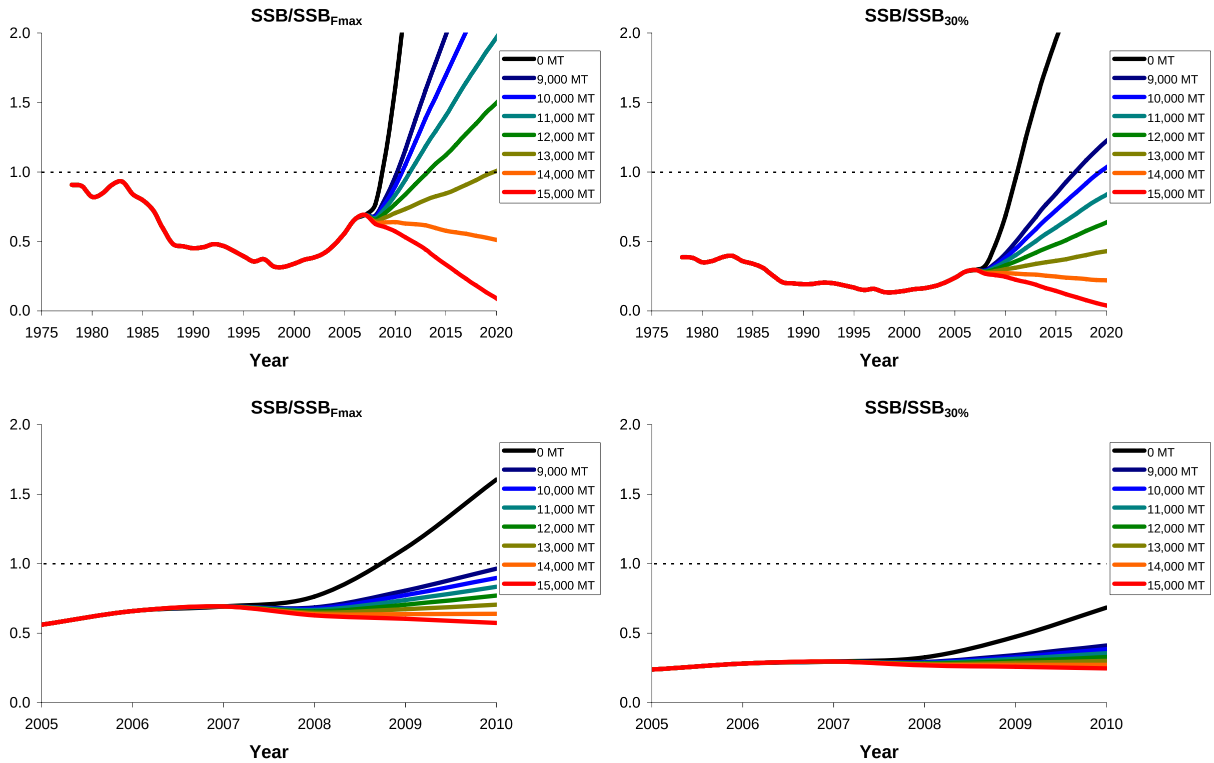

Figure 25. Bootstrap median trajectories of spawning biomass (SSB) relative to the equilibrium level corresponding to maximum yield per recruit (SSB_{MSY}) and a spawning potential ratio of 30% ($SSB_{30\%}$) under the average recruitment scenario. SSB_{MSY}= SSB_{MAX}.

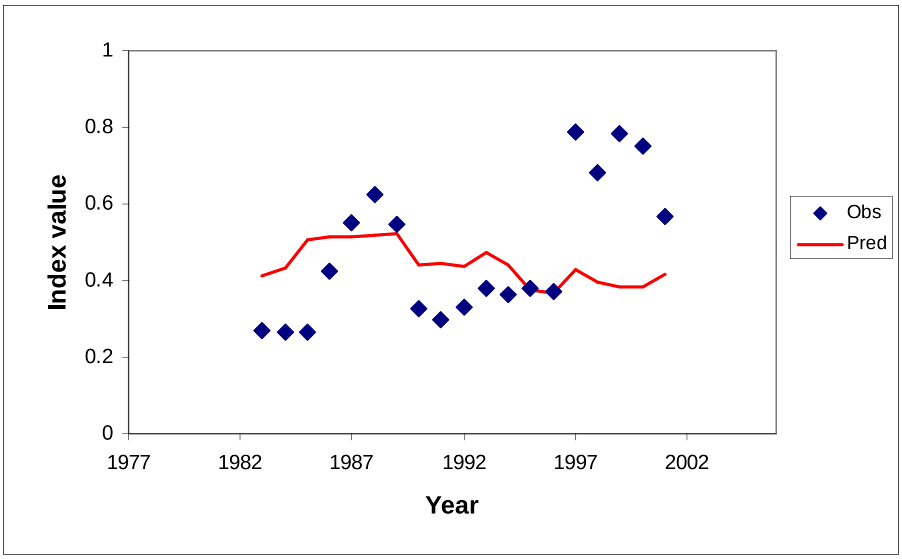

Figure 26. VPA fits to the standardized CPUE of age 1 North Atlantic swordfish by the Spanish longline fleet.

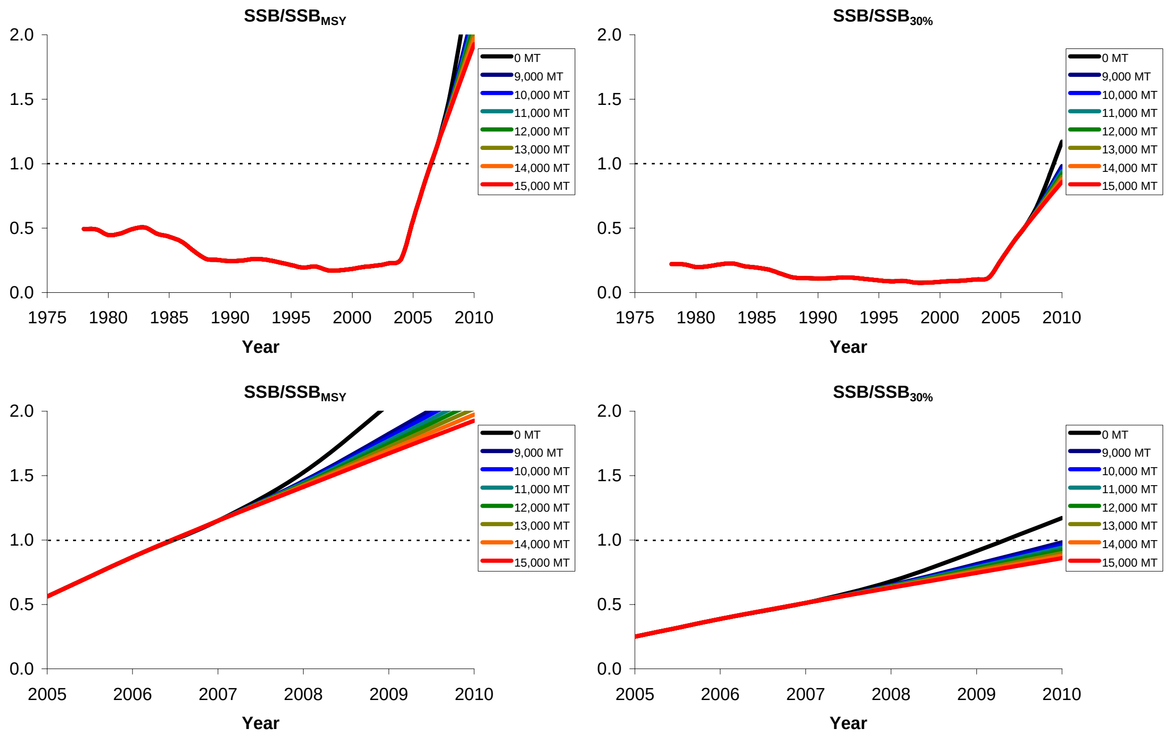

Figure 27. Bootstrap median trajectories of spawning biomass (SSB) relative to the equilibrium level corresponding to maximum yield per recruit (SSB$_{MSY}$) and a spawning potential ratio of 30% (SSB$_{30\%}$) under the high recruitment scenario. SSB$_{MSY}$= SSB$_{MAX}$.

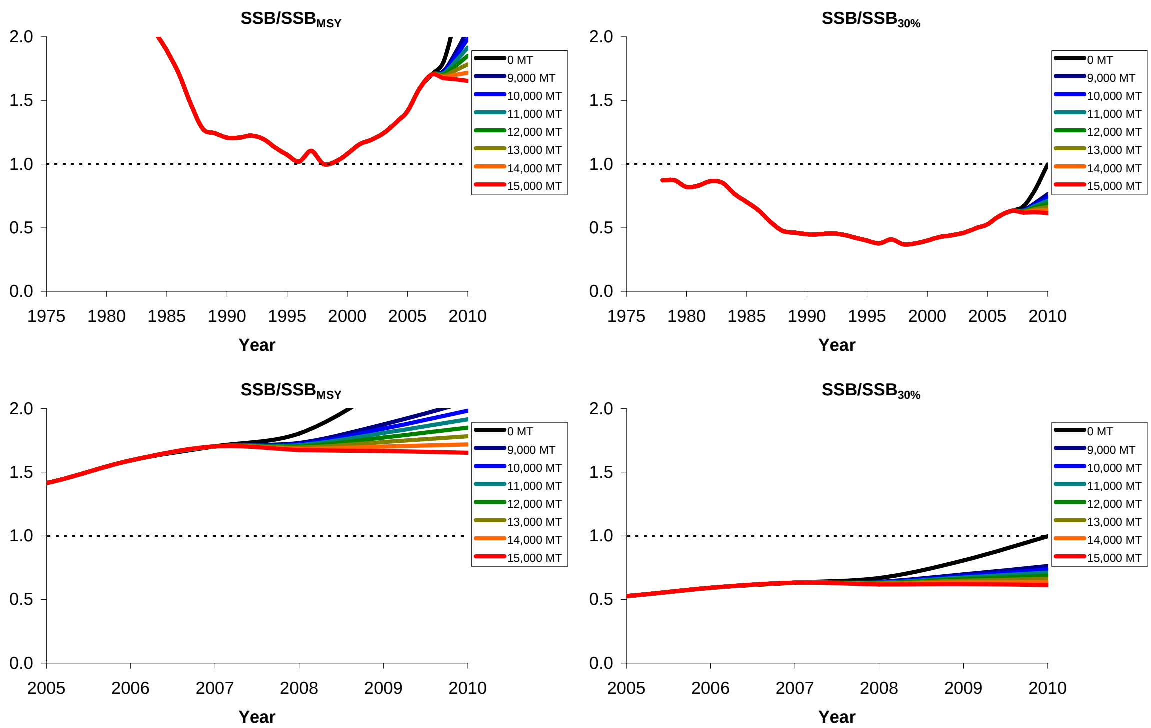

Figure 28. Bootstrap median trajectories of spawning biomass (SSB) relative to the equilibrium level corresponding to maximum yield per recruit (SSB$_{MSY}$) and a spawning potential ratio of 30% (SSB$_{30\%}$) under the average recruitment scenario when the F-ratio is estimated.. SSB$_{MSY}$= SSB$_{MAX}$.

Appendix 1

AGENDA

1. Opening, adoption of the Agenda and meeting arrangements.
2. Review of recommendations from the 2006 SWO Stock Structure Workshop
3. Biological data, including tagging information
4. Catch data, including fisheries trends
   - 4.1 Overview
   - 4.2 Recent developments
   - 4.3 Catch data
5. Relative abundance indices
   - 5.1 Relative abundance indices – North
   - 5.2 Relative abundance indices – South
6. Methods and other data relevant to the assessment
   - 6.1 Methods – North
   - 6.2 Methods – South
7. Stock status results
   - 7.1 Stock status – North
   - 7.2 Stock status – South
8. Projections
   - 8.1 Projections – North
   - 8.2 Projections – South
9. Recommendations
   - 9.1 Research and statistics
   - 9.2 Management
10. Other matters
11. Adoption of the report and closure

Appendix 2

ATLANTIC SWORDFISH WORK PLAN

Assessment

In conformity with Recommendation [03-03], it is recommended that the next Atlantic swordfish stock assessments be conducted in September 2006. The Atlantic assessment will be completed in five days. The deadline for submission Task I and II data is July 31, 2006. However, if National Scientists cannot meet the 31 July deadline for the 2005 data, and if National Scientists prepare the catch-at-size raised to the catch, then late submissions (for 2005 data only) can be accepted up to August 23, 2006. Data received after this date may not be included in the assessment. Action: National Scientists.

The assessments should take into account the conclusions reached by the SWO Stock Structure Symposium (currently scheduled to meet in January, 2006).

All National Scientists should provide catch, size and CPUE data up to and including 2005 where available. The Group recognizes that this may not be possible for all fleets. Assessment software should be adapted to accommodate the possibility of incomplete data for 2005. Action: National Scientists.

North

The priority for the north stock is to monitor the status of the stock relative to B_{MSY}.

- The lumped biomass production model analyses will be updated using data to the end of 2004, or 2005 where available, and include 5-year projections.
- Catch at size is required to evaluate the effects of regulations. Catch at size should be available at the beginning of the meeting. *Action Secretariat*.
- Age-specific analyses will be conducted, data and schedule permitting.
- The meeting will provide a response to [Res. 02-04] regarding the effects on the mortality of immature swordfish, the stock, and fishing activities of the new management measures for North Atlantic swordfish for 2003 and 2004.

South

The priority for the south stock is to update the 2002 assessment.

- The lumped biomass production model analyses will be updated using data to the end of 2004, or 2005 where available, and include 5-year projections.
- Catch at size is required to evaluate the effects of regulations. Catch at size should be available at the beginning of the meeting. *Action Secretariat.*

Appendix 3

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Pallarés, Pilar
Palma, Carlos

Appendix 4

LIST OF DOCUMENTS

SCRS/2006/031	Les espadons *(Xyphias gladius)* de la pêcherie artisanale maritime ivoirienne de 1988 à 2005: Structure de taille des stocks exploitées. N'DA, K. & G.R. Dedo
SCRS/2006/115	Activity of the Spanish surface longline fleet catching swordfish *(Xiphias gladius)* during the year 2004. MEJUTO, J., B. García-Cortés, J. M. de la Serna, A. Ramos-Cartelle
SCRS/2006/116	Updated sex- and age-specific CPUE from the Canadian swordfish longline fishery, 1988-2005. PAUL, S. and J.D. Neilson
SCRS/2006/117	Standardized *Xiphias gladius* CPUE of Santos longliners operating off Southern Brazil (1971-2005). MOURATO, B.L., H. A. Andrade, A. F. Amorim and C. A. Arfelli
SCRS/2006/118	Análisis de la CPUE y la composicin de tallas del SWO (*Xiphias gladius*), capturado por la flota uruguaya (2001-2005) en el Atlántico SW. DOMINGO, A., O. Mora, M. Pons, P. Miller and G. Pereyra
SCRS/2006/119	Genetic and growth profiles of three specimens of swordfish *(Xiphias gladius)* tagged and recaptured in the North Atlantic. KASAPIDIS, P., X. Valeiras, A. Antoniou, G. Kotoulas, B. García-Cortés and J. Mejuto
SCRS/2006/120	Standardization of South Atlantic swordfish by-catch rate for Taiwanese longline fleet. CHANG, S.K., H.H. Lee and H.I. Liu
SCRS/2006/121	Update of standardized CPUE of swordfish caught by Japanese longliners. YOKAWA, K.
SCRS/2006/124	Update of standardized catch rates by sex and age for swordfish (*Xiphias gladius*) from the U.S. longline fleet 1981-2005. ORTIZ, M.
SCRS/2006/125	Situation recente de la pêcherie marocaine de l'espadon (*Xiphias gladius*). Periode: 1996-2005. ABID, N. et M. Idrissi
SCRS/2006/126	Fishing strategy and target species of the Brazilian tuna longline fishery, from 1978 to 2005, inferred from cluster analysis. HAZIN, H.G., F. Hazin, P. Travassos, F. C. Carvalho, and K. Erzini
SCRS/2006/127	Standardization of swordfish CPUE series caught by Brazilian longliners in the Atlantic Ocean, by GLM, using the targeting strategy inferred by cluster analysis. HAZIN, H.G., F. Hazin, P. Travassos , F. C. Carvalho, and K. Erzini
SCRS/2006/128	Essential fish habitat and spatial prediction of swordfish (*Xiphias gladius*) catches in the South Atlantic. HAZIN, H. and K. Erzini

2006 SCRS – SWO - ATL
VERSION – Final adoption
November 1, 2006; 10:20

Doc. No. SCI-025 A/ 2006

Original: English

SWO-ATL-ATLANTIC SWORDFISH

A new assessment for Atlantic swordfish was conducted in 2006. Other information relevant to Atlantic swordfish is presented elsewhere in this SCRS Report: Advice relevant to *Resolution by ICCAT for the evaluation of small-swordfish mortality* [Res. 02-04] is provided in Section 16 and Recommendations pertinent to Atlantic swordfish are presented in Section 15.

SWO-ATL-1. Biology

A Workshop on swordfish stock structure took place in Crete in early 2006, in response to *Resolution by ICCAT on the clarification of the stock structure and boundaries between the swordfish stocks in the Atlantic* [Res. 99-03], at which 13 scientific documents on swordfish biology were presented. The results of the research presented gave general support to the stock structure currently assumed for Atlantic Swordfish (Mediterranean and North and South Atlantic stocks). The Workshop agreed that the precise delimitation between these three stocks cannot be improved upon without intensified collaborative and multi-disciplinary research. Similarly, the classification of swordfish caught near the boundaries to their stock of origin is subject to uncertainty and cannot be made accurately without intensified collaborative and multi-disciplinary research taking into account fine-scale (e.g., 1º squares) and quarterly sampling strata. The Workshop also noted that while there was some mixing between Atlantic and Mediterranean stocks near the Straits of Gibraltr, there was strong evidence that the Mediterranean is genetically distinct from the Atlantic, Pacific and Indian Ocean stocks.

Three scientific documents related to SWO biology were presented during the stock assessment meeting. These contributions provided new insight into the potential usefulness of hard parts of swordfish for age determinations in combination with genetic analyses, sex-ratio at size data for the south-west Atlantic (Uruguay) and length composition information off western Africa (Côte d'Ivoire). A further scientific document was presented to the Swordfish Species Group meeting. That contribution explored the impact of exclusion of JLL indices for 2004 and 2005 in the North Atlantic VPA, and concluded that the view of stock status and projections obtained excluding the JLL indices was generally consistent with the results of age-aggregated production analyses presented in the Detailed Report of the swordfish assessment working group.

SWO-ATL-2. Fishery indicators

Because of the broad geographical of distribution of the Atlantic swordfish, in coastal and offshore areas, mostly ranging from 45ºN to 45ºS, this species is available to a large number of fishing countries. Directed longline fisheries from Canada, EC-Spain, and the United States have operated since the late 1950s or early 1960s, and harpoon fisheries have existed at least since the late 1800s. Other directed swordfish fisheries include fleets from Brazil, Morocco, Namibia, EC-Portugal, South Africa, Uruguay, and Venezuela. The primary by-catch or opportunistic fisheries that take swordfish are tuna fleets from Chinese Taipei, Japan, Korea and EC-France. The tuna longline fishery started in 1956 and has operated throughout the Atlantic since then, with substantial catches of swordfish that are produced as a by-catch of tuna fisheries. The largest proportion of the Atlantic catches are made using surface drifting longline. However, many additional gears are used, including traditional gillnets off the coast of western Africa.

As a result of ICCAT and domestic regulatory recommendations, there are recent developments in the fisheries of some nations. (1) Starting in February 2000 and finishing in December 2003, Japanese vessels fishing in the North Atlantic were domestically required during this period to discard or release all swordfish caught as the Japanese block quota had been reached. However, the domestic recommendation for live release of swordfish was extended to the present. (2) In 2001, U.S. pelagic longline fishing was prohibited or restricted in five areas-times to reduce incidental catches including juvenile swordfish and by-catch species. (3) The Canadian directed swordfish fishery has reduced effort in recent years as a result of a combination of factors, including reduced quota, increased opportunities for fishing other species, relatively low market value, and the introduction of an Individual Transferable Quota (ITQ) management system in 2002. (4) A further change in the fishery has resulted from changes in technology of several fleets, i.e. there has been a change in the type or style of longline gear used by many EU vessels that have gone from the traditional multifilament to monofilament gear, changes in targeting operation in several fleets, etc. The Committee notes these recent developments and their potential effect on the available data, its continuity and complexity and therefore its interpretation. Specific research actions about these issues are needed in the near future.

Total Atlantic. The total Atlantic estimated catch of swordfish (North and South, including discards) reached a historical high of 38,624 t in 1995 **(SWO-Table 1** and **SWO-Figure 2**). The 2005 estimated catch (reported and carried over) was 24,830 t (reported catch was 24,462 t). A substantial number of countries have not yet reported their 2005 catches so values should be considered provisional and subject to revision.

North Atlantic. For the past decade, the North Atlantic estimated catch (landings plus discards) has averaged about 11,900 t **(SWO-Table 1** and **SWO-Figure 2)**, and the 2005 landings (including carry-overs) plus discards were 12,143 t (reported catch was 11,775 t). In 2005, there has been a 40% decrease in estimated catches (including discards and carry-overs) since the 1987 peak in North Atlantic landings (20,236 t), in response to ICCAT recommendations. Reduced landings have also been attributed to shifts in fleet distributions, including movement of some vessels to the South Atlantic and out of the Atlantic. In addition, some fleets, including Canada, EC-Portugal, EC-Spain, and the United States, have changed operating procedures to opportunistically target other large pelagic species (tuna and/or sharks), taking advantage of market-price conditions and their high relative catch rates.

The available age-specific indices of abundance from the various fleets harvesting northern Atlantic swordfish show generally consistent trends over the period of overlap, with a few exceptions especially in the most recent period. There appears a pattern of relatively strong recruitment in the mid 1990's which then progressed into medium size and spawning-size swordfish. This, in combination with lower catches resulted in an increase in spawning biomass. Unfortunately, there is little information available with which to judge the most recent recruitment levels. The overall indicator of northern Atlantic swordfish biomass from the major fisheries reflected an increase in biomass in the late 1990s **(SWO-ATL Figure 3)**.

South Atlantic. The historical trend of catch (landings plus discards) can be divided in two periods: before and after 1980. The first one is characterized by relatively low catches, generally less than 5,000 t (with an average value of 2,300 t). After 1980, landings increased continuously up to a peak of 21,780 t in 1995, levels that match the peak of North Atlantic harvest (20,236 t). This increase of landings was in part due to progressive shifts of fishing effort to the South Atlantic, primarily from the North Atlantic, as well as other waters. Expansion of fishing activities by southern coastal countries, such as Brazil and Uruguay, also contributed to this increase in catches. The reduction in catch following the peak in 1995 resulted from regulations, and partly due to a shift to other oceans and target species. In 2004, the 12,902 t reported catches were about 40% lower than the 1995 reported level. The reported 2005 catch is 12,687 t, and should be considered provisional and is probably an underestimate.

For the 2006 assessment there was some improvement in the information level available from fisheries harvesting southern Atlantic stock swordfish. Catch rate fishery indicators from targeted and by-catch fisheries were similar in the early part of the available time-series, but the patterns diverged starting in the mid 1990's (**SWO-ATL Figure 4**) and without additional research it will not be possible to resolve if either pattern best reflects the total biomass trend. It is possible that the by-catch and targeted fisheries CPUE trends could track different elements. This view was supported to some degree by the limited size-frequency information for southern stock swordfish catch, but much additional research and data collection would also be required to test this hypothesis.

Discards. Since 1991, several fleets have reported discards (see **SWO-Table 1**). The volume of Atlantic-wide reported discards since then has ranged from 215 to 1139 t. The most recent (2005) reported level of discards is 348 t, a reduction of 67% from the peak level reported for 2000.

SWO-ATL-3. State of the Stocks

North Atlantic

The 2006 assessment indicated that North Atlantic swordfish biomass had improved possibly due to strong recruitment in the late 1990s, combined with reductions in reported catch since then, especially compared to the peak catch values of 1987 **(SWO-ATL Figure 2)**. The estimate of maximum sustainable yield from production model analyses is about 14,100 t. The biomass at the beginning of 2006 was estimated to be about 99% of the biomass needed to produce MSY and the 2005 fishing mortality rate was estimated to be about 14% below the

fishing mortality rate at MSY. Although there is some uncertainty in these estimates, most of the bootstrap outcomes show that current F is less than F_{MSY}, while about half of the current biomass estimates are less than B_{MSY} (**SWO-ATL Figure 4**). The replacement yield for the year 2006 (14,438 t) was estimated to be slightly more than the MSY level. As the TAC for North Atlantic swordfish for 2005 was 14,000 t (about equal to MSY), it was considered likely that biomass would continue to approach or attain the B_{MSY} level under those catch levels.

South Atlantic

If the available CPUE information is used in a simple production model, two different conclusions are reached about the status of southern Atlantic swordfish. Using by-catch fishery data leads to overly-pessimistic results, while using target fishery data leads to optimistic results (**SWO-ATL Figure 5**) The Group believes that in the case of the by-catch CPUE data, the estimates of MSY and intrinsic growth rate obtained could not be supported by current knowledge of swordfish population dynamics and historical catch levels. On the other hand, the Group believed that the recent increase in the Target pattern CPUE was more likely due to changes in catchability than it was to an increase in abundance, possibly leading to an overestimation of the intrinsic growth rate. As a result, the Group has based its base case analyses on a Composite CPUE pattern that has been constructed from both types of fisheries. Recognizing that further research is required in order to make better use of the available data, the results obtained indicate that the stock is in good condition: The current estimated fishing mortality rate is likely below that which would produce MSY, and the current biomass is likely above that which would result from fishing at Fmsy in the long term (**SWO-ATL Figure 6**). The estimated MSY (about 17,000 t) is 33% higher than current reported landings.

SWO-ATL-4. Outlook

North Atlantic

The Committee believes that it is likely that the northern swordfish stock is nearly rebuilt to B_{MSY}. Although there is some uncertainty associated with this conclusion (**SWO-ATL Figure 4**), almost half of the bootstrap estimates of current biomass were greater than or equal to B_{MSY}. If the current TAC management strategy is maintained, the stock is likely to remain near the level that would produce MSY.

South Atlantic

While the Committee believes the southern swordfish stock appears to be in a healthy condition at present, it is unclear if substantially higher catches than currently envisioned by the Commission could be sustained in the long-run, due to the divergent views of stock status provided by the targeted and by-catch fisheries indicators.

SWO-ATL-5. Effects of current regulations

This report only takes into account catch data transmitted to the SCRS by the different countries and which were available during the meeting. Total catch is considered provisional and subject to revision for 2005 **(SWO-ATL Table 1)**.

Canada, Chinese Taipei, EC-Spain, Japan, Morocco, South Africa, and the United States provide catch-at-size data based on national sampling. Other nations are either partially (e.g., Brazil, EC-Portugal) or completely substituted from these data. The SCRS considers that it is not appropriate to apply these scientific estimates for purposes of evaluating compliance, and therefore only summary data are provided.

Catch limits

The total allowable catch in the North Atlantic in 2002 was 10,400 t (10,200 t retained and 200 t discarded). The reported landings in 2002 were about 9,000 t and the estimated discards were about 535 t. The total allowable catch in the North Atlantic in 2003 was 14,000 t (13,900 t retained and 100 t discarded). The reported landings in 2003 were about 10,800 t and the estimated discards were about 460 t. The total allowable catch in the North Atlantic in 2004 was 14,000 t. The reported landings and discards in 2004 were about 12,300 t. Reports for 2004 are considered provisional and subject to change.

The total allowable catch in the South Atlantic for the years 2002, 2003, 2004, and 2005 were respectively, 14,620 t, 15,631 t, 15,776 t, and 15,956. The reported landings and discards for the same years were respectively 14,000 t, 12,300 t, 12,800 t, and 12,687. Reports for 2005 are considered provisional and subject to change.

Minimum size limits

There are two minimum size options that are applied to the entire Atlantic: 125 cm LJFL with a 15% tolerance, or 119 cm LJFL with zero tolerance and evaluation of the discards. In the absence of size data, these calculations could not be updated or examined for 2005.

In 2000, the percentage of swordfish reported landed (throughout the Atlantic) less than 125 cm LJFL was about 21% (in number) overall for all nations fishing in the Atlantic. If this calculation is made using reported landings plus estimated discards, then the percentage less than 125 cm LJFL would be about 25%. The Committee noted that this proportion of small fish did not increase very much even though recruitment in the North may have been at a high level in recent years.

Other implications

The Committee is concerned that in some cases regulations have resulted in the discard of swordfish caught in the North stock and, to a certain extent, could have influenced similar behavior of the fleet that fishes the South Atlantic swordfish stock. The Committee considers that regulations may have had a detrimental effect on the availability and consistency of scientific data on catches, sizes and CPUE indices of the Atlantic fleet. The Committee expressed its serious concern over this limitation on data for future assessments.

SWO-ATL-6. Management recommendations

North Atlantic

In order to maintain the northern Atlantic swordfish stock close to a level that would produce MSY, the Committee recommends continuing the present TAC (14,000 t). Given the current estimate of stock productivity (r=0.49) and MSY (14,100 t), this TAC should be sustainable into the future, and reflects the maximum yield that could be harvested from the population under existing environmental and fishery conditions.

South Atlantic

Until sufficiently more research has been conducted to reduce the high uncertainty in stock status evaluations for the southern Atlantic swordfish stock, the Committee recommends that annual catch should not exceed the provisionally estimated MSY (about 17,000 t).

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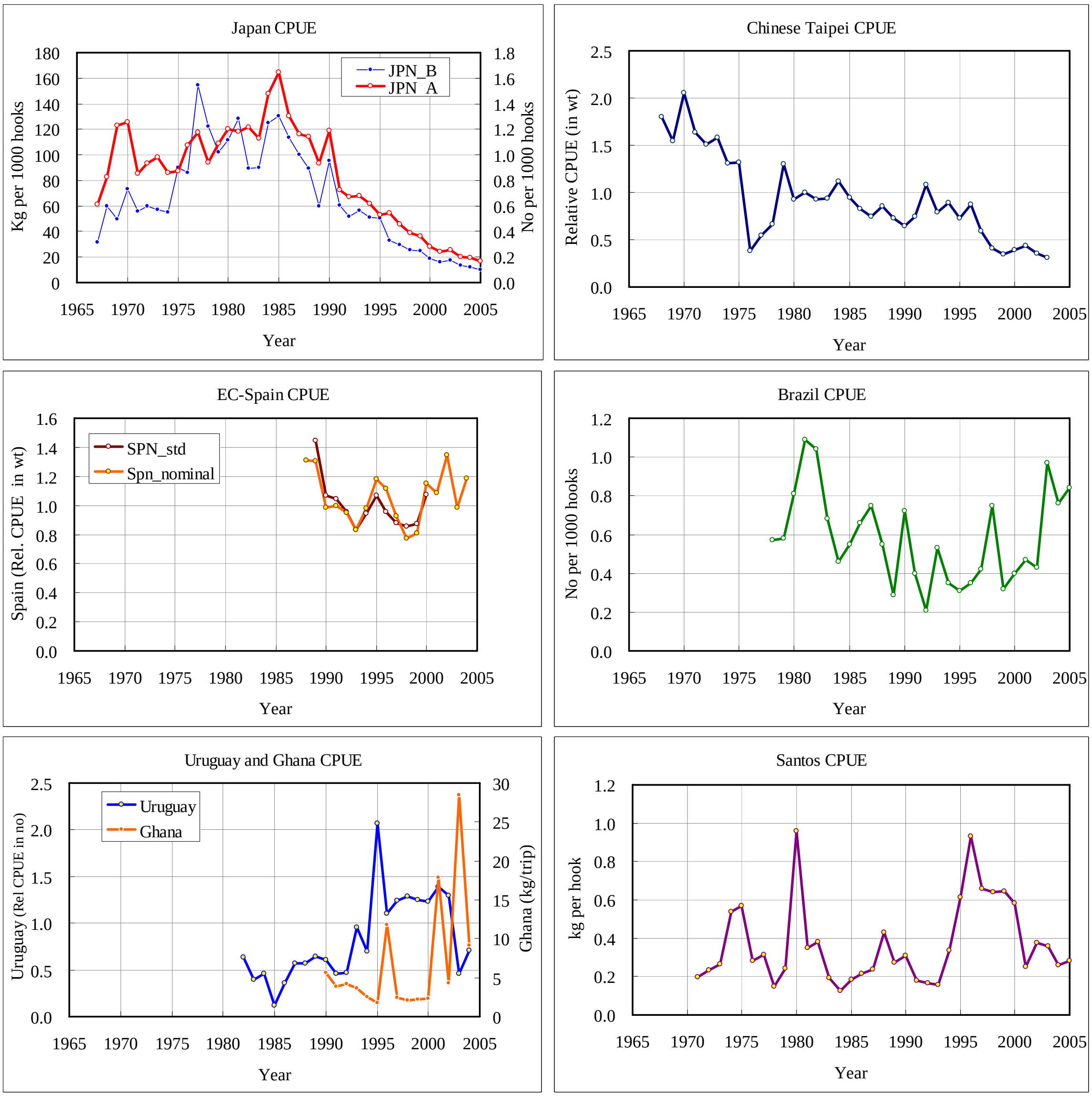
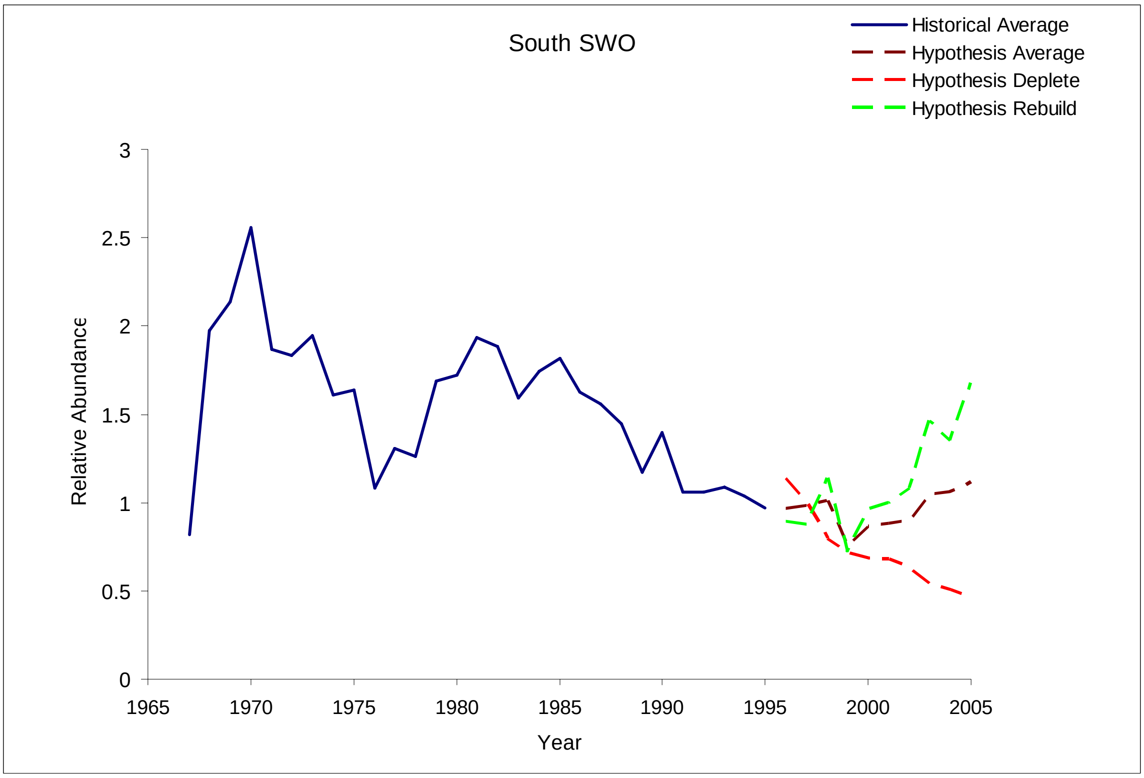
ATLANTIC SWORDFISH SUMMARY

	North Atlantic	**South Atlantic**
Maximum Sustainable Yield[1]	14,133 t (12,800-14,790)[3]	~17,000t[5]
Current (2005) Yield[2]	12,143 t	12,687 t
Current (2006) Replacement Yield[3]	14,438 t	Not estimated
Relative Biomass (B_{2006}/B_{MSY})	0.99 (0.87 - 1.27)[4]	Likely >1
Relative Fishing Mortality		
F_{2005}/F_{MSY}[1]	0.86 (0.65 - 1.04)[4]	Likely <1
F_{2005}/F_{max}	1.2	Not estimated
$F_{2005}/F_{0.1}$	2.4	Not estimated
$F_{2005}/F_{30\%SPR}$	2.4	Not estimated
Management Measures in Effect:	Country-specific TACs [Rec. 02-02]; 125/119 cm LJFL minimum size.	TAC target [Rec. 02-03]; 125/119 cm LJFL minimum size [Rec. 02-02].

[1] Base Case production model (Logistic) results based on catch data 1950-2005.
[2] Provisional and subject to revision.
[3] For next fishing year.
[4] 80% confidence intervals are shown.
[5] Provisional and preliminary, based on production model (Exponential) results based on catch data 1970-2005.



圖一、各國南劍 CPUE 趨勢圖



圖二、合併各國南劍並進行簡單 GLM 標準化結果圖