INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS
COMMISSION INTERNATIONALE POUR LA CONSERVATION DES THONIDES DE L'ATLANTIQUE
ICCAT CICTA CICAA
COMISIÓN INTERNACIONAL PARA LA CONSERVACIÓN DEL ATÚN ATLÁNTICO

ICCAT-SALIDA
N.° 035
FECHA 11 ENE. 2010

Madrid – January 11, 2010

The Secretary General
Convention on International Trade in Endangered Species
of Wild Fauna and Flora (CITES)
International Environment House
Chemin des Anémones
CH 1219 Châtelaine, Geneva, Switzerland

Dear Sir:

I have the honor to refer to your request for comments, to be received by January 15, 2010, regarding Monaco's proposal to list Atlantic bluefin tuna under Appendix I of CITES. At this time, we have no submission to make other than the documents that we already sent to the CITES Secretariat and to the FAO on November 30, 2009 (attached).

In addition, ICCAT will be represented by me and by Drs. Hazin, Scott, and Gauthiez at the 15th Meeting of the Conference of the Parties to CITES in Doha in March, where we would be grateful to have the opportunity to make statements and respond to questions from the Parties, as appropriate.

Please accept the assurances of my highest consideration.

COMISIÓN INTERNACIONAL - ICCAT - Conservación At.

Driss Meski
ICCAT Executive Secretary

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Madrid – November 30, 2009

The Director General
Food and Agriculture Organization of the United Nations (FAO)
Via delle Terme de Caracalla
Rome, Italy

SUBJECT: FI-36(a) FAO Expert Panel on CITES Listing Proposals - Regional Fisheries Bodies

Dear Director General:

I have the honor to refer to the correspondence received from your office on November 12, 2009, inviting Member Countries and RFMOs to submit any additional information and any comments pertinent to the CITES (CoP 15) listing proposals for due consideration by the FAO *ad hoc* Advisory Panel for Assessment of Listing Proposals to CITES for Commercially-Exploited Aquatic Species.

Of the various species proposed for consideration in CoP 15, Atlantic bluefin tuna (*Thunnus thynnus*) is the only one for which ICCAT has direct management responsibility as an RFMO. In addition, ICCAT has taken steps to assess porbeagle (*Lamna nasus*) with a view to potentially adopting management measures for Atlantic tuna fisheries in which this species is taken, primarily as incidental catch. Therefore, our response to your request is limited to these two species.

1. Lamna nasus

ICCAT has not yet adopted specific management measures for this species. However, earlier this year ICCAT's Standing Committee on Research and Statistics (SCRS), jointly with ICES, conducted an assessment of the four stocks in the Atlantic Ocean. Attached please find the following relevant documents:

Attachment 1: 2009 Executive Summary of SCRS on Sharks
Attachment 2: 2009 Detailed Report of the Joint ICES-ICCAT Porbeagle Shark Assessment Session

2. Thunnus thynnus

ICCAT has actively managed Atlantic bluefin tuna for a number of years. Annex 1 to this letter provides a summary of the actions taken by ICCAT to manage the two stocks (western Atlantic, and eastern Atlantic and Mediterranean). Annex 2 to this letter summarizes the many monitoring and reporting requirements that are in place for the species in the eastern Atlantic and Mediterranean.

The main ICCAT management measures that are currently in place[1] for the species are attached as follows:

For the western stock:
Attachment 3: Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program [Rec. 08-04].

For the eastern+Mediterranean stock:
Attachment 4: Recommendation by ICCAT Amending the Recommendation by ICCAT to Establish a Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean [Rec. 08-05].
Attachment 5: Recommendation Amending Recommendation 08-05 to Establish a Multiannual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean [Rec. 09-06].
Attachment 6: Recommendation by ICCAT on Bluefin Tuna Farming [Rec. 06-07].

[1] Recommendations adopted in 2009 will formally enter into force in June 2010. Notwithstanding, ICCAT Parties have committed to implement the measures for the entire 2010 fishing season.

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Attachment 7: Recommendation by ICCAT Concerning Data Exchange Format and Protocol in Relation to the Vessel Monitoring System for the Bluefin Tuna in the ICCAT Convention Area [Rec.07-08].

For both stocks:

Attachment 8: Recommendation by ICCAT Amending the Recommendation 08-12 on an ICCAT Bluefin Tuna Catch Documentation Program [Rec. 09-11].

In terms of assessment, the last full stock assessment conducted by SCRS was conducted in 2008. In 2009, SCRS updated its management recommendations and held a meeting to examine the status of the bluefin tuna stocks with respect to the biological criteria for listing species in CITES Appendices. These reports are attached as follows:

Attachment 9: Report of the 2008 Atlantic Bluefin Stock Assessment Session.

Attachment 10: 2009 Executive Summary of SCRS on Bluefin Tuna.

Attachment 11: Report of the Extension of the 2009 SCRS Meeting to Consider the Status of Atlantic Bluefin Tuna Populations with Respect to CITES Biological Listing Criteria.

While the report in Attachment 11 is of particular relevance to the deliberations of the *ad hoc* Advisory Panel, I should note that the SCRS limited its analyses to biological criteria. Given that the Terms of Reference for the *ad hoc* Advisory Panel are wider in scope, including trade issues, I believe that it is important to highlight the comprehensive nature of the monitoring and control measures that ICCAT has adopted, particularly for the eastern Atlantic and Mediterranean stock of bluefin tuna (Attachments 4, 5, 6, 7 and 8). Notably, the management plan has 100% observer coverage on purse seining operations and farm harvests, a one-month fishing season for purse seiners, mandatory VMS reporting of positions, and near real-time reporting of catches. In addition, the Catch Documentation System for bluefin tuna is extremely comprehensive and tracks bluefin tuna from the initial catch to the market, whether or not this involves international trade.

In summary, I trust that the attached documents will be of use to the *ad hoc* Panel and I offer of assistance of the ICCAT Secretariat in providing further information as requested.

Please receive the assurances of my highest consideration.

Driss Meski
Executive Secretary

cc: I. Nomura, FAO
K. Cochrane, FAO
F. Hazin, ICCAT Chair
Z. Driouich, First-Vice Chair of ICCAT
P.N. Keita, Second-Vice Chair of ICCAT
G. Scott, ICCAT SCRS Chair
F. Gauthiez, ICCAT Panel 2 Chair

Attachments: As noted.

Annex 1

SUMMARY OF MEASURES TAKEN HISTORICALLY BY ICCAT FOR BLUEFIN TUNA

A1.1 ICCAT measures taken for the West Atlantic

While some of the initial concerns which had led to the creation of ICCAT stemmed from the eastern Atlantic, it was the western stock on which management measures were first concentrated, where longline and purse seine catches had increased from around 100 t each in the late 1950s to 12,000 t and 5,000t respectively in 1964.

The 1981 Recommendation [Rec. 81-01] set out specific requirements for the western Atlantic bluefin stock, including a total allowable catch limit, and continuing the 1974 size limit of 6.4 kg for all bluefin tuna.

New Regulations for the Atlantic Bluefin Tuna Catch [1983] [82-01], pertaining again mainly to the western Atlantic stock were adopted in 1982, and were continued, with gradual refinements, up to 1986, by which time the measures included a closure of the fishery during the spawning season in the Gulf of Mexico and additional requirements in relation to minimum size. This measure was extended annually by the Commission until 1990.

In 1991, the Commission adopted the *Recommendation by ICCAT for the Enhancement of the Current Management of Western Atlantic Bluefin Tuna* [Rec. 91-01], which specified the individual catch limits in the body of the text for the first time. Prior to that, the TAC had been distributed in accordance with an arrangement agreed at an inter-sessional meeting by the parties involved in the fisheries (*Record of the Meeting on the Western Atlantic Bluefin Management Measures* (ICCAT, 1982[2]). Similar allocations were made through the *Recommendations for the 1992-1993 Management of Western Atlantic Bluefin Tuna* [Rec. 92-04], which in fact extended the allocations up to 1994, although these were revised upwards through the *Recommendation by ICCAT on the Management of Bluefin Tuna Fishing in the Western Atlantic* [Rec. 93-05], in accordance with the conclusions of the Management Review Committee for West Atlantic Bluefin Tuna[3] held in Tokyo, Japan 1992. It was also agreed during the meeting of this Committee to proceed to tag all Atlantic bluefin tuna harvested and available for sale and implement a system whereby import of all bluefin tuna be accompanied by a certificate of origin (see Statistical Document Programme below).

Recommendation by ICCAT for the Management of Bluefin Tuna Fishing in the Western Atlantic Ocean [Rec. 94-12] set individual quotas for west Atlantic bluefin tuna, which continued, with an increase in the TAC of 300 t, through the *Recommendation by ICCAT to Establish a Scientific Monitoring Quota for Bluefin Tuna in the Western Atlantic for 1997-1998* [Rec. 96-04].

In 1998, recognising that the western stock of bluefin tuna was over-exploited, the Commission adopted a twenty-year[4] rebuilding plan through the *Recommendation by ICCAT to Establish a Rebuilding Program for Western Atlantic Bluefin Tuna* [98-07], modified in 2002, 2003, 2004 and 2006 (*Recommendation by ICCAT Concerning Conservation of Western Atlantic Bluefin Tuna* [02-07]; *Recommendation by ICCAT Concerning the Stock Assessment Schedule for Western Atlantic Bluefin Tuna* [03-08]); *Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program and the Conservation and Management measures for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [04-05] and the *Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program* [06-06]. This plan set a TAC, modifiable in accordance with scientific advice, a closed area during the spawning season in the Gulf of Mexico and a sharing arrangement based on percentage shares of the TAC. A further *Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program* [Rec. 08-04] was adopted in 2008 to, *inter alia*, further reduce the TAC of western bluefin.

Measures for western bluefin tuna have been in place for over twenty-five years, and the rebuilding plan for ten years, and in recent years, catches have been well below the TAC in a consistent manner.

A1.2 ICCAT measures taken for the East Atlantic and Mediterranean

The increase in catch levels led to the consideration of management measures for this stock in the early 1990s. The first measure specifically for the eastern Atlantic, the *Recommendation by ICCAT on Supplemental Regulatory Measures for the Management of Eastern Atlantic Bluefin Tuna* [Rec. 93-07] was adopted in 1993,

[2] ICCAT, 1982. *Record of the Meeting on the Western Atlantic Bluefin Management Measures*
[3] ICCAT, 1993. *Report for the Biennial Period 1992-1993, Part 1* (1992), pp. 71-77
[4] The duration of the rebuilding plan is commensurate with the longevity of the species, which is thought to be around 40 years.

and established a closed season for longline vessels in the Mediterranean. In the same year, the Commission adopted the *Recommendation by ICCAT on the Management of Bluefin Tuna Fishing in the Central North Atlantic Ocean* [Rec. 93-06], limiting catches in this area. This limitation has been continued, with minor modifications, through the *Resolution by ICCAT on Fishing for Bluefin Tuna in the Atlantic Ocean* [Res. 02-12] and the *Supplemental Resolution by ICCAT on Fishing for Bluefin Tuna in the Atlantic Ocean* [Res. 04-8], and the *Resolution by ICCAT on Fishing Bluefin Tuna in the Atlantic Ocean* [Res. 06-08].

In 1994, *the Recommendation by ICCAT for the Management of Bluefin Tuna Fishing in the Eastern Atlantic Ocean and Mediterranean Sea* [Rec. 94-11] limited catches in the east by recommending measures to prevent any increase in the fishing mortality rate for the years 1995 and beyond; measures to prevent any catch by vessels under their jurisdiction in 1995 in excess of the level of catch in 1993 or 1994 (whichever the higher); starting in 1996, measures to reduce by 25% (or such lower amount which may be specified by the SCRS) their catches from the catch level specified above, such reduction to be accomplished by the end of 1998; and cooperation in the development, by 1998, of a long-term recovery plan for bluefin tuna in the eastern Atlantic and the Mediterranean. Recognising some unusually high catch reports for 1994, the *Recommendation by ICCAT on Supplemental Management Measures for Eastern Atlantic Bluefin Tuna* [Rec. 95-05] was adopted in 1995 to prevent significant increases in catches over the level of recent years.

In 1996, retaining on board, landing or sale of age-0 fish was prohibited through the *Recommendation by ICCAT Concerning Age 0 Bluefin Tuna* [Rec. 96-03], and this prohibition was extended to fish less than 3.2 kg in 1998 through the *Recommendation by ICCAT amending the "Recommendation on Bluefin Catch Limits in the Eastern Atlantic Ocean and Mediterranean Sea"* and the *"Recommendation by ICCAT on Supplemental Management Measures Concerning Age 0 Bluefin Tuna*" [Rec. 98-04].

The *Recommendation by ICCAT on the Limitation of Catches of Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 98-05], set individual catch limits for eastern Atlantic and Mediterranean bluefin tuna for the first time, and closed seasons were introduced by the *Recommendation by ICCAT Concerning the Changes of Closed Season for the Purse Seine Fishery for Bluefin Tuna in the Mediterranean Sea* [Rec. 98-06].

Recommendation by ICCAT Concerning Bluefin Tuna Catch Limits in the East Atlantic and Mediterranean [Rec. 00-09] set the total allowable catch and individual allocations for the years 2000 and 2001. No catch limits were set for 2002. A more comprehensive approach to the various aspects of management was taken in 2002 through *Recommendation by ICCAT Concerning a Multi-year Conservation and Management Plan for Bluefin Tuna in the East Atlantic and Mediterranean* [Rec. 02-08], although some aspects were adopted separately through the *Recommendation by ICCAT to Develop a Plan Aimed at Reducing the Catches of Juvenile Bluefin Tuna in the Mediterranean* [Rec. 02-09] and changes to the minimum size limits were introduced though the *Recommendation by ICCAT on Bluefin Tuna Size Limit* [Rec. 04-07].

Following the SCRS concerns expressed in 2006 about the decline in stock size as a result of increasing catches, the Commission adopted a rebuilding plan through the *Recommendation by ICCAT to Establish a Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 06-05], aimed at rebuilding the stock by 2023. The initial year of the plan the TAC was exceeded and the *Recommendation by ICCAT in Regard to Compliance with the Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 07-04], instituting a pay-back plan for the over-harvest, was adopted. Following review at the 2008 Commission meeting, the plan was strengthened considerably through additional monitoring and control measures through the *Recommendation Amending the Recommendation by ICCAT to Establish a Multiannual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 08-05]. This year, the recovery plan was strengthened further through the *Recommendation by ICCAT Amending Recommendation 08-05 to Establish a Multiannual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 09-06]. This Recommendation shortened the purse seine fishing season to one month and set a TAC for 2010 that is consistent with the advice given by SCRS. The Recommendation also links future TACs to the planned 2010 evaluation by SCRS of management measures that will rebuild the stock to B_{MSY} by 2023 with a 60% chance. Finally, the management plan also includes drastic reductions in fishing capacity for all Parties that are commensurate with the established catch limits.

In summary, the eastern and Mediterranean stock has been managed actively since the mid-1990s. The catch limits and other regulations that were set initially were largely ineffective in preventing increases in landings. Farming and fattening operations in the Mediterranean grew considerably between the end of the 1990s and the middle of the current decade, and these brought about considerable increases in fishing capacity. In 2006 ICCAT adopted a comprehensive rebuilding plan that includes multiple monitoring, control and reporting measures (see

Appendix A2.2 for a list of reporting requirements). This rebuilding plan was adjusted in 2008 and 2009, each time becoming increasingly tighter in its control measures and with considerably lower catch quotas and capacity limits. The future decisions in the rebuilding plan are linked to scientific advice from SCRS.

A1.3 Farming

In view of the rapid development of the practice of bluefin tuna farming/fattening, mainly in the Mediterranean, the Commission began to consider the need for specific measures to regulate this activity. In 2000, a *Resolution by ICCAT on Bluefin Tuna Farming* [Res. 00-10] was adopted and in 2002 a *Recommendation by ICCAT on Bluefin Tuna Farming* [Rec. 02-10]. Since then, revised versions of this Recommendation have been adopted each year (*Recommendation by ICCAT on Bluefin Tuna Farming* [Rec. 03-09]; *Recommendation by ICCAT on Bluefin Tuna Farming* [Rec. 04-06]; *Recommendation by ICCAT to Amend the Recommendation on Bluefin Tuna Farming [Rec.04-06]* [Rec. 05-04] and *Recommendation by ICCAT on Bluefin Tuna Farming* [Rec. 06-07]. The combination of the measures taken to regulate farming activities and the recovery of the stock, as well as the Catch Documentation Scheme will allow quantities caught and traded to be monitored.

A1.4 Statistical Document Program and unreported catches

With the aim of countering underreporting of catches, particularly by non-Contracting Parties, and the uncertainty in statistical data needed for reliable stock assessments, the Commission adopted a *Resolution Concerning Catches of Bluefin Tuna by non-Contracting Parties* [Res. 91-02] which paved the way for the creation of the Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures (PWG) in 1992. At the second meeting of the Management Review Committee for West Atlantic Bluefin Tuna (September 1992), the parties developed an outline for a Certificate of Origin Program for Bluefin Tuna, based on the deliberations and recommendations of the ICCAT Working Group to Develop Technical Details for the Implementation of the ICCAT Resolution on Catches by non-Contracting Parities (Tokyo, May 1992). Japanese trade data available at that time indicated that approximately 3,000 t of bluefin tuna was imported into Japan in 1991 from non-Contracting Parties.

The Program was presented to the Commission in 1992 and led to the adoption of *Recommendation by ICCAT Concerning the ICCAT Bluefin Tuna Statistical Document Program* [Rec. 92-01], which required all imported bluefin tuna to be accompanied by an ICCAT Statistical Document, with the double aim of estimating the real level of catches and reducing catches taken in a manner which could undermine the ICCAT conservation and management measures. The Statistical Document Program was developed over several years through the adoption of *Resolution by ICCAT Concerning Validation by a Government Official of the Bluefin Tuna Statistical Document* [Rec. 93-02]; *Recommendation by ICCAT Concerning the Implementation of the ICCAT Bluefin Tuna Statistical Document Program on Fresh Products* [Rec. 93-03]; *Resolution by ICCAT on Interpretation and Application of the ICCAT Bluefin Tuna Statistical Document Program* [Res. 94-04]; *Resolution by ICCAT Concerning the Effective Implementation of the ICCAT Bluefin Tuna Statistical Document Program* [Res. 94-05]; *Recommendation by ICCAT on the Validation of Bluefin Statistical Documents between ICCAT Contracting Parties which are Members of the European Community* [Rec. 96-10]; *Recommendation by ICCAT Concerning the Implementation of the ICCAT Bluefin Tuna Statistical Document Program on re-export* [Rec. 97-04]; *Recommendation by ICCAT on Validation of the Bluefin Tuna Statistical Document by the European Community* [Rec. 98-12]; and the *Recommendation by ICCAT Concerning the Amendment of the Forms of the ICCAT Bluefin/Bigeye/Swordfish Statistical Documents* [Rec. 03-19]. The Program has been a valuable tool in identifying illegal, unreported and unregulated (IUU) fishing activities, and the elimination of a considerable amount of IUU fishing. In 1997, the data compiled from the Bluefin Statistical Document Program were compared with the reported catch statistics, and considerable differences were found, leading to the *Recommendation by ICCAT Concerning Unreported Catches of Bluefin Tuna, Including Catches Classified as Not Elsewhere Included (NEI)* [Rec. 97-03], which was later followed up by the PWG with a variety of measures aimed at eliminating this practice to the extent possible.

A1.5 Catch Document Scheme

While the Bluefin Tuna Statistical Document Program has been a useful tool in detecting unreported catches, it has two major limitations; 1) domestic consumption of bluefin tuna cannot be detected and 2) quantities of tuna caged for farming purposes cannot be adequately determined.

In order to overcome the shortcomings of the Bluefin Statistical Document Program, and with a view to strengthening the conservation and management measures in force for Atlantic bluefin tuna in 2007 and the measures taken to control bluefin tuna farming, the Commission adopted the R*ecommendation by ICCAT on an ICCAT Bluefin Tuna Catch Documentation Program* [07-10]. The objective of this scheme is to ensure the reporting of all catches, whether they be destined for export, domestic consumption or farming purposes. Refinements were made to this scheme in 2008 through the *Recommendation by ICCAT Amending Recommendation 07-10 on an ICCAT Bluefin Tuna Catch Documentation Program* [Rec. 08-12], and in 2009 through the *Recommendation by ICCAT Amending the Recommendation 08-12 on an ICCAT Bluefin Tuna Catch Document Program* [Rec. 09-11], with instructions being included in 2009 for clarity and improved implementation.

A1.6 Scientific research

In addition to the conservation and management measures adopted for the two Atlantic bluefin tuna stocks, the Commission has remained aware of the need for further research on this species and has adopted several measures specifically covering aspects of research required. Many of these have been aimed at improving knowledge to ascertain the possible extent of mixing between the two-stocks, and additional statistical and scientific elements required to assure sound management advice. These measures include:

Resolution by ICCAT for Atlantic Bluefin Tuna Recovery Programs [Res. 95-4]; *Resolution by ICCAT for the Development of Additional Recovery Scenarios for Atlantic Bluefin Tuna* [Res. 97-16]; *Recommendation by ICCAT on Bluefin Tuna Research in the Central North Atlantic Ocean* [Rec. 00-08]; *Resolution by ICCAT for SCRS to Examine the Effects of Mixing for Stock Assessments and Management and Consider the Appropriateness of the Current Boundary Between the Western and Eastern Management Units for Atlantic Bluefin Tuna* [Res. 00-11]; *Resolution by ICCAT on Conversion Factors for Bluefin Tuna from Product Weight to Live Weight* [Res. 00-12]; *Supplemental Recommendation by ICCAT on Bluefin Tuna Research in the Central North Atlantic Ocean* [Rec. 01-08]; *Resolution by ICCAT Regarding the SCRS Mixing Report on Atlantic Bluefin Tuna* [Res. 01-09]. In 2006, the Commission adopted the *Resolution by ICCAT Concerning Atlantic Bluefin Tuna Scientific Research on Stock Origin and Mixing* [Res. 08-06] to strengthen research on the possibility of mixing. It should be noted, however, that many of the conservation and management measures cited in earlier sections of this report contain provisions relating to research and tasks assigned to the SCRS.

The Bluefin Year Program was established in 1992-1997 through informal coordination of national research activities. Since 1997, this program has been financed through the regular budget of the Commission. The aims of the Program are to improve general biological information and statistical fisheries data on bluefin tuna. In 2008, ICCAT decided to embark upon a much more comprehensive, Atlantic-wide program, expected to last for six years. This research program (GBYP) is being financed principally by extra-budgetary funds from several Contracting Parties. Program elements include aerial surveys, conventional and archival tagging studies, otolith microchemistry analyses, data mining, and research on bluefin biology.

Annex 2

MANAGEMENT MEASURES TAKEN HISTORICALLY FOR BLUEFIN TUNA AND CURRENT REPORTING REQUIREMENTS

A2.1 List of measures adopted by ICCAT. "Rec." denotes binding decisions. These measures can be downloaded from http://www.iccat.int/en/RecsRegs.asp.

Ref.	*Type*	*Title*	*Group*	*Active*
2009-06	Rec	Recommendation by ICCAT Amending Recommendatin 08-05 to Establish a multiannual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean	BFT	No (not yet in force)
2008-06	Res	Resolution by ICCAT Concerning Atlantic Bluefin Tuna Scientific Research on Stock Origin and Mixing	BFT	Yes
2008-05	Rec	Recommendation by ICCAT Amending the Recommendation by ICCAT to Establish a Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean	BFT	Yes
2008-04	Rec	Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program	BFT	Yes
2007-05	Res	Resolution by ICCAT for Rebuilding of the Eastern Atlantic Bluefin Tuna Stock	BFT	Yes
2007-04	Rec	Recommendation by ICCAT in Regard to Compliance in the Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean	BFT	Yes
2006-08	Res	Resolution by ICCAT on Fishing Bluefin Tuna in the Atlantic Ocean	BFT	Yes
2006-07	Rec	Recommendation by ICCAT on Bluefin Tuna Farming	BFT	Yes
2006-06	Rec	Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program	BFT	Yes
2006-05	Rec	Recommendation by ICCAT to Establish a Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean	BFT	Yes
2005-04	Rec	Recommendation by ICCAT to Amend the Recommendation on Bluefin Tuna Farming [Rec.04-06]	BFT	No
2004-08	Res	Supplemental Resolution by ICCAT on fishing for bluefin tuna in the Atlantic Ocean	BFT	No
2004-07	Rec	Recommendation by ICCAT on bluefin tuna size limit	BFT	No
2004-06	Rec	Recommendation by ICCAT on bluefin tuna farming	BFT	No
2004-05	Rec	Recommendation by ICCAT concerning the western atlantic bluefin tuna rebuilding program and the conservation and management measures for bluefin tuna in the eastern Atlantic and Mediterranean	BFT	No
2003-09	Rec	Recommendation by ICCAT on bluefin tuna farming	BFT	No
2003-08	Rec	Recommendation by ICCAT concerning the stock assessment schedule for western Atlantic bluefin tuna	BFT	No
2002-12	Res	Resolution by ICCAT on fishing for bluefin tuna in the Atlantic Ocean	BFT	No
2002-10	Rec	Recommendation by ICCAT on bluefin tuna farming	BFT	No
2002-09	Rec	Recommendation by ICCAT to develop a plan aimed at reducing the catches of juvenile bluefin tuna in the Mediterranean	BFT	No
2002-08	Rec	Recommendation by ICCAT concerning a multi-year conservation and management plan for bluefin tuna in the East Atlantic and Mediterranean	BFT	No
2002-07	Rec	Recommendation by ICCAT concerning conservation of western Atlantic bluefin tuna	BFT	No
2001-09	Res	Resolution by ICCAT regarding the SCRS mixing report on Atlantic bluefin tuna	BFT	Yes
2001-08	Rec	Supplemental Recommendation by ICCAT on bluefin tuna research in the central North Atlantic Ocean	BFT	Yes
2000-12	Res	Resolution by ICCAT on conversion factors for bluefin tuna from product weight to live weight	BFT	No
2000-11	Res	Resolution by ICCAT for SCRS to examine the effects of mixing for stock assessments & management and consider the appropriateness of the current boundary between the western and eastern management units for Atlantic bluefin tuna	BFT	No
2000-10	Res	Resolution by ICCAT on bluefin tuna farming	BFT	No
2000-09	Rec	Recommendation by ICCAT concerning bluefin tuna catch limits in the East Atlantic and Mediterranean	BFT	No
2000-08	Rec	Recommendation by ICCAT on bluefin tuna research in the central North Atlantic Ocean	BFT	No
1998-07	Rec	Recommendation by ICCAT to establish a rebuilding program for western Atlantic bluefin tuna	BFT	No
1998-06	Rec	Recommendation by ICCAT concerning the changes of closed season for the purse seine fishery for bluefin tuna in the Mediterranean Sea	BFT	No
1998-05	Rec	Recommendation by ICCAT on the limitation of catches of bluefin tuna in the eastern Atlantic and Mediterranean	BFT	No
1998-04	Rec	Recommendation by ICCAT amending the "Recommendation on bluefin catch limits in the Eastern Atlantic Ocean and Mediterranean Sea" and the "Recommendation by ICCAT on supplemental management measures concerning age 0 bluefin tuna"	BFT	No

1997-16	Res	Resolution by ICCAT for the development of additional recovery scenarios for Atlantic bluefin tuna	BFT	No
1997-03	Rec	Recommendation by ICCAT concerning unreported catches of bluefin tuna, including catches classified as not elsewhere included (NEI)	BFT	Yes
1997-02	Rec	Recommendation by ICCAT on a supplemental management measure concerning age zero bluefin tuna	BFT	No
1996-05	Res	Resolution for SCRS to evaluate the appropriateness of the current boundary between East and West Atlantic bluefin tuna	BFT	No
1996-04	Rec	Recommendation by ICCAT to establish a scientific monitoring quota for bluefin tuna in the western Atlantic for 1997-1998	BFT	No
1996-03	Rec	Recommendation by ICCAT concerning Age 0 bluefin tuna	BFT	No
1996-02	Rec	Supplemental Recommendation by ICCAT on east Atlantic bluefin tuna concerning the Mediterranean closed season	BFT	No
1995-07	Rec	Recommendation by ICCAT for quota exemption for small-scale domestic bluefin tuna fisheries in the western Atlantic	BFT	No
1995-05	Rec	Recommendation by ICCAT on supplemental management measures for eastern Atlantic bluefin tuna	BFT	No
1995-04	Res	Resolution by ICCAT for Atlantic bluefin tuna recovery programs	BFT	No
1994-12	Rec	Recommendation by ICCAT for the management of bluefin tuna fishing in the Western Atlantic Ocean	BFT	No
1994-11	Rec	Recommendation by ICCAT for the management of bluefin tuna fishing in the Eastern Atlantic Ocean and Mediterranean Sea	BFT	No
1994-07	Res	Resolution by ICCAT on fishing in the Mediterranean during spawning months	BFT	No
1993-07	Rec	Recommendation by ICCAT on supplemental regulatory measures for the management of eastern Atlantic bluefin tuna	BFT	No
1993-06	Rec	Recommendation by ICCAT on the management of bluefin tuna fishing in the central North Atlantic Ocean	BFT	No
1993-05	Rec	Recommendation by ICCAT on the management of bluefin tuna fishing in the western Atlantic	BFT	No
1992-04	Rec	Recommendations for the 1992-1993 management of western Atlantic bluefin tuna	BFT	No
1991-02	Res	Resolution by ICCAT concerning catches of bluefin tuna by non-Contracting Parties	BFT	No
1991-01	Rec	Recommendation by ICCAT (made in 1991) for the enhancement of the current management of western Atlantic bluefin tuna	BFT	No
1986-01	Rec	Regulations for the Atlantic bluefin tuna (1987)	BFT	No
1985-01	Rec	Regulations for the Atlantic bluefin tuna (1986)	BFT	No
1984-01	Rec	Regulations for the Atlantic bluefin tuna catch (1985)	BFT	No
1983-01	Rec	New regulations for the Atlantic bluefin tuna catch [1984]	BFT	No
1982-01	Rec	New regulations for the Atlantic bluefin tuna catch [1983]	BFT	No
1981-01	Rec	Recommendation on bluefin management measures	BFT	No
1974-01	Rec	Recommendation by ICCAT concerning a limit on bluefin tuna size and fishing mortality	BFT	No
		Statistical and catch document programs		
2009-11	Rec	Recommendation by ICCAT Amending the Recommendation 08-12 on an ICCAT Bluefin Tuna Catch Document Program	SDP	No (not yet in force)
2008-12	Rec	Recommendation by ICCAT Amending Recommendation 07-10 on an ICCAT Bluefin Tuna Catch Documentation Program	SDP	Yes
2008-11	Rec	Recommendation by ICCAT Amending Ten Recommendations and Three Resolutions	SDP	Yes
2007-10	Rec	Recommendation by ICCAT on an ICCAT Bluefin Tuna Catch Documentation Program	SDP	Yes
2006-16	Rec	Recommendation by ICCAT on an Electronic Statistical Document Pilot Program	SDP	Yes
2006-15	Rec	Recommendation by ICCAT on Additional Measures for Compliance of the ICCAT Conservation and Management Measures	SDP	No
2003-19	Rec	Recommendation by ICCAT concerning the amendment of the forms of the ICCAT bluefin/bigeye/swordfish statistical documents	SDP	Yes
2000-22	Rec	Recommendation by ICCAT on establishing Statistical Document Programs for swordfish, bigeye tuna, and other species managed by ICCAT	SDP	Yes
1998-12	Rec	Recommendation by ICCAT on validation of the Bluefin Tuna Statistical Document by the European Community	SDP	Yes
1997-04	Rec	Recommendation by ICCAT concerning the implementation of the ICCAT Bluefin Tuna Statistical Document Program on re-export	SDP	No
1996-10	Rec	Recommendation by ICCAT on the validation of Bluefin Statistical Documents between ICCAT Contracting Parties which are members of the European Community	SDP	No

1994-05	Res	Resolution by ICCAT concerning the effective implementation of the ICCAT Bluefin Tuna Statistical Document Program	SDP	No
1994-04	Res	Resolution by ICCAT on interpretation and application of the ICCAT Bluefin Tuna Statistical Document Program	SDP	No
1993-03	Rec	Recommendation by ICCAT concerning the implementation of the ICCAT Bluefin Tuna Statistical Document Program on fresh products	SDP	No
1993-02	Res	Resolution by ICCAT concerning validation by a government official of the Bluefin Tuna Statistical Document	SDP	Yes
1992-01	Rec	Recommendation by ICCAT concerning the ICCAT Bluefin Tuna Statistical Document Program	SDP	No

A2.2 Reporting requirements for ICCAT Parties fishing for eastern Atlantic and Mediterranean bluefin tuna.

Information required	*Ref.*	*Deadline*	*Information required from*
Bluefin tuna farming facilities	Rec. 06-07	At time of each change	CPCs involved in bluefin tuna farming
Bluefin tuna farming reports	Rec. 06-07	31-Aug-10	CPCs involved in bluefin tuna farming
Bluefin tuna caging declaration	Rec. 06-07 and 08-05	Within one week of caging	CPCs involved in bluefin tuna farming
Growth factors and methodology used	Rec.08-05	Before SCRS meeting	CPCs involved in bluefin tuna farming
Size sampling from farms	Rec. 06-07	see 27 TII size sampling above	CPCs involved in bluefin tuna farming
Annual fishing plan (including quota management and specific quota for recreational and sport fisheries)	Rec. 08-05	01-Mar-10	CPCs fishing bluefin tuna in East Atl. + Medi
Report on implementation of annual fishing plan	Rec. 08-05	15-Oct-10	CPCs fishing bluefin tuna in East Atl. + Medi
Report on implementation of Rec.08-05	Rec. 08-05	15-Oct-10	CPCs which have implemented Rec. 08-05
Management plan on fishing capacity	Rec. 08-05 and 09-06	before the 2010 Commission meeting	CPCs which licence vessels to fish E-BFT
Farming Capacity limitation	Rec. 08-05	revision at 2010 Commission meeting	CPCs involved in bluefin tuna farming
Bluefin tuna catching vessels	Rec. 08-05	One month before start of fishing season	CPCs fishing bluefin tuna in East Atl. + Medi
Bluefin tuna other vessels	Rec. 08-05	One month before start of fishing season	CPCs fishing, farming or transporting bluefin tuna in East Atl. + Medi
Bluefin tuna active vessels 2009	Rec. 08-05	01-Mar-10	CPCs whose vessels fished for E-BFT in 2009
Vessels not covered by Rec . 08-05 and presumed to have fished	Rec. 08-05	Any time	CPCs which have detected fishing by unauthorized vessels
List of baitboats and trollers	Rec. 08-05	30-Jan-10	CPCs with baitboats and trollers catching East Atl. + Medi BFT
List of vessels operating in the Adriatic	Rec. 08-05	30-Jan-10	CPCs whose vessels catch BFT in the Adriatic Sea
List of Artisanal vessels in the Mediterranean	Rec. 08-05	30-Jan-10	CPCs with artisinal vessels operating in the Med for BFT
Plans for participation in Joint Inspection Scheme, including lists of inspectors and inspection vessels	Rec. 08-05	01-Mar-10	CPCs participating in the ICCAT Scheme of Joint Int'l Inspection
Copies of inspection reports	Rec. 08-05	At time of each occurence or change	CPCs authorising inspection vessels under the E-BFT plan
Bluefin tuna traps	Rec. 08-05	01-Mar-10	CPCs fishing bluefin tuna in East Atl. + Medi
Bluefin tuna trap declarations	Rec. 08-05	Within 48 hours of harvest	CPCs catching East Atl. and Medi BFT with traps
Bluefin tuna weekly catch reports	Rec. 08-05	Every week on Monday	CPCs fishing bluefin tuna in East Atl. + Medi
Bluefin tuna monthly catch reports	Rec. 08-05	Every month	CPCs fishing bluefin tuna in East Atl. + Medi
Sport and Recreational fishing data	Rec. 08-05	31-Jul-10	CPCs operating sport and/or recreational fisheries
Bluefin tuna transhipment ports	Rec. 08-05	01-Mar-10	CPCs fishing bluefin tuna in East Atl. + Medi
Bluefin tuna landing ports	Rec. 08-05	01-Mar-10	CPCs fishing bluefin tuna in East Atl. + Medi
VMS messages	Rec.07-08 and 08-05	Every six hours	CPCs with vessels over 15m fishing for East Atl and Medi BFT
Joint Fishing Operations	Rec. 08-05 and 09-06	10 days before fishing	CPCs participating in joint operations
List of BFT observers	Rec.08-05	01-Feb-10	CPCs with observer coverage on vessels / farms
Data from National Observer programmes	Rec. 08-05	Before SCRS meeting	CPCs fishing bluefin tuna in East Atl. + Medi

8.12 SHK – SHARKS

In response to the *Supplementary Recommendation by ICCAT Concerning the Conservation of Sharks caught in Association with Fisheries Managed by ICCAT* [Rec. 06-10], *an updated assessment of the stocks of blue shark (Prionace glauca*) and *shortfin mako (Isurus oxyrinchus)* was conducted in 2008. Ecological risk assessments (ERA) were also conducted for nine additional priority species of pelagic elasmobranchs, for which available data are very limited (*Isurus paucus*; *Alopias superciliosus*; *Alopias vulpinus*; *Carcharhinus longimanus*; *C. falciformis*; *Lamna nasus*; *Sphyrna lewini*; *Sphyrna zygaena*; and *Pteroplatytrygon violacea*). In 2009, an assessment of porbeagle stocks was conducted jointly with ICES, in response to the *Resolution by ICCAT on Porbeagle Shark* [Rec. 08-08].

The quantity and quality of the data available (e.g., historical catches and CPUE information) to conduct stock assessments have increased with respect to those available in the first (2004) shark assessments conducted by ICCAT. However, they are still quite uninformative and do not provide a consistent signal to inform the assessment. Unless these and other issues can be resolved, the assessments of stock status for all pelagic shark species will continue to be very uncertain and our ability to detect stock depletion to levels below the Convention Objective level will remain considerably low.

A summary of the Committee's findings based on the 2008 and 2009 assessment results is presented below. Although pelagic sharks are captured in the Atlantic Ocean with a wide variety of fishing gears, the largest volume of most of the species of major concern to ICCAT are captured by pelagic longline fisheries.

The Committee assessed blue and shortfin mako sharks in 2008 assuming the existence of three separate stocks: North, South and Mediterranean. However, the data available to the Committee for the Mediterranean were not considered sufficient to conduct quantitative assessments for these species. The assessment results presented high levels of uncertainty due to data limitations. Similarly, the Committee assessed in 2009 porbeagle sharks assuming the existence of four separate stocks: Northwest, Northeast (including the Mediterranean, for which only limited information is available), Southwest and Southeast. The assessment results for the southern porbeagle stocks also presented high levels of uncertainty due to data limitations.

Increased research and data collection are required to enable the Committee to improve the advice it can offer.

SHK-1 Biology

A great variety of shark species are found within the ICCAT Convention area, from coastal to oceanic species. Biological strategies of these sharks are very diverse and are adapted to the needs within their respective ecosystems where they occupy a very high position in the trophic chain as active predators. Therefore, generalization as regards to the biology of these very diverse species results in inevitable inaccuracies, as would occur for teleosts. To date, ICCAT has prioritized the biological study and assessment of the major sharks of the epipelagic system as these species are more susceptible of being caught as by-catch by oceanic fleets targeting tuna and tuna-like species. Among these shark species there are some of special prevalence and with an extensive geographical distribution within the oceanic-epipelagic ecosystem, such as the blue shark and shortfin mako shark, and others with less or even limited prevalence, such as porbeagle, hammerhead sharks, thresher sharks, white sharks, etc.

Blue shark and shortfin mako sharks show a wide geographical distribution, most often between 50ºN and 50ºS latitude. On the contrary, porbeagle show a distribution that is restricted to cold-temperate waters, preferably close to the continental shelf of both hemispheres where this species rarely overlaps with the fishing activity directed at tunas and tuna-like species. These three species have an ovoviviparous reproductive strategy, which increases the probability of survival of their young, with litters from only a few individuals in the case of shortfin mako and porbeagle, to abundant litters of about 40 pups in the case of blue shark. Their growth rates differ between sexes and among these three species. Females often reach first maturity at a large size. A characteristic of these species is usually their tendency to segregate temporally and spatially by size-sex, according to their respective processes of feeding, mating-reproduction, gestation and birth. Numerous aspects of the biology of these species are still poorly understood or completely unknown, particularly for some regions, which contributes to increased uncertainty in quantitative and qualitative assessments.

SHK-2. Fishery indicators

Earlier reviews of the shark database resulted in recommendations to improve data reporting on shark catches. Though global statistics on shark catches included in the database have improved, they are still insufficient to permit the Committee to provide quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels. Reported catches for blue shark, shortfin mako and porbeagle are provided in **SHK-Table 1**. Given that catch reports to ICCAT are incomplete, the Committee attempted to develop a more accurate estimate of shark mortality and capture related to the Atlantic tuna fleets on the basis of the expected proportions among tunas and sharks and in the landings of these fleets (**SHK-Figure 1 to 4)** as well as using shark fin trade data. These information sets were used to reconstruct plausible estimates of historic catches used in blue shark and shortfin mako assessments in 2008 and porbeagle in 2009.

A number of standardized CPUE data series for blue shark and shortfin mako were presented in 2008 as relative indices of abundance. The Committee placed emphasis on using the series that pertained to fisheries that operate in oceanic waters over wide areas. **SHK-Figure 5** presents the central tendency of the available series for the four stocks of these species.

Considering the quantitative and qualitative limitations of the information available to the Committee, the results presented in 2008, as those of the 2004 assessment (Anon. 2005c), are not conclusive. During the porbeagle assessment in 2009, standardized CPUE data were presented for three of the four stocks (NE, NW and SW; **SHK-Figure 6)**. These series when referring to fisheries targeting porbeagle could fail to reflect the global abundance of the stock and where they refer to sharks caught as by-catch they could be highly variable.

With regard to the species for which ERAs were conducted, the Committee understands that, in spite of existing uncertainties, results make it possible to identify those species that are more susceptible and vulnerable (based only on productivity) to prioritize research and management measures **(SHK-Table 2)**. These ERAs are conditional on the biological variables used to estimate productivity as well as the susceptibility values for the different fleets and thus may change in the future as new information becomes available.

SHK-3 State of the Stocks

Ecological risk assessments for eleven priority species of sharks (including blue shark and shortfin mako) caught in ICCAT fisheries demonstrated that most Atlantic pelagic sharks have exceptionally limited biological productivity and, as such, can be overfished even at very low levels of fishing mortality. Specifically, the analyses indicated that bigeye threshers, longfin makos, and shortfin makos have the highest vulnerability (and lowest biological productivity) of the shark species examined (with bigeye thresher being substantially less productive than the other species). All species considered in the ERA, particularly smooth hammerhead, longfin mako, bigeye thresher and crocodile sharks, are in need of improved biological data to evaluate their biological productivity more accurately and thus specific research projects should be supported to that end. **SHK-Table 2** provides a productivity ranking of the species considered. ERAs should be updated with improved information on the productivity and susceptibility of these species.

SHK-3.1. Blue shark

For both North and South Atlantic blue shark stocks, although the results are highly uncertain, biomass is believed to be above the biomass that would support MSY and current harvest levels below F_{MSY}. Results from all models used in the 2008 assessment were conditional on the assumptions made (*e.g.*, estimates of historical catches and effort, the relationship between catch rates and abundance, the initial state of the stock in the 1950s, and various life-history parameters), and a full evaluation of the sensitivity of results to these assumptions was not possible during the assessment. Nonetheless, as for the 2004 stock assessment, the weight of available evidence does not support hypotheses that fishing has yet resulted in depletion to levels below the Convention objective (**SHK-Figure 7**).

SHK-3.2. Shortfin mako shark

Estimates of stock status for the North Atlantic shortfin mako obtained with the different modeling approaches applied in 2008 were much more variable than for blue shark. For the North Atlantic, most model outcomes indicated stock depletion to about 50% of biomass estimated for the 1950s. Some model outcomes indicated that the stock biomass was near or below the biomass that would support MSY with current harvest levels above

F_{MSY}, whereas others estimated considerably lower levels of depletion and no overfishing (**SHK-Figure 7**). In light of the biological information that indicates the point at which B_{MSY} is reached with respect of the carrying capacity which occurs at levels higher than for blue sharks and many teleost stocks. There is a non-negligible probability that the North Atlantic shortfin mako stock could be below the biomass that could support MSY. A similar conclusion was reached by the Committee in 2004, and recent biological data show decreased productivity for this species. Only one modeling approach could be applied to the South Atlantic shortfin mako stock, which resulted in an estimate of unfished biomass which was biologically implausible, and thus the Committee can draw no conclusions about the status of the South stock.

SHK-3.3. Porbeagle shark

In 2009, the Committee attempted an assessment of the four porbeagle stocks in the Atlantic Ocean: Northwest, Northeast (including the Mediterranean), Southwest and Southeast. In general, data for southern hemisphere porbeagle are too limited to provide a robust indication on the status of the stocks. For the Southwest, limited data indicate a decline in CPUE in the Uruguayan fleet, with models suggesting a potential decline in porbeagle abundance to levels below MSY and fishing mortality rates above those producing MSY (**SHK-Figure 8**). But catch and other data are generally too limited to allow definition of sustainable harvest levels. Catch reconstruction indicates that reported landings grossly underestimate actual landings. For the Southeast, information and data are too limited to assess their status. Available catch rate patterns suggest stability since the early 1990s, but this trend cannot be viewed in a longer term context and thus are not informative on current levels relative to B_{MSY}.

The Northeast Atlantic stock has the longest history of commercial exploitation. A lack of CPUE data for the peak of the fishery adds considerable uncertainty in identifying the current status relative to virgin biomass. Exploratory assessments indicate that current biomass is below B_{MSY} and that recent fishing mortality is near or above F_{MSY} (**SHK-Figure 9**). Recovery of this stock to B_{MSY} under no fishing mortality is estimated to take ca. 15-34 years. The current EC TAC of 436 t in effect for the Northeast Atlantic may allow the stock to remain stable, at its current depleted biomass level, under most credible model scenarios. Catches close to the current TAC (e.g. 400 t) could allow rebuilding to B_{MSY} under some model scenarios, but with a high degree of uncertainty and on a time scale of 60 (40-124) years.

An update of the Canadian assessment of the Northwest Atlantic porbeagle stock indicated that biomass is depleted to well below B_{MSY}, but recent fishing mortality is below F_{MSY} and recent biomass appears to be increasing. Additional modelling using a surplus production approach indicated a similar view of stock status, i.e., depletion to levels below B_{MSY} and current fishing mortality rates also below F_{MSY} (**SHK-Figure 10**). The Canadian assessment projected that with no fishing mortality, the stock could rebuild to B_{MSY} level in approximately 20-60 years, whereas surplus-production based projections indicated 20 years would suffice. Under the Canadian strategy of a 4% exploitation rate, the stock is expected to recover in 30 to 100+ years according to the Canadian projections.

SHK-4. Management Recommendations

Precautionary management measures should be considered for stocks where there is the greatest biological vulnerability and conservation concern, and for which there are very few data. Management measures should ideally be species-specific whenever possible.

For species of high concern (in terms of overfishing), which are expected to have high survivorship in fishing gears after release, particularly the bigeye thresher, the Committee recommends that the Commission prohibit retention and landings of the species to avoid fishing mortality. For other species which can be easily misidentified, such prohibitions could complicate compliance monitoring and therefore, other measures might be more appropriate. For example, minimum landing lengths or maximum landing lengths would afford protection to juveniles or the breeding stock, respectively, although other technical measures such as gear modifications, time-area restrictions, or other approaches, could be alternative means to protecting different life stages, provided they are tested for effectiveness through research projects before they are implemented.

Both porbeagle stocks in the NW and NE Atlantic are estimated to be overfished, with the northeastern stock being more depleted. The main source of fishing mortality on these stocks is from non-ICCAT, directed porbeagle fisheries that are being managed by most of the relevant Contracting Parties through quotas and other measures.

The Committee recommends that countries initiate research projects to investigate means to minimize by-catch and discard mortality of sharks, with a particular view to recommending to the Commission complementary measures to minimize porbeagle by-catch in fisheries for tuna and tuna-like species.

For porbeagle sharks, the Committee recommends that the Commission work with countries catching porbeagle, particularly those with targeted fisheries, and relevant RFMOs to ensure recovery of North Atlantic porbeagle stocks and prevent overexploitation of South Atlantic stocks. In particular, porbeagle fishing mortality should be kept to levels in line with scientific advice and with catches not exceeding current level. New targeted porbeagle fisheries should be prevented, porbeagles retrieved alive should be released alive, and all catches should be reported.

Management measures and data collection should be harmonized among all relevant RFMOs, and ICCAT should facilitate appropriate communication.

NORTH ATLANTIC BLUE SHARK SUMMARY

2007 Yield		61,845 t[1]
Current Yield (2008)		30,545 t[2]
Relative Biomass:	B_{2007}/B_{MSY}	1.87-2.74[3]
	B_{2007}/B_0	0.67-0.93[4]
Relative Fishing Mortality:	F_{MSY}	0.15[5]
	F_{2007}/F_{MSY}	0.13-0.17[6]

[1] Estimated catch used in the 2008 assessments.
[2] Task I catch.
[3] Range obtained from the Bayesian Surplus Production (BSP) (low) and the Catch-Free Age Structured Production (CFASP) (high) models.
Value from CFASP is SSB/SSB_{MSY}.
[4] Range obtained from BSP (high), CFASP and Age-Structured Production Model (ASPM) (low) models.
[5] From BSP and CFASP models (same value). CV is from CFASP model.
[6] Range obtained from BSP (high) and CFASP (low) models.

SOUTH ATLANTIC BLUE SHARK SUMMARY

2007 Yield		37,075 t[1]
Current Yield (2008)		23,278 t[2]
Relative Biomass:	B_{2007}/B_{MSY}	1.95-2.80[3]
	B_{2007}/B_0	0.86-0.98[4]
Relative Fishing Mortality:	F_{MSY}	0.15-0.20[5]
	F_{2007}/F_{MSY}	0.04-0.09[6]

[1] Estimated catch used in the 2008 assessments.
[2] Task I catch.
[3] Range obtained from BSP (low) and CFASP (high) models. Value from CFASP is $SSB/SSB_{MSY.}$
[4] Range obtained from BSP (high) and CFASP (low) models. Value from CFASP is SSB/SSB0.
[5] Range obtained from BSP (low) and CFASP (high) models.
[6] Range obtained from BSP (low) and CFASP (high) models.

NORTH ATLANTIC SHORTFIN MAKO SUMMARY

2007 Yield		5,996 t[1]
Current Yield (2008)		3,372 t[2]
Relative Biomass:	B_{2007}/B_{MSY}	0.95-1.65[3]
	B_{2007}/B_0	0.47-0.73[4]
Relative Fishing Mortality:	F_{MSY}	0.007-0.05[5]
	F_{2007}/F_{MSY}	0.48-3.77[6]
Management measures in effect		[Rec. 04-10], [Rec. 07-06]

[1] Estimated catch used in the 2008 assessments.
[2] Task I catch.
[3] Range obtained from BSP (low) and CFASP (high) models. Value from CFASP is $SSB/SSB_{MSY.}$
[4] Range obtained from BSP (low), AS, and CFASP (high) models. Value from CFASP is SSB/SSB0.
[5] Range obtained from BSP (low) and CFASP (high) models.
[6] Range obtained from BSP (high) and CFASP (low) models.

NORTHWEST ATLANTIC PORBEAGLE SUMMARY

Current Yield (2008)		144.3 t[1]
Relative Biomass:	B_{2008}/B_{MSY}	0.43-0.65[2]
Relative Fishing Mortality:	F_{MSY}	0.025-0.075[3]
	F_{2008}/F_{MSY}	0.03-0.36[4]
Management measures in effect		TAC of 185, 11.3 t[5]

[1] Estimated catch allocated to the Northwest stock area.
[2] Range obtained from age-structured model (Canadian assessment; low) and BSP model (high). Value from Canadian assessment is in numbers; value from BSP in biomass. All values in parentheses are CVs.
[3] Range obtained from BSP model (low) and age-structured model (high).
[4] Range obtained from BSP model (low) and age-structured model (high).
[5] The TAC for the Canadian EEZ is 185 t (MSY catch is 250 t); the TAC for the USA is 11.3 t.

SOUTHWEST ATLANTIC PORBEAGLE SUMMARY

Current Yield (2008)		164.6 t[1]
Relative Biomass:	B_{2008}/B_{MSY}	0.36-0.78[2]
Relative Fishing Mortality:	F_{MSY}	0.025-0.033[3]
	F_{2008}/F_{MSY}	0.31-10.78[4]
Management measures in effect		None

[1] Estimated catch allocated to the Southwest stock area.
[2] Range obtained from BSP (low and high) and CFASP models. Value from CFASP model (SSB/SSB_{MSY}) was 0.48 (0.20).
[3] Range obtained from BSP (low) and CFASP (high) models.
[4] Range obtained from BSP (low and high) and CFASP models. Value from CFASP model was 1.72 (0.51).

NORTHEAST ATLANTIC PORBEAGLE SUMMARY

Current Yield (2008)		287 t[1]
Relative Biomass:	B_{2008}/B_{MSY}	0.09-1.93[2]
Relative Fishing Mortality:	F_{MSY}	0.02-0.03[3]
	F_{2008}/F_{MSY}	0.04-3.45[4]
Management measures in effect		TAC of 436 t[5]
		Maximum landing length of 210 cm FL[5]

[1] Estimated catch allocated to the Northeast stock area.
[2] Range obtained from BSP (high) and ASPM (low) models. Value from ASPM model is SSB/SSB_{MSY}. The value of 1.93 from the BSP corresponds to a biologically unrealistic scenario; all results from the other BSP scenarios ranged from 0.29 to 1.05.
[3] Range obtained from the BSP and ASPM models (low and high for both models).
[4] Range obtained from BSP (low) and ASPM (high) models. The value of 0.04 from the BSP corresponds to a biologically unrealistic scenario; all results from the BSP scenarios ranged from 0.70 to 1.26.
[5] In the European Community.

SHK-Table 1. Estimated catches (t) of major sharks species (BSH,SMA,POR) by major area, gear and flag.

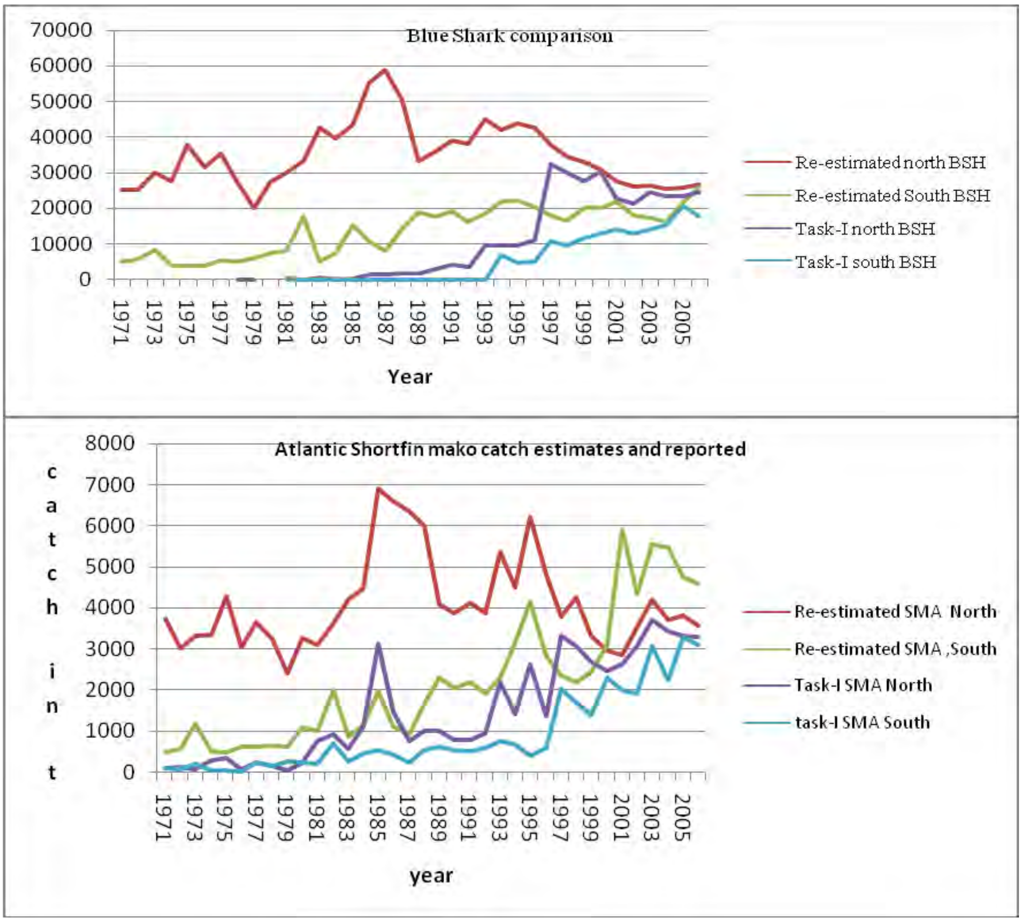
			1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
BSH TOTAL			121	380	1482	1614	1835	1810	3028	4307	3643	9577	9562	9634	9560	37610	33809	35093	39101	34447	32735	35572	36304	43071	40351	47045	53902
	ATN		121	380	1482	1614	1835	1810	3028	4299	3536	9566	8084	8285	7258	29053	26510	25741	27965	21022	20037	22911	21740	22357	23215	26917	30545
	ATS		0	0	0	0	0	0	0	8	107	10	1472	1341	2301	8409	7238	9332	11091	13378	12682	12650	14438	20642	16957	20077	23278
	MED		0	0	0	0	0	0	0	0	0	0	6	8	2	148	61	20	44	47	17	10	125	72	178	51	80
Landings	ATN	Longline	0	0	0	0	0	0	1387	2257	1583	5734	5880	5871	5467	27618	25288	24405	26473	20013	18426	21936	20304	21033	22090	25958	30266
		Other surf.	121	380	1482	1088	1414	1330	900	1270	1768	2696	1632	1793	1086	1255	1030	1228	1355	904	1543	975	1372	1258	1080	905	150
	ATS	Longline	0	0	0	0	0	0	0	8	107	10	1472	1341	2294	8398	7231	9305	11091	13376	12678	12645	14339	20638	16898	20007	22889
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	27	0	1	4	6	99	3	59	10	375
	MED	Longline	0	0	0	0	0	0	0	0	0	0	6	8	2	148	61	20	44	47	17	10	44	72	83	49	79
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81	0	95	2	1
Discards	ATN	Longline	0	0	0	526	421	480	741	772	184	1136	572	621	602	180	170	104	137	105	68	0	63	66	45	53	129
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	103	0	22	4	0	0	0	0	1	0	0	0	1
	ATS	Longline	0	0	0	0	0	0	0	0	0	0	0	0	7	5	4	1	0	0	0	0	0	0	0	60	14
		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	
Landings	ATN	Brasil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	
		Canada	0	0	320	147	968	978	680	774	1277	1702	1260	1494	528	831	612	547	624	581	836	346	965	1134	977	843	0
		Cape Verde	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	185	104	148	0	0	0	367	109
		Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	171	206	240	588	284	106
		EC.Denmark	0	0	0	0	0	2	2	1	1	0	1	2	3	1	1	0	2	1	13	5	1	0	0	0	
		EC.España	0	0	0	0	0	0	0	0	0	0	0	0	0	24497	22504	21811	24112	17362	15666	15975	17314	15006	15464	17038	20788
		EC.France	14	39	50	67	91	79	130	187	276	322	350	266	278	213	163	399	395	207	221	57	106	120	99	167	119
		EC.Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66	31	66	11	2	0	0	0	0	0
		EC.Netherlands	0	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	1387	2257	1583	5726	4669	4722	4843	2630	2440	2227	2081	2110	2265	5643	2025	4027	4338	5283	6167
		EC.United Kingdom	0	0	0	0	0	0	1	0	0	0	0	12	0	0	1	0	12	9	6	4	6	5	3	6	6
		Japan	0	0	0	0	0	0	0	0	0	0	1203	1145	618	489	340	357	273	350	386	558	1035	1729	1434	1921	2686
		Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	254	892	285
		Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	456	0	0	0	0	43	134
		Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	2	1	1	0	2
		U.S.A.	107	341	1112	874	355	271	87	308	215	680	29	23	283	211	255	217	291	39	0	0	7	2	2	1	8
		UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0
		Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	26	10	18	7
	ATS	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	259	0	236	109
		Benin	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	27	0	0	0	0	0	0	0	0	
		Brasil	0	0	0	0	0	0	0	0	0	0	0	0	743	1103	0	179	1683	2173	1971	2166	1667	2523	2591	2258	1986
		China P.R.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	565	316	452	0	0	0	585	40
		Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	521	800	866	1805	2186	1868
		EC.España	0	0	0	0	0	0	0	0	0	0	0	0	0	5272	5574	7173	6951	7743	5368	6626	7366	6410	8724	8942	9615
		EC.Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
		EC.Portugal	0	0	0	0	0	0	0	0	0	0	0	847	867	1336	876	1110	2134	2562	2324	1841	1863	3184	2751	4493	4866
		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	239	0	
		Japan	0	0	0	0	0	0	0	0	0	0	1388	437	425	506	510	536	221	182	343	331	209	236	525	896	1945
		Namibia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2213	0	1906	6616	0	0	1829
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	168	22	0	0	0	0	0	0	0	521
		Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	
		South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	21	0	83	63	232	128	154	90	82	126
		U.S.A.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	
		Uruguay	0	0	0	0	0	0	0	8	107	10	84	57	259	180	248	118	81	66	85	480	462	376	232	337	359
	MED	EC.Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	3	6	5	0	0	
		EC.España	0	0	0	0	0	0	0	0	0	0	0	0	0	146	59	20	31	6	3	3	4	8	61	3	2
		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.Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	113	1	95	46	75
		EC.Malta	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	0	2	2
		EC.Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	5	41	14	3	0	56	22	0	
		Japan	0	0	0	0	0	0	0	0	0	0	5	7	1	1	0	0	0	0	0	1	1	2	0	0	
Discards	ATN	U.S.A.	0	0	0	526	421	480	741	772	184	1136	572	618	704	180	192	100	137	106	68	0	65	66	45	54	129
		UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	8	0	0	0	0	0	0	0	0	
	ATS	Brasil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	14
		U.S.A.	0	0	0	0	0	0	0	0	0	0	0	0	7	5	4	1	0	0	0	0	0	0	0	0	
SMA TOTAL			1793	3803	1951	1028	1562	1648	1349	1326	1446	2966	2972	4870	2778	5570	5477	4097	4994	4654	5361	7324	7487	6336	6073	6633	5062
	ATN		1112	3143	1481	766	1014	1011	785	797	953	2193	1526	3109	2019	3545	3816	2738	2568	2651	3395	3895	5063	3190	3113	3915	3372
	ATS		680	661	471	262	548	637	564	529	493	773	1446	1761	759	2019	1652	1355	2422	1996	1964	3426	2423	3130	2951	2716	1690
	MED		0	0	0	0	0	0	0	0	0	0	0	0	0	6	8	5	4	7	2	2	2	17	10	2	1
Landings	ATN	Longline	183	194	184	295	214	321	497	573	660	1499	1173	1633	1770	3369	3648	2645	2254	2424	3129	3792	4755	3172	3105	3898	3337
		Other surf.	929	2949	1297	462	795	681	278	213	254	670	331	1447	248	177	168	91	313	227	266	104	308	18	8	10	27
	ATS	Longline	680	661	471	262	548	637	564	519	480	763	1426	1748	744	1997	1642	1345	2413	1979	1949	3395	2347	3116	2907	2691	1690
		Other surf.	0	0	0	0	0	0	0	9	13	10	20	13	15	23	10	10	9	18	15	31	76	14	43	25	
	MED	Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	6	8	5	4	7	2	2	2	17	10	2	1
Discards	ATN	Longline	0	0	0	9	5	9	10	11	38	24	21	29	1	0	0	0	0	0	0	0	0	0	0	7	6
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1
Landings	ATN	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	
		Canada	0	0	0	0	0	0	0	0	0	0	0	111	67	110	69	70	78	69	78	73	80	91	71	72	43
		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	81	16
		Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84	57	19	30	24	23
		EC.España	0	0	0	0	0	0	0	0	0	0	0	0	0	2416	2199	2051	1566	1684	2047	2068	3404	1751	1918	1816	1895
		EC.Portugal	0	0	0	0	0	0	193	314	220	796	649	657	691	354	307	327	318	378	415	1249	473	1109	951	1540	1021
		EC.United Kingdom	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2	1	1	1	0	0	0	1
		Japan	141	142	120	218	113	207	221	157	318	425	214	592	790	258	892	120	138	105	438	267	572	0	0	82	140
		Mexico	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	10	16	0	10	6	9	5	8	6
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	49	13
		Philippines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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	8	17
		St. Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	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	1	0	1	2	3	1	2	1	1	1
		U.S.A.	971	3001	1361	540	896	795	360	315	376	948	642	1710	469	407	347	159	454	395	415	142	411	187	130	216	186
		UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0
		Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	20	6	11	2
	ATS	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	17	2
		Brasil	0	0	0	0	0	0	0	0	0	0	0	0	83	190	0	27	219	409	226	283	238	426	210	36	
		China P.R.	0	0	0	0	0	0	0	0	0	34	45	23	27	19	74	126	305	22	208	260	0	0	0	77	6
		Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	626	121	128	138	214	125
		Côte D'Ivoire	0	0	0	0	0	0	0	9	13	10	20	13	15	23	10	10	9	15	15	30	15	14	16	25	
		EC.España	0	0	0	0	0	0	0	0	0	0	0	0	0	1356	1141	861	1200	1235	811	1158	703	584	664	654	628
		EC.Portugal	0	0	0	0	0	0	0	0	0	0	0	92	94	165	116	119	388	140	56	625	13	242	493	375	321
		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	5	0	
		Japan	462	540	428	234	525	618	538	506	460	701	1369	1617	514	244	267	151	264	56	133	118	398	0	0	72	127
		Namibia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	459	0	509	1415	1243	1002	295
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	1	0	0	0	0	0	0	0	10
		Philippines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	
		Russian Federation	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	19	13	0	79	19	138	126	125	99	208	136
		U.S.A.	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	2	0	0	0	0	0	0	0	
		Uruguay	218	121	43	28	23	19	26	13	20	28	12	17	26	20	23	21	35	40	38	188	249	146	68	36	41
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	12	13	1	
	MED	EC.Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0

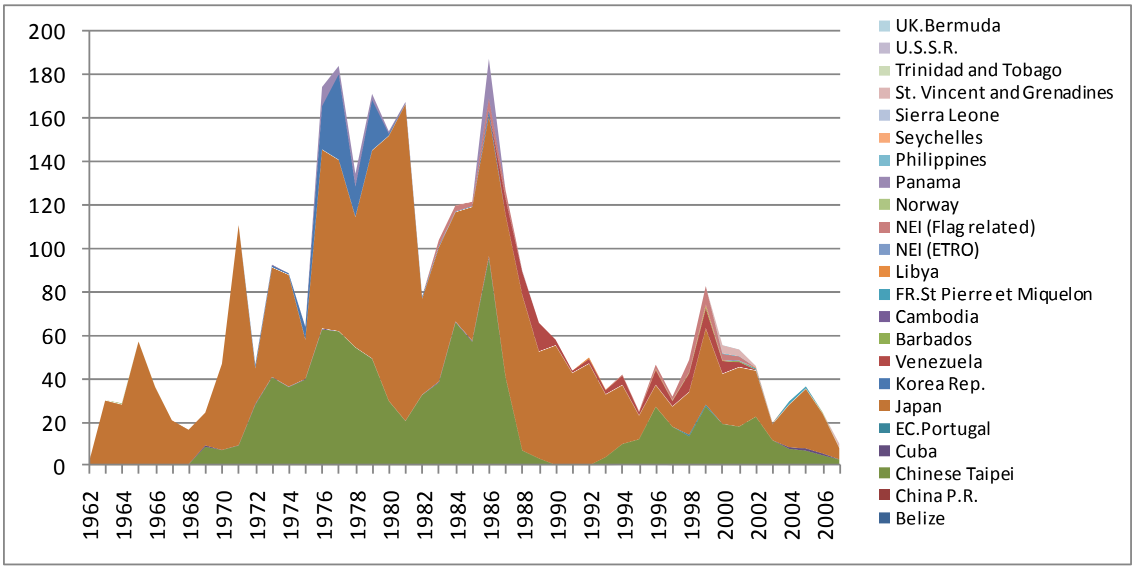
		EC.España	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	5	3	2	2	2	2	2	4	1	0
		EC.Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	5	0	0	0	15	5	0	
		Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discards	ATN	Mexico	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
		U.S.A.	0	0	0	9	5	9	10	11	38	24	21	28	1	0	0	0	0	0	0	0	0	0	0	7	7
		UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	
POR TOTAL			706	664	706	813	957	971	1282	1944	2588	1889	2676	2121	1518	1859	1469	1403	1469	999	848	648	745	571	507	515	606
	ATN		706	664	706	813	955	971	1282	1943	2588	1888	2674	2118	1514	1833	1451	1393	1457	998	838	604	725	539	470	502	513
	ATS		0	0	0	0	1	0	0	0	0	1	2	3	3	26	17	10	11	1	11	43	17	31	37	13	91
	MED		0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	3	2	1	0	2
Landings	ATN	All gears	706	664	706	813	955	971	1282	1943	2586	1888	2673	2118	1514	1833	1451	1393	1457	998	838	604	725	539	470	502	513
	ATS		0	0	0	0	1	0	0	0	0	1	2	3	3	26	16	9	11	1	11	43	17	31	37	13	91
	MED		0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	3	2	1	0	2
Discards	ATN		0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ATS		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	
Landings	ATN	Canada	20	26	24	59	83	73	78	329	813	919	1575	1353	1051	1334	1070	965	902	499	237	142	232	202	192	93	124
		EC.Denmark	38	72	114	56	33	33	46	85	80	91	93	86	72	69	85	107	73	76	42	0	0	0	0	0	
		EC.España	0	0	0	0	0	0	0	0	0	0	0	0	0	25	25	18	13	24	54	27	11	14	34	8	41
		EC.France	411	254	260	280	446	341	551	300	496	633	820	565	267	315	219	240	410	361	461	303	413	276	194	354	311
		EC.Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	1	3	0	0	0	0	0	
		EC.Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	2	6	3	11	18	0	4	8	7
		EC.Netherlands	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	3	3	2	2	1	0	0	0	0	0	0	0	0	7	4	10	101	50	14	6	0	3
		EC.Sweden	9	10	8	5	3	3	2	2	4	3	2	2	1	1	1	1	1	1	0	0	0	0	0	0	
		EC.United Kingdom	5	12	6	3	3	15	9	0	0	0	0	0	0	0	1	6	8	12	10	0	0	24	11	26	15
		Faroe Islands	126	210	270	381	373	477	550	1189	1149	165	48	44	8	9	7	10	0	0	0	0	0	0	0	0	
		Iceland	1	0	0	0	0	0	0	0	1	3	4	6	5	3	4	2	2	3	2	1	1	0	1	0	1
		Japan	0	0	0	0	0	0	0	0	0	0	0	0	5	4	0	0	0	0	0	0	0	0	0	12	11
		Norway	96	80	24	25	11	25	43	32	41	24	24	26	28	17	27	32	22	11	14	19	0	8	27	0	
		U.S.A.	0	0	0	1	0	2	2	5	1	50	106	35	78	56	13	3	1	1	1	0	1	0	0	0	1
	ATS	Benin	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	
		Chile	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.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	
		EC.España	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	7	1	2	9	4	0	3	5	4
		EC.Netherlands	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	1	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	4	2	0	0	
		Falklands (Malvinas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
		Japan	0	0	0	0	1	0	0	0	0	1	0	0	3	14	0	1	0	0	0	0	0	0	0	5	47
		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	
		Uruguay	0	0	0	0	0	0	0	0	0	0	0	3	0	5	13	2	4	0	8	34	8	28	34	3	40
	MED	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.Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	2
		EC.Malta	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	1	0	0	0
Discards	ATN	U.S.A.	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ATS	Uruguay	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	

SHK-Table 2. Productivity values ranked from lowest to highest.

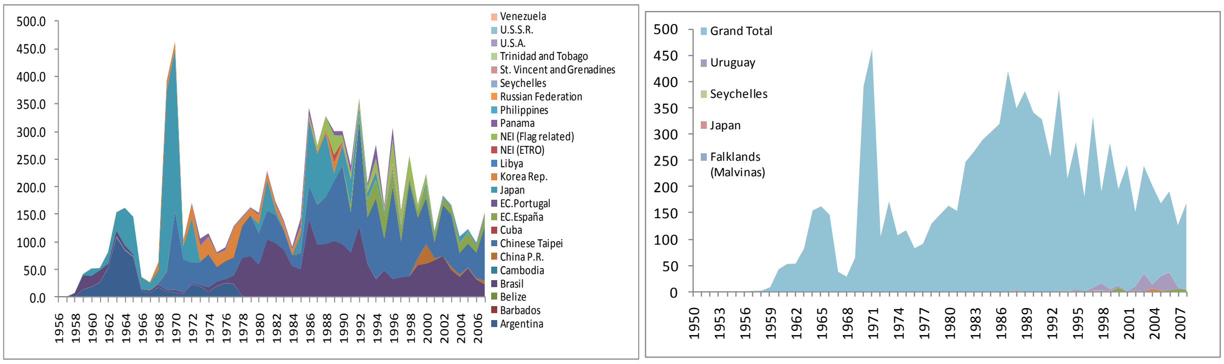
Species	*Productivity (r)*	*Productivity rank*
BTH (*Alopias superciliosus*)	0.010	1
SMA (*Isurus oxyrinchus*)	0.014	2
LMA (*Isurus paucus*)	0.014	3
POR (*Lamna nasus*)	0.053	4
FAL (*Carcharhinus falciformis*)	0.076	6
OCS (*Carcharhinus longimanus*)	0.087	7
SPL (*Sphyrna lewini*)	0.090	8
SPZ (*Sphyrna zygaena*)	0.124	9
ALV (*Alopias vulpinus*)	0.141	10
PST (*Pteroplatytrygon violacea*)	0.169	11
BSH (*Prionace glauca*)	0.301	12
CRO (*Pseudocarcharias kamoharai*)	-	-



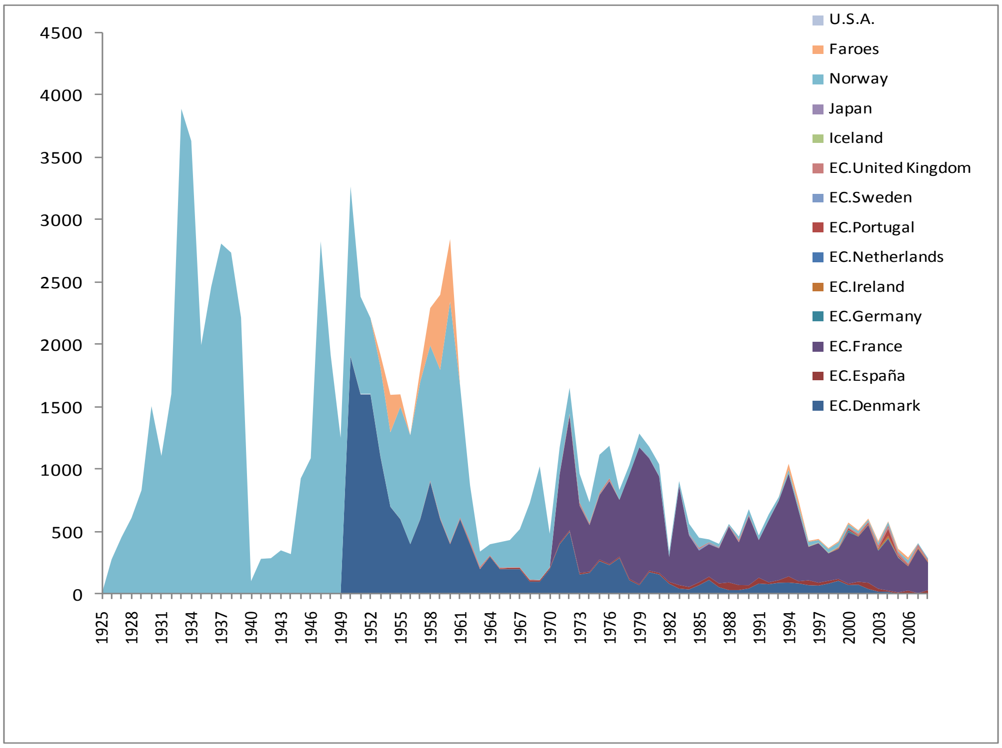
SHK-Figure 1. Blue shark and shortfin mako catches reported to ICCAT and estimated by the Committee.



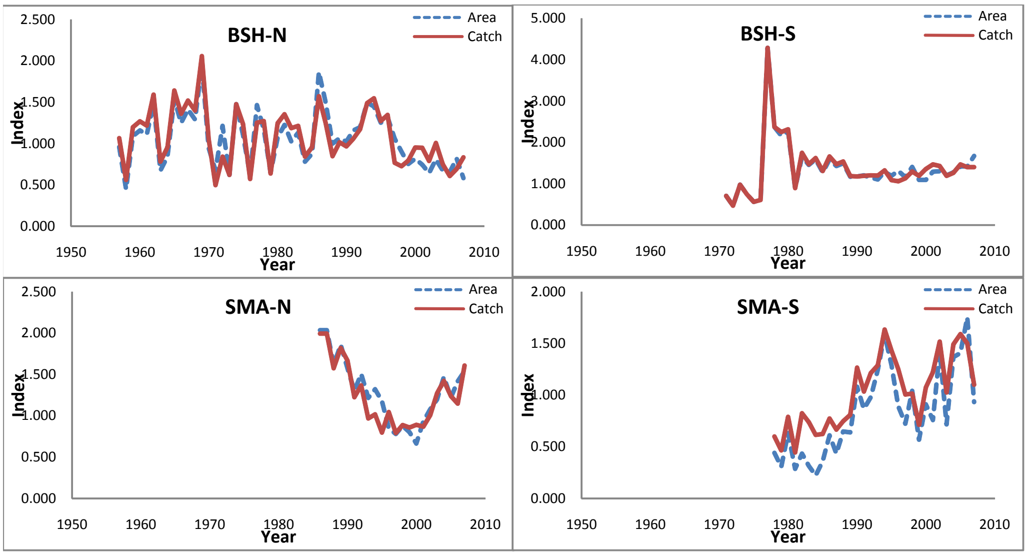
SHK-Figure 2. Estimated potential catch of porbeagle by non-reporting longline fleets using catch ratios for the NW stock. Limited observations across the time-series result in an unquantified uncertainty in the estimates.



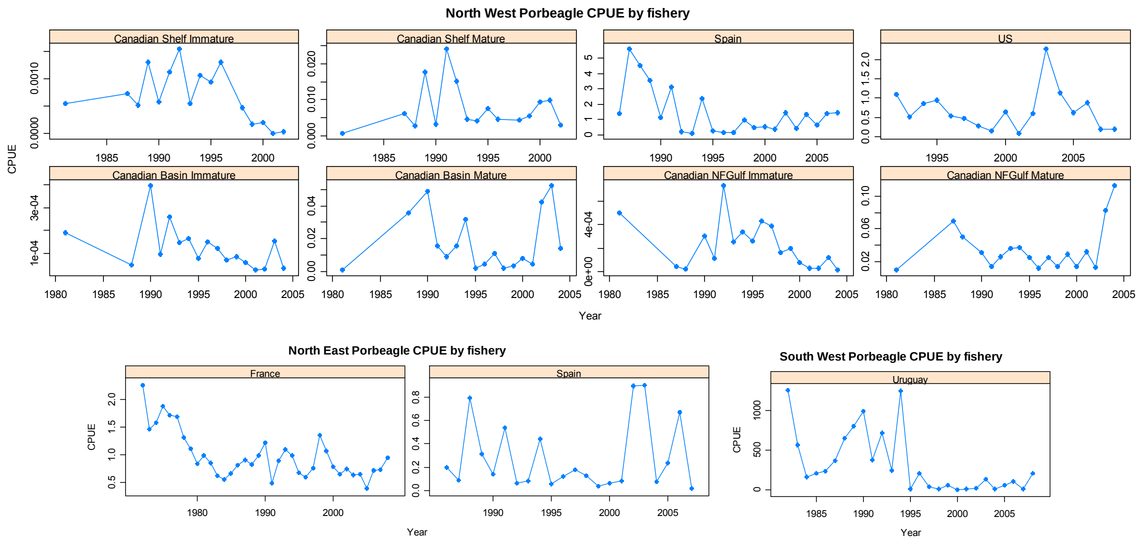
SHK Figure 3. Left plate: Estimated potential catch of porbeagle by non-reporting longline fleets using catch ratios for the SW stock. Very limited observations across the time-series result in a high but unquantified uncertainty in the estimates. Right plate: Comparison of estimates for non-reporting longline fleets with reported catch levels held in the Task I data set for the SW stock area.



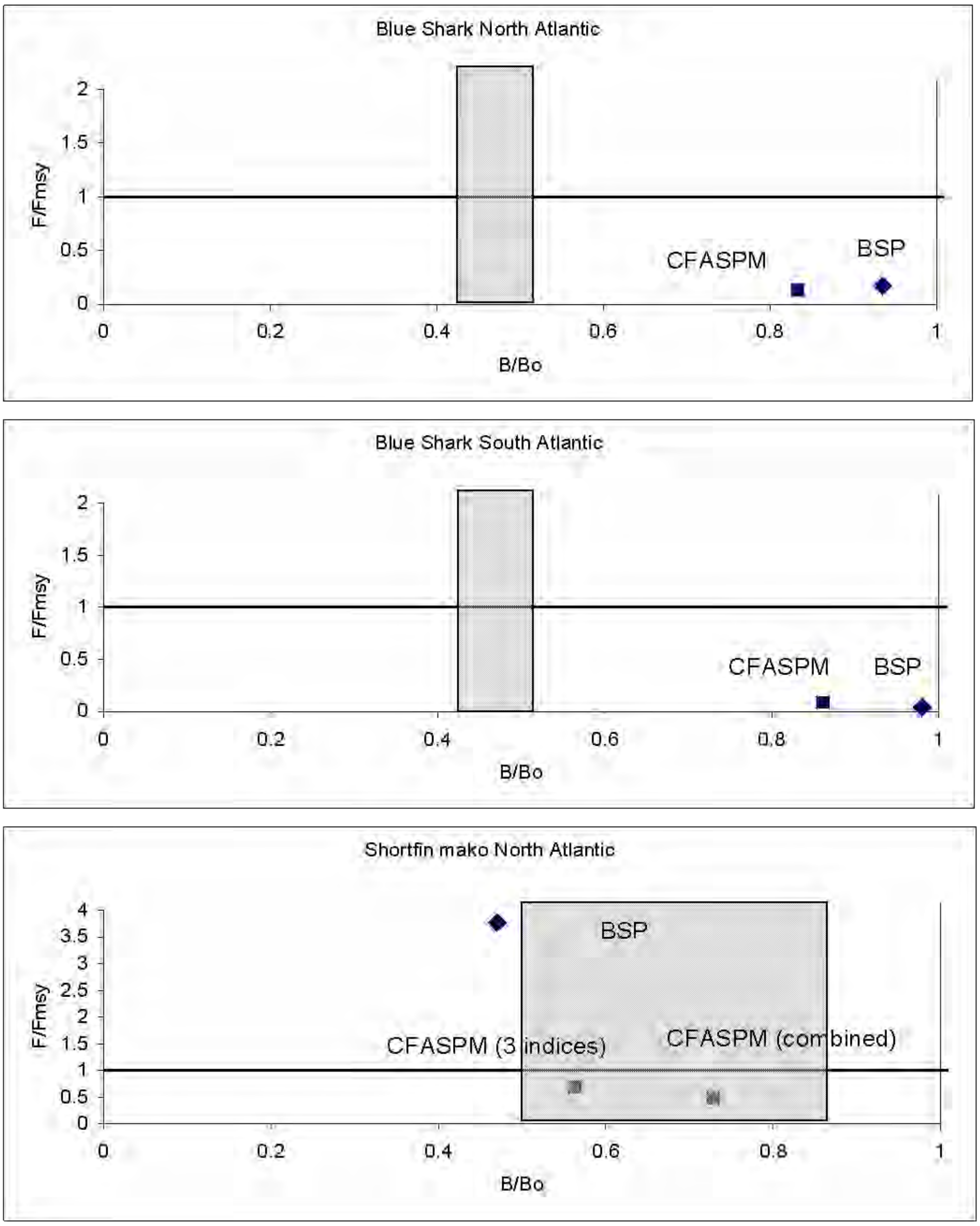
SHK Figure 4. Catch by flag of porbeagle sharks from the northeastern Atlantic used in the assessment. While these catches are considered the best available,, they are believed to underestimate the pelagic longline catches for this species.



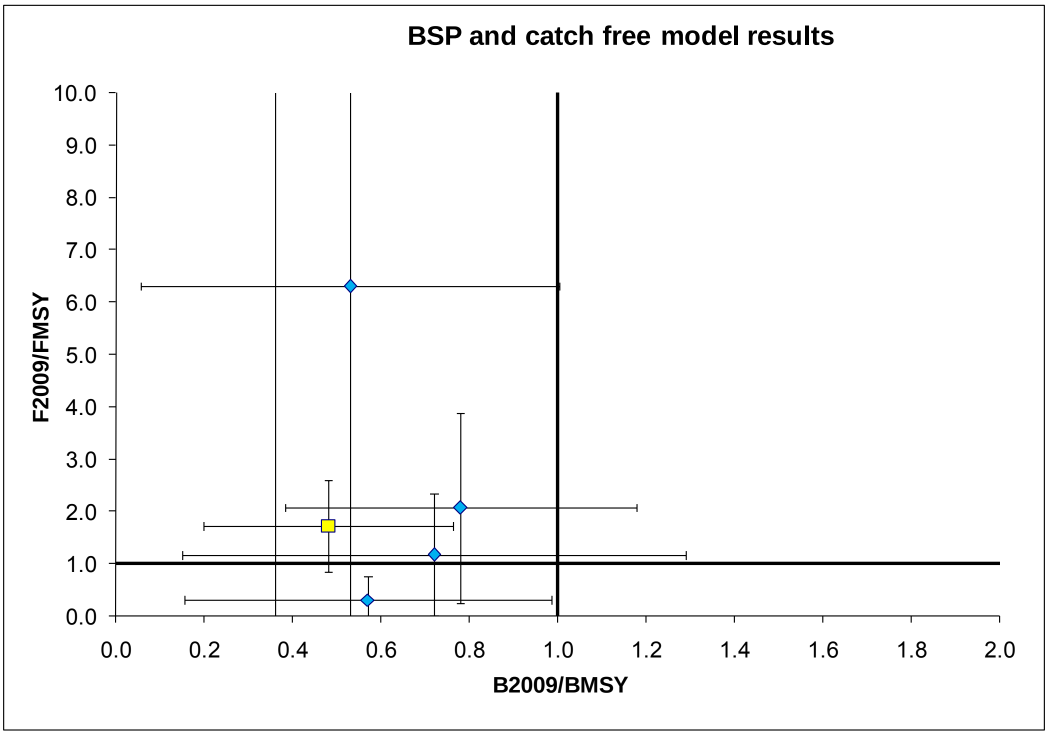
SHK-Figure 5. Average trends in the CPUE series used in the assessments of blue shark (BSH) and shortfin mako (SMA). The averages were calculated by weighting the available series either by their relative catch or by the relative spatial coverage of the respective fisheries.



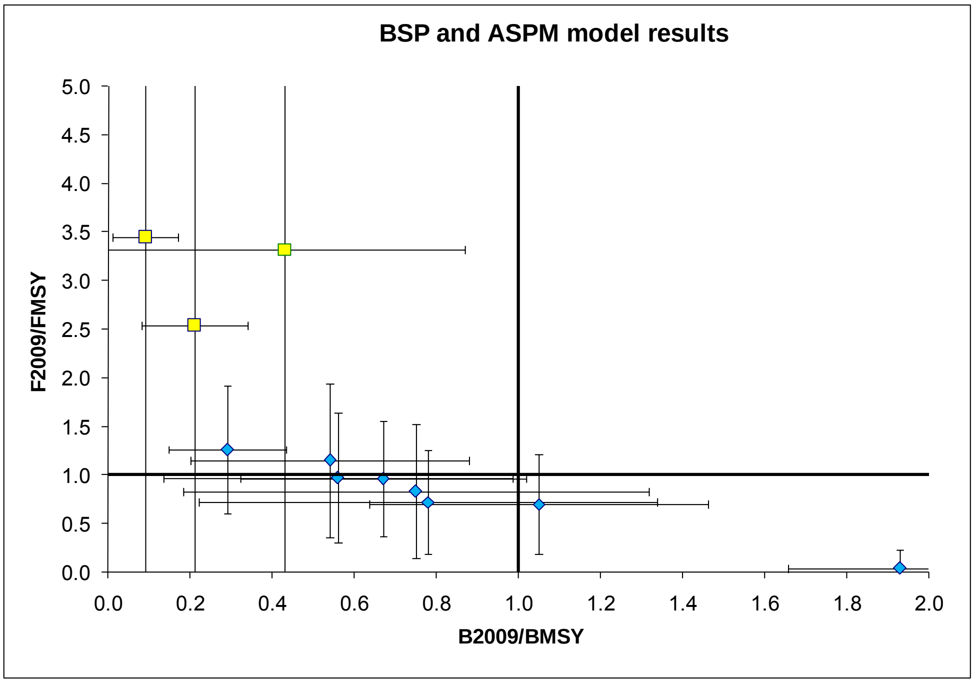
SHK-Figure 6. CPUE series for the porbeagle NW stock (upper figures), NE stock (lower left figures) and SW stock (lower right figure).



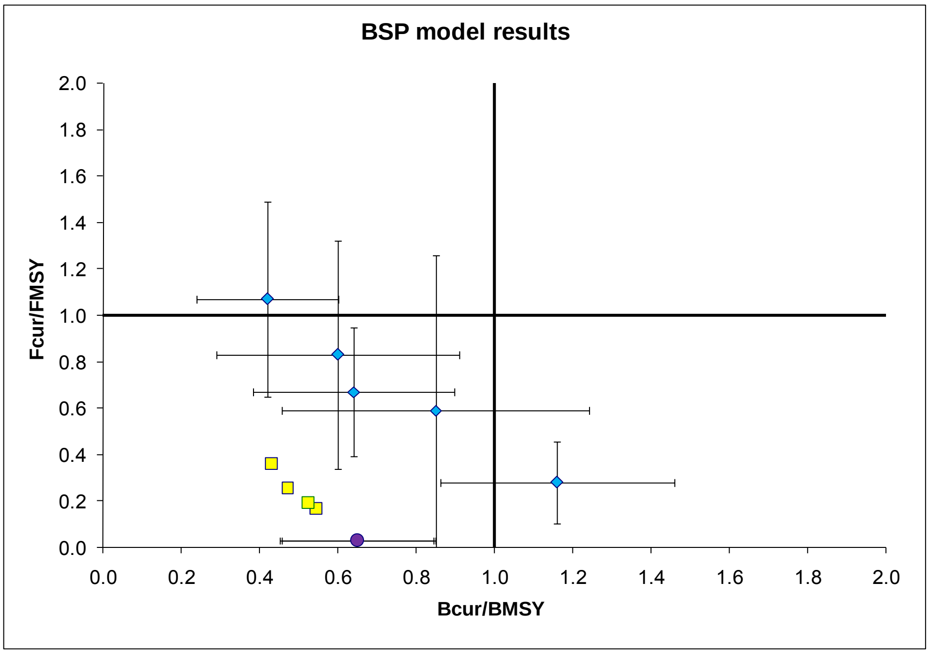
SHK-Figure 7. Phase plots summarizing base scenario outputs for the current stock status of blue shark (BSH) and shortfin mako (SMA). BSP=Bayesian surplus production model; CFASPM=catch-free, age-structured production model. The shaded box represents the area at which the biomass at MSY is estimated to be reached. Any points inside or to the left of the box indicate the stock is overfished (with respect to biomass). Any points above the horizontal line indicate overfishing (with respect to F) is occurring.



SHK-Figure 8. Phase plot for the southwest Atlantic porbeagle, showing status in 2009 from both the BSP model runs (diamonds) and the catch free age structured production model (square) results. Error bars are plus and minus one standard deviation.



SHK-Figure 9. Phase plot showing current status of northeast Atlantic porbeagle for the BSP model (diamonds) and the ASPM model (squares). Error bars are plus and minus one standard deviation.



SHK-Figure 10. Phase plot showing the northwest Atlantic porbeagle expected value of B/B_{MSY} and F/F_{MSY} in the current year, which is either 2005 (diamonds) or 2009 (circles), as well as approximate values from SCRS/2009/095 (squares). B/B_{MSY} was approximated from SCRS/2009/095 as N2009/N1961 times 2. Error bars are plus and minus one standard deviation.

REPORT OF THE 2009 PORBEAGLE STOCK ASSESSMENTS MEETING

(Copenhagen, Denmark, June 22 to 27, 2009)

1. Opening, adoption of Agenda and meeting arrangements

The meeting was opened by Dr. Jim Ellis and Andrés Domingo, and the chairs welcomed Working Group participants. Helle Gjeding Jørgensen welcomed participants on behalf of the ICES Secretariat and Laurence Kell, on behalf of ICCAT, thanked ICES for hosting this joint ICES/ICCAT meeting, The chairs summarised the terms of reference for the meeting and presented a background of the process. After opening the meeting, the Agenda was reviewed and adopted (**Appendix 1**). The List of Participants is included as **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3.**

The following participants served as Rapporteurs for various sections of the report:

Section	*Rapporteurs*
1	L. Kell
2	S. Campana, S. McCully, S. Fowler, E. Cortés
3	E. Cortés, E. Babcock, S. Campana, L. Kell
4	G. Scott
5, 6, 8,	J. Ellis and A. Domingo
7	V. Restrepo

2. Update of data for assessment

2.1 Stock structure and life history parameters

The issue of stock structure and life history parameters was addressed in the following presented papers: SCRS/2009/188; SCRS/2009/089; SCRS/2009/090; SCRS/2009/092; SCRS/2009/094. Some of these papers also presented biological information or genetic and tagging studies and are described in these respects in subsequent sections of this report.

SCRS/2009/188 updated some preliminary results from SCRS/2008/152, presenting updated information on the French targeted porbeagle fishery. Biological parameters, including sex ratio, catch composition, size at maturity, diet composition, trophic level and growth curves from porbeagle caught from the Bay of Biscay and Celtic Sea were presented. The differences in growth parameters noted between this study and that reported for the NW Atlantic support the hypothesis of two separate stocks in the North Atlantic.

Document SCRS/2009/089 presented new data on the size composition, sex ratio and distribution of porbeagle, collected by the Uruguayan pelagic longline fleet observer program. Data on the size at maturity for males (clasper length vs. fork length) were provided, and a possible nursery area in the open ocean off Uruguay and south of Brazil, where porbeagle of 67-119 cm fork length were caught in the summer of 2009, was illustrated.

Document SCRS/2009/090 presented data on the genetic structure of porbeagle in the Atlantic Ocean based on the analysis of mitochondrial DNA of 53 specimens, from both the North Atlantic (41°38-41°50'N, 55°16'-55°74'W, n = 4) and South Atlantic (39°26'-43°41'S, 00°05'-26°59'E, n = 49). These data support the current view of restricted gene flow between the North and South Atlantic populations. While this study suggested that the South Atlantic population could be divided into more than one sub-population, data were insufficient and further research is required to examine the structure of southern hemisphere stocks.

The document SCRS/2009/092 is presented to the working group as a “porbeagle national report” to summarize the most important Spanish fisheries within the ICCAT, ICES and NAFO convention areas where potential impact on porbeagle could be expected based on the areas of distribution of this species and their geographical overlap with the areas of activity of some of these fleets. Any targeted fishery is developed by Spain on this species. The porbeagle is a very rare bycatch within ICES and NAFO fisheries of CE-Spain and the level of their possible bycatch should be considered null or negligible.

Additionally, the Spanish surface longline targeting swordfish (*Xiphias gladius*) within the ICCAT convention area has sporadically caught porbeagle as a low prevalent bycatch in the North and South Atlantic areas, with the two most prevalent shark species being blue shark (*Prionace glauca*) and, to a lesser extent, shortfin mako (*Isurus oxyrinchus*). The paper summarize some of the old and recent scientific references on this Spanish fleet where information on porbeagle was included since mid eighties of last century about, areas of activity, level of catches, catch rates, size, length-weight relationships, sex-ratio at size, relative prevalence, etc. as well as recent catch estimations and standardized CPUE trends. The paper also summarizes other papers presented to the working group (SCRS/2009/053, SCRS/2009/062 and SCRS/2009/087).

Document SCRS/2009/094 presented information about migratory routes, potential nursery areas, swimming behavior, and environmental associations in the NW Atlantic. Pop-up satellite archival tags were deployed on 20 porbeagles in November 2006. The sharks, ten males and ten females, ranged from 128-154 cm fork length, and were tagged and released from a commercial longliner fishing on the northwestern edge of Georges Bank, about 150 km east of Cape Cod, MA. Based on known and derived geopositions, the porbeagle exhibited broad seasonally dependent horizontal and vertical movements ranging from 77-870 km and from the surface to 1300 m depth, respectively. All of the sharks remained in the NW Atlantic, from the Gulf of St. Lawrence and the coast of Nova Scotia to Georges Bank and oceanic and shelf waters south to North Carolina. In general, the population appeared to contract during the summer and autumn, with more extensive radiation in the winter and spring. Although sharks moved through temperatures ranging from 2-26°C, the majority of time (76%) was spent in water ranging from 8-16°C. In the spring and summer months, the sharks were epipelagic, swimming in the upper 200m of the water column. In late autumn and winter, some of the porbeagle (n=10) moved to mesopelagic depths (200-1000 m). Temperature records indicate that these fish were likely associated with the Gulf Stream. Since none of these fish moved to the NE Atlantic, this work also supported the two stock hypotheses for the North Atlantic.

2.2 Stock definition

Maps of the North Atlantic, with ICCAT, NAFO and ICES boundaries are shown in **Figure 1**. **Figure 2** shows the distribution of porbeagle in the Atlantic and other oceans.

2.2.1 NW Atlantic porbeagle

Northwest Atlantic porbeagles are largely concentrated in the waters on and adjacent to the continental shelf of North America. Observer data from the Canadian, U.S., Spanish and Icelandic fleets indicate that porbeagles are found throughout the high seas of the North Atlantic north of 35°N, but that the CPUE on the high seas is relatively low. Conventional tagging data (~200 recaptures from three separate studies) indicate that NW Atlantic porbeagles are highly migratory within their stock area, but do not undertake trans-Atlantic migrations. More recent satellite tagging results reinforce this conclusion. Therefore the ICCAT sub-group concludes that there is a single stock of porbeagle in the NW Atlantic north of 35°N and west of 42°W, corresponding roughly to ICCAT region BIL94b and NAFO areas 0-6.

2.2.2 NE Atlantic porbeagle

The ICCAT sub-group considered that there is a single-stock of porbeagle in the NE Atlantic that occupies the entire ICES area (sub-areas I-XIV). This stock extends from the Barents Sea to northwest Africa. For management purposes the southern boundary of the stock is 36°N and the western boundary at 42°W. Given that porbeagle abundance in the central Atlantic appears to be small, ICCAT region BIL94b is a reasonable approximation of NE Atlantic porbeagle stock area. Historic tagging studies and recent satellite tagging studies indicate that few, if any, porbeagles make transatlantic crossings.

2.2.3 SW Atlantic porbeagle

The distribution of the porbeagle stock in the SW Atlantic, south of 25°S and west of 20°W was considered. It was suggested that it could apparently comprise waters of the southeast Pacific Ocean but more robust data are required to confirm this fact which would have direct implications on the management of this stock.

2.2.4 SE Atlantic porbeagle

The distribution of the porbeagle stock in the SE Atlantic, south of 25°S and east of 20°W was considered. It was suggested that it could apparently comprise waters of the southwest Indian Ocean but more robust data are required to confirm this fact which would have direct implications on the management of this stock.

2.2.5 Information from other Publications

Documents SCRS/2001/085 and SCRS/2005/095 contributed information on the distribution in the North hemisphere and catches in the high seas.

2.3 Summary of life-history parameters

Porbeagle life history parameters are reasonably well known for the NW Atlantic and South Pacific stocks, with less information available for the NE Atlantic and even less for South Atlantic stocks. Some biological parameters (e.g. growth) differ markedly between the NW Atlantic and South Pacific, indicating that at least some of the parameters are not universal among the stocks, although other parameters (e.g. fecundity) are similar. Available life history information is summarized in **Table 1.**

Available information suggests that NE Atlantic porbeagle life history characteristics are somewhat similar to those of the NW Atlantic, although growth rates in the NE Atlantic are lower than those in the NW Atlantic. Virtually no information is available on South Atlantic porbeagle. However, given that southern Atlantic porbeagle distribution appears to be continuous around the tip of South America and southern Africa, it seems probable that south Atlantic parameters would be more similar to those of the South Pacific than to those of the North Atlantic.

2.4 Catch estimates

2.4.1 Overview of national landings

Available catch reports held in the ICCAT Task I data base (as of 12 June 2009, **Table 2**, **Figure 3**) were reviewed and found to be generally incomplete, especially for the South Atlantic fisheries. Information held in various literature sources and made available by National Scientists attending the meeting was compared to Task I reports and incorporated into a catch compilation for the purposes of conducting the assessment. Efforts to estimate catches for non-reporting longline fleets were undertaken using observer data, where available. The approach used is further discussed in subsequent paragraphs.

The Working Group considered the separation of the NE and NW stocks of porbeagle at 40^{o}W longitude and the separation of the SE and SW stocks at 20^{o}W longitude. Catches reported and estimated for the Spanish longline fleet in SCRS/2009/087 represented a 1950-2008 time-series of northern hemisphere porbeagle harvest estimates for this fleet. These estimates were partitioned between the NW and NE stock areas in proportion to the distribution of hooks fished by the Spanish fleet based on the hooks time series data base maintained at ICCAT, which provides estimated nominal longline effort (hooks fished) in monthly time steps and 5x5 spatial resolution. Similar partitioning was done for reported catches for other fleets which reported some catches from the NWC Atlantic fishing area in Task I.

2.4.2 Discards information

Insufficient data were available, although as porbeagle is a high-value species, it is unlikely that large numbers are discarded. Discard survival is not known for either longline-caught porbeagle (which could be high) or for porbeagle caught in other fisheries on the continental shelf.

2.4.3 Quality of catch data

Catch data are thought to be relatively complete for the NW Atlantic, although it is noted that landings are estimated for some high seas fleets. Although there is a long time-series for landings data in the NE Atlantic, some European states have incomplete recording of porbeagle (or they have been reported as generic sharks). Although catch data for this stock are considered to be underestimates, these are mostly for nations catching small quantities, and data are available for the major fishing nations.

Catch data for South Atlantic stocks are incomplete, as the stock(s) may extend into the SE Pacific and SW Indian Oceans.

2.4.4 Overview of missing data and methods to estimate catches

SCRS/2009/062 presented an overview of the recent FAO statistics on porbeagle shark and examined their relationship with the reported catch of the related shortfin mako *Isurus oxyrinchus*, establishing a ratio between the two. The data suggest that there may be some inconsistencies between the statistics reported for the two species over the time series, emphasizing the need to maintain smooth coordination between the RFMOs and the FAO and to set up programs aimed at the dissemination of specific information directed at the different countries, to improve the statistics of these species.

SCRS/2009/087 presented the historic catch series of porbeagle by the Spanish surface longline fleet targeting swordfish in the North Atlantic for the period 1950-2008, reconstructed using various information sources, such as previous studies by the authors and data from Task I available on ICCAT's database, always considering the ratio between porbeagle and the target species. An increasing trend was observed from 1950-1989. Thereafter there has been a declining trend with strong variations from year to year until the end of the period.

Estimates of potential porbeagle catch by various longline fleets which fished in areas where porbeagle are known to occur were based on observed catch of porbeagle relative to the catch of tunas and swordfish, following approaches adopted previously for estimating catches of blue and shortfin mako shark catches from non-reporting longline fleets (see, for example, SCRS/2008/017 – the report of the 2008 shark assessment meeting). **Figure 4** provides an overview of the overall longline effort distribution compared to the distribution of porbeagle in the Atlantic, which indicates the potential overlap is restricted generally to 30^{o} or greater latitudes in both hemispheres.

Observer data considered sufficient to conduct this estimation were available to the Working Group only for the NW and SW stock areas. For the NW, Canadian and U.S. observer data from their national fleets and Canadian observer data from Japanese vessels operating in the Canadian EEZ were available. For the SW Atlantic, Uruguayan observer data were available for analysis. Icelandic observer data from Japanese vessels operating in Iceland's EEZ were also provided to the Working Group, but these data were considered too geographically limited to be applied across the entire NE Atlantic non-reporting longline fleets. Observer data from other fleets were requested, but not received during the meeting.

This method requires observer data from the area and fishery in question to determine the underlying catch ratio, and makes several assumptions. The key assumption is that the observer-based catch ratio is applicable to other fisheries, times and locations. To test this assumption, observer data from three sources (Canada, U.S. and Iceland) were analyzed in terms of porbeagle catches relative to those of tunas and/or swordfish. The resulting ratios were mapped by 5-degree squares (**Figures 5, 6** and **7**).

The observed maps of catch ratios indicated that the relative abundance of porbeagle in the catch tended to be greatest on or near the continental shelf, and declined markedly in the high seas. There were significant and sometimes large differences in catch ratios among fisheries from different nations, but the relative proportion of porbeagle in the high seas catch was almost always less than 2%. Based on these results, estimation of total (unreported) porbeagle catch in the high seas fisheries of nations which have not previously reported porbeagle catch can be only approximated using catch ratios. In addition, the underlying observed catch ratios must be spatially structured (e.g. by 5-degree squares) if they are to be useful.

This result is consistent with general belief about the (current) density distribution of the catches with the dominant part of the catch coming from continental shelf and shelf-edge fishing grounds, although high-seas catches do occur. At a coarser resolution (5x5), the latitudinal gradient was not strong. In the NW, the Canadian observer data from Japanese vessels showed the broadest geographical coverage and for that reason were selected to form the basis for estimating the proportion of porbeagle to tunas and swordfish in the catch to apply against the catches of non-reporting longline fleets. In the SW, the Uruguayan observer data were used.

Figure 8 shows the pattern in the proportion of porbeagle to tunas and swordfish applied against the catches of swordfish and tunas by longline fleets not reporting porbeagle in the NW and SW stock areas.

In the SW region, both a gear (monofilament vs. multifilament) and longitude effect was hypothesized based on the observations. **Tables 3 and 4** and **Figures 9** and **10** provide the estimated porbeagle catches for non-reporting fleets in these regions by this method. These estimates have high, but unquantified levels of uncertainty owing to the limited observations on catch ratios across fleets and time, but provide a basis for considering the potential impact of these fleets on overall porbeagle catch levels compared to directed fleet catches.

Table 5 and **6** and **Figures 11** and **12** show the catch patterns used in the assessment for the NE and NW stocks, respectively. For the Southern Hemisphere the reported catch data are sporadic at best, with only a few fleets reporting any information. In addition, there is belief that catches made in the southeastern Pacific and southwestern Indian Ocean impact the SW and SE Atlantic porbeagle stocks respectively, which should be taken into consideration into future assessments.

2.4.5 Nominal and estimated landings of porbeagle by stock

Figure 13 draws comparison of NW Atlantic catch compilations made at this meeting, including estimates of catch by non-reporting longline fleets, with those reported in SCRS/2009/05. There are relatively small differences in these catch compilations which warrant further investigation.

Table 2 shows the nominal landings of porbeagle (by stock) as reported to ICCAT (north western, north eastern and southern hemisphere). These are broadly comparable with data used by ICES WGEF data.

2.5 Trends in catch rates

Overview of fishery-dependent CPUE data

SCRS/2009/069 presented indices of relative abundance developed for porbeagle from the U.S. pelagic longline logbook program (1992-2008). Indices were calculated using a two-step delta-lognormal approach that treats the proportion of positive sets and the CPUE of positive catches separately. Standardized indices with 95% confidence intervals were reported. The time series showed a generally decreasing trend, which can be decomposed into an initial decrease from 1992-2001, followed by a sharp increase to 2003 and a subsequent decrease to 2008.

Document SCRS/2009/091 presented standardized CPUE for porbeagle calculated using the Southern bluefin tuna (SBT) observer data from 1992–2007. The standardized CPUE showed some fluctuations but there was not a clear trend. This result is supposed to indicate that the stock status of porbeagle did not change significantly during the research period in this fishery, although further studies are required to fully support this.

Document SCRS/2009/093 presented standardized indices of catch-per-unit-of-effort (CPUE) of porbeagle caught by the Uruguayan longline fleet. The indices were obtained by Generalized Linear Models (GLM) with a delta lognormal approach. The data in weight of the fish caught were from the fishing logbooks of the Uruguayan longline fleet that operated in the South Atlantic Ocean between 1982 and 2008. The standardized CPUE shows an important decline over the past twelve years, which may or may not be indicative of stock abundance and could be the result of environmental changes, changes in fishing strategies or other changes.

SCRS/2009/053 presented standardized catch rates for North Atlantic porbeagle during the period 1986-2007, caught as low prevalent by-catch in the Spanish surface longline fishery targeting swordfish in the Atlantic Ocean. The analysis was performed using a GLM approach assuming a delta-lognormal distribution error and considered several factors such as longline style, quarter, bait and also spatial effects by including seven zones. The base case suggested a moderately decreasing trend between 1986 and 1996, a period of stability until the year 2000 and a slight increase thereafter. The results obtained using only the traditional style longline indicate that the trend was substantially stable from 1986-2000. The results obtained show standardized CPUE trends that were very similar for the whole time series, regardless of the type of analysis conducted. Scientific estimations of annual catches for the period 1997-2008 were also updated. The Working Group requested the authors to make additional runs restricted to the defined zones 1&2 (West) and 4&5 (East) to provide indices of abundance for the NW and NE Atlantic stocks, respectively. These additional analyses were made available to the group as Annex 1 to

SCRS/2009/053. However, reservations were expressed by the authors about the appropriateness of the areas selected by the group for monitoring "stocks" or “units" of North Atlantic porbeagle taking into consideration the catch distribution.

Figure 14 shows the CPUE trends for the Atlantic porbeagle North western, North eastern and South western stocks.

Availability of fishery-independent surveys

No fisheries-independent data were available to the group, and the absence of such data means that there is a reliance on fishery-dependent trends. Fishery-dependent data for fisheries targeting porbeagle may not reflect overall stock abundance, and fisheries-dependent data for fisheries where porbeagle are a by-catch may be highly variable.

3. Assessment model and results

3.1 Bayesian surplus production model

3.1.1 Methods

Document SCRS/2009/068 applied a Bayesian Surplus Production (BSP) model to estimate status and project population trends for NW Atlantic porbeagle. This model was used in previous ICCAT assessments for blue and shortfin mako shark in 2004 and 2008. An informative prior was developed for the rate of population increase (r) based on demographic data. Catch and catch per unit effort data were taken from the 2005 assessment of Gibson and Campana. The BSP model results were more pessimistic than the results of the age structured assessment model, because the BSP model was only fitted to CPUE data for mature sharks, which have declined more than immature sharks. The authors recommended using the BSP model to assess the status of NE Atlantic and South Atlantic porbeagle populations, provided that it is possible to develop at least one CPUE index of abundance for each population, as well as a time series of catches. If catch data are not available for the entire history of the fishery, the BSP model can estimate catches from longline effort data in the early years of the fishery.

NW Atlantic porbeagle

To determine whether the BSP model gives similar results to the age- and space-structured model applied to NW Atlantic porbeagle, it would be preferable to be able to fit the BSP model to a standardized CPUE index in units of biomass of all porbeagle sharks for all areas combined. Such an index was not available for the 2009 Canadian assessment (SCRS/2009/095), because the CPUEs were standardized within the assessment model in 2009 so that it was not possible to extract a standardized CPUE series independent of the age-structured model. In the 2005 Canadian assessment (Gibson and Campana 2005), the CPUE indices were standardized independently of the model, but were standardized separately for immature and mature sharks in each of three spatial regions. We entered these six CPUE series into the BSP model as biomass indices, either weighted by the relative proportion of total catch in numbers in each series in each year, or weighted equally. It was not possible to weight by total catch in biomass in each series in each year because these data were not available. The total catches from Gibson and Campana (2005) were used for consistency between the two models. The informative prior for r had a mean of 0.05 and a CV of 10%, as specified in SCRS/2009/068. The prior for K was uniform on log K and the prior for Bo/K was lognormal with a mean of 1.0 and a CV of 0.20.

To use the BSP model to assess the status of NW Atlantic porbeagle in 2009, we ran the BSP model with eight CPUE series: the six Canadian CPUE series through 2004, the U.S. series, and the Spanish series for area 1 and 2 only. Each point in each data series was given equal weight. Thus, the Canadian series together were given more weight than either the U.S. or the Spanish series. This seemed appropriate considering that the majority of the catches come from the Canadian fleet. Catches were taken from the ICCAT Task I data, as allocated to NE and NW stock areas by the Working Group either with or without additional catches inferred for non-reporting fleets. The same priors were used for r, K and Bo/K.

SW Atlantic porbeagle

For SW Atlantic porbeagle, the catches reported to ICCAT are very small and began in 1982. Unreported catches are probably substantial given the large and increasing longline effort in the SW Atlantic region. One CPUE index of abundance was available, for the Uruguayan fleet from 1982 to 2008. The BSP model runs varied in whether the CPUE data points were weighted equally or by the inverse of their CVs, and in how catches were estimated. The catches were either based on those reported to ICCAT, estimated from the longline effort series or estimated from the ratio of porbeagle to other species in the catch (**Tables 2** and **4**). The posterior for *r* was informative, with a mean having the same value used for the Northwest Atlantic (0.05) and a standard deviation twice that in the North Atlantic, implying a CV of 0.21. The prior for *K* was uniform on log *K* and the prior for *Bo/K* was lognormal with a mean of 1.0 and a CV of 0.20, with *Bo* being the biomass in the first year for which either catch or effort data were available.

NE Atlantic porbeagle

For NE Atlantic porbeagle, the highest catches occurred in the 1930s and 1950s, long before any CPUE data were available to track abundance trends (**Figure 15**). We tried several variations of the model, either starting the model run in 1926 or 1961, and with a number of different assumptions (**Table 10**). We used a lognormal prior for *r*, with a mean of 0.062 based on demographic data and a CV of 0.16. This CV implied a standard deviation twice that estimated from the demographic analysis, to make the prior slightly less informative. The prior for *K* was uniform on log *K* with several different upper limits.

3.1.2 Results

NW Atlantic porbeagle

For the BSP model applied to the Canadian assessment data through 2005, it was expected that the model run with the indices weighted by relative catch numbers would give results that were most similar to the age- structured model results, but this was not the case. The catch-weighted model (run a3 in **Table 7**), gave more optimistic results than the age-structured model. This model estimated current (2005) biomass to be 66% of the 1961 biomass, compared to the age-structured model result that current numbers were between 10 and 24% of 1961 numbers. The BSP model with equal weighting (run a4 in **Table 7, Figure 16**) gave results that were much more similar to the age-structured model results, estimating current biomass at 37% of 1961 biomass. The BSP model with equal weighting predicted that the population would recover to B_{MSY} in about 20 years with no fishing (**Table 8**). This is roughly consistent with the results of the age-structured model, considering that the age-structured model results are in numbers and the BSP results are in biomass.

These results demonstrated that the BSP model can adequately capture the population dynamics of the porbeagle shark, but the model is quite sensitive to how the input CPUE series are calculated and weighted. Standardized CPUE indices calculated in biomass and weighted by catch in biomass would be most consistent with the assumptions of the BSP model.

To further explore the implications of the informative prior on *r* on the final results, we ran a retrospective analysis, including the CPUE data only through 1998, 2000 or 2002 (runs a403, a402 and a401 in **Table 7**). The posterior distribution of *r* remained similar to the prior for all the retrospective runs. The CVs of the other parameters were lowest when the data were included through 2002, and increased as more years of data were removed in some cases. The credibility interval of biomass relative to B_{MSY} was narrowest when data were included through 2002. We expected the CVs to be lower when more years of data were included. This was generally true for data from 1998 to 2002. Presumably the higher CVs using the 2003 and 2004 data were caused by the high variability of the data in those years.

The results of the BSP model applied to data through 2009 (runs NW1 and NW2 in **Table 7, Figure 17**) were similar to the results in the Canadian age structured assessment with only Canadian data (SCRS/2009/095). Both catch series gave similar results. These two models showed a depletion similar to that found in 2004, but a low current fishing mortality rate relative to *Fmsy* (**Figure 18**), because the 2008 catches were low.

SW Atlantic porbeagle

For all the catch scenarios, the model estimated that biomass had declined since the beginning of the fishery, consistent with the decline seen in the Uruguay longline CPUE data (**Table 9** and **Figures 19** to **22**). The most apparent difference between the model runs is the estimate of *K*. Because the catch series scales the biomass estimates, the model runs that used the ICCAT catches, which were never above 40 t per year, estimated *K* around 1000 t. This low value allowed the model to fit a declining biomass trend with very small catches (runs SW1 and SW2). When catches were estimated from effort, with the constant of proportionality between catch and effort calculated either for 2005-2006 (run SW4) or 1997-2007 (run SW4), the estimated *K* was much higher (11,000-24,000 t). With the ratio estimate of catch, which was much higher than the catches estimated from the effort particularly in recent years, the estimated *K* was 71,000 t. All models estimated recent fishing mortality rates above *Fmsy*, although the median *F* dropped below *Fmsy* in 2009 for run SW4. For all models the replacement yield was very low. This result is driven by the trend in the Uruguay longline series. CPUE data from the other fleets in the region would be useful to verify this trend.

NE Atlantic porbeagle

The posterior distributions of *r* were similar to the prior distributions for all model runs (**Table 10**). The prior for *K* was uniform on log *K*, with an upper limit of 100,000 t. This upper limit was set to be somewhat higher than the total of the catch series from 1926 to the present (total catch= 92,000 t). With equal weighting of all the data points in both CPUE series and starting the model in 1926 (**Figure 23, Table 10**), the model estimated a declining population trend with biomass currently depleted to 78% of the biomass that would sustain the maximum sustainable yield, *Bmsy*. The posterior distribution of *K* had a mode around 60,000 t, but there was a substantial probability assigned to values as high as the upper limit of 100,000 t. To determine whether the data supported a higher value of *K*, we ran the model with a biologically unreasonable high upper limit of *K* of 1.0E8 t (run NE101 in **Table 10**). The model estimated a posterior of *K* that was similar to the uniform on log *K* prior, implying that there was very little information in the data to allow the model to estimate any of the parameters. Because the prior was only weakly informative, and allowed a substantial probability to be assigned to high values of *K*, this model estimated a very high expected value of *K*, with almost no depletion of the population. A biomass of 1.0E8 t of porbeagle is not likely, given that catch rates are relatively low compared to the catch rates of swordfish, tunas and other sharks, all of which have biomass levels that are lower than 1.0E8. Also, the estimated total biomass of porbeagle in the Northwest Atlantic is around 10,000 t. We also tried a lower maximum K of 80,000 t, and this gave similar results to those with an upper limit of 100,000 t. The rest of the model runs specified 100,000 t as the maximum value of *K*.

Weighting the CPUE series of Spain and France by their relative catches gave results similar to the equal weighting case (**Table 10** and **Figure 23**). Starting the model in 1961 and setting an informative prior on the level of depletion of the population in 1961, with a mean of either 1.0, 0.5 or 0.2 gave somewhat different results. All of these models found that the population continued to decline slightly after 1961, consistent with the decline in the French CPUE series. The current level of depletion and current fishing mortality rates were dependent on the level of depletion assumed in 1961. Considering that the largest catches in the fishery took place before 1961, the model runs that assumed model depletion in 1961, or started in 1926 are more realistic than those that assumed a high biomass in 1961.

Figure 24 shows the current status of northeast Atlantic porbeagle for the BSP model and the ASPM model. These results are highly uncertain, given that the majority of the fishery removals occurred before data were available to estimate abundance trends. All the models that used biologically plausible assumptions about unfished biomass inferred that the population is currently depleted.

3.2 Catch-free, age-structured production model (CFASPM)

3.2.1 Methods

A state-space, catch-free, age-structured production model (CFASPM; Porch *et al.* 2005) was applied to the SW Atlantic stock of porbeagle to provide contrast with the BSP model. Briefly, this is an age-structured production model that does not require catches, and recasts the population dynamics in terms relative to virgin biomass. Dynamics incorporate age-specific parameters for survival, fecundity, maturity, growth, and selectivity. The stock-recruitment function is parameterized in terms of maximum reproductive rate at low density (alpha; Myers *et al.* 1999). Two periods are considered in the model: a historic period, for which the data are sparse, and a modern period, for which there are data, such as catch rates. During the historic period, the model uses a relative biomass trend. Biological, fishery and other inputs used for the SW Atlantic porbeagle stock are listed in **Table 11**.

3.2.2 Results

SW Atlantic porbeagle

Table 12 summarizes stock status estimates from the model run, in which the historical period was 1961-1981 and the modern period, 1982-2008. The model was fitted to the Uruguayan longline CPUE series in the modern period. A selectivity function was derived from length frequency data obtained by the Uruguayan longline observer program, which were transformed into ages using the growth curve from the NW Atlantic. A logistic selectivity curve was thus estimated. At the request of the Working Group, the slope of the curve was subsequently increased slightly (shifted to the left) to better accommodate early age classes (**Figure 25**). The model did not use effort data, rather a constant F was estimated for the historic period, and an average F with annual deviations was estimated for the modern period. The estimate of current spawning stock biomass (SSB) was 18% of virgin level and SSB_{2008}/SSB_{MSY} was 0.48. Current fishing mortality rate (F_{2008}) was estimated to be 0.056, or over F_{MSY} (0.03), thus F_{2008}/F_{MSY}=1.72. The maximum lifetime reproductive rate (alpha) was only 2.95 and M=0.20. The fit to the index is shown in **Figure 26**. The relative trend in SSB shows that the model predicted a depletion of 46% by the beginning of the modern period in 1982 (**Figure 27**). Stock status results from the CFASPM were thus in general agreement with predictions from the BSP model (SSB_{2008}/SSB_{MSY} = 0.48 vs. B_{2008}/B_{MSY} = 0.78; F_{2008}/F_{MSY}=1.72 vs. F_{2008}/F_{MSY}=2.07, **Figure 22**).

3.3 Age-structured production model (ASPM)

3.3.1 Methods

A state-space, age-structured production model (ASPM; Porch *et al.* 2005) was applied to the NE Atlantic stock of porbeagle o provide contrast with the BSP model. The model dynamics are age-structured, incorporating age-specific parameters for survival, fecundity, maturity, growth, and selectivity, as in the CFASPM model described above. The stock-recruitment function is also parameterized in terms of maximum reproductive rate at low density (alpha; Myers *et al.* 1999). In this case, a prior is given to virgin recruitment (R0) and pup (age-0) survival, and age-specific M-values for ages 1+ are imputed. The values of M were the same as those used for the NW Atlantic stock assessment, i.e., M=0.10 for immature and M=0.2 for mature individuals. The model also has the ability to consider two periods: a historic period, for which the data are sparse, and which begins when virgin conditions can be assumed; and a modern period, for which there are more data. The model assumes a constant effort for the modern period, but allows for process error (annual deviations in fishing effort). The effort for the historic period can be set at different levels. Biological, fishery and other inputs used for the NE Atlantic porbeagle stock are listed in **Table 13**.

3.3.2 Results

NE Atlantic porbeagle

Table 14 summarizes stock status estimates from the model run, in which the historical period was 1926-1971 and the modern period, 1972-2008. The model was fitted to catches in 1926-2008 and to two indices in the modern period: the French longline CPUE series (1972-2008) and the Spanish longline CPUE series (1981-2007). A selectivity function was derived from length frequency data obtained from the French longline fleet, which were transformed into ages using a growth curve recently derived for the NE Atlantic stock. A logistic selectivity curve was thus estimated (**Figure 28**).

Current depletion with respect to virgin conditions was 6% in biomass and 7% in numbers **(Figure 29**). Current relative spawning stock fecundity (SSF_{2008}/SSF_{MSY}) was only 0.09. Current fishing mortality rate (F_{2008}) was estimated to be 0.09, well over F_{MSY} (0.03), and thus F_{2008}/F_{MSY}=3.45. The relative SSF and F trajectories were below and above sustainable levels, respectively (**Figure 30**). The fit to the catches and indices of relative abundance is shown in **Figure 31**.

Because the Working Group felt that the high constant F, on the order of 0.08, estimated by the model for the historic period was unrealistic, it was decided to explore the effect of assuming other levels of F on results. Two runs were conducted, one with an F=50% of the value estimated in the original run and one with F=0. Stock status improved (SSF_{2008}/SSF_{MSY}=0.21 and 0.43, respectively) and the level of overfishing decreased (F_{2008}/F_{MSY}=2.54 and 3.32, respectively) (**Table 14**).

3.4 Age structured assessment model

3.4.1 Methods and results

SCRS/2009/095 evaluated the current status of porbeagle in the NW Atlantic using a forward projecting, age- and sex-structured life history model, fit to catch-at-length and catch per unit effort data between 1961 and 2008. Four variants of the population model were presented, all of which differed in their assumed productivity. The total population size is currently estimated to be about 22% to 27% of its size in 1961 and about 95% to 103% its size in 2001. The estimated number of mature females in 2009 is in the range of 11,000 to 14,000 individuals, or 12% to 16% of its 1961 level and 83% to 103% of its 2001 value. All analyses indicated that this porbeagle stock can recover at fishing mortalities below 4% of the vulnerable biomass. Under the low productivity model, recovery to SSN_{MSY} was predicted to take over 100 years at exploitation rates of 4% of the vulnerable biomass. All other models predicted recovery times to SSN_{MSY} on the order of decades.

The implications of flat-topped selectivity patterns were explored at the meeting. The fit of the flat-topped selectivity model was considerably worse (objective function value of 16277 versus the original 13212), and there were extreme residual patterns in proportions at length, indicating that the model was inappropriate. Although the resulting fishing mortality estimates were reduced by about half, and fishable biomass doubled, all fishing mortality reference points were reduced accordingly, producing little net change in recovery trajectory or time.

3.5 Gadget

3.5.1 Methods

A Gadget (Globally applicable Area Disaggregated General Ecosystem Toolbox, Begley 2003, http://www.hafro.is/gadget) implementation for northeast Atlantic porbeagle was presented SCRS/2009/071 and updated with the new catch and CPUE data made available at the meeting. GADGET provides a flexible and powerful tool for creating ecosystem models. It can be fitted for a variety of assumptions related to the fisheries, stock structure and life history parameters and using data on catch and relative abundance (which may be biomass, age- or size-based), tagging and stomach contents. A single stock, area, fleet, age- and length- structured model was developed, which can now be used for projecting forwards under different management scenarios. Gadget can potentially be used to evaluate the value of collecting additional information on fisheries and biology and of using alternative management measures and assessment methods, particularly as it will allow spatial structure to be represented. It is intended to use it in the future to evaluate stock assessment methods like BSP and ASPM. Also for species like porbeagle where there are few data and large uncertainty, Gadget can help in the development of precautionary management by evaluating alternative measures such as size limits and time-area restrictions and help design research projects to improve our knowledge on porbeagle and the fisheries in which they are taken.

4. Projections

4.1 Bayesian surplus production model

NE Altantic porbeagle

The five most credible BSP model runs for Northeast Atlantic porbeagle were used to generate projected abundance trajectories for a range of constant catch and constant harvest rate management strategies. The resulting expected biomass relative to *Bmsy*, probability that biomass will be above *Bmsy*, probability that biomass will be above the current biomass and median number of years to rebuild (**Table 15, Figure 32**) vary between models. The current TAC of 436 t is likely to cause the population to remain fairly stable under most models. Reductions in fishing mortality are required to allow the population to rebuild, and rebuilding will take several decades under most models (**Table 16**).

4.2 Yield per recruit analysis

The BSP analysis concentrates on total allowable catch; however, as noted below the development of precautionary management also requires the evaluation of alternative measures such as size limits and restrictions intended to improve selection pattern in the fisheries. Therefore a yield per recruit analysis using FLR (ww.flr-project.org) was conducted.

The effect of different selection patterns on the NE Atlantic porbeagle stock were evaluated in F**igure 33** This shows four selection patterns corresponding to flat-topped and dome-shaped (thick and thin lines, respectively) curves and with maximum selectivity at either age 5 or13 (red and blue, respectively). Age 13 corresponds to age at maturity of females and to the current maximum landing length (MLL) of 210 cm fork length. Life history parameters were taken from the Gadget implementation.

The analysis shows that both potential stock size and yields are increased if fishing mortality is reduced on immature fish (blue).

In **Figure 34** fishing mortality on individuals greater than the MLL is reduced to 0.

Table 17 shows the fishing mortality, yield, biomass and SSB relative to that achieved at the effort level corresponding to the $F_{0.1}$ level for a flat-topped selection pattern with maximum selection at age 3. The difference due to the MLL, as also seen by comparing **Figures 33** and **34**, is that stock levels are improved at the expense of yield

5. Research recommendations

The Group considered the importance of developing research projects at the regional (stock) level which will result in rapidly increasing our available knowledge on porbeagle sharks:

- Scientists were urged to study the technical and operative aspects of the fleets that could reduce the incidental catch of sharks and/or maximise the opportunity for live release,
- Prepare better estimates of discards in shelf and high-seas fisheries and initiate studies to measure post-release survival.
- Observer programs to collect better resolution data on catch rates for those fleets where there is a high likelihood of porbeagle by-catch, including from existing marine mammal observer programmes.
- Better understand the dynamics of porbeagle in the southern hemisphere in conjunction with other RFMOs, including IOTC, CCSBT, and IATTC so as to collate better data on catch, distribution, commercial CPUE and stock structure.
- Given that the stock identity for South Atlantic stocks is unclear, further studies (including genetic studies as well as life-history and tagging studies) are required to better inform on stock units in the southern hemisphere.
- Although stock structure in the North Atlantic is better understood, there is a need for specific investigations. For example, to better understand the affinity of catches off Iceland, and potential mixing between NW African and Mediterranean porbeagle.
- A better understanding of vertical and migratory movements of porbeagle in the main areas of their distribution is required to better understand the potential interaction between the populations and fishing activities.

- Porbeagle may associate with hydrographic features (or as an indirect effect via associating with their main prey). A better understanding of the temporal and spatial distribution of porbeagle in relation to such environmental/ecosystem features (including population structure) may facilitate our understanding of catch and CPUE trends.

- Spatial management of porbeagle has been established in Canadian waters. A better knowledge of the distribution and fidelity of critical porbeagle habitats (including pupping and nursery grounds, and sites with a high proportion of mature females) would facilitate more widespread use of spatial management.

- The reliance of fishery-dependent data for assessments is problematic, as such data are not necessarily informative. Fisheries-independent surveys for porbeagle are required in the main stock areas.

- More historical information on catch and effort data may be available and should be investigated. In the absence of historical effort data, estimates of fleet size could provide a useful surrogate.

- Given that porbeagle are a key pelagic stock on continental shelf ecosystems as well as in the high seas, ICCAT and RFMOs (e.g. NAFO, ICES) should continue to cooperate in developing assessments and management actions for this species.

6. Management recommendations

Precautionary management measures should be considered for those stocks where there is the greatest biological vulnerability and conservation concern, and for which there are very few data. Porbeagle are known to be susceptible to over-fishing.

Given that porbeagle are primarily a continental shelf species, management measures should be harmonized between all relevant RFMOs, and ICCAT should facilitate appropriate communication.

South Atlantic

Data for southern hemisphere porbeagle are too limited to provide a robust indication on the status of the stock(s). Limited data indicate a decline in CPUE in the Uruguayan fleet, suggesting a potential decline in porbeagle abundance in the SW Atlantic to levels below MSY. Results of the two modeling approaches applied to the SW Atlantic stock (BSP and CFASPM) coincided in estimating depletion levels below MSY and fishing mortality rates above those producing MSY. But catch and other data are generally too limited to allow definition of sustainable harvest levels. Catch reconstruction indicates that reported landings grossly under-estimate actual landings.

Information and data for porbeagle in the SE Atlantic are too limited to assess their status. Available catch rate patterns suggest stability since the early 1990s. This trend cannot be viewed in a longer term context and so are not informative on current levels relative to $_{BMSY}$.

Given the history of depletion in the North Atlantic, suggestion of decline to below MSY in the SW Atlantic and lack of basic catch and effort data from the total fleets impacting the stock (including non ICCAT fleets) the Commission should consider adopting precautionary measures, including restricting fisheries affecting the stock(s) to by-catch only and/or restricting fishing activities in areas known to have high abundance of important life-history stages (e.g. mating, pupping and nursery grounds). Other (national) fleets should report catch and effort data in accordance with Resolution 07-06.

The distribution of South Atlantic stock(s) extends into other ocean basins, emphasizing the need to harmonize both biological and fisheries data collection and management with other RFMOs.

NE Atlantic

The NE Atlantic stock has the longest history of commercial exploitation. The lack of CPUE data for the peak of the fishery adds considerable uncertainty in identifying the current status relative to virgin biomass. Exploratory assessments indicate that current biomass is below B_{MSY} and that recent fishing mortality is near or possibly above F_{MSY}.

ICES consider the stock to be depleted, especially in the northern parts of the ICES area. ICES suggested that the stock was still depleted, and fisheries in the northern parts of the stock area had not resumed since the peak of that fishery. Fisheries in the southern part of the stock area continue at low levels, with some evidence of a decline over time in CPUE. CPUE data for the peak of the fishery were not available and thus do not reflect longer term trends.

The assessments conducted at this meeting support the previous ICES view of stock depletion.

ICES (2008) advised, in the absence of a quantitative assessment "*Given the state of the stock, no targeted fishing for porbeagle should be permitted and by-catch should be limited and landings of porbeagle should not be allowed*".

Existing EC management measures in the NE Atlantic include a TAC. Reported landings in 2008 were less than the TAC. A maximum landing length (210 cm fork length) was introduced in 2009 to deter fisheries targeting mature females.

Given the depleted state of the stock, its low productivity, and uncertainty in the assessment, conservative management measures are appropriate under the precautionary approach. The Commission should consider adopting TACs which provide a high probability of allowing stock rebuilding. Additionally, the Commission should consider restricting fishing activities in areas known to have high abundance of important life-history stages (e.g. mating, pupping and nursery grounds). Nations and RFMOs should consider adopting further management measures to reduce fishing mortality (e.g. the EC brought in size restrictions).

High-seas fisheries should not target porbeagle and all by-catch should be reported. Due to their lower abundance in the high seas, by-catch data collection and reporting would require scientific observer sampling at a high level of coverage. Increased effort on the high seas within the stock area could compromise stock recovery efforts.

Recovery of this stock to B_{MSY} under zero fishing mortality is estimated to take ca. 15-34 years (**Table 15**). Sustained reductions in fishing mortality would be required if there is to be any stock recovery (**Table 16**).

The current TAC (436 t) may allow the stock to remain stable, at its current depleted biomass level, under most credible model scenarios. Catches close to the current TAC (e.g. 400 t) imply catch levels that could allow rebuilding to B_{MSY} under some model scenarios, but with a high degree of uncertainty and on a time scale of 60 (40-124) years.

Constant catches of 200 t or less resulted in higher probabilities of recovery to B_{MSY} within 25-50 years under nearly all model scenarios.

Given uncertainty in the assessment and the low productivity of the stock, any fishery should be closely monitored and assessed at frequent intervals.

NW Atlantic

Canadian scientists updated their assessment of the NW Atlantic porbeagle stock. This assessment indicates that biomass is depleted to well below B_{MSY}, although recent fishing mortality is also below F_{MSY}. Recent biomass appears to be increasing. There is now a conservative harvest regime (TAC of 185 t relative to the MSY catch of 250 t; closure of the mating grounds to target fisheries) in place in the Canadian EEZ. Despite this, stock rebuilding is projected to take decades due to the low productivity of the species.

Additional modelling by the Working Group using a surplus production approach indicated a similar view of stock status, i.e., depletion to levels below B_{MSY} and current fishing mortality rates also below F_{MSY}.

The success of the Canadian recovery program is contingent on proper accounting of all catches, including high-seas fleets. Catches within the Canadian EEZ appear to be well accounted for. However, the quantities of porbeagle taken in high-seas longline fleets are unclear, as there is widespread non-reporting and generic reporting of sharks.

Estimates of potential porbeagle catch by various high-seas longline fleets which fished in areas where porbeagle are known to occur were reconstructed based on observed catch ratios of porbeagle relative to tunas and swordfish. For the NW Atlantic this reconstruction indicates that unaccounted high-seas longline catches of porbeagle were a minor proportion of the total reported catch historically and catches have been even smaller in recent years.

The inclusion of reconstructed high-seas catches into the assessment did not appreciably affect the output. Future assessments should cover the entire stock area. Because the high-seas catches are currently low in proportion to the total reported catch it is not expected that inclusion of the reconstructed catches would appreciably change the catch levels required to achieve the conservation objectives in the Canadian Management Plan.

The United States has adopted management plans to reduce fishing mortality on porbeagle, in support of management plans introduced into Canadian waters, including a TAC of 11.3 t dressed weight (dw), of which 1.7 t dw are allocated as a commercial quota (2008).

The Commission should adopt management measures that support the recovery objectives of the Canadian Management Plan. High-seas fisheries should not target porbeagle and all by-catch should be reported. Due to their lower abundance in the high seas, by-catch data collection and reporting would require scientific observer sampling at a high level of coverage.

Areas known to have high abundance of important life-history stages (e.g. mating, pupping and nursery grounds) should be subject to fishing restrictions. Such grounds are not exclusively in the Canadian EEZ.

Increased effort on the high seas within the stock area could compromise stock recovery efforts.

7. Executive Summary for Porbeagle

The group decided to finish and approve the executive summary for porbeagle during the species group meeting in September.

8. Other matters

No other matters were discussed.

9. Report adoption and closure

The report will be adopted by correspondence. The Chairmen thanked participants for their hard work.
The meeting was adjourned.

Gibson and Campana 2005
Myers *et al.* 1999
Poech et al. 2005
Begley 2003
2008 SHK detailed report

Appendix 1

AGENDA

1 Opening, adoption of agenda and meeting arrangements
2 Update of data for assessment
  2.1 Stock structure and life history parameters
  2.2 Stock definition
  2.3 Summary of life-history parameters
  2.4 Catch estimates
  2.5 Trends in catch rates
3 Assessment model and results
  3.1 Bayesian surplus production model
  3.2 Catch-free, age-structured production model
  3.3 Age-structured production model
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4 Projections
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  4.2 Yield per recruit analysis
5 Research recommendations
6 Management recommendations
7 Executive Summary for Porbeagle
8 Other matters
9 Report adoption and closure

Appendix 2

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Appendix 3

LIST OF DOCUMENTS

SCRS/2009/053	Historical data and standardized catch rates of porbeagle (Lamna nasus) caught as bycatch of the Spanish surface longline fishery targeting swordfish (Xiphias gladius) in the Atlantic ocean. Mejuto, J., Ortiz, J., García-Cortés, B., Ortiz de Urbina, J. and Ramos-Cartelle, A. M.
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SCRS/2009/068	Bayesian surplus production model applied to porbeagle catch, CPUE and effort data. Babcock, B.A. and Cortes, E.
SCRS/2009/069	Standardized catch rates for porbeagle sharks from the us pelagic longline logbook program. Cortés, E.
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SCRS/2009/092	National Report EC-Spain, Atlantic Lamna nasus, ICES+ICCAT meeting 2009. Mejuto, J., Punzón, A. and González, F.
SCRS/2009/093	Standardized CPUE of porbeagle shark (Lamna nasus) caught by Uruguayan pelagic longline fleet (1982-2008). Pons, M. and Domingo, A.
SCRS/2009/094	Habitat Utilization and Movement Patterns of Porbeagle Sharks (Lamna nasus) in the Western North Atlantic. Skomal, G., Marshall, H., Chisholm, J., Natanson, L. and Bernal, D.
SCRS/2009/095	Population dynamics of porbeagle in the northwest Atlantic, with an assessment of status to 2009 and projections for recovery. Campana, S.E., Jamie, A., Gibson, F., Fowler, M., Dorey, A. and Joyce, W.
SCRS/2009/188	Data On French Targeted Porbeagle (Lamna Nasus) Fishery In The Northeast Atlantic Ocean: Captures And Biological Parameters. Jung, A., Lorrain,A., Cherel,Y., Priac,A., Baillon ,S. and Campana, S.

Table 1. Summary of porbeagle biological parameters, adapted from Francis et al (2008).[a]

	Southern hemisphere stock(s)[b]		*NW Atlantic*		*NE Atlantic*	
Parameter	*Value*	*Source*	*Value*	*Source*	*Value*	*Source*
Length–weight relationship (kg, cm)	F+M: $W=8.91\times10^{-6}\,FL^{3.128}$ (juveniles < 150 cm)	1	F+M: $W=5\times10^{-5}\,FL^{2.713}$ F+M: $W = 1.4823\times10^{-5}\,FL^{2.9641}$	4 18	F+M: $W= 1.292\times10^{-4}\,TL^{2.4644}$ F: $W= 3\times10^{-5}\,FL^{2.8164}$ M: $W=5\times10^{-5}\,FL^{2.7290}$	15 14 14
Length at birth (cm)	58–67 FL	1, 2	60–75 FL	16, 17	Similar to NW Atlantic?	
Length at maturity (cm)	F: 170–180 FL M: 140–150 FL	3	F: 210–230 FL; 50% 218 FL M: 162–185 FL; 50% 174 FL	6 6	F: 200-250 FL M: 150-200 FL	12 12
Growth	NZ: FL=66.5+19.8 Age Aust: FL=65.4+16.1 Age (juveniles < 150 cm)	1	F+M: $FL=289.4(1–e^{–0.066\,(t+6.06)})$ F: $FL=309.8(1–e^{–0.060\,(t+5.90)})$ M: $FL=257.7(1–e^{–0.080\,(t+5.78)})$	7	F+M: $FL=276.6(1–e^{–0.045\,(t+8.03)})$	13
Median age at maturity (yr)	F: ? M: ?		F: 13 M: 8	6, 7 6, 7	Similar to NW Atlantic?	
Age at recruitment (yr)	0–1	1	0–1	8	0-1?	
Maximum length (cm)	F: 214FL M: 204 FL	1, 2, 11	F: 317 FL; M: 262 FL	9	F: 278 FL; M: 253 FL	5
Longevity (yr)	> 60[19]		> 26	10	>23	13
Natural mortality ($yr^{–1}$)	?		0.10–0.20	4, 8	?	
Gestation period (months)	8–9	1, 2	8–9	6	8-9?	12
Reproductive cycle (yr)	≥ 1	1	1	6	1?	
Mean litter size	3.75	1, 2	3.7–4.0 (3.9)	6	3.7	5
Annual fecundity	≤ 3.75	1, 2	3.7–4.0 (3.9)	6	~3.7	5
Embryonic sex ratio	1:1	1, 2	1:1	6	1:1 ?	

[a]?, unknown; FL, fork length; TL, total length; PL, precaudal length; W, weight; M, males; F, females.
Sources: 1, Francis and Stevens (2000); 2, M. P. Francis, unpubl. data; 3, Francis and Duffy (in press); 4, Campana *et al.* (1999); 5, Gauld (1989); 6, Jensen *et al.* (2002); 7, Natanson *et al.* (2002); 8, Campana *et al.* (2001); 9, S. E. Campana, unpubl. data; 10, Campana *et al.* (2002a); 11,Forselledo *et al*, (XXXX); 12, Aasen (1961); 13 This report; 14, Jung (2008); 15, Ellis and Shackley (1995); 16, Aasen (1963); 17, Compagno (1984); 18, Kohler *et al*. (1995); 19 Francis *et al.* (2007)

[b] All values for the South Atlantic are currently unknown, but are probably closer to the South Pacific values than to those of the North Atlantic

Table 2. Estimated catches (t) of porbeagle (*Lamna nasus*) by major area, gear and flag (as of Jun 12, 2009 at 9:25am).

Year	TOTAL (Landings+Discards)				Landings			Discards		Landings																												Discards		
	ALL	ATN	ATS	MED	ATN	ATS	MED	ATN	ATS	ATN															ATS											MED		ATN		ATS
					All gears	All gears	All gears	All gears	All gears	Canada	EC.Denmark	EC.España	EC.France	EC.Germany	EC.Ireland	EC.Netherlands	EC.Portugal	EC.Sweden	EC.United Kingdom	Faroe Islands	Iceland	Japan	Norway	U.S.A.	Benin	Chile	EC.Bulgaria	EC.España	EC.Netherlands	EC.Poland	EC.Portugal	Falklands	Japan	Seychelles	Uruguay	EC.Italy	EC.Malta	EC.Ireland	U.S.A.	Uruguay
1961	1924	1924			1924															1			1824																	
1962	3016	3016			316															8			2216																	
1963	6563	6563			6563															8			5763																	
1964	9274	9274			9274															1214			86																	
1965	5151	5151			5151					28										178			445																	
1966	2114	2114			2114															741			1373																	
1967	589	589			589															589																				
1968	931	931			931															662			269																	
1969	865	865			865															865																				
1970	205	205			25															25																				
1971	777	777			777								546							231																				
1972	1262	1262			1262								915							26			87																	
1973	1222	1222			1222						158		538	4					21	269	2		23																	
1974	726	726			726						17		373	3					13		2		165																	
1975	1184	1184			1184						265		514	3				1	13	8	4		34																	
1976	1483	1483			1483						233		661						2	37	3		259																	
1977	1118	1118			1118						289		454							295	3		77																	
1978	3231	3231			3231					1	112	287	834							121			76																	
1979	1572	1572			1572					2	72		192					1		299	1		15																	
1980	1594	1594			1594					1	176		896					8	3	425	1		84																	
1981	1370	1370			137						158		768					5	2	344			93																	
1982	584	584			585					1	84		199					6	1	259	1		33	1																
1983	1141	1141			1141					9	45		791					5	2	256			33																	
1984	706	706			76					2	38		411					9	5	126	1		96	0																
1985	664	664			664					26	72		254					1	12	21			8	0																

1986	706	706			76					24	114		26					8	6	27			24	0																
1987	813	813			813					59	56		28				3	5	3	381			25	1																
1988	957	955	1		955	1				83	33		446				3	3	3	373			11	0				0					1							
1989	971	971	0		972	0				73	33		341				2	3	15	477			25	2						0										
1990	1282	1282			1282					78	46		551				2	2	9	55			43	2																
1991	1944	1943	0		1943	0				329	85		3				1	2		1189			32	5			0													
1992	2588	2588	1		2586	1		2		813	8		496				0	4		1149	1		41	1						1									2	
1993	1889	1888	1		1888	1				919	91		633					3		165	3		24	5						0		1	1							
1994	2676	2674	2	0	2673	2	0	1		1575	93		82					2		48	4		24	16		1		0		1			0				0		1	
1995	2121	2118	3	0	2118	3	0			1353	86		565					2	0	44	6		26	35				0				0	0		3		0			
1996	1518	1514	3	1	1514	3	1			16	72		267					1		8	6	5	28	78				0				0	3				1			
1997	1859	1833	26	0	1833	26	0			1334	69	25	315					1		9	3	4	17	56	4	0		2				0	14		5		0			
1998	1469	1451	17	1	146	16	1		1	17	85	25	219					1	1	7	4		27	13	0			2				1	1	1	13		1			1
1999	1403	1393	10	0	1392	9	0	1	1	965	17	18	240	0	7		0	1	6	1	2		32	3	5			2				0	1		2		0	1		1
2000	1468	1456	11	1	1456	11	1			92	73	13	41	17	1		7	1	8		2		22	2				7				1			4		1			
2001	999	998	1	2	998	1	2			499	76	24	361	1	6		4	1	12		3		11	1				1				0					2			
2002	848	838	2	0	838	2	0			237	42	54	461	3	3		1		1		2		14	1				2				0			8		0			
2003	637	593	44	0	593	44	0			142		27	34				11				1		19	1				9							34		0			
2004	727	707	17	3	77	17	3			232		12	413				5				1			1				4			4				8	2	0			
2005	571	539	4	2	539	4	2			22		14	276				14		24		0		8	0				0			2				28	1	1			
2006	504	466	37	1	466	37	1			192		34	194				6		11		1		27	0				3							34	1				
2007	490	482	9	0	482	9	0			93		8	354			0	0		26		1			0				5	0						3		0			

Table 3. Estimates of potential porbeagle catch for non-reporting longline fleets operating in the NW stock areas based on catch-ratios.

Year	Belize	China P.R.	Chinese Taipei	Cuba	EC.Portugal	Japan	Korea Rep.	Venezuela	Barbados	Cambodia	Libya	NEI (ETRO)	NEI (Flag related)	Norway	Panama	Philippines	Seychelles	Sierra Leone	St. Vincent and Grenadines	Trinidad and Tobago	U.S.S.R.	UK.Bermuda	Grand Total
1962						0.5																	0.5
1963						29.9																	29.9
1964						28.0								0.4									28.4
1965						57.0								0.0									57.1
1966						36.0								0.1									36.1
1967						20.8																	20.8
1968			0.5	0.1		15.8																	16.4
1969			8.6	0.6		15.1																	24.3
1970			7.1	0.0		39.6																	46.8
1971			9.2	0.1		101.3															0.0		110.6
1972			28.0	0.4		16.3	1.4								0.0						0.0		46.1
1973			40.6	0.1		50.3	1.0								0.5						0.0		92.5
1974			36.2	0.1		51.3	0.6								0.1								88.3
1975			39.7	0.2		17.9	5.6								0.4						0.0		63.8
1976			62.8	0.3		82.1	20.3								8.9								174.4
1977			61.9	0.0		78.6	39.7								3.9								184.2
1978			54.4	0.0		59.8	14.1								6.0								134.4
1979			49.2	0.1		95.6	23.5								2.8								171.3
1980			29.8	0.0		121.8	1.3								1.1								154.0
1981			20.5	0.0		145.7	0.5								0.8								167.5
1982			32.6	0.1		44.1	0.8					0.1											77.6
1983			38.2	0.4		61.7	0.6					0.0	2.7										103.5

1984			66.1	0.2		50.2	0.2	0.1					2.7							0.1			119.6
1985			57.1	0.4		61.4	0.2						1.9										121.1
1986			95.6	0.8		64.5	2.4						5.9		18.3								187.4
1987			40.7	0.1		74.4		7.4					3.9										126.5
1988			6.9	0.0		71.4		10.6				0.3	0.4										89.5
1989			3.2			49.1		13.1															65.4
1990			0.3			54.9		2.5															57.6
1991						42.5		0.9															43.4
1992			0.0			46.8		1.9			0.8		0.0										49.5
1993		0.0	3.9			28.7		1.8			0.3		0.1										34.7
1994		0.1	9.9			27.0		4.2			0.1	0.0	0.4										41.6
1995		0.0	12.1			10.8		1.4			0.0		0.4										24.7
1996		0.1	26.9			9.9		6.7			0.6	0.2	1.8										46.1
1997			17.9			9.1		2.4	0.1		0.2	0.1	1.6										31.4
1998			13.4		0.7	19.5		8.5	0.3		0.2		5.7			0.0							48.3
1999			27.3		0.7	34.9		9.1	0.8	0.0	0.9	0.2	8.5			0.0						0.1	82.4
2000			19.1		0.0	22.9		5.6	0.2		0.2	0.1	2.8			0.4	0.0	0.0	3.7			0.1	55.3
2001			17.9			27.2		2.2	0.4		0.0	0.3	1.9			0.2		0.0	3.1			0.1	53.3
2002			22.5			21.1		0.2	0.1		0.4	0.0	0.0						0.8				45.7
2003			11.6		0.0	7.3		0.1	0.1		0.2	0.0	0.0										19.3
2004			7.7	0.7		19.6			0.1			0.0											29.3
2005			6.8	1.0		27.3		0.0	0.1			0.0							0.0				36.1
2006			4.7	0.8	0.0	18.3			0.4		0.1	0.0											24.3
2007	0.1		2.6		0.1	5.2			0.1										1.6			0.1	9.8

Table 4. Estimates of potential porbeagle catch for non-reporting longline fleets operating in the SW stock areas based on catch-ratios.

Year	Argentina	Barbados	Belize	Brasil	Cambodia	China P.R.	Chinese Taipei	Cuba	EC.España	EC.Portugal	Japan	Korea Rep.	Libya	NEI (ETRO)	NEI (Flag related)	Panama	Philippines	Russian Federation	Seychelles	St. Vincent and Grenadines	Trinidad and Tobago	U.S.A.	U.S.S.R.	Venezuela	Grand Total
1956											0.8														0.8
1957											1.0														1.0
1958				7.4							0.4														7.8
1959	14.3			25.3							2.4														42.0
1960	18.5			20.1							13.5														52.1
1961	26.8			21.8							4.2														52.8
1962	53.0			7.7							21.3														82.0
1963	109.4			11.1				0.0			33.6														154.2
1964	85.8			7.8				0.0			68.6	0.0													162.2
1965	73.7			3.8			0.0	0.0			68.4	0.0													146.1
1966	11.1			2.8			0.0	0.0			22.6	0.5													37.1
1967	8.3			3.9			0.1				14.4	1.3													28.0
1968	18.0			4.3			2.8	0.5			23.1	15.0											0.0		63.8
1969	10.3			3.0			30.9	1.8			329.5	16.1											0.0		391.6
1970	8.6			4.6			142.1	0.1			295.6	11.5											0.0		462.5
1971	5.9			2.9			59.6	0.1			24.7	11.1											0.0		104.3
1972	22.9			2.2			37.4	0.1			81.0	27.5				0.4							0.0		171.5
1973	19.7			3.0			40.5	0.2			2.6	28.1				12.6							0.0		106.7
1974	9.9			7.9			59.6	0.6			0.0	31.9				6.5							0.0		116.5
1975	20.2			8.5			26.2	0.2			0.2	24.3				2.5							0.0		82.2
1976	25.5			7.0			32.6	0.4				20.0				5.2									90.8
1977	24.2			15.1			33.0	0.1			0.1	54.8				2.0							0.0		129.2
1978	2.5			67.9			57.8	0.1			1.1	14.9				2.1							0.0		146.4
1979				74.4			73.8	0.2			0.1	13.2				1.5									163.2
1980	0.3			58.6			56.9	0.3			17.5	16.0				3.9									153.5

1981	0.6			103.2			52.2	0.3			57.2	14.0				1.8							0.0		246.8
1982				97.8			50.5	1.1			8.9	11.5				3.6								0.3	266.7
1983				85.4			34.9	1.3			1.0	10.9			1.0	4.7					0.1			1.2	289.1
1984				56.1			19.9	0.5			0.1	9.8			0.5	4.9					0.0			0.8	304.1
1985				50.4			26.7	2.1			35.3	12.4			0.7	15.3					0.0			1.0	319.7
1986				141.0			59.9	0.3			121.9	5.7			1.6	12.5								0.6	420.3
1987				94.7			72.1	1.1	0.8		91.7	5.3			9.3									0.1	348.0
1988				95.8			84.9	0.2			117.6	6.3			22.6	0.8					0.0			0.4	381.9
1989				101.5			108.2	0.2			15.2	19.0		13.9	35.6	7.1					0.0			0.3	341.1
1990				95.5			142.3	1.1	0.7		37.2	3.3		1.9	11.1	8.0									328.0
1991				81.0			72.6	0.0	12.9		47.7	2.8		0.1	7.8	13.6									256.1
1992				128.0			191.9	0.2	12.0		11.5	1.5	0.1	0.1	13.6	1.6									384.5
1993				59.6		0.1	85.0		32.5		12.6	0.5	0.2	0.4	9.5	5.6									212.7
1994				32.4		0.6	145.9		34.9		13.7	2.2	0.1	0.7	21.5	24.2									281.4
1995		0.1		48.8		0.3	56.7		42.8		5.6	0.9	0.0	0.4	7.5	4.0									180.1
1996		0.0		32.8		0.0	167.6		27.8		5.9	6.4	0.1	1.0	44.9	20.9									326.5
1997		0.2		36.0		0.0	64.9	0.0	24.5	0.5	4.0	1.2	0.0	0.6	22.4	2.6									174.6
1998		0.4		37.5		0.0	170.2		11.0		0.7		0.0	1.1	35.5		0.2								279.0
1999		0.1		58.0	0.0	12.7	72.9		12.3		1.2		0.0	0.4	10.3	0.1	0.1								183.6
2000		0.4		60.1		35.6	83.7		19.8	0.0	6.7		0.1	0.4	14.9	1.0	0.3		0.1			0.6			240.2
2001		0.1		66.6		3.8	28.9		13.3	0.6	4.5		0.1	0.1	3.0		0.1					0.6			141.8
2002		0.6		73.7		0.0	92.7		12.5	0.5	3.4		0.1	0.0	1.1		0.2		0.0			0.4			204.7
2003		0.3		49.4		5.4	94.6		13.9	1.0	2.3		0.1	0.0	0.5		0.2								188.5
2004		0.1		36.9		3.8	39.4		17.8	0.7	11.0			0.0			1.0								138.3
2005		0.1	0.0	52.3		1.6	43.2		20.6	0.6	2.8	0.0		0.0			3.0	0.0							153.9
2006		0.2		31.9		1.9	46.8		13.4	1.2	3.4		0.0	0.0			0.5			0.0					118.5
2007		0.1	0.7	22.6		6.4	98.5		17.3	1.7	3.6	3.0								0.3					164.6

Table 5. Estimated harvest levels of northeastern Atlantic porbeagle by flag adopted by the Working Group for the assessment.

Year	EC.Denmark	EC.España	Norway	EC.France	EC.Germany	EC.Ireland	EC.Netherlands	EC.Portugal	EC.Sweden	EC.United Kingdom	Iceland	Japan	Norway	Faroes	U.S.A.	EC.Italy	EC.Malta	Total
1925																		0.0
1926			279.0										279.0					279.0
1927			457.0										457.0					457.0
1928			611.0										611.0					611.0
1929			832.0										832.0					832.0
1930			1,505.0										1,505.0					1,505.0
1931			1,106.0										1,106.0					1,106.0
1932			1,603.0										1,603.0					1,603.0
1933			3,884.0										3,884.0					3,884.0
1934			3,626.0										3,626.0					3,626.0
1935			1,993.0										1,993.0					1,993.0
1936			2,459.0										2,459.0					2,459.0
1937			2,805.0										2,805.0					2,805.0
1938			2,733.0										2,733.0					2,733.0
1939			2,213.0										2,213.0					2,213.0
1940			104.0										104.0					104.0
1941			283.0										283.0					283.0
1942			288.0										288.0					288.0
1943			351.0										351.0					351.0
1944			321.0										321.0					321.0
1945			927.0										927.0					927.0
1946			1,088.0										1,088.0					1,088.0
1947			2,824.0										2,824.0					2,824.0
1948			1,914.0										1,914.0					1,914.0
1949			1,251.0										1,251.0					1,251.0
1950	1,900.0	4.5	1,358.0										1,358.0					3,262.5
1951	1,600.0	3.0	778.0										778.0					2,381.0
1952	1,600.0	3.0	606.0										606.0					2,209.0

1953	1,100.0	3.7	712.0							712.0	100.0		1,915.7
1954	700.0	1.0	594.0							594.0	300.0		1,595.0
1955	600.0	1.9	897.0							897.0	100.0		1,598.9
1956	400.0	1.2	871.0							871.0			1,272.2
1957	600.0	3.1	1,097.0							1,097.0	100.0		1,800.1
1958	900.0	2.6	1,080.0					7.0		1,080.0	300.0		2,289.6
1959	600.0	3.4	1,183.0					9.0		1,183.0	600.0		2,395.4
1960	400.0	2.2	1,929.0					10.0		1,929.0	500.0		2,841.2
1961	600.0	5.3	2,145.0					9.0		1,053.0			1,667.3
1962	400.0	7.2	1,771.0					20.0		444.0			871.2
1963	200.0	3.1	4,554.0					17.0		121.0			341.1
1964	300.0	5.6	5,594.0					5.0		89.0			399.6
1965	200.0	4.5	2,329.0					8.0		204.0			416.5
1966	200.0	9.3	576.0					6.0		218.0			433.3
1967	200.0	8.4	305.0					7.0		305.0			520.4
1968	100.0	11.0	881.0					7.0		612.0			730.0
1969	100.0	10.9	909.0					3.0		909.0			1,022.9
1970	200.0	9.8	269.0					5.0		269.0			483.8
1971	400.0	10.5	211.0	546.0				7.0		211.0			1,174.5
1972	500.0	10.0	293.0	915.0				15.0	6.0	206.0			1,652.0
1973	158.0	11.9	230.0	538.0	4.0			21.0	2.0	230.0			964.9
1974	170.0	9.0	165.0	373.0	3.0			13.0	2.0	165.0			735.0
1975	265.0	11.7	304.0	514.0	3.0		1.0	13.0	4.0	304.0			1,115.7
1976	233.0	8.8	259.0	661.0			3.0	20.0	3.0	259.0			1,187.8
1977	289.0	10.3	77.0	454.0					3.0	77.0			833.3
1978	112.0	11.3	76.0	834.0						76.0			1,033.3
1979	72.0	8.0	106.0	1,092.0			5.0	1.0	1.0	106.0			1,285.0
1980	176.0	11.8	84.0	896.0			8.0	3.0	1.0	84.0			1,179.8
1981	158.0	12.5	93.0	768.0			5.0	2.0	1.0	93.0			1,039.5
1982	84.0	14.2	33.0	199.0			6.0	1.0	1.0	33.0			338.2
1983	45.0	28.0	33.0	791.0			5.0	2.0	1.0	33.0			905.0
1984	38.0	20.0	97.0	411.0			9.0	5.0	1.0	80.0			564.0
1985	72.0	23.1	80.0	254.0			10.0	12.0	1.0	80.0			452.1
1986	114.0	25.5	24.0	260.0			8.0	6.0	1.0	24.0			438.5
1987	56.0	30.0	25.0	280.0		3.0	5.0	3.0	1.0	25.0		0.0	403.0
1988	33.0	60.9	12.0	446.0		3.0	3.0	3.0	1.0	12.0			561.9

1989	33.0	40.0	27.0	341.0				1.6	3.0	15.0	1.0		27.0					461.6
1990	46.0	25.9	45.0	551.0				2.0	1.7	8.7			45.0					680.3
1991	85.0	46.5	35.0	300.0				1.1	2.4				35.0					470.0
1992	80.0	15.0	43.0	496.0				0.3	3.8		1.0		43.0					639.1
1993	91.3	20.5	24.0	633.0	1.0			1.0	2.5		3.0		24.0					776.3
1994	93.0	49.0	26.0	820.0				1.0	2.1		4.1		26.0	48.0			0.1	1,043.4
1995	86.0	17.4	28.0	565.0				1.0	2.2	0.1	6.0		28.0	44.0			0.2	749.9
1996	72.0	38.8	31.0	267.0				1.0	1.1		5.0	3.0	31.0	8.0			1.0	427.9
1997	69.0	23.0	19.0	315.0				1.0	1.3		2.9	2.0	19.0	9.0			0.2	442.4
1998	85.0	21.6	28.0	219.0	2.0			1.0	0.5	0.6	4.4		28.0	7.0			0.9	370.0
1999	107.0	15.0	34.0	239.7	0.3	7.9		0.1	0.8	6.2	2.3		34.0	10.0			0.3	423.5
2000	73.0	11.3	23.0	410.0	16.7	1.0		15.2	1.1	7.5	1.6		23.0	13.0			0.5	573.8
2001	76.0	23.3	17.0	361.0	1.1	6.0		4.2	0.5	11.9	2.9		17.0	8.0			1.1	513.0
2002	42.0	49.3	14.0	461.0	3.0	3.3		10.6		10.2	1.7		14.0	10.0	0.0		0.0	605.1
2003	21.0	22.3	19.0	303.1	5.0	11.0		3.9		25.0	1.2		19.0	14.0			0.1	425.6
2004	20.0	8.8	24.4	412.8	6.8	18.2		57.0	4.7	24.0	1.2		24.4	5.0		2.4	0.5	585.9
2005	4.0	10.5	11.0	276.3	4.5	3.1		10.3	0.1	24.4	0.3		11.0	19.0		1.1	0.6	365.2
2006	3.0	25.6	27.4	194.2	0.4	3.7		6.4	0.0	11.4	0.8		27.4	21.0		0.7		294.6
2007	2.0	6.3	9.8	353.9		7.8	0.1	1.6	0.8	26.0	0.1		9.8				0.5	408.8
2008	1.0	31.6		221.0		7.0		0.9	0.3	13.0	0.2		12.0					287.0

Table 6. Estimated harvest levels of northwestern Atlantic porbeagle by flag. The column labeled SCRS/2009/05 represents the catch compilation used in the assessment presented in that document and the %Diff column represents the percentage difference between the estimates compiled at this meeting and SCRS/2009/095.

Year	Faroe Islands	Canada	EC.España	EC.Portugal	Japan	St.Pierre et Miquelon	Norway	U.S.A.	Non-reporting LL	NWToT	SCRS/09/95	% Diff
1961	100.0						1,824.0			1,924.0	1,924.0	0.0%
1962	800.0						2,216.0			3,016.0	3,016.0	0.0%
1963	800.0						5,763.0		0.5	6,563.5	6,563.0	0.0%
1964	1,214.0						8,060.0		29.9	9,303.9	9,281.0	0.2%
1965	1,078.0	28.0					4,045.0		28.4	5,179.4	5,151.0	0.5%
1966	741.0						1,373.0		57.1	2,171.1	2,114.0	2.6%
1967	589.0								36.1	625.1	625.0	0.0%
1968	662.0						269.0		20.8	951.8	1,068.0	-12.2%
1969	865.0								16.4	881.4	1,073.0	-21.7%
1970	205.0								24.3	229.3	879.0	-283.3%
1971	231.0								46.8	277.8	452.0	-62.7%
1972	260.0						87.0		110.6	457.6	347.0	24.2%
1973	269.0								46.1	315.1	269.0	14.6%
1974									92.5	92.5	0.0	100.0%
1975	80.0								88.3	168.3	80.0	52.5%
1976	307.0								63.8	370.8	307.0	17.2%
1977	295.0								174.4	469.4	295.0	37.2%
1978	121.0	1.0							184.2	306.2	122.0	60.2%
1979	299.0	2.0							134.4	435.4	301.0	30.9%
1980	425.0	1.0							171.3	597.3	426.0	28.7%
1981	344.0								154.0	498.0	347.0	30.3%
1982	259.0	1.0						0.1	167.5	427.6	261.0	39.0%
1983	256.0	9.0						0.0	77.6	342.6	265.0	22.6%
1984	126.0	20.0					96.0	0.2	103.5	345.7	164.0	52.6%
1985	210.0	26.0						0.3	119.6	355.9	236.0	33.7%

1986	270.0	24.0						0.2	121.1	415.3	300.0	27.8%
1987	381.0	59.0						1.5	187.4	628.9	468.0	25.6%
1988	373.0	83.0	7.6					0.4	126.5	590.5	500.0	15.3%
1989	477.0	73.0	1.5					2.5	89.5	643.4	566.0	12.0%
1990	550.0	78.0	0.4					2.0	65.4	695.8	664.0	4.6%
1991	1,189.0	329.0	0.4					4.8	57.6	1,580.9	1,566.9	0.9%
1992	1,149.0	813.0	0.0					3.6	43.4	2,008.9	1,991.0	0.9%
1993	165.0	919.0	0.5					51.1	49.5	1,185.1	1,432.0	-20.8%
1994	48.0	1,575.0	3.4					107.5	34.7	1,768.6	1,578.0	10.8%
1995	44.0	1,353.2	1.2			7.0		35.3	41.6	1,482.3	1,364.0	8.0%
1996	8.0	1,050.5	2.4		2.0	40.0		77.7	24.7	1,203.3	1,100.0	8.6%
1997	9.0	1,334.1	2.2		2.0	13.0		55.8	46.1	1,460.3	1,336.7	8.5%
1998	7.0	1,070.1	3.1			20.0		12.5	31.4	1,144.2	1,095.1	4.3%
1999	10.0	965.3	3.2					3.2	48.3	1,030.0	966.8	6.1%
2000		902.3	1.9			13.0		1.1	82.4	1,000.7	940.7	6.0%
2001		498.6	0.8			2.0		0.9	55.3	557.6	528.4	5.2%
2002		236.6	5.1			1.0		0.9	53.3	296.9	235.6	20.6%
2003		142.4	4.2			2.0		0.0	45.7	194.3	142.9	26.4%
2004		231.5	2.3			4.0		0.6	19.3	257.8	228.5	11.4%
2005		202.2	3.5	0.5				0.0	29.3	235.4	210.4	10.6%
2006		192.2	7.9	0.0				0.4	36.1	236.7	198.8	16.0%
2007		93.4	1.7					0.1	24.3	119.4	99.0	17.1%
2008		125.0	9.5					0.0	9.8	144.3	162.0	-12.3%

Table 7. BSP model definitions, and posterior expected values and CVs of the estimated parameters for northwest Atlantic.

(a) Run definitions

Run	a3	a4	a402	a401	a403	NW1	NW2
Current year	2005	2005	2005	2005	2005	2009	2009
Last year of data	2004	2004	2002	2000	1998	2008	2008
Weighting of CPUEs	Catch	Equal	Equal	Equal	Equal	Equal	Equal

(b) Runs ending in 2005

	Catch weighted		Equal weight, data to 2004		Equal weight, to 2002		Equal weight, to 2000		Equal weight, to 1998	
Run	a3		a4		a401		a402		a403	
Parameter	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV
K	69858	0.22	51149	0.17	47107	0.13	50985	0.20	58829	0.25
r	0.05	0.10	0.05	0.10	0.05	0.10	0.05	0.10	0.05	0.10
Binit	61252	0.24	44184	0.17	40463	0.10	44059	0.20	51092	0.26
MSY	844.96	0.23	615.82	0.18	567.15	0.15	614.08	0.21	709.55	0.26
repY	742.4	0.19	493	0.27	359	0.31	458.47	0.37	590.52	0.35
Bmsy	34929	0.22	25575	0.17	23554	0.13	25492	0.20	29414	0.25
Bcur	42205	0.42	16969	0.60	10154	0.56	16254	0.77	27209	0.68
Bcur/K	0.58	0.26	0.32	0.40	0.21	0.43	0.3	0.52	0.42	0.46
Bcur/Bmsy	1.16	0.26	0.64	0.40	0.42	0.43	0.6	0.52	0.85	0.46
Bcur/Binit	0.66	0.25	0.37	0.38	0.24	0.40	0.34	0.50	0.48	0.45
Ccur/MSY	0.27	0.24	0.36	0.15	0.39	0.13	0.37	0.17	0.33	0.23
Ccur/repY	0.31	0.25	0.47	0.27	0.67	0.30	0.55	0.42	0.45	0.66
Fcur/Fmsy	0.28	0.64	0.67	0.41	1.07	0.39	0.83	0.60	0.59	1.13

(c) Runs ending in 2009

	ICCAT catches		Catches est. from ratios	
Run	NW1		NW2	
Parameter	EV	CV	EV	CV
K	47650	0.13	50808	0.13
r	0.05	0.10	0.05	0.11
Binit	41198	0.11	43929	0.11
MSY	577.01	0.14	612.69	0.14
repY	476.41	0.20	504.64	0.21
Bmsy	23825	0.13	25404	0.13
Bcur	15608	0.40	16631	0.41
Bcur/K	0.32	0.30	0.32	0.31
Bcur/Bmsy	0.65	0.30	0.65	0.31
Bcur/Binit	0.37	0.27	0.37	0.28
Ccur/MSY	0.02	0.13	0.02	0.13
Ccur/repY	0.02	0.20	0.02	0.21
Fcur/Fmsy	0.03	0.31	0.03	0.32

Table 8. Decision table for the BSP model fitted to the six series in the Canadian 2005 assessment for northwest Atlantic porbeagle, with each data point weighted equally. Harvest policies are harvest rates (HR) as a fraction of total biomass.

Horizon	Policy	E(Bfin/K)	E(Bfin/Bmsy)	P(Bfin<0.2K)	P(Bfin>Bmsy)	P(Bfin>Bcur)	P(Ffin<Fcur)
10 -year	HR= 0	0.42	0.85	0.01	0.25	1	1
	HR= 0.02	0.35	0.71	0.05	0.12	0.94	0.27
	HR= 0.04	0.29	0.59	0.16	0.04	0.15	0
	HR= 0.07	0.22	0.44	0.46	0	0	0
20 -year	HR= 0	0.53	1.07	0	0.55	1	1
	HR= 0.02	0.39	0.77	0.01	0.15	0.94	0.27
	HR= 0.04	0.27	0.55	0.17	0	0.15	0
	HR= 0.07	0.16	0.32	0.8	0	0	0
50 -year	HR= 0	0.82	1.63	0	1	1	1
	HR= 0.02	0.47	0.94	0	0.37	0.94	0.27
	HR= 0.04	0.24	0.48	0.26	0	0.15	0
	HR= 0.07	0.07	0.14	1	0	0	0

Table 9. BSP model definitions, and posterior expected values and CVs of the estimated parameters for southwest Atlantic.

(a) Run definitions

Run	SW1	SW2	SW3	SW4	SW5
Weighting of CPUE data	Equal	CV	CV	CV	CV
Catch data	ICCAT	ICCAT	Effort (2005-2006)	Effort (1997-2008)	Ratio
First year of fishery	1982	1982	1961	1961	1957

(b) Results

	ICCAT catch, equal wt		ICCAT catch, CV wt		Effort 2005-2006		Effort (1997-2007)		Catch from ratios	
Run	SW1		SW2		SW3		SW4		SW5	
Parameter	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV
K	952.59	5.87	1296.08	5.48	24777.77	8.70	11807.19	4.96	70699.21	7.77
r	0.05	0.21	0.05	0.21	0.05	0.20	0.05	0.21	0.05	0.21
Binit	940.16	5.91	1241.01	5.52	22895.47	8.78	10919.91	5	65230.25	7.83
Cat0	0.94	1.15	1.00	1.19	NA	NA	NA	NA	NA	NA
MSY	11.36	6.02	15.45	5.62	294.51	9.00	141.21	5.09	846.87	7.99
repY	3.05	2.11	2.70	4.07	39.90	4.42	10.91	4.55	79.62	4.85
Bmsy	476.29	5.87	648.04	5.48	12388.88	8.70	5903.6	4.96	35349.61	7.77
Bcur	787.52	7.07	1112.50	6.30	21446.80	9.96	11227.68	5.17	63028.19	8.65
Bcur/K	0.39	0.51	0.27	0.89	0.28	0.73	0.36	0.79	0.18	1.12
Bcur/Bmsy	0.78	0.51	0.53	0.89	0.57	0.73	0.72	0.79	0.36	1.12
Bcur/Binit	0.40	0.50	0.28	0.89	0.31	0.73	0.4	0.8	0.2	1.12
Ccur/MSY	1.09	0.39	1.27	0.39	0.11	0.87	0.4	0.49	1.64	0.27
Ccur/repY	1.42	3.35	2.86	1.71	0.20	1.99	0.74	4.01	4.48	5.09
Fcur/Fmsy	2.07	0.88	6.31	1.45	0.31	1.48	1.17	1	10.78	1.09

Table 10. BSP model run definitions and results for the northeast Atlantic.

(a) Run definitions

Run	NE1	NE101	NE2	NE6	NE7	NE3	NE4	NE5
Start year	1926	1926	1926	1926	1926	1961	1961	1961
Mean of Bo/K	1	1	1	1	1	1	0.5	0.2
Weighting of CPUE data points	equal	equal	catch	catch	catch	catch	catch	catch
Max K	100000	10000000	100000	80000	100000	100000	100000	100000
r rprior	0.062	0.062	0.062	0.062	0.04	0.062	0.062	0.062

(b) Results for runs starting in 1926

	From 1926		From 1926, High K		From 1926 C weighted		From 1926, low K max		From 1926, lower r prior	
Run	NE1		NE101		NE2		NE6		NE7	
Parameter	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV
K	65543	0.2	1.10E+08	1.87	65091	0.2	60176	0.12	73723	0.13
r	0.06	0.17	0.06	0.16	0.06	0.17	0.06	0.16	0.04	0.16
Binit	60072	0.22	9.99E+07	1.88	59574	0.22	54826	0.14	67196	0.14
MSY	976.26	0.27	1705671	1.9	969.66	0.27	878.72	0.16	708.42	0.16
repY	610.83	0.31	5798.09	3.59	585.32	0.36	549.84	0.38	486.88	0.42
Bmsy	32771	0.2	5.49E+07	1.87	32546	0.2	30088	0.12	36861	0.13
Bcur	28719	0.9	1.10E+08	1.87	27419	0.94	17789	0.88	21055	0.74
Bcur/K	0.39	0.71	0.96	0.14	0.37	0.76	0.28	0.76	0.27	0.63
Bcur/Bmsy	0.78	0.71	1.93	0.14	0.75	0.76	0.56	0.76	0.54	0.63
Bcur/Binit	0.43	0.72	1.08	0.2	0.41	0.77	0.31	0.75	0.3	0.61
Ccur/MSY	0.31	0.21	0.03	2.45	0.31	0.2	0.33	0.14	0.41	0.14
Ccur/repY	0.53	0.39	0.27	24.7	0.58	0.49	0.62	0.47	0.72	0.51
Fcur/Fmsy	0.72	0.74	0.04	4.76	0.83	0.83	0.97	0.69	1.15	0.69

(c) Results for runs starting in 1961

	From 1961, depl 1.0		From 1961, depl. 0.5		From 1961, depl. 0.2	
Run	NE3		NE4		NE5	
Parameter	EV	CV	EV	CV	EV	CV
K	38925.53	0.43	42305.11	0.28	67779.65	0.16
r	0.06	0.16	0.06	0.16	0.06	0.16
Binit	34453.98	0.47	21021.83	0.34	14917.78	0.14
MSY	592.07	0.45	629.92	0.27	990.48	0.11
repY	456.92	0.23	484.7	0.34	470.46	0.41
Bmsy	19462.77	0.43	21152.55	0.28	33889.82	0.16
Bcur	23341.01	0.82	15445.05	0.85	9942.12	0.55
Bcur/K	0.53	0.39	0.34	0.52	0.15	0.49
Bcur/Bmsy	1.05	0.39	0.67	0.52	0.29	0.49
Bcur/Binit	0.6	0.38	0.67	0.46	0.65	0.45
Ccur/MSY	0.55	0.3	0.48	0.19	0.29	0.12
Ccur/repY	0.67	0.31	0.67	0.4	0.72	0.43
Fcur/Fmsy	0.7	0.73	0.96	0.62	1.26	0.52

Table 11. Model inputs for the catch-free, age-structured production model (CFASPM) applied to the southwestern Atlantic porbeagle shark stock.

Stock	Indices	Weighting	Model time	Historic catch period	Initial depletion in hist. per.	VB growth function, Females: K	Linf (FL)	t0	Length-weight relationship: Wa	Wb	Fecundity (pups/litter)	Reproductive frequency	Maturity ogive: a50	b	Selectivity function: a50	b	Maximum age (plus group)	alpha	M (1-max)
Southwest	Uruguay LL	no	1961-2008	1961-1981	0	0.061	275.2	-5.9	$5x10^{-4}$	2.713	3.9	annual	13	1.042	0.958	0.150	20	LN(2.209,0.2)[1]	LN(0.15,0.2)[1]

[1] Lognormal distribution (mean, CV)

Table 12. Stock status estimates for the southwestern Atlantic porbeagle shark obtained with the CFASPM (values in parentheses are CVs). F_{modern} refers to the fishing mortality in the first year for which data are available (1982); F_{hist} refers to the fishing mortality in the first year of the model run (1926).

Model	Starting year	Objective Function	SSB_{curr}/SSB_0	SSB_{curr}/SSB_{MSY}	F_{curr}	F_{curr}/F_{MSY}	F_{modern}	F_{hist}	F_{MSY}	SPR_{MSY}	M	alpha
SWA Stock; virgin conditions in 1982, scaling indices	1961	-17.17	0.18 (0.55)	**0.48 (0.55)**	0.056 (0.50)	**1.72 (0.51)**	0.059	0.050	0.03 (0.08)	0.58	0.203 (0.19)	2.95 (0.13)

Table 13. Model inputs for the age-structured production model (SPASM) applied to the northeastern Atlantic porbeagle shark stock.

Stock	Indices	Weighting	Model time	Historic catch period	Initial depletion in hist. per.	VB growth function, Females: K	Linf (FL)	t0	Length-weight relationship: Wa	Wb	Fecundity (pups/litter)	Reproductive frequency	Maturity ogive: a50	b	Selectivity function: a50	b	Maximum age (plus group)	alpha	M (1-max)
Northeast	France LL Spain LL	no	1926-2008	1926-1971	0	0.045	276.6	-8.0	$5x10^{-4}$	2.706	3.9	annual	13	1.042	0.940	0.160	20	LN(0.75,0.25)[1]	$U(10^3-10^{10})$[2]

[1] Lognormal distribution (mean, CV)
[2] Uniform distribution (min,max)

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Table 14. Stock status estimates for the northeastern Atlantic porbeagle shark obtained with the ASPM.

	Initial run		50% of F		0% of F	
Benchmark	Estimate	CV	Estimate	CV	Estimate	CV
SSF_{2008}/SSF_{MSY}	0.09	0.86	0.21	0.86	0.43	0.86
F_{2008}/F_{MSY}	3.45	1.89	2.54	1.89	3.32	1.89
N_{2008}/N_{MSY}	0.11		0.24		0.46	
MSY	45,633		34,852		14,907	
SPR_{MSY}	0.65		0.71		0.73	
F_{MSY}	0.03		0.02		0.02	
SSF_{MSY}	202,150		167,220		73,912	
N_{MSY}	1,031,734		791,602		339,205	
F_{2008}	0.09		0.05		0.06	
SSF_{2008}	18,523	0.86	35,685	0.86	32,114	0.86
N_{2008}	127,367		204,180		168,624	
SSF_{2008}/SSF_0	0.04	0.86	0.09	0.86	0.18	0.86
B_{2008}/B_0	0.05	0.86	0.11	0.86	0.21	0.86
R_0	210,370	0.24	170,130	0.24	73,811	0.24
Pup-survival	0.99	0.0001	0.82	0.0001	0.77	0.0001
alpha	2.37		1.97		1.84	
steepness	0.37		0.33		0.32	

Table 15. Decision tables for northeast Atlantic porbeagle BSP models, showing (a) the expected biomass relative to Bmsy in 10, 20 or 50 years, (b) the probability that biomass is above Bmsy, (c) the Probability that biomass is above current biomass for a number of constant F and constant total catch management strategies, and (d) the number of years until the median biomass trajectory rebuilds to B_{MSY}.

(a) E(B/Bmsy)

Horizon	Policy	Model run					
		NE1	NE2	NE6	NE7	NE4	Mean
10 -year	TAC= 0	0.97	0.93	0.76	0.68	0.92	0.85
	TAC= 100	0.94	0.90	0.72	0.65	0.86	0.81
	TAC= 200	0.91	0.86	0.68	0.62	0.81	0.78
	TAC= 300	0.87	0.83	0.64	0.59	0.76	0.74
	TAC= 400	0.84	0.79	0.61	0.56	0.70	0.70
	TAC= 436	0.83	0.78	0.59	0.55	0.68	0.69
	TAC= 500	0.80	0.76	0.57	0.53	0.65	0.66
	HRmsy* 0.25	0.91	0.88	0.71	0.64	0.87	0.80
	HRmsy* 0.5	0.85	0.82	0.67	0.61	0.82	0.75
	HRmsy* 0.75	0.79	0.77	0.63	0.58	0.77	0.71
	HRmsy* 1	0.73	0.73	0.59	0.55	0.73	0.67
20 -year	TAC= 0	1.18	1.14	0.98	0.83	1.18	1.06
	TAC= 100	1.11	1.06	0.91	0.76	1.07	0.98
	TAC= 200	1.04	0.99	0.82	0.70	0.96	0.90
	TAC= 300	0.97	0.92	0.74	0.64	0.85	0.82
	TAC= 400	0.90	0.84	0.66	0.57	0.73	0.74

	TAC= 436	0.87	0.82	0.63	0.55	0.69	0.71
	TAC= 500	0.83	0.77	0.58	0.51	0.62	0.66
	HRmsy* 0.25	1.05	1.02	0.88	0.76	1.07	0.96
	HRmsy* 0.5	0.93	0.92	0.79	0.69	0.97	0.86
	HRmsy* 0.75	0.82	0.83	0.71	0.63	0.87	0.77
	HRmsy* 1	0.72	0.74	0.63	0.57	0.79	0.69
50 -year	TAC= 0	1.72	1.68	1.62	1.31	1.75	1.62
	TAC= 100	1.60	1.55	1.47	1.15	1.59	1.47
	TAC= 200	1.46	1.39	1.28	0.98	1.38	1.30
	TAC= 300	1.28	1.20	1.07	0.80	1.11	1.09
	TAC= 400	1.09	1.01	0.84	0.64	0.83	0.88
	TAC= 436	1.02	0.95	0.77	0.59	0.74	0.81
	TAC= 500	0.91	0.85	0.66	0.51	0.59	0.70
	HRmsy* 0.25	1.44	1.44	1.37	1.11	1.53	1.38
	HRmsy* 0.5	1.18	1.21	1.15	0.93	1.31	1.16
	HRmsy* 0.75	0.96	1.01	0.94	0.77	1.11	0.96
	HRmsy* 1	0.76	0.83	0.77	0.64	0.93	0.79

(b) P (B>Bmsy)

Horizon	Policy	NE1	NE2	NE6	NE7	NE4	Mean
10 -year	TAC= 0	0.37	0.36	0.23	0.20	0.36	0.30
	TAC= 100	0.36	0.35	0.22	0.19	0.32	0.29
	TAC= 200	0.35	0.34	0.21	0.18	0.27	0.27
	TAC= 300	0.35	0.33	0.20	0.17	0.24	0.26
	TAC= 400	0.34	0.33	0.19	0.16	0.21	0.25
	TAC= 436	0.34	0.33	0.19	0.16	0.20	0.24
	TAC= 500	0.33	0.32	0.18	0.15	0.19	0.23
	HRmsy* 0.25	0.35	0.34	0.21	0.18	0.31	0.28
	HRmsy* 0.5	0.33	0.33	0.19	0.16	0.26	0.25
	HRmsy* 0.75	0.31	0.31	0.17	0.14	0.22	0.23
	HRmsy* 1	0.30	0.30	0.16	0.12	0.18	0.21
20 -year	TAC= 0	0.53	0.50	0.39	0.30	0.67	0.48
	TAC= 100	0.48	0.46	0.33	0.26	0.54	0.41
	TAC= 200	0.44	0.42	0.30	0.24	0.44	0.37
	TAC= 300	0.40	0.39	0.27	0.22	0.35	0.33
	TAC= 400	0.38	0.36	0.23	0.19	0.27	0.29
	TAC= 436	0.37	0.36	0.23	0.19	0.25	0.28
	TAC= 500	0.36	0.34	0.21	0.17	0.22	0.26
	HRmsy* 0.25	0.44	0.44	0.31	0.24	0.55	0.40
	HRmsy* 0.5	0.38	0.37	0.25	0.20	0.44	0.33
	HRmsy* 0.75	0.33	0.33	0.20	0.16	0.32	0.27
	HRmsy* 1	0.28	0.29	0.15	0.11	0.22	0.21
50 -year	TAC= 0	0.99	0.98	0.98	0.78	1.00	0.95
	TAC= 100	0.96	0.92	0.89	0.62	0.97	0.87

	TAC= 200	0.87	0.80	0.77	0.48	0.85	0.75
	TAC= 300	0.72	0.66	0.58	0.37	0.65	0.60
	TAC= 400	0.58	0.54	0.44	0.30	0.46	0.46
	TAC= 436	0.54	0.50	0.40	0.27	0.39	0.42
	TAC= 500	0.47	0.45	0.33	0.23	0.30	0.36
	HRmsy* 0.25	0.95	0.92	0.89	0.60	0.98	0.87
	HRmsy* 0.5	0.74	0.75	0.71	0.40	0.92	0.70
	HRmsy* 0.75	0.44	0.52	0.42	0.23	0.71	0.46
	HRmsy* 1	0.19	0.30	0.18	0.09	0.40	0.23

(c) P (B>Bcur)

		P (B>Bcur)					
Horizon	Policy						
		NE1	NE2	NE6	NE7	NE4	Mean
10 -year	TAC= 0	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 100	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 200	1.00	0.99	0.98	0.95	0.98	0.98
	TAC= 300	0.96	0.91	0.89	0.80	0.88	0.89
	TAC= 400	0.84	0.77	0.73	0.59	0.67	0.72
	TAC= 436	0.78	0.71	0.66	0.52	0.58	0.65
	TAC= 500	0.68	0.62	0.53	0.42	0.44	0.54
	HRmsy* 0.25	0.97	0.99	1.00	1.00	1.00	0.99
	HRmsy* 0.5	0.76	0.80	0.95	1.00	0.97	0.90
	HRmsy* 0.75	0.70	0.73	0.88	0.91	0.93	0.83
	HRmsy* 1	0.62	0.68	0.82	0.79	0.86	0.75
20 -year	TAC= 0	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 100	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 200	1.00	0.99	0.98	0.95	0.98	0.98
	TAC= 300	0.96	0.91	0.89	0.80	0.88	0.89
	TAC= 400	0.84	0.77	0.73	0.59	0.67	0.72
	TAC= 436	0.78	0.71	0.66	0.52	0.58	0.65
	TAC= 500	0.68	0.62	0.53	0.42	0.44	0.54
	HRmsy* 0.25	0.97	0.99	1.00	1.00	1.00	0.99
	HRmsy* 0.5	0.76	0.80	0.95	1.00	0.97	0.90
	HRmsy* 0.75	0.70	0.73	0.88	0.91	0.93	0.83
	HRmsy* 1	0.62	0.68	0.82	0.79	0.86	0.75
50 -year	TAC= 0	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 100	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 200	1.00	0.99	0.98	0.95	0.98	0.98
	TAC= 300	0.96	0.91	0.89	0.80	0.88	0.89
	TAC= 400	0.84	0.77	0.73	0.59	0.67	0.72
	TAC= 436	0.78	0.71	0.66	0.52	0.58	0.65
	TAC= 500	0.68	0.62	0.53	0.42	0.44	0.54
	HRmsy* 0.25	0.97	0.99	1.00	1.00	1.00	0.99
	HRmsy* 0.5	0.76	0.80	0.95	1.00	0.97	0.90

HRmsy* 0.75	0.70	0.73	0.88	0.91	0.93	0.83
HRmsy* 1	0.62	0.68	0.82	0.79	0.86	0.75

(d) Median number of years to rebuild.

	NE1	NE2	NE6	NE7	NE4
TAC= 0	2028	2030	2034	2043	2024
TAC= 100	2031	2033	2038	2050	2028
TAC= 200	2035	2037	2044	>2059	2034
TAC= 300	2040	2043	2052	>2059	2044
TAC= 400	2049	2053	>2059	>2059	>2059
TAC= 436	2053	2059	>2059	>2059	>2059
TAC= 500	>2059	>2059	>2059	>2059	>2059
HRmsy* 0.25	2033	2034	2039	2053	2028
HRmsy* 0.5	2043	2042	2048	>2059	2033
HRmsy* 0.75	>2059	2058	>2059	>2059	2043
HRmsy* 1	>2059	>2059	>2059	>2059	>2059

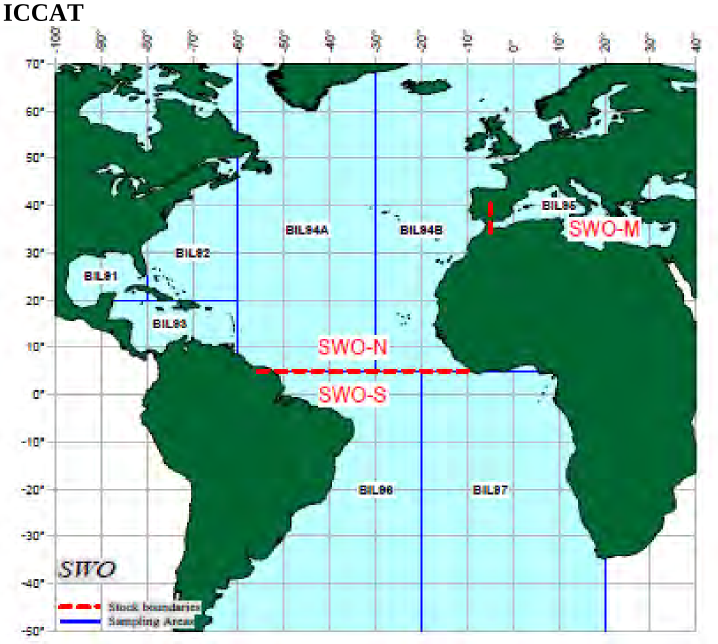
Table 16. Average probabilities across the 5 most credible BSP model runs for the northeast Atlantic porbeagle population.

Total catch	*Probability of some increase within 10 years*	*Probability of stock rebuilding to BMSY within:* 20 years	50 years
0	1.00	0.478	0.946
100	1.00	0.414	0.872
200	0.98	0.368	0.754
300	0.89	0.326	0.596
400	0.72	0.286	0.464

Table 17 Fishing mortality, yield, biomass and SSB relative to that achieved at the effort level corresponding to the $F_{0.1}$ level for a flat-topped selection pattern with maximum selection at age 3.

Selection Pattern	*Age Max Selection*	*Maximum Landing Length*	*F*	*Yield*	*Biomass*	*SSB*
Domed	5	No	211%	68%	202%	120%
Flat	13	No	211%	79%	280%	176%
Domed	13	No	279%	68%	295%	178%
Flat	5	Yes	150%	84%	134%	105%
Domed	5	Yes	217%	67%	206%	120%
Flat	13	Yes	698%	35%	377%	191%
Domed	13	Yes	698%	35%	377%	191%

ICCAT



NAFO (left) and ICES (right) boundaries

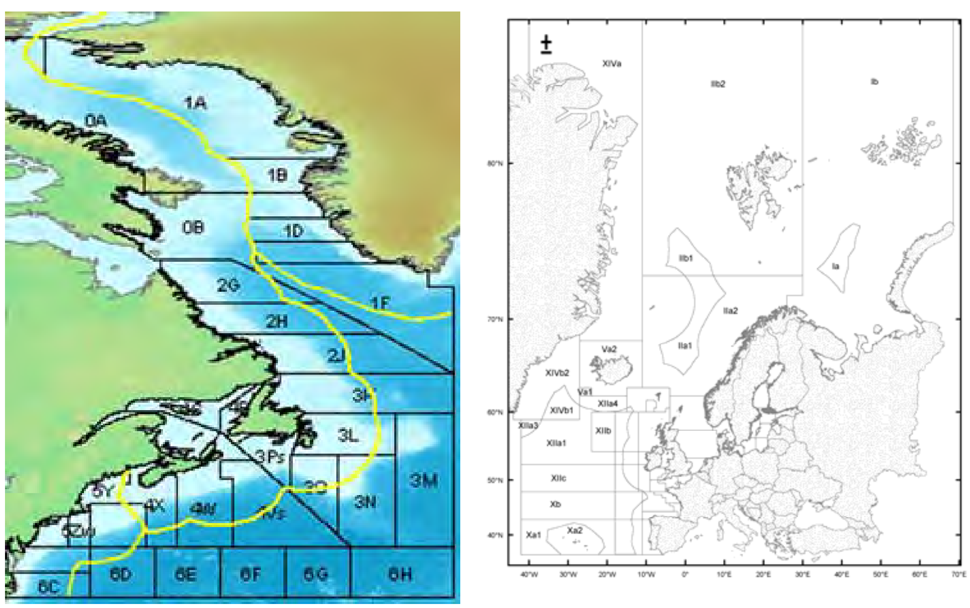


Figure 1. Maps of the North Atlantic terms of ICCAT, NAFO and ICES boundaries.

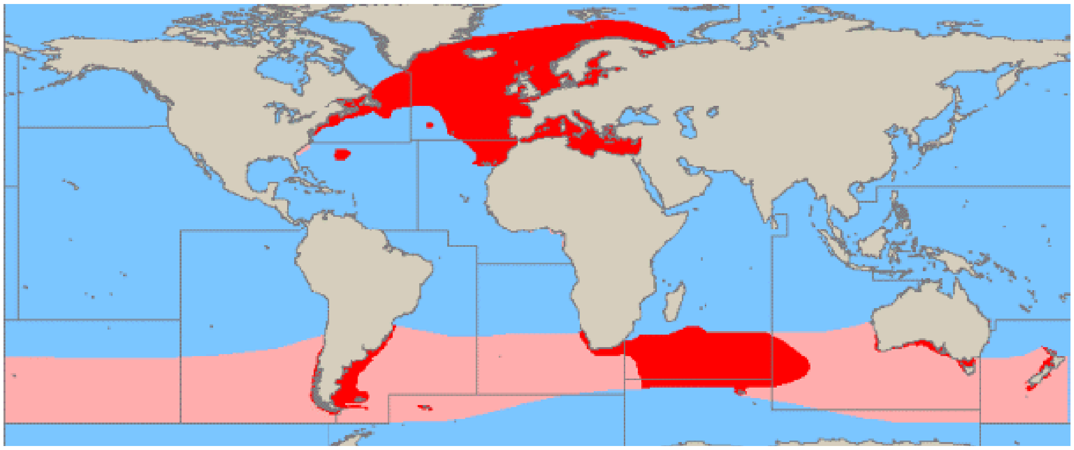


Figure 2. Distribution of the porbeagle stock in the East Atlantic, south of 25°S and East of 20°W.

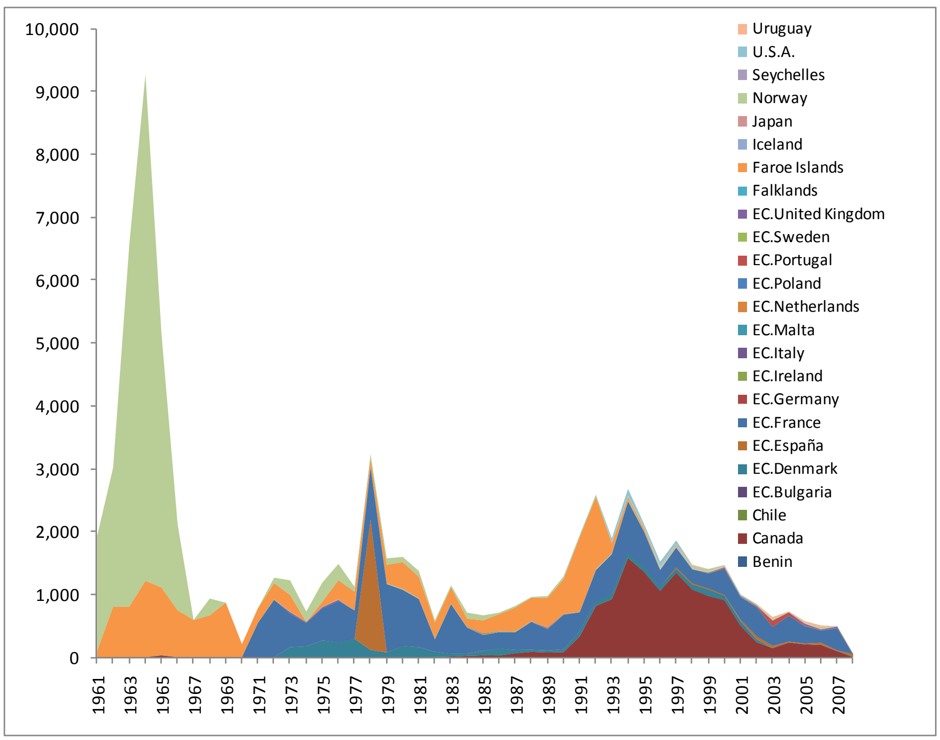


Figure 3 Reported and estimated catches of Atlantic porbeagle held in Task I (as of June 12, 2009).

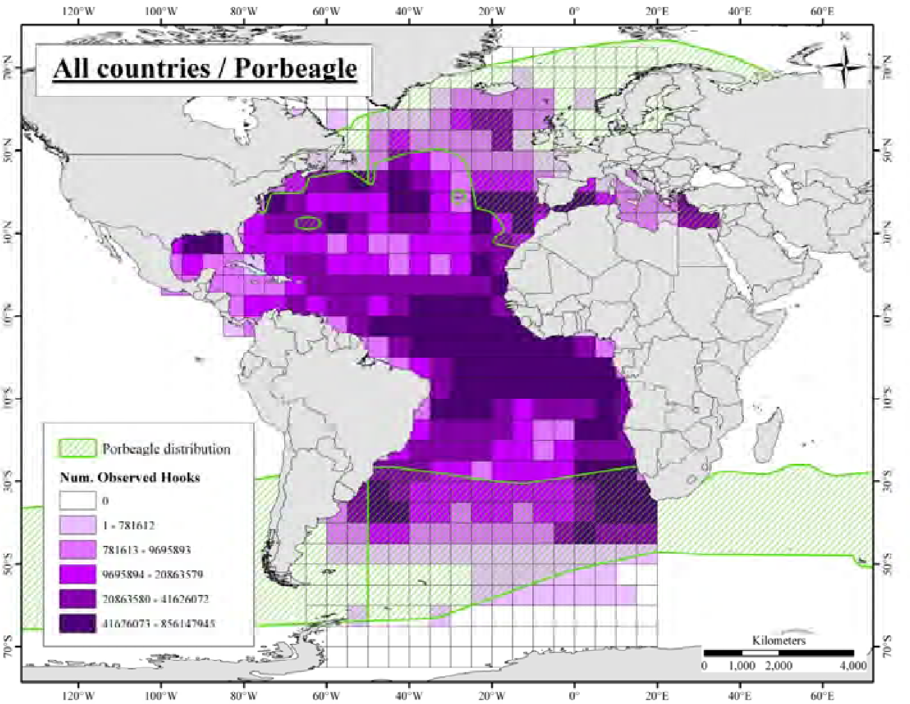


Figure 4. Density distribution of hooks fished by longline fisheries for Atlantic tuna and tuna-like species from 1950-2007 overlapped with the distribution of porbeagle in the Atlantic**.**

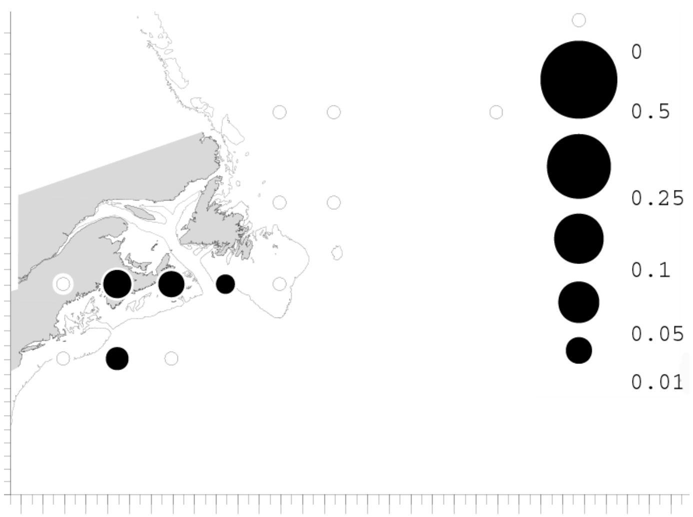


Figure 5. Porbeagle:swordfish/tuna catches as observed in the Japanese pelagic longline fishery.

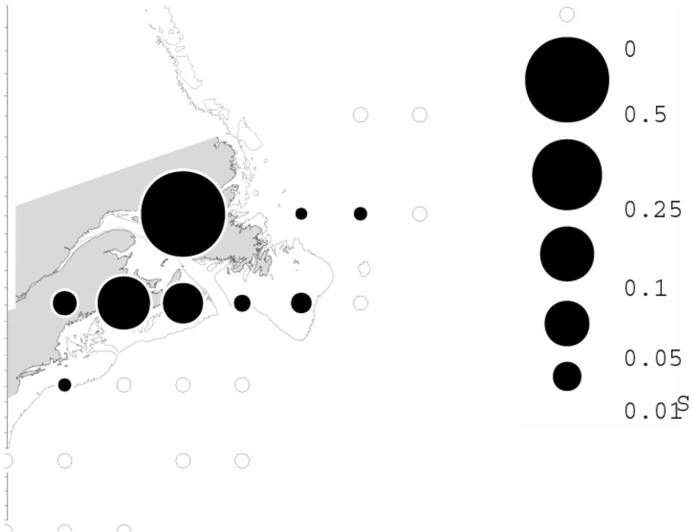


Figure 6. Porbeagle: swordfish/tuna catch ratios as observed in the Canadian pelagic longline fishery.

Figure 7. Porbeagle: swordfish/tuna catch ratios as observed in the U.S. swordfish fishery.

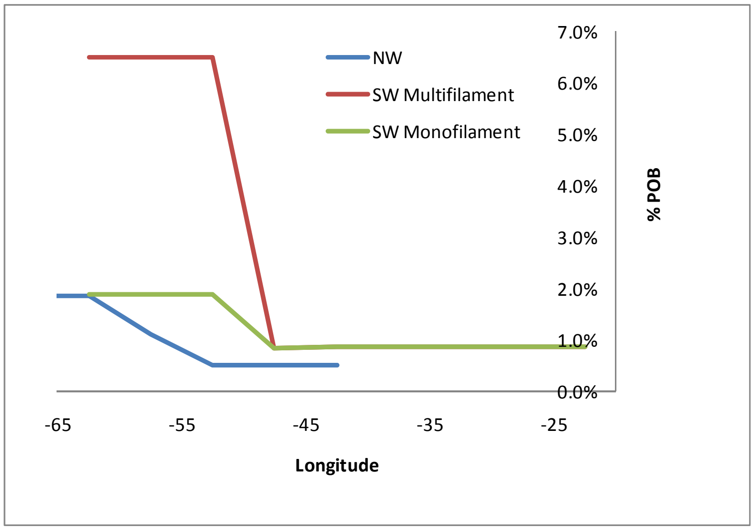


Figure 8. Percentage of porbeagle observed in catch of tunas and swordfish as a function of longitude, hemisphere and gear-type (multifilament and monofilament mainline) used in estimating potential porbeagle catch for non-reporting longline fleets fishing in the stock areas.

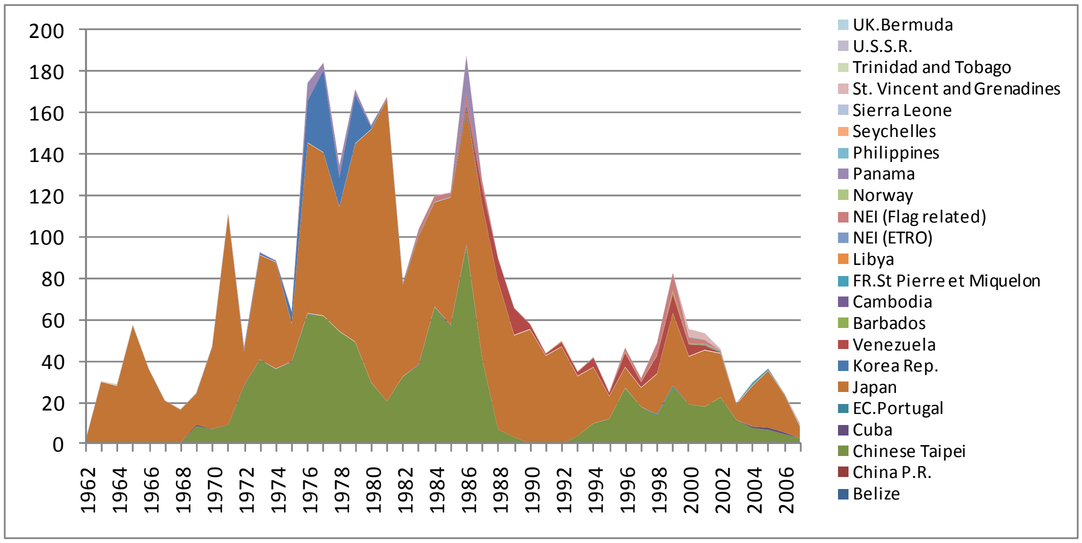


Figure 9. Estimated potential catch of porbeagle by non-reporting longline fleets using catch ratios for the NW stock. Limited observations across the time-series result in an unquantified uncertainty in the estimates.

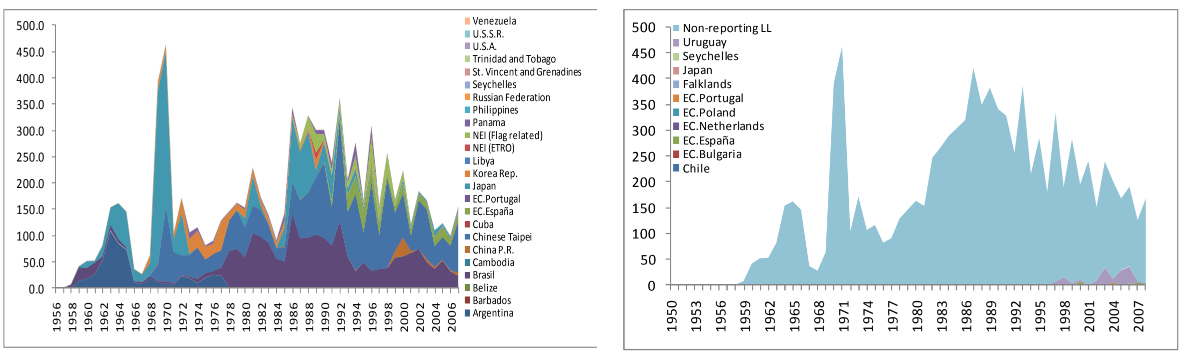


Figure 10. Left plate: Estimated potential catch of porbeagle by non-reporting longline fleets using catch ratios for the SW stock. Very limited observations across the time-series result in a high but unquantified uncertainty in the estimates. Right plate: Comparison of estimates for non-reporting longline fleets with reported catch levels held in the Task I data set for the SW stock area.

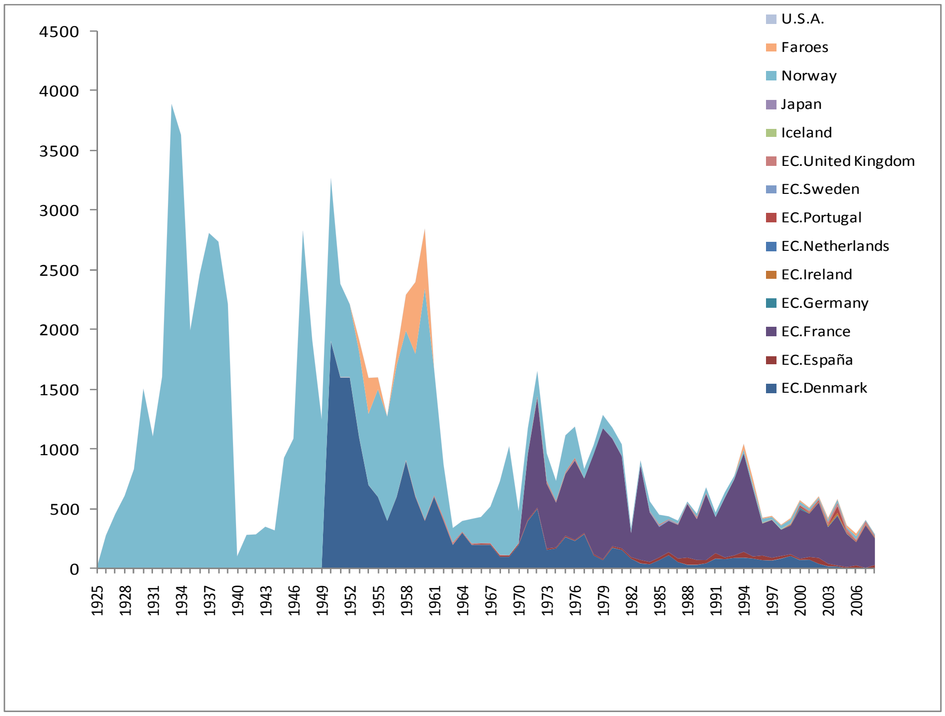


Figure 11. Catch by flag of porbeagle sharks from the northeastern Atlantic used in the assessment. While these catches are considered the best available,, they are believed to underestimate the pelagic longline catches for this species.

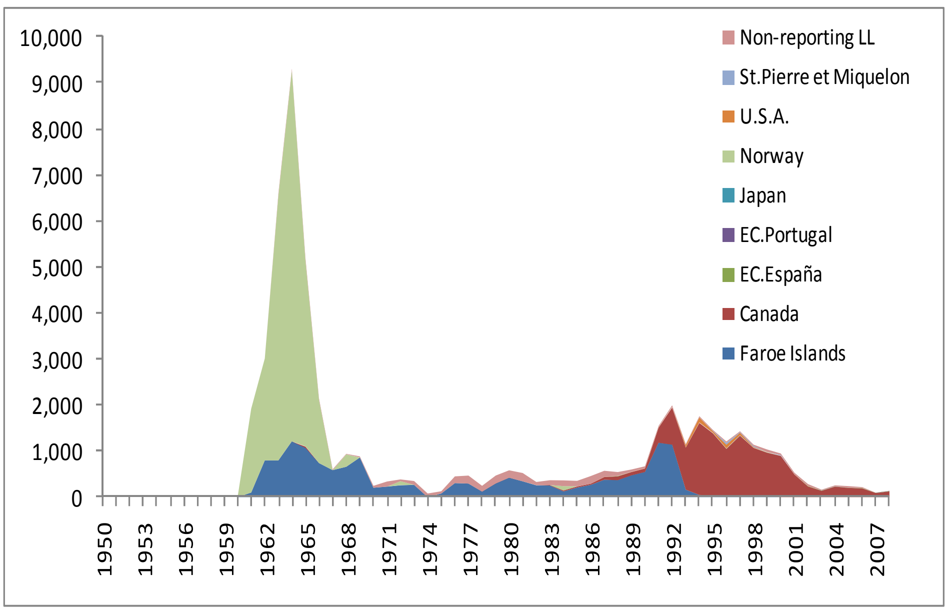


Figure 12. Catch by flag of porbeagle sharks from the northwestern Atlantic available for the assessment, including estimated catch by non-reporting longline fleets which, in this case represents a small proportion of the overall total.

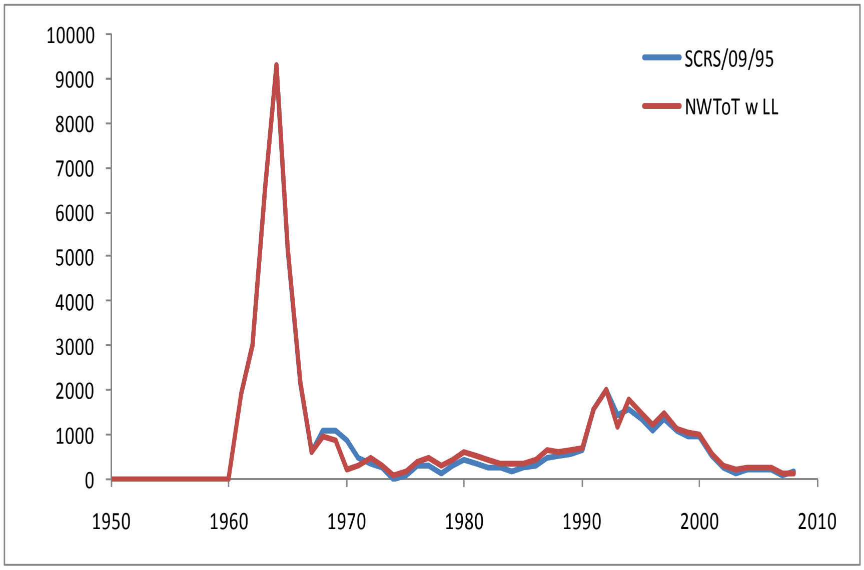


Figure 13. Comparison of northwestern Atlantic catch compilations made at this meeting, including estimates of catch by non-reporting longline fletes, with those reported in SCRS/2009/095. There are relatively small differences in these catch compilations which warrant further investigation.

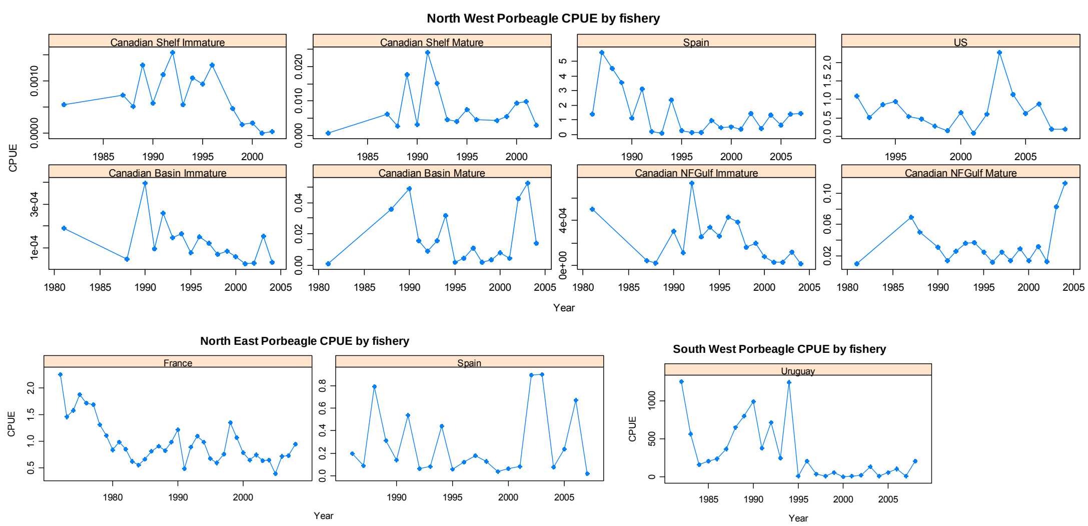


Figure 14. CPUE series for the porbeagle NW stock (upper figures), NE stock (lower left figures) and SW stock (lower right figure).

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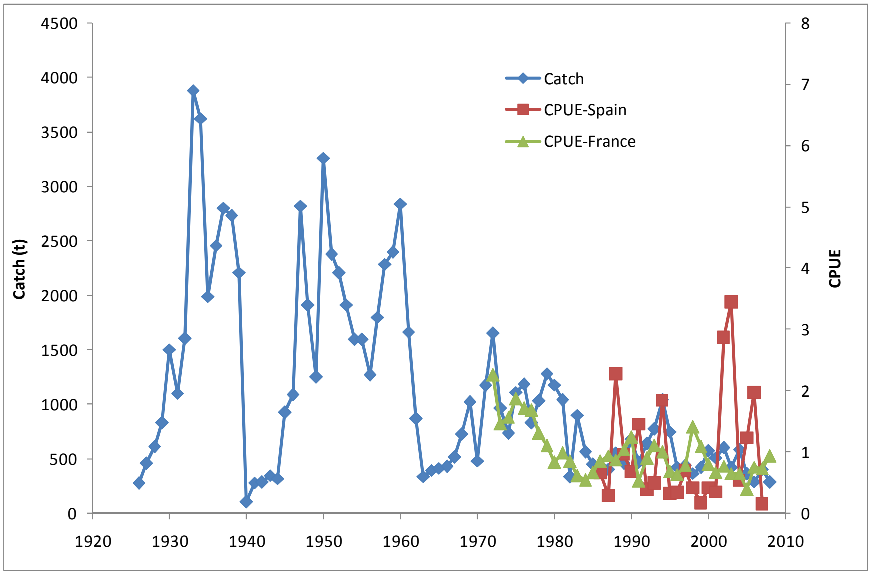

Figure 15. Catch and CPUE data for northeast Atlantic porbeagle**.**

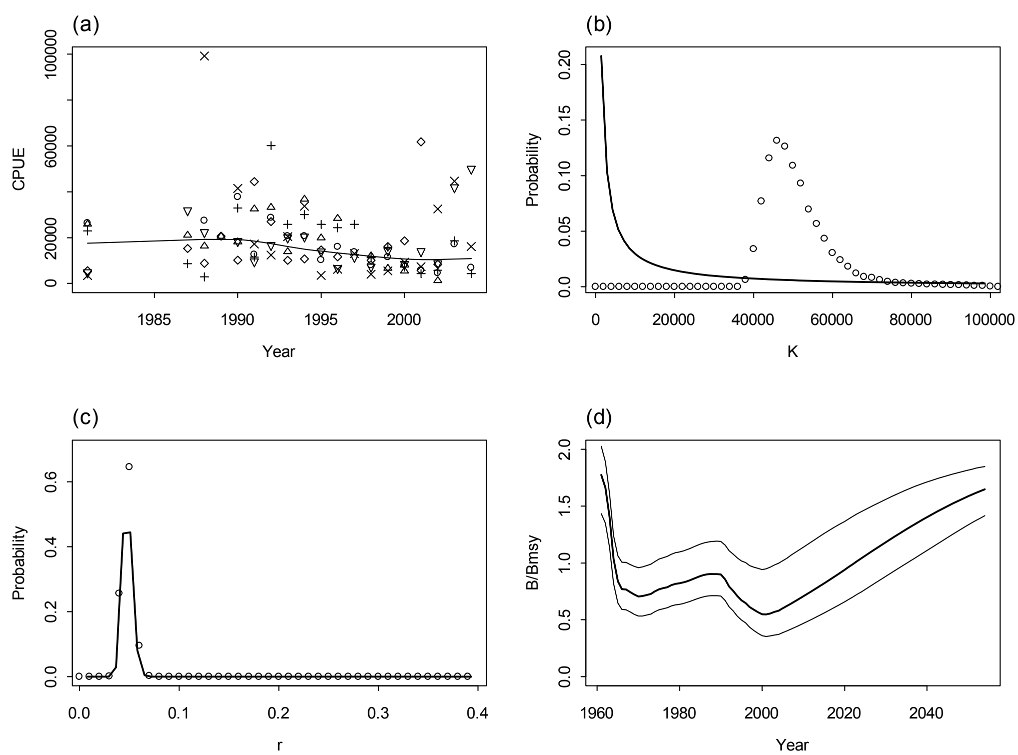

Figure 16. For northwest Atlantic porbeagle BSP model run fitted to the six Canadian series weighted equally, (a) fitted biomass trend (line) and CPUE series (points), (b) prior (line) and posterior (points) distributions of r, (c) prior and posterior distributions of K, and (d) the median and 80% credibility interval for biomass relative to B_{MSY} with no fishing after 2004.

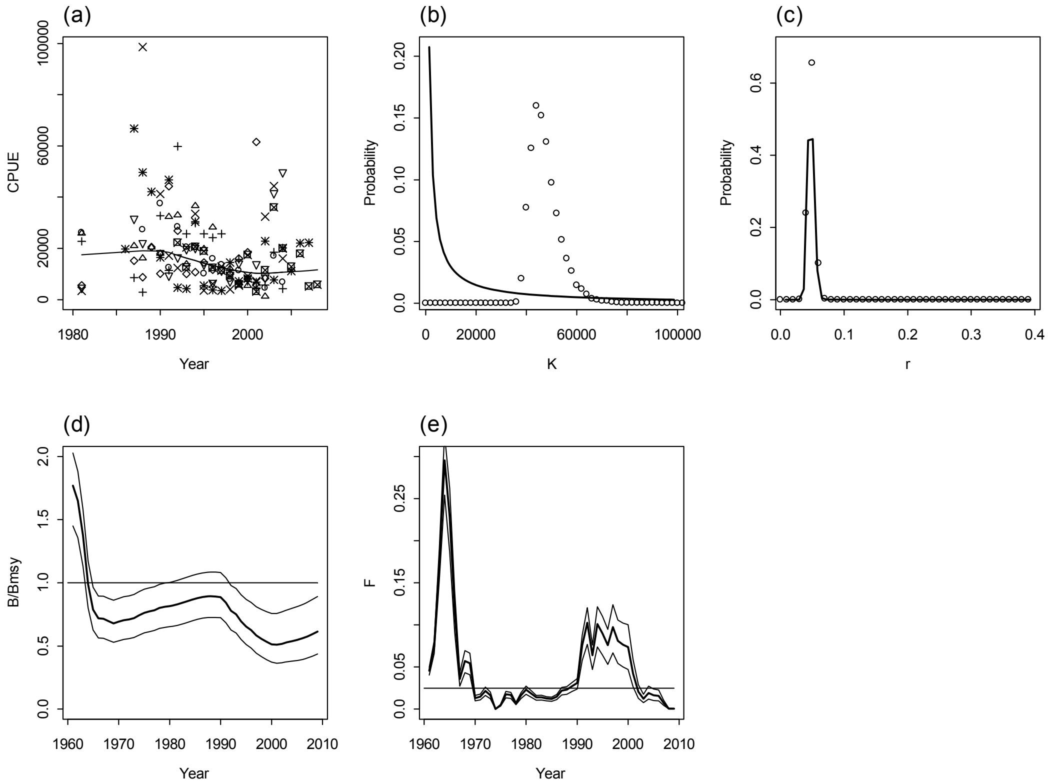

Figure 17. For the BSP model ending in 2009 with equal weighting, and the Canadian, U.S. and Spanish CPUE series, (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of K, (c) prior and posterior of r, and median and 80% credibility interval of (d) biomass relative to B_{MSY} and (e) F.

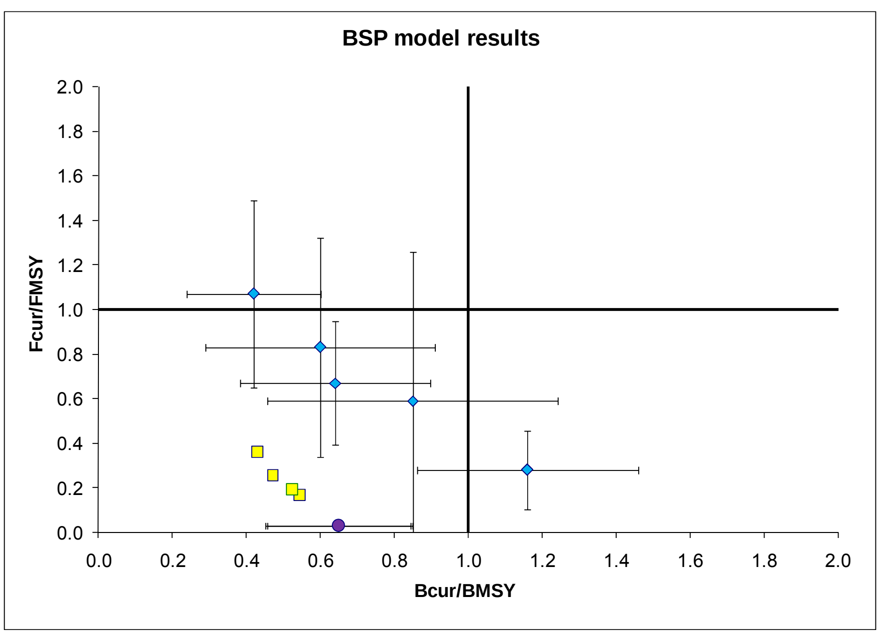

Figure 18. Phase plot showing the expected value of B/B_{MSY} and F/F_{MSY} in the current year, which is either 2005 (diamonds) or 2009 (circles), for the runs described in Table BSP NW 1, as well as approximate values from SCRS/2009/095 (squares). B/B_{MSY} was approximated from SCRS/2009/095 as N2009/N1961 times 2. Error bars are plus and minus one standard deviation.

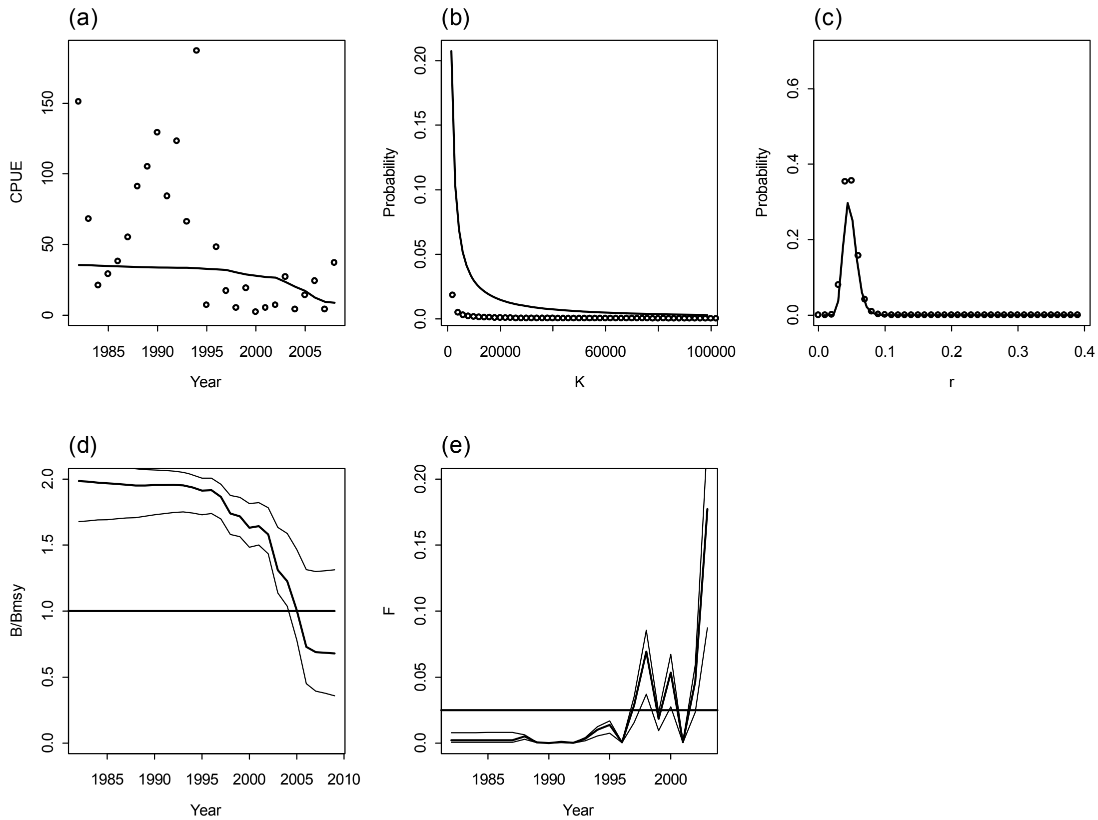

Figure 19. BSP results for Southwest Atlantic porbeagle, with the Uruguay CPUE series and equal weighting of data points and ICCAT Task 1 catches (run SW1), (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of *K*, (c) prior and posterior of *r*, and median and 80% credibility interval of (d) biomass relative to B_{MSY} and (e) F.

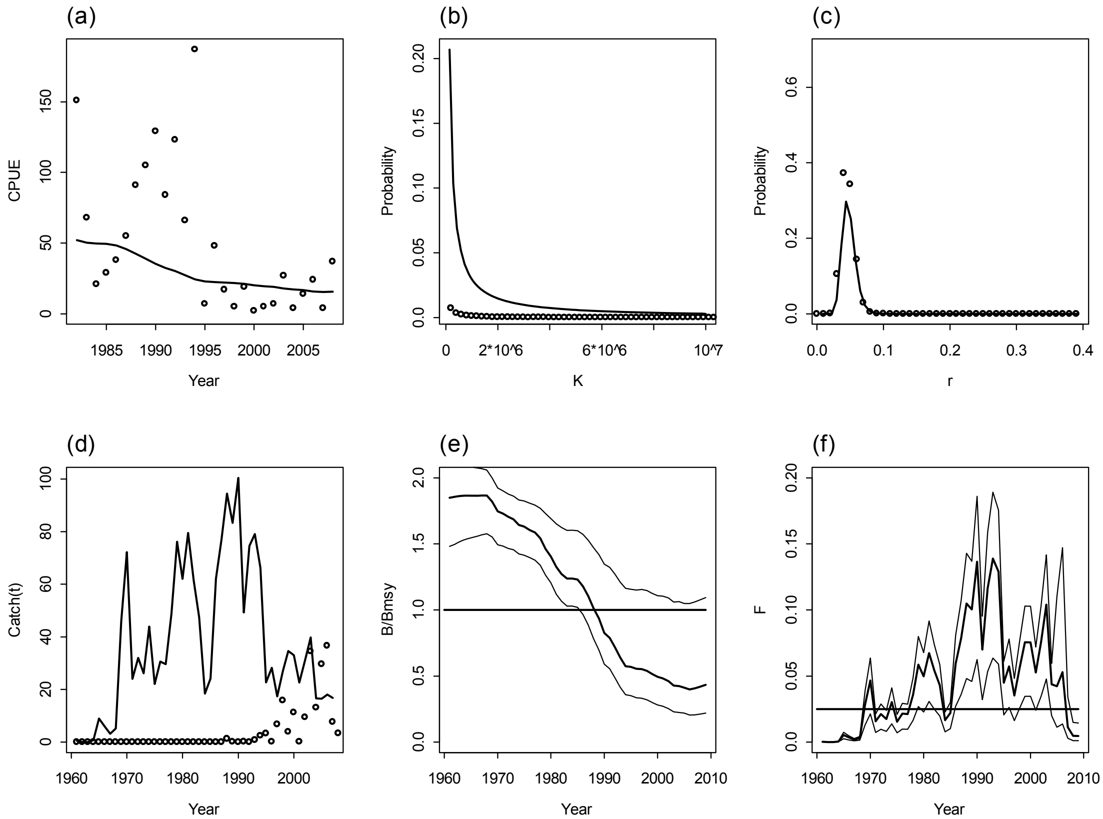

Figure 20. BSP model for the southwest Atlantic assuming that catches are proportional to effort (run SW3), with the constant of proportionality calculated with data from 2005-2006, (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of *K*, (c) prior and posterior of *r*, (d) estimated (line) and reported (points) catches, and median and 80% credibility interval of (e) biomass relative to B_{MSY} and (f) F.

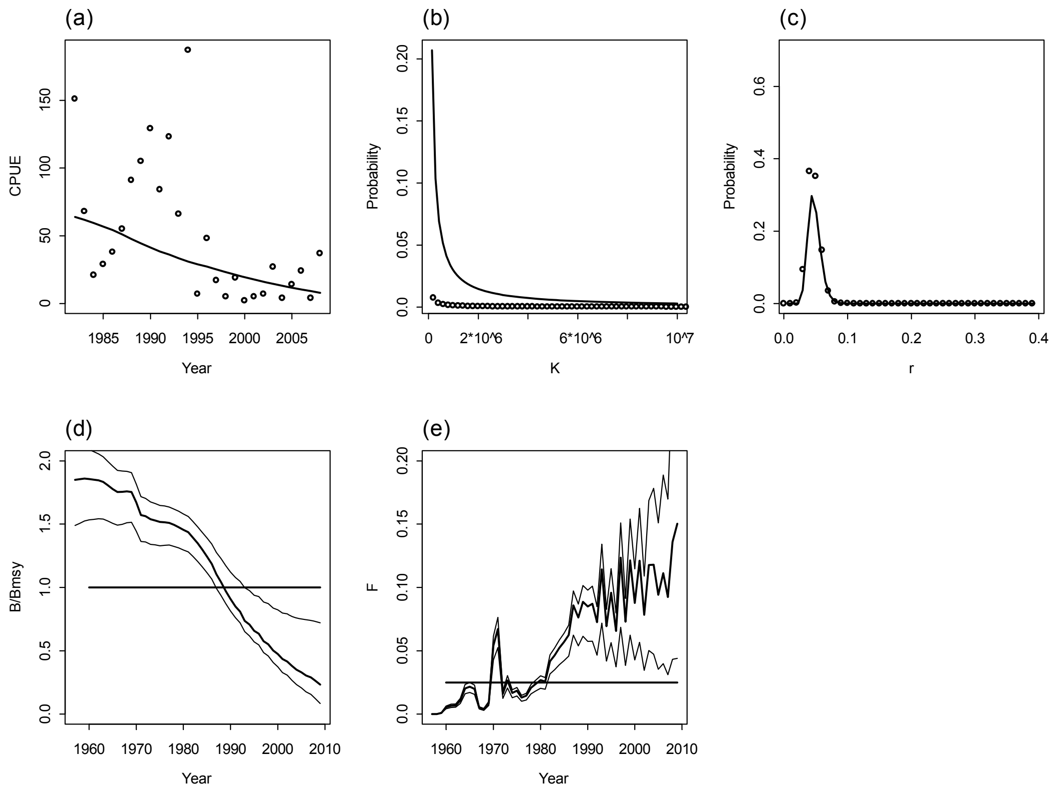

Figure 21. BSP results for southwest Atlantic porbeagle, with catches estimated from the ratio of porbeagle to tuna and swordfish (run SW5), (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of *K*, (c) prior and posterior of *r*, and median and 80% credibility interval of (d) biomass relative to B_{MSY} and (e) F.

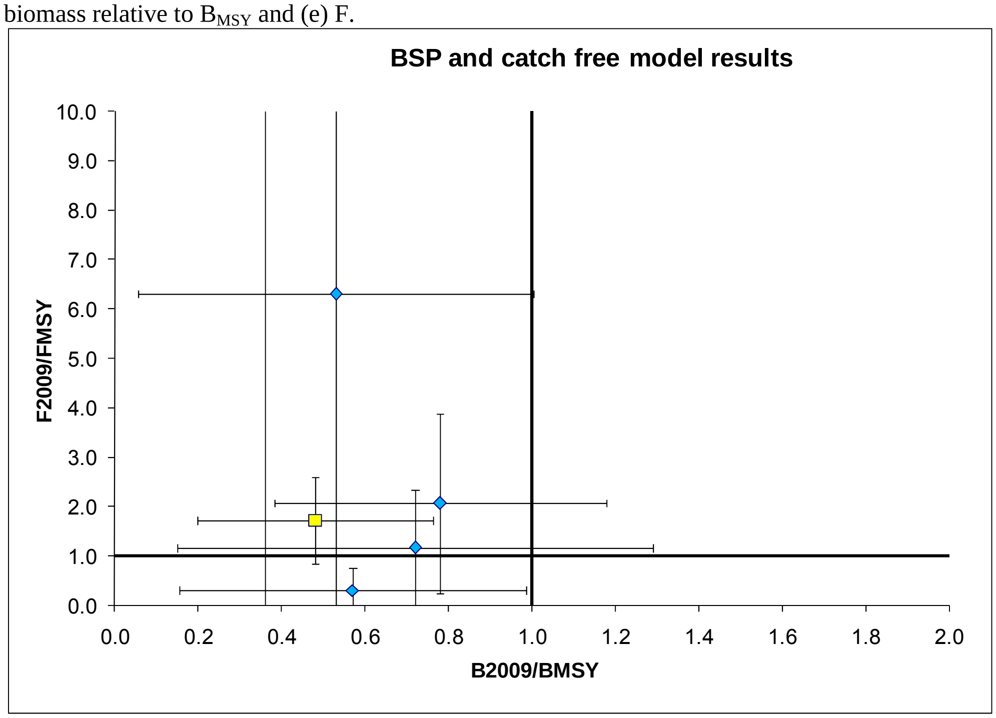

Figure 22. Phase plot for the southwest Atlantic porbeagle, showing status in 2009 from both the BSP model runs (diamonds) and the catch free age structured production model (square) results. Error bars are plus and minus one standard deviation.

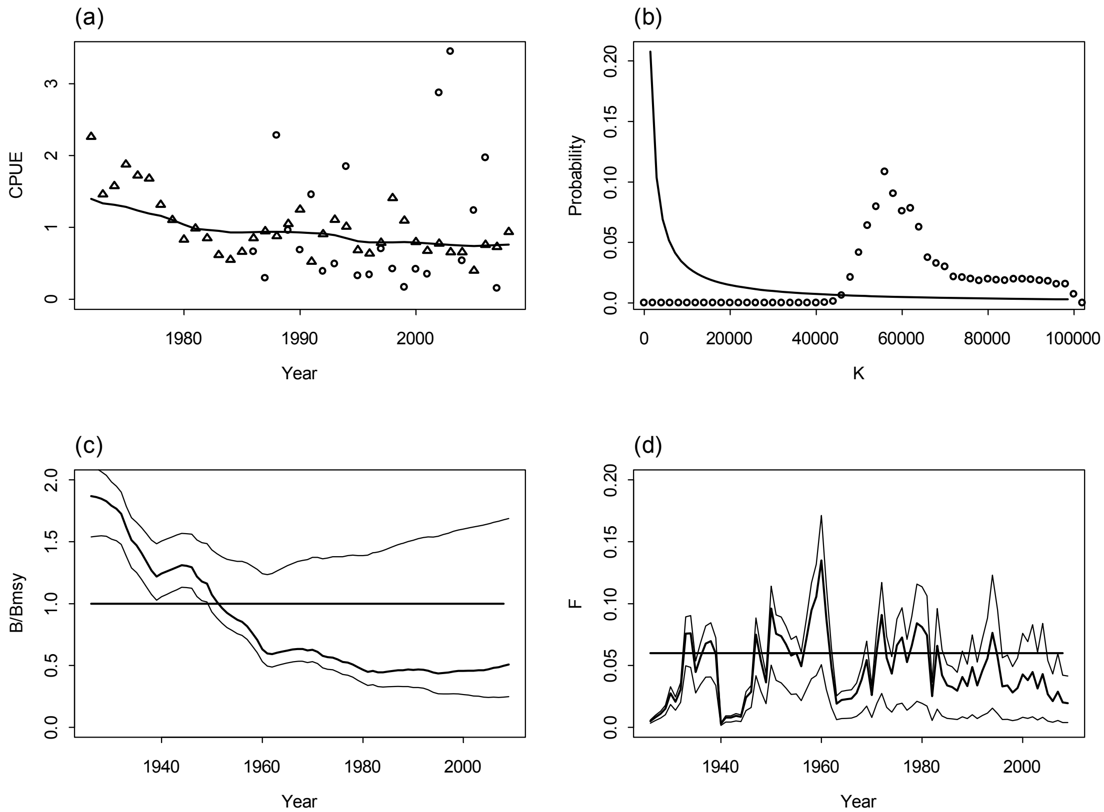

Figure 23. Equal weighting. Spain (area 4 and 5) and France (standardized), with catch data from 1926 and maximum of K set to 100000 (run NE1),), (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of *K* and median and 80% credibility interval of (c) biomass relative to B_{MSY} and (d) F.

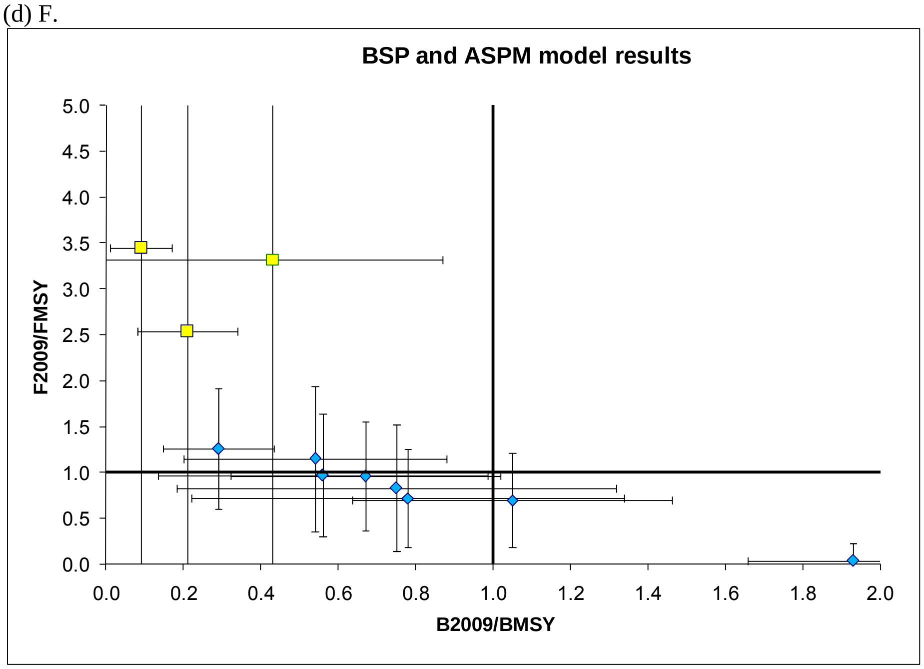

Figure 24. Phase plot showing current status of northeast Atlantic porbeagle for the BSP model (diamonds) and the ASPM model (squares). Error bars are plus and minus one standard deviation.

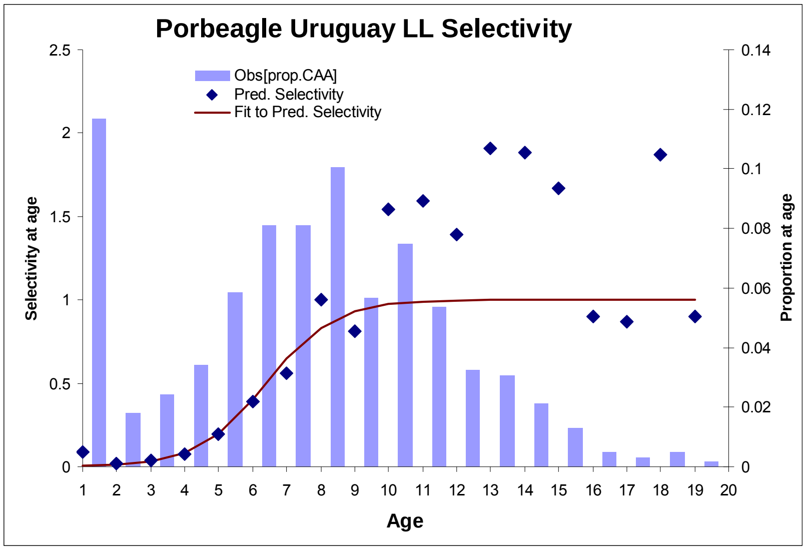

Figure 25. Logistic selectivity function fit to age frequency data estimated from lengths of porbeagle sharks observed in the Uruguayan longline observer program.

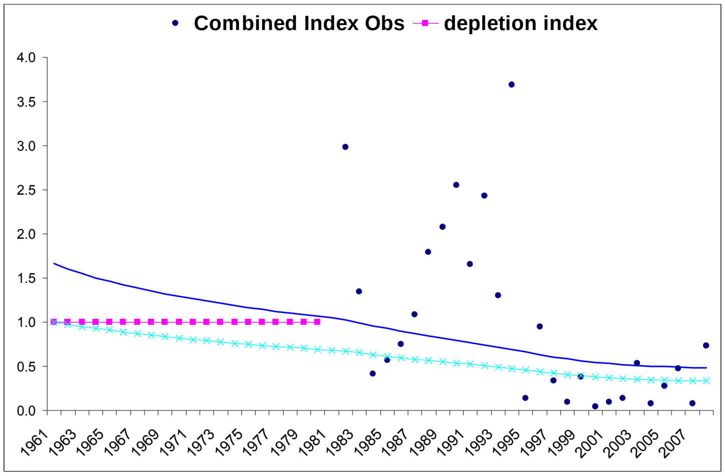

Figure 26. Fit to the Uruguay CPUE index and historical depletion index based on assuming virgin conditions in 1961 for Southwest Atlantic porbeagle shark. The solid line is the fit to the Uruguay index and the hatched line is the fit to the historical depletion index.

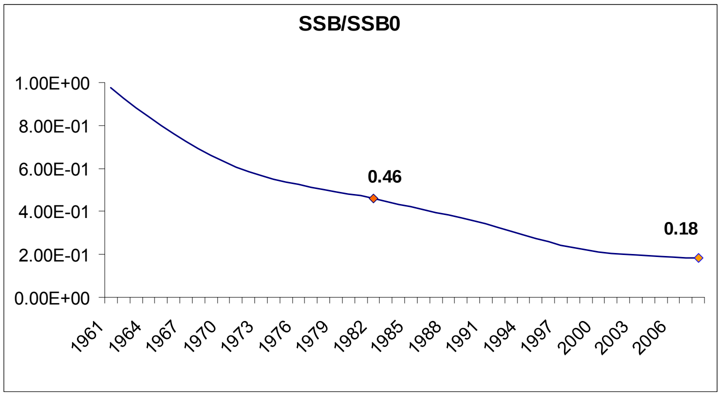

Figure 27. Relative spawning stock biomass (SSB) trend for the CFASP model assuming virgin conditions in 1961 for southwest Atlantic porbeagle shark. The dots indicated on the line correspond to depletion at the beginning of the modern period (1982) and current depletion (2008).

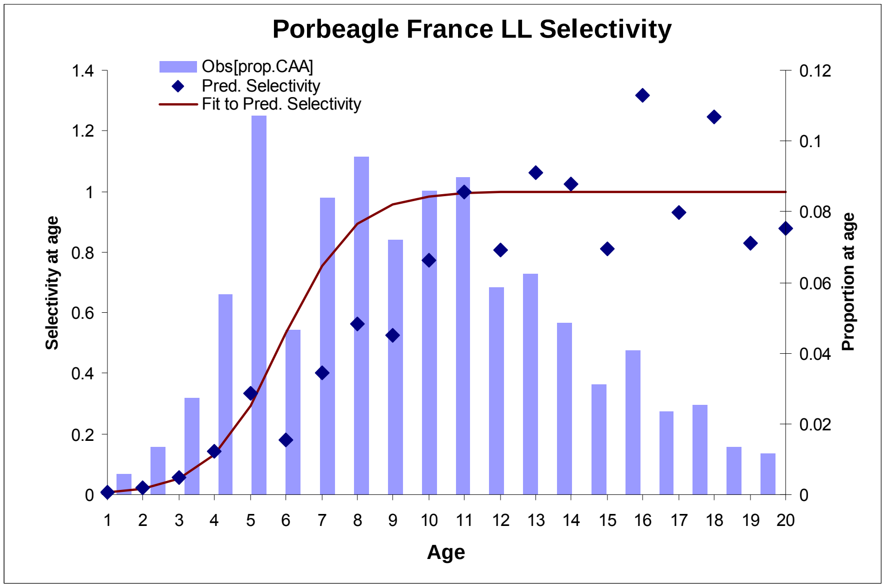

Figure 28. Logistic selectivity function fit to age frequency data estimated from lengths of porbeagle sharks recorded from the French longline fleet.

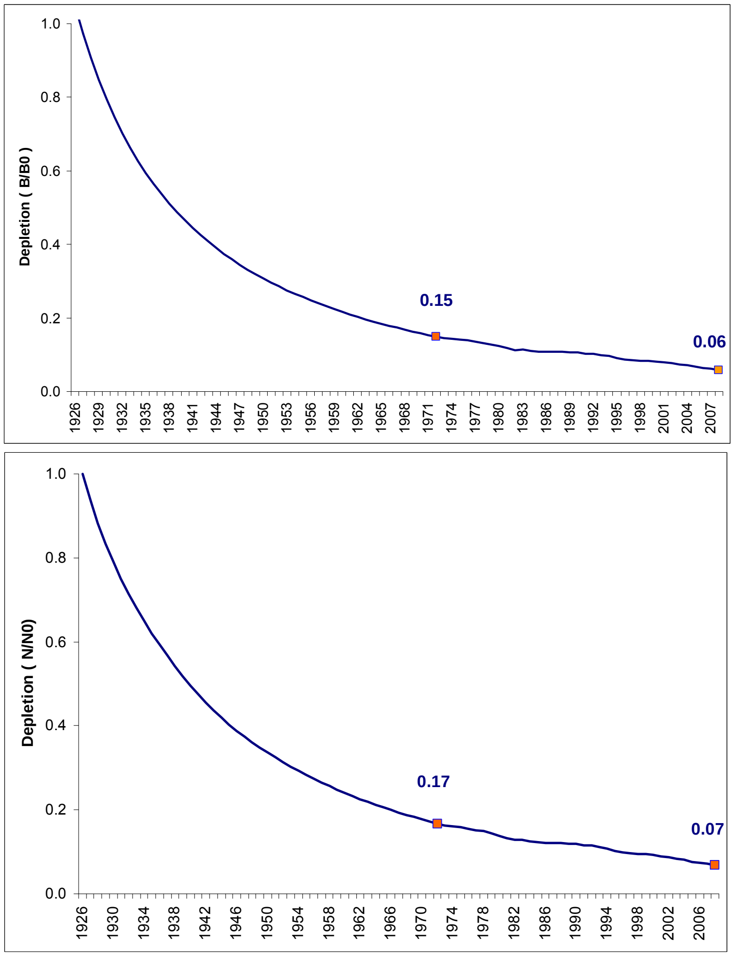

Figure 29. Depletion in total biomass (upper panel) and numbers (lower panel) for the SPAS model assuming virgin conditions in 1926 for Northeast Atlantic porbeagle shark. The dots indicated on the line correspond to depletion at the beginning of the modern period (1972) and current depletion (2008).

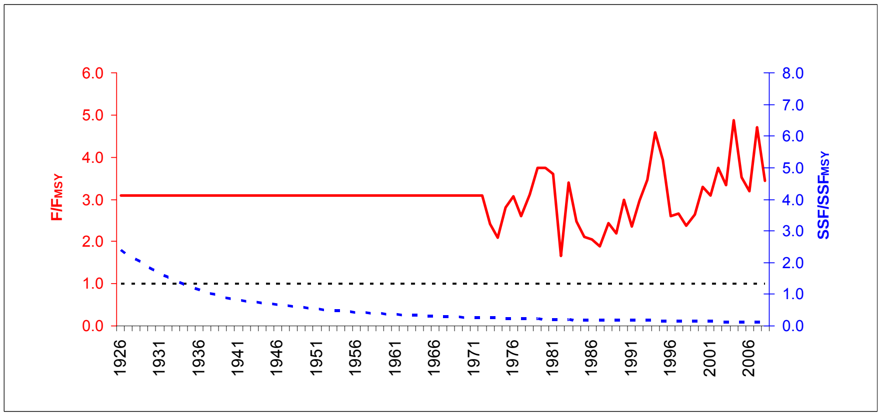

Figure 30. Relative biomass and fishing mortality trajectories for the ASPM model assuming virgin conditions in 1926 for northeast Atlantic porbeagle shark.

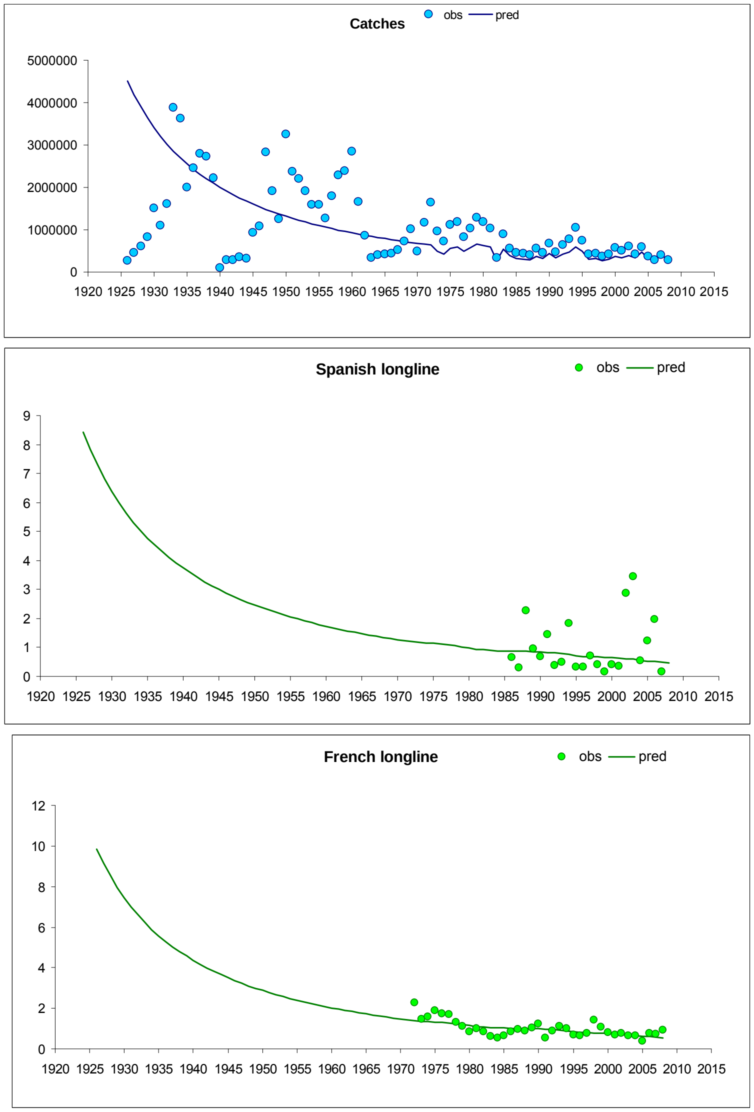

Figure 31. Model fits to catches (upper panel) and CPUE indices for the ASPM model assuming virgin conditions in 1926 for northeast Atlantic porbeagle shark.

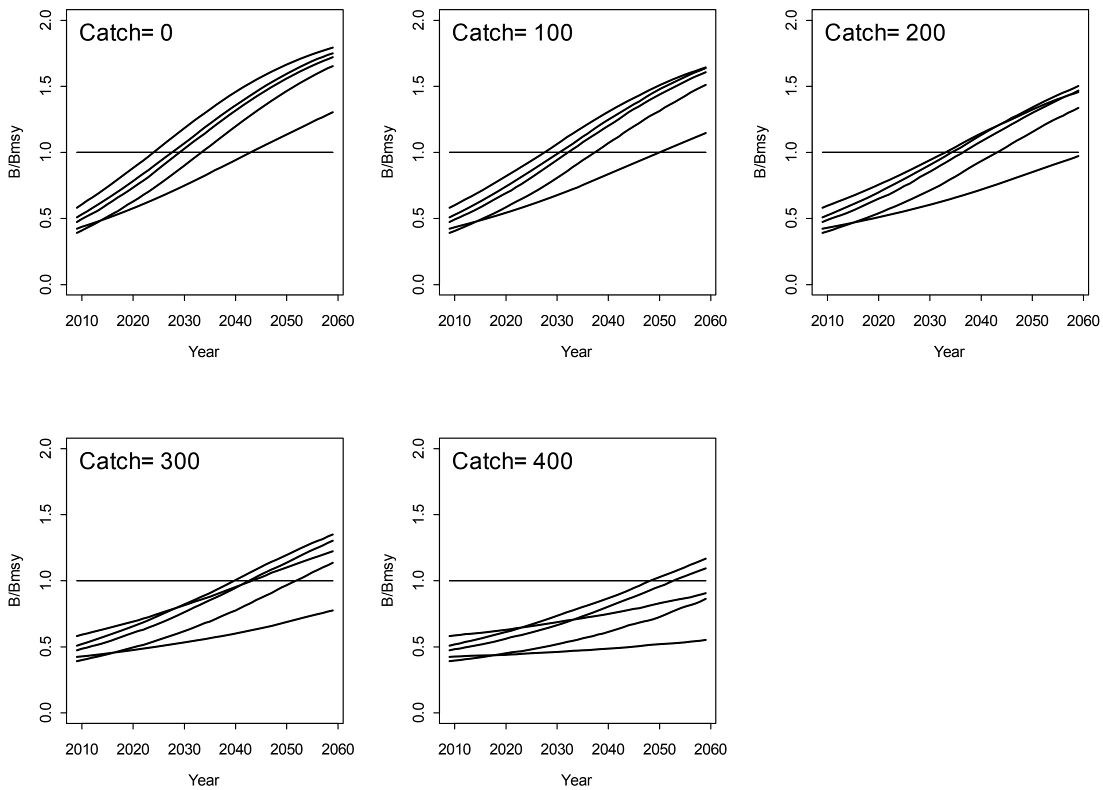

Figure 32. Median trajectories of B/BMSY for each total catch strategy. Each line is one of the five credible BSP model runs.

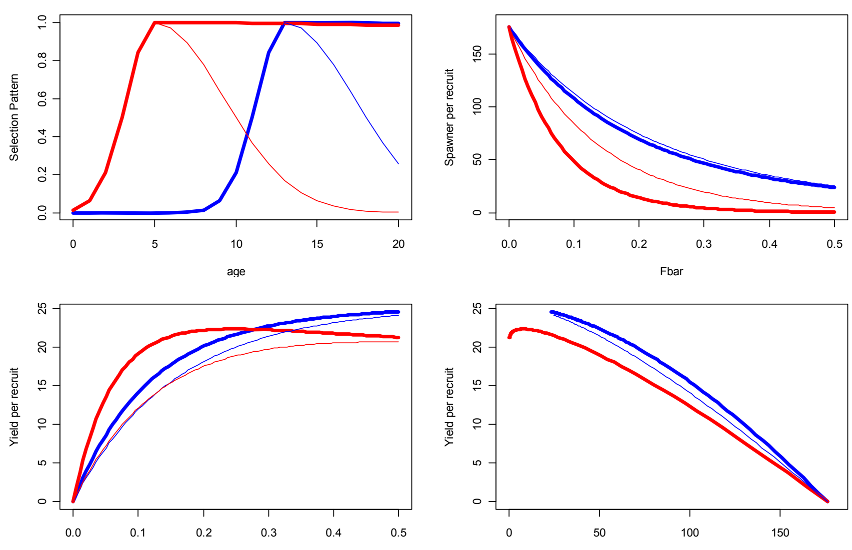

Figure 33. Per recruit analysis, top-left) selection pattern, top-right) Spawner per recruit, bottom-left) Yield per recruit, bottom-right) Yield vs. SSB.

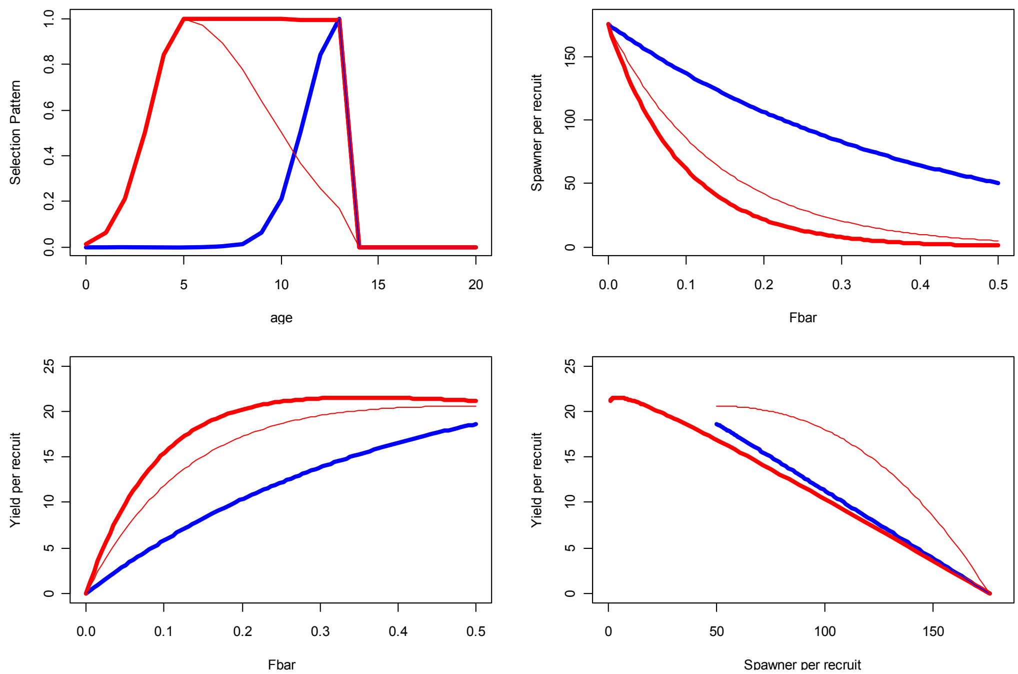

Figure 34. Per recruit analysis for a 100% effective MLL, top-left) selection pattern, top-right) Spawner per recruit bottom-left) Yield per recruit, bottom-right) Yield vs. SSB.

08-04 **BFT**

SUPPLEMENTAL RECOMMENDATION BY ICCAT CONCERNING THE WESTERN ATLANTIC BLUEFIN TUNA REBUILDING PROGRAM

RECALLING the *1998 Recommendation by ICCAT to Establish a Rebuilding Program for Western Atlantic Bluefin Tuna* [Rec. 98-07], the *Recommendation by ICCAT Concerning Conservation of Western Atlantic Bluefin Tuna* [Rec. 02-07], the *Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program and the Conservation and Management Measures for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 04-05], and the *Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program* [Rec. 06-06],

FURTHER RECALLING that the objective of the Convention is to maintain populations at levels that will support maximum sustainable catch (usually referred to as MSY),

CONSIDERING that the 2008 Standing Committee on Research and Statistics (SCRS) stock assessment indicates that a constant total allowable catch (TAC) below 2,100 t over the period of 2009-2010 would produce gains in spawning stock biomass (SSB) of western Atlantic bluefin tuna,

ACKNOWLEDGING that management actions taken in the eastern Atlantic and Mediterranean are likely to impact recovery in the western Atlantic, and that the current fishing mortality rate in the eastern Atlantic and Mediterranean bluefin tuna fisheries may be more than three times the level which would permit that stock to stabilize at the MSY level,

RECOGNIZING the need to amend the rebuilding program for western Atlantic bluefin tuna in light of scientific advice in the 2008 stock assessment,

THE INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS (ICCAT) RECOMMENDS THAT:

1. The Contracting Parties whose vessels have been actively fishing for bluefin tuna in the western Atlantic will initiate a 20-year rebuilding program beginning in 1999 and continuing through 2018.

Effort and capacity limits

2. In order to avoid increasing fishing mortality of bluefin tuna in the eastern or western Atlantic, Contracting Parties, non-Contracting Parties, Entities and Fishing Entities will continue to take measures to prohibit any transfer of fishing effort from the western Atlantic to the eastern Atlantic and from the eastern to the western Atlantic.

Catch limits and quotas

3. The rebuilding program for bluefin tuna in the western Atlantic, which began in 1999 and will continue through 2018, will have a total allowable catch (TAC), inclusive of dead discards, of 1,900 t in 2009 and 1,800 t in 2010.

4. The annual TAC, maximum sustainable yield (MSY) target, and 20-year rebuilding period may be adjusted based upon subsequent SCRS advice. No adjustment to the annual TAC or the 20-year rebuilding period shall be considered unless SCRS advice indicates that the TAC under consideration will allow the MSY target to be achieved within the rebuilding period with a 50 percent or greater probability.

5. At such time as the SCRS determines the stock size has achieved the level that would produce MSY, TAC levels up to the level of MSY will be considered.

6. The allocation of the annual TAC, inclusive of dead discards, will be indicated as follows:

   a) The annual TAC shall include the following allocations:

CPC	*Allocation*
UK (in respect of Bermuda)	4 t
France (in respect of St. Pierre & Miquelon)	4 t
Mexico (including incidental catch in longline fisheries in the Gulf of Mexico	95 t
USA (by-catch related to directed longline fisheries in vicinity of management area boundary)	25 t
Canada (by-catch related to directed longline fisheries in vicinity of management area boundary)	15 t

b) After subtracting the amounts under paragraph 6 (a), the remainder of the annual TAC will be allocated as follows:

	If the remainder of the annual TAC is:			
CPC	**< 2,413 t (A)**	**2,413 t (B)**	**> 2,413-2,660 t (C)**	**> 2,660 t (D)**
USA	57.48 %	1,387 t	1,387 t	52.14 %
Canada	23.75 %	573 t	573 t	21.54 %
Japan	18.77 %	453 t	453 t + all increase between 2,413 t and 2,660 t	26.32 %

c) Consistent with paragraphs 1 and 6 (b), the TAC for each of 2009 and 2010 results in the following CPC-specific quota allocations (not including by-catch allowances listed in 6 a):

	2009	*2010*
	(1,900 t)	(1,800 t)
USA	1,009.92 t	952.44 t
Canada	417.29 t	393.54 t
Japan	329.79 t	311.02 t

d) Notwithstanding paragraph 8 below, in 2009, 73 t will be transferred to Canada from Mexico's 2007 underage.

e) Notwithstanding paragraph 8 below, in 2010, underharvests carried forward by Mexico from 2008 to 2010 will be subsequently transferred to Canada, such that Canada's initial allocation (excluding the by-catch allowance listed in 6 a) for 2010 is 480 t. If such a transfer results in an initial Canadian allocation (excluding the by-catch allowance listed in 6 a) of less than 480 t, then a transfer of underharvest from the US will be used to bring Canada's initial 2010 allocation (excluding the by-catch allowance listed in 6 a) to 480 t.

f) The two-year combined Canadian total catch (excluding by-catch allowed under 6 a) for 2009 and 2010 will be no more than 970 t.

7. Contracting Parties and Cooperating non-Contracting Parties, Entities and Fishing Entities (CPCs) holding TAC allocations of western Atlantic bluefin tuna agree to re-negotiate the quota allocations for this stock in 2010 and that, at such time, all directed fishing allocations are to be included in the allocation table in accordance with ICCAT's allocation criteria.

8. Any overharvest of a CPC's specific TAC allocation provided under paragraph 6 shall be subtracted from that CPC's specific TAC allocation for the next year. Any underharvest of a CPC's specific TAC allocation in a given year may be carried forward to the next year. In no event shall the underharvest that is carried forward exceed 50% of the CPC's initial TAC allocation under paragraph 6 above, with the exception of

those CPCs with initial allocations of 25 t or less. After 2010, the underharvest that may be carried forward by any CPC to the following year shall not exceed 10% of the CPC's initial TAC allocation. Each year shall be considered as an independent management period for the purposes of paragraph 9 below.

9. a) If, in the applicable management period, and each subsequent management period, any CPC has an overharvest of its TAC allocation under paragraph 6, its TAC allocation will be reduced in the next subsequent management period by 100% of the amount in excess of such TAC allocation; and ICCAT may authorize other appropriate actions.

   b) Notwithstanding paragraph 9 (a), if a CPC has an overharvest of its TAC allocation under paragraph 6 during any two consecutive management periods, the Commission will recommend appropriate measures, which may include, but are not limited to, reduction in the CPC's TAC allocation equal to a minimum of 125% of the overharvest amount and, if necessary, trade restrictive measures. Any trade measures under this paragraph will be import restrictions on the subject species and consistent with each CPC's international obligations. The trade measures will be of such duration and under such conditions as the Commission may determine.

10. Notwithstanding the *Recommendation by ICCAT Regarding the Temporary Adjustment of Quotas* [Rec. 01-12], in between meetings of the Commission, a CPC with a TAC allocation under paragraph 6 may make a one-time transfer within a fishing year of up to 15% of its TAC allocation to other CPCs with TAC allocations, consistent with domestic obligations and conservations considerations. The transfer shall be notified to the Secretariat. Any such transfer may not be used to cover overharvests. A CPC that receives a one-time quota transfer may not retransfer that quota. For parties with a quota allocation of 4 t, the transfer may be up to 100% of the allocation.

Minimum fish size requirements and protection of small fish

11. Contracting Parties, non-Contracting Parties, Entities and Fishing Entities will prohibit the taking and landing of western Atlantic bluefin tuna weighing less than 30 kg or, in the alternative, having a fork length of less than 115 cm.

12. Notwithstanding the above measures, Contracting Parties, non-Contracting Parties, Entities and Fishing Entities may grant tolerances to capture western Atlantic bluefin tuna either weighing less than 30 kg, or in the alternative, having a fork length of less than 115 cm, provided they limit the take of these fish so that the average over the 2009 and 2010 fishing periods is no more than 10% by weight of the total bluefin tuna quota for each CPC, and institute measures to deny economic gain to the fishermen from such fish.

13. Contracting Parties, non-Contracting Parties, Entities and Fishing Entities will encourage their commercial and recreational fishermen to tag and release all fish less than 30 kg or, in the alternative, having a fork length less than 115 cm.

Area and time restrictions

14. There shall be no directed fishery on the bluefin tuna spawning stocks in the western Atlantic in spawning areas such as the Gulf of Mexico.

Scientific research and data and reporting requirement

15. The SCRS shall conduct a stock assessment of western Atlantic bluefin tuna in 2010 and thereafter every two/four years.

16. If scientific evidence results in an SCRS recommendation to alter the definition of management units, or to take explicit account of mixing between management units, then the rebuilding program shall be re-evaluated.

17. In 2010, the SCRS will conduct a stock assessment for bluefin tuna for the western Atlantic and eastern Atlantic and Mediterranean and provide advice to the Commission on the appropriate management measures, *inter alia*, on total allowable catch levels for those stocks for future years.

18. All Contracting Parties, non-Contracting Parties, Entities and Fishing Entities shall monitor and report on all sources of fishing mortality, including dead discards, and shall minimize dead discards to the extent practicable.

19. All Contracting Parties, non-Contracting Parties, Entities and Fishing Entities shall provide the best available data for the assessment of the stock by the SCRS, including information on the catches of the broadest range of age classes possible, consistent with minimum size restrictions.

20. This Recommendation replaces the *Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program* [Rec. 06-06].

08-05 **BFT**

RECOMMENDATION AMENDING THE RECOMMENDATION BY ICCAT TO ESTABLISH A MULTIANNUAL RECOVERY PLAN FOR BLUEFIN TUNA IN THE EASTERN ATLANTIC AND MEDITERRANEAN[1]

TAKING INTO ACCOUNT the discussions in the ICCAT Compliance Committee in 2008 concerning the implementation of the recovery plan adopted in 2006,

TAKING INTO ACCOUNT the stock recovery scenario developed by SCRS based on the stock assessment carried out in 2008,

DESIRING to achieve a stock level consistent with the objective of the Convention within 15 years,

CONVINCED that to achieve this objective, it is necessary to strengthen the recovery plan for that stock adopted in 2006. The objective is to recover the stock through a combination of management measures which will protect the spawning stock biomass and reduce juvenile catches,

RECOGNIZING that the success of the recovery plan involves the strengthening of the control system, which should include a set of effective control measures to ensure the respect of the management measures and to ensure the traceability of all the catches,

CONSIDERING the necessity to improve the responsibility of the industry, flag States, port States, farm States and market States to ensure compliance with the present recommendation,

GIVEN the need to address the overcapacity of the fleet and the farming capacity;

THE INTERNATIONAL COMMISSION FOR THE CONSERVATION
OF THE ATLANTIC TUNAS (ICCAT) RECOMMENDS THAT:

Part I
General provisions

1. The Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities (hereinafter referred to as CPCs), whose vessels have been actively fishing for bluefin tuna in the East Atlantic and Mediterranean shall implement a 15 year Recovery Plan for bluefin tuna in the East Atlantic and Mediterranean starting in 2007 and continuing through 2022, with the goal of achieving B_{MSY}, with greater than 50% probability.

Definitions

2. For the purposes of this Plan:

   a) "Fishing vessel" means any vessel used or intended for use for the purposes of the commercial exploitation of bluefin tuna resources, including catching vessels, fish processing vessels, support ships, tug and towing vessels, vessels engaged in transhipment and transport vessels equipped for the transportation of tuna products and auxiliary vessels, except container vessels;
   b) "Catching vessel" means a vessel used for the purposes of the commercial capture of bluefin tuna resources;
   c) "Processing vessel" means a vessel on board of which fisheries products are subject to one or more of the following operations, prior to their packaging: filleting or slicing, freezing and/or processing;
   d) "Auxiliary vessel" means any vessel used to transport dead bluefin tuna (not processed) from a cage to a designated port.

[1] After the official transmission on December 18, 2008 of the Recommendations adopted by the Commission at its 2008 meeting, paragraph 21 of this Recommendation was amended following the results of a mail vote.

e) "Fishing actively" means, for any catching vessel, the fact that it targets bluefin tuna during a given fishing season;
f) "Joint fishing operation" means any operation between two or more catching vessels flying the flag of different flag States CPCs where the catch of one catching vessel is attributed to one or more other catching vessels in accordance with an allocation key;
g) "Transfer activities" means:

− any transfer of live bluefin tuna from the catching vessel net to the transport cage;
− any transfer of live bluefin tuna from the transport cage to another transport cage;
− any transfer of dead bluefin tuna from the transport cage to an auxiliary vessel.
− any transfer from a bluefin tuna farm or a tuna trap to a processing vessel, transport vessel or to land.

h) “Tuna trap” means fixed gear anchored to the bottom usually containing a guide net that leads fish into an enclosure.
i) "Caging" means the transfer of bluefin tuna from the transport cage to the fattening and farming cages.
j) "Fattening" means caging of bluefin tuna for a short period (usually 2-6 months) aiming mostly at increasing the fat content of the fish.
k) "Farming" means caging of bluefin tuna for a period longer than one year, aiming to increase the total biomass.
l) "Transhipment" means the unloading of all or any of the fish on board a fishing vessel to another fishing vessel at port.
m) "Sport fishery" means a non-commercial fishery whose members adhere to a national sport organization or are issued with a national sport license.
n) "Recreational fishery" means a non-commercial fishery whose members do not adhere to a national sport organization or are not issued with a national sport license.

Length of vessels

3. All lengths of vessels referred to in this Recommendation shall be understood as length overall.

Part II
Management measures

TAC and quotas

4. The total allowable catches (TACs) are fixed:

2007: 29,500 t
2008: 28,500 t
2009: 22,000 t
2010: 19,950 t[2]
2011: 18,500 t

5. The SCRS shall monitor and review the progress of the Plan and submit an assessment to the Commission in 2010.

6. The TAC for 2011 onwards may be adjusted following the SCRS advice. The relative shares shall be decided by the Commission in 2010.

7. The allocation scheme for 2007-2010 is set in **Annex 4** to this Recommendation.

Associated conditions to TAC and quotas

8. Each CPC shall take the necessary measures to ensure that the fishing effort of its catching vessels and its traps are commensurate with the fishing opportunities on bluefin tuna available to that CPC in the Eastern Atlantic and Mediterranean Sea, including by establishing individual quotas for its catching vessels over 24 m included in the list referred to in paragraph 54 a).

[2] This TAC may be adjusted at 2009 annual meeting of the Commission in case of substantial overharvest of TAC identified in 2009 and/or new relevant scientific findings and/or relevant international developments.

9. Each CPC shall draw up an annual fishing plan for the catching vessels and traps fishing bluefin tuna in the Eastern Atlantic and Mediterranean Sea. The annual fishing plan shall identify, *inter alia*, the catching vessels over 24 meters included in the list referred to in paragraph 54 a) and the individual quota allocated to them and the method used to allocate quota as well as the measure to ensure the respect of the individual quota.

10. Each CPC shall also allocate a specific quota for the purpose of recreational and sport fisheries as defined in paragraph 2 m) and n).

11. No later than 1 March each year, the annual fishing plan shall be transmitted by each CPC to the ICCAT Executive Secretariat. Any subsequent modification to the annual fishing plan or to the specific method used to manage their quota shall be transmitted to the ICCAT Executive Secretariat at least 10 days before the exercise of the activity corresponding to that modification.

12. No later than 15 October, each CPC shall report to the ICCAT Executive Secretariat on the implementation of their annual fishing plans for that year. Those reports shall include:

    a) the number of catching vessels actually engaged in active fishing activities involving bluefin tuna in the Eastern Atlantic and Mediterranean;
    b) the catches of each catching vessel; and
    c) the total number of days each catching vessel fished in the Eastern Atlantic and Mediterranean.

13. The flag CPC may require the catching vessel to proceed immediately to a port designated by it when the individual quota is deemed to be exhausted.

14. a) No carry-over of any under-harvests shall be made under this Plan.
    b) By derogation to paragraph 4 of the 2002 *Recommendation by ICCAT Concerning a Multi-year Conservation and Management Plan for Bluefin Tuna in the East Atlantic and Mediterranean* [Rec. 02-08], no more than 50 % carry-over of any under-harvests arising from 2005 and/or 2006 may be made under this Plan. Paragraph 2 of the 1996 *Recommendation by ICCAT Regarding Compliance in the Bluefin Tuna and North Atlantic Swordfish Fisheries* [Rec. 96-14] shall not apply for the overages in 2005 and 2006.
    c) The underages of Libya, Morocco and Tunisia in 2005 and 2006 may be carried over to 2009 and 2010 as follows:

CPCs	*2009*	*2010*
Libya	145 t	145 t
Morocco	327 t	327 t
Tunisia	202 t	202 t

    d) Any overage of a CPC shall be deducted from the next year's quotas of that CPC. Notwithstanding this provision, the payback of the European Community for its overage in 2007 shall be spread over 2009-2012 (500 t in 2009 and 2010, 1,510 t in 2011 and 2012). This payback shall be reviewed in the light of a general transparency and incentive provision on overages to be adopted by ICCAT at the latest in 2010.

15. CPCs shall be encouraged to voluntarily reduce their catches of bluefin tuna in Eastern Atlantic and Mediterranean in 2009. Notwithstanding paragraph 14 a), the voluntary reduced portion of the CPC's allocation may be carried over to 2011 on condition that such voluntary reduced portion is notified to the ICCAT Secretariat before March 1, 2009.

16. Private trade arrangements and or transfer of quotas/catch limits between CPCs shall be done only under authorization by the CPCs concerned and the Commission.

17. To comply with paragraph 1 of 2002 *Recommendation by ICCAT on Vessel Chartering* [Rec. 02-21], the percentage of a CPC's bluefin tuna quota/catch limit that may be used for chartering shall not exceed 60%, 40% and 20% of the total quota in 2007, 2008, 2009, respectively. No chartering operation for the bluefin tuna fishery is permitted in 2010.

By derogation to paragraph 3 of the 2002 *Recommendation by ICCAT on Vessel Chartering* [Rec. 02-21], only bluefin tuna catching vessels flying the flag of a CPC can be chartered.

The number of bluefin tuna catching vessels chartered and the duration of the charter shall be commensurate with the quota allocated to the charter CPC.

18. Any joint fishing operation for bluefin tuna shall only be authorized with the consent of the flag States if the vessel is equipped to fish bluefin tuna and has an individual quota, and in accordance with the following requirements.

At the moment of the application for the authorization, following the format set in **Annex 6**, each flag State shall take the necessary measures to obtain from its catching vessel(s) participating in the joint fishing operation the following information:

- duration,
- identity of the operators involved,
- individual vessels' quotas,
- the allocation key between the vessels for the catches involved,
- and the information on the fattening or farming farms of destination.

Each flag State authorizing its vessels to participate shall transmit all this information to the other participating flag State. The CPCs involved in the joint fishing operation shall transmit all this information to the ICCAT Secretariat at least ten days before the start of the operation.

The Commission shall establish and maintain an ICCAT record of all joint fishing operations authorized by the flag States CPCs in the eastern Atlantic and Mediterranean Sea.

Closed fishing seasons

19. Bluefin tuna fishing shall be prohibited in the East Atlantic and Mediterranean by large-scale pelagic longline catching vessels over 24 m during the period from 1 June to 31 December with the exception of the area delimited by West of 10◦W and North of 42◦N, where such fishing shall be prohibited from 1 February to 31 July.

20. Purse seine fishing for bluefin tuna shall be prohibited in the East Atlantic and Mediterranean during the period from 15 June to 15 April.

21. If a CPC can demonstrate that due to bad weather (Beaufort Sea State 4 or more for wooden-hulled vessels of less than 24 m and Beaufort Sea State 5 or more for all other vessels) certain of its purse seine catching vessels have been unable to utilize the fishing days referred to in paragraph 20, the CPC may carry over a maximum of 5 days lost until 20 June. This CPC shall notify by 15 June to the ICCAT Secretariat the information on the additional fishing days granted, with evidence of bad weather. The ICCAT Secretariat shall forward without delay this information to other CPCs.

22. Bluefin tuna fishing by baitboats and trolling boats shall be prohibited in the East Atlantic and Mediterranean during the period from 15 October to 15 June.

23. Bluefin tuna fishing by pelagic trawlers shall be prohibited in the East Atlantic during the period from 15 October to 15 June.

24. Bluefin tuna recreational and sport fishing shall be prohibited in the eastern Atlantic and Mediterranean from 15 October to 15 June.

Spawning grounds

25. For the annual meeting of the Commission in 2010, the SCRS shall identify as precisely as possible spawning grounds in the Mediterranean in view of the creation of sanctuaries.

Use of aircraft

26. CPCs shall take necessary measures to prohibit the use of airplanes or helicopters for searching for bluefin tuna in the Convention area.

Minimum size

27. CPCs shall take the necessary measures to prohibit catching, retaining on board, transhipping, transferring, landing, transporting, storing, selling, displaying or offering for sale bluefin tuna (*Thunnus thynnus thynnus*) weighing less than 30 kg.

28. By derogation of paragraph 27, a minimum size for bluefin tuna (*Thunnus thynnus thynnus*) of 8 kg shall apply to the following situations in accordance with the procedures set out in **Annex 1.**

    a) Bluefin tuna caught by baitboats and trolling boats in the eastern Atlantic.
    b) Bluefin tuna caught in the Adriatic Sea for farming purposes.
    c) Bluefin tuna caught in the Mediterranean Sea by the coastal artisanal fishery for fresh fish by baitboats, longliners and handliners.

29. For catching vessels fishing actively for bluefin tuna, an incidental catch of maximum 5% of bluefin tuna weighing between 10 and 30 kg may be authorized. This percentage is calculated on the total incidental catches in number of fish retained on board this vessel, or their equivalent in percentage in weight. Incidental catches must be deducted from the quota of the flag State CPC. The procedures referred to in paragraphs 61, 62, 63, 64, 66, 67 and 68 shall apply to the incidental catch.

By-catch

30. Catching vessels not fishing actively for bluefin tuna are not authorized to retain on board bluefin tuna exceeding more than 5% of the total catch on board by weight or/and number of pieces. By-catches must be deducted from the quota of the flag state CPC.

    The procedures referred to in paragraphs 61, 62, 63, 64, 66, 67 and 68 shall apply to the by-catch.

Recreational fisheries

31. Recreational fisheries on bluefin tuna shall be subject to the authorization for each vessel issued by the flag State CPC.

32. CPCs shall take the necessary measures to prohibit the catch and retention on board, transshipment or landing of more than one bluefin tuna in each sea trip.

33. The marketing of bluefin tuna caught in recreational fishing shall be prohibited except for charitable purposes.

34. Each CPC shall take measures to record catch data from recreational fishing and transmit them to the SCRS. Catches of recreational fisheries shall be counted against the quota allocated to the CPC in accordance with paragraph 10.

35. Each CPC shall take the necessary measures to ensure, to the greatest extent possible, the release of bluefin tuna caught alive, especially juveniles, in the framework of recreational fishing.

Sport fisheries

36. CPCs shall take the necessary measures to regulate sport fishing, notably by fishing authorizations.

37. The marketing of bluefin tuna caught in sport fishing competitions shall be prohibited except for charitable purposes.

38. Each CPC shall take measures to record catch data from sport fishing and transmit them to the SCRS. Catches of sport fishing shall be counted against the quota allocated to the CPC in accordance with paragraph 10.

39. Each CPC shall take the necessary measures to ensure, to the greatest extent possible, the release of the bluefin tuna caught alive, especially juveniles, in the framework of sport fishing.

Part III
Capacity measures

Adjustment of fishing capacity

40. Each CPC shall ensure that its fishing capacity is commensurate with its allocated quota.

41. To that purpose each CPC shall establish a management plan over 2010-2013. Such plan shall be submitted to the Commission by 15 September 2009 for discussion and approval by the Commission at its annual meeting in 2009, and shall be reviewed at its annual meeting in 2010. Such plan shall include the information referred to in paragraphs 42 to 48.

Freezing of fishing capacity

42. CPCs shall limit the number, and the corresponding gross registered tonnage, of their fishing vessels to the number and tonnage of their vessels that fished for, retained on board, transshipped, transported, or landed bluefin tuna during the period 1 January 2007 to 1 July 2008. This limit shall be applied by gear type for catching vessels and by vessel type for other fishing vessels.

43. Paragraph 42 shall not be interpreted to affect the measures contained in **Annex 1** paragraphs 1 and 2 of this Recommendation.

44. CPCs shall limit the number of their traps engaged in the eastern Atlantic and Mediterranean bluefin tuna fishery to the number authorized by each CPC by 1 July 2008.

45. This freezing may not apply to certain CPCs, in particular developing States that demonstrate that they need to develop their fishing capacity so as to fully use their quota. Such CPCs shall indicate in their management plans the programming of the introduction of additional fishing capacity into the fishery.

Reduction of fishing capacity

46. Without prejudice to paragraph 45, each CPC shall reduce its fishing capacity referred to in paragraphs 42, 43 and 44 so as to ensure for 2010 that at least 25% of the discrepancy between its fishing capacity and its fishing capacity commensurate with its allocated quota in 2010 is achieved.

47. To calculate its fishing capacity reduction, each CPC shall take into account *inter alia*, the estimated yearly catch rates per vessel and gear.

48. This reduction may not apply to certain CPCs that demonstrate that their fishing capacity is commensurate with their allocated quotas.

Adjustment of farming capacity

49. Each farming or fattening CPC shall establish a management plan over 2010-2013. Such plan shall be submitted to the Commission by 15 September 2009 for discussion and approval by the Commission at its annual meeting in 2009, and shall be reviewed at its annual meeting in 2010. Such plan shall include the information referred in paragraphs 50 to 53.

50. Each CPC shall limit its tuna farming capacity to the farming capacity of the farms that were registered in the ICCAT list or authorized and declared to ICCAT as of 1 July 2008.

51. Each CPC shall establish for 2010 a maximum input of wild caught bluefin tuna into its farms at the level of the input quantities registered with ICCAT by its farms in 2005, 2006, 2007 or 2008.

52. Within the maximum input quantity of wild caught bluefin tuna referred to in paragraph 51, each CPC shall allocate inputs to its farms.

53. Further adjustment of farming capacity shall be decided by the Commission at its annual meeting in 2010, depending on the level of the TAC after 2010.

Part IV
Control measures

ICCAT bluefin tuna records of vessels

54. a) The Commission shall establish and maintain an ICCAT record of all catching vessels authorized to fish actively for bluefin tuna in the eastern Atlantic and Mediterranean Sea.

b) The Commission shall establish and maintain an ICCAT record of all other fishing vessels (i.e. catching vessels excluded) authorized to operate for bluefin tuna in the eastern Atlantic and Mediterranean Sea.

During a calendar year, a fishing vessel shall be registered in only one of the ICCAT records referred to paragraphs a) and b). Without prejudice to paragraph 30, for the purposes of this recommendation, fishing vessels not entered into one of the ICCAT records referred to in paragraph a) and b) are deemed not to be authorized to fish for, retain on board, tranship, transport, transfer, process or land bluefin tuna in the eastern Atlantic and Mediterranean Sea.

55. Each flag CPC shall submit electronically each year to the ICCAT Executive Secretary, at the latest one month before the beginning of the fishing seasons referred to in paragraphs 19 to 23, when applicable, and otherwise by 1 March, the list of its catching vessels authorized to fish actively for bluefin tuna and the list of its other fishing vessels authorized to operate in the eastern Atlantic and Mediterranean Sea referred to in paragraph 54 a) and b), in accordance with the format set in the Guidelines for submitting data and information required by ICCAT.

Any subsequent changes shall not be accepted unless a notified fishing vessel is prevented from participation due to legitimate operational reasons or *force majeure*. In such circumstances¸ the CPC concerned shall immediately inform the ICCAT Executive Secretariat, providing:

a) full details of the intended replacement fishing vessel(s) referred to in paragraph 54;
b) a comprehensive account of the reasons justifying the replacement and any relevant supporting evidence or references.

56. Conditions and procedures referred in the 2002 *Recommendation by ICCAT Concerning the Establishment of an ICCAT Record of Vessels Over 24 Meters Authorized to Operate in the Convention Area* [Rec. 02-22] (except paragraph 3) shall apply *mutatis mutandis*.

ICCAT record of tuna traps authorized to fish for bluefin tuna

57. The Commission shall establish and maintain an ICCAT Record of all tuna traps authorized to fish for bluefin tuna in the eastern Atlantic and Mediterranean Sea. For the purposes of this recommendation, tuna traps not entered into the record are deemed not to be authorized to be used to fish for, retain, transfer or land bluefin tuna.

58. Each CPC shall submit electronically to the ICCAT Executive Secretary, by 1 March each year, the list (including the name of the traps, register number) of its authorized tuna traps referred to in paragraph 57. Conditions and procedures referred in the 2002 *Recommendation by ICCAT Concerning the Establishment of an ICCAT Record of Vessels Over 24 Meters Authorized to Operate in the Convention Area* [Rec. 02-22] (except paragraph 3) shall apply *mutatis mutandis*.

Information on fishing activities

59. By 1 March each year, each CPC shall notify the ICCAT Secretariat the list of the catching vessels included in the ICCAT record referred to in paragraph 54 a) that have fished for bluefin tuna in the eastern Atlantic and Mediterranean in the preceding fishing year.

60. Each CPC shall notify the ICCAT Secretariat of any information concerning vessels not covered in paragraph 59 but known or presumed to have fished for bluefin tuna in the eastern Atlantic and Mediterranean. The ICCAT Secretariat shall forward such information to the flag State for action as appropriate, with a copy to other CPCs for information.

Transhipment

61. Transhipment at sea operations of bluefin tuna in the East Atlantic and Mediterranean Sea shall be prohibited.

62. Fishing vessels shall only tranship bluefin tuna catches in designated ports of CPCs. To this end, each CPC shall designate ports in which transhipping of bluefin tuna is authorized and communicate a list of these ports to the ICCAT Secretariat by 1 March each year.

    For a port to be determined as designated port, the port State shall specify permitted transshipping times and places.
    The Port State shall ensure full inspection coverage during all transhipping times and at all transhipping places.

    On the basis of this information the ICCAT Secretariat shall maintain a list of designated ports on the ICCAT website.

63. Prior to entry into any port, the receiving fishing vessel or its representative, shall provide the relevant authorities of the Port State at least 48 h before the estimated time of arrival, with the following:

    a) estimated time of arrival,
    b) estimated quantity of bluefin tuna retained on board, and information on the geographic area where it was taken;
    c) the name of the transhipping fishing vessel and its number in the ICCAT record of catching vessels authorized to fish actively for bluefin tuna or in the ICCAT record of other fishing vessels authorized to operate in the eastern Atlantic and Mediterranean Sea,
    d) the name of the receiving fishing vessel, its number in the ICCAT record of catching vessels authorized to fish actively for bluefin tuna or in the ICCAT record of other fishing vessels authorized to operate in the eastern Atlantic and Mediterranean Sea,
    e) the tonnage and the geographic area of the catch of bluefin tuna to be transshipped.

    Any transhipment requires the prior authorization from the flag State of the transshipping fishing vessel concerned.

    The master of the transshipping fishing vessel shall, at the time of the transhipment, inform its Flag State of the following:

    a) the quantities of bluefin tuna involved,
    b) the date and port of the transhipment,
    c) the name, registration number and flag of the receiving fishing vessel and its number in the ICCAT record of catching vessels authorized to fish actively for bluefin tuna or in the ICCAT record of other fishing vessels authorized to operate in the eastern Atlantic and Mediterranean Sea,
    d) the geographical area of the catch of bluefin tuna.

    The relevant authority of the port State shall inspect the receiving vessel on arrival and check the cargo and documentation related to the transhipment operation.

    The relevant authority of the port State shall send a record of the transhipment to the flag State authority of the transhipping fishing vessel, within 48 hours after the transhipment has ended.

Recording requirements

64. The masters of catching vessels shall keep a bound or electronic logbook of their operations, indicating particularly the quantities of bluefin tuna caught and kept on board, whether the catches are weighed or estimated, the date and location of such catches and the type of gear used in accordance with the requirements set out in **Annex 2**.

65. The masters of the catching vessels involved in a joint fishing operation shall record in their logbook:

a) as regards the catching vessel transferring the fish into cages:

- its name and international radio call sign;
- the date and the time of the catch and of the transfer,
- the location of the catch and of the transfer (longitude/latitude),
- amount of catches taken on board, and amount of catches transferred into cages,
- amount of catches counted against its individual quota,
- the name of the tug boat and its ICCAT number.

b) as regards the other catching vessels not involved in the transfer of the fish:

- their names and international radio call signs;
- the date and the time of the catch and of the transfer,
- the location of the catch and of the transfer (longitude/latitude),
- that no catches have been taken on board or transferred into cages,
- amount of catches counted against their individual quotas,
- the name and the ICCAT number of the catching vessel referred to in (a),
- the name of the tug boat and its ICCAT number.

66. Fishing vessels shall only land bluefin tuna catches in designated ports of CPCs. To this end, each CPC shall designate ports in which landing of bluefin tuna is authorized and communicate a list of these ports to the ICCAT Secretariat by 1 March each year.

For a port to be determined as designated port, the port State shall specify permitted landing times and places. The port State shall ensure full inspection coverage during all landing times and at all landing places.

On the basis of this information the ICCAT Secretariat shall maintain a list of designated ports on the ICCAT website.

67. Prior to entry into any port, the fishing vessels or their representative, shall provide the relevant authorities of the port, at least 4 hours before the estimated time of arrival, with the following:

a) estimated time of arrival,
b) estimate of quantity of bluefin tuna retained on board,
c) the information on the geographic area where the catch was taken;

Port State authorities shall keep a record of all prior notices for the current year.

Each landing or caging shall be subject to an inspection by the relevant authorities of the port.

The relevant authority shall send a record of the landing to the flag State authority of the fishing vessel, within 48 hours after the landing has ended.

After each trip and within 48 hours of landing, the masters of catching vessels shall submit a landing declaration to the competent authorities of the CPC where the landing takes place and to its flag State. The master of the authorized catching vessel shall be responsible for the accuracy of the declaration, which shall indicate, as a minimum, the quantities of bluefin tuna landed and the area where they were caught. All landed catches shall be weighed and not only estimated.

68. The masters of fishing vessels shall complete and transmit to their flag State the ICCAT transhipment declaration no later than 48 hours after the date of transhipment in port in accordance with the format set out in **Annex 3.**

Communication of catches

69. a) Each CPC shall ensure that its catching vessels fishing actively for bluefin tuna shall communicate by electronic or other means, to their competent authorities, a weekly catch report, with, as a minimum, information on the catch amount, including nil catch returns, the date and the location (latitude and longitude) of the catches. This report shall be transmitted by the latest Monday noon with the catches taken in the Plan Area during the preceding week ending Sunday midnight GMT. This report shall include information on the number of days in the Plan Area since the beginning of the fishing or since the last weekly report.

b) Each CPC shall ensure that its purse seine catching vessels and its other catching vessels over 24 m fishing actively for bluefin tuna shall communicate, except in case of nil catch returns, by electronic or other means, to their competent authorities, a daily catch report, with, as a minimum, information on the catch amount, the date and the location (latitude and longitude) of the catches. If a CPC requires such daily reports even in case of nil catch returns, the weekly reports referred to in a) shall not be required.

c) On the basis of the information referred to in (a) and (b), each CPC shall transmit without delay weekly catch reports for all vessels to the ICCAT Secretariat in accordance with the format set out in **Annex 5.**

Reporting of catches

70. Each CPC shall report its provisional monthly catches of bluefin tuna. This report shall be sent to the ICCAT Secretariat within 30 days of the end of the calendar month in which the catches were made.

71. The ICCAT Secretariat shall within 10 days following the monthly deadlines for receipt of the provisional catch statistics collect the information received and circulate it to CPCs together with aggregated catch statistics.

72. The Executive Secretary shall notify without delay all CPCs of the date on which the accumulative reported catch taken by catching vessels of the CPCs is estimated to equal 85% of the concerned CPC quota for this stock. The CPC shall take the necessary measures to close its bluefin tuna fisheries before its quota is exhausted and notify this closure without delay to the ICCAT Secretariat which will circulate this information to all CPCs.

Cross check

73. CPCs shall verify, including by using inspection reports and observer reports, VMS data, the submission of logbooks and relevant information recorded in the logbooks of their fishing vessels, in the transfer/transhipment document and in the catch documents.

The competent authorities shall carry out cross checks on all landings, all transhipment or caging between the quantities by species recorded in the fishing vessel logbook or quantities by species recorded in the transhipment declaration and the quantities recorded in the landing declaration or caging declaration, and any other relevant document, such as invoice and/or sales notes.

Transfer operations

74. Before any transfer operation into towed cages, the master of the catching vessel shall send to its flag State CPC authorities before the transfer, a prior transfer notification indicating:

- name of the catching vessel and ICCAT number record,
- estimated time of transfer,
- estimate of quantity of bluefin tuna to be transferred,
- information on the position (latitude/longitude) where the transfer will take place,
- name of the tug vessel, number of cages towed and ICCAT number record.

75. The transfer operation shall not begin without the prior authorization of the catching vessel flag State. If the flag State of the catching vessel considers on receipt of the prior transfer notification that:

a) the catching vessel declared to have caught the fish had not sufficient quota for bluefin tuna put into the cage,
b) the quantity of fish has not been duly reported and not taken into account for the consumption of the quota that may be applicable,
c) the catching vessel declared to have caught the fish is not authorized to fish for bluefin tuna, or
d) the tug vessel declared to receive the transfer of fish is not registered in the ICCAT record of all other fishing vessels referred to in paragraph 54 b) or is not equipped with a Vessel Monitoring System,

it shall inform the master of the catching vessel that the transfer is not authorized and to proceed to the release of the fish into the sea.

76. The masters of catching vessels shall complete and transmit to their flag State the ICCAT transfer declaration at the end of the transfer operation to the tug vessel, in accordance with the format set out in **Annex 3.**

77. The transfer declaration shall accompany the transfer of fish during transport to the farm or a designated port.

78. The authorization for transfer by the flag State does not prejudge the authorization of the caging operation.

79. The master of the caging vessel shall ensure that the transfer activities shall be monitored by video camera in the water.

80. The ICCAT Regional Observer on board the catching vessel, as referred to in the ICCAT Regional Observer Program (**Annex 7**), shall record and report upon the transfer activities carried out, verify the position of the catching vessel when engaged in transfer operation, observe and estimate catches transferred and verify entries made in the prior transfer operation as referred to in paragraph 75 and in the ICCAT transfer declaration as referred to in paragraph 76.

81. The ICCAT Regional Observer shall countersign the prior transfer notification and the ICCAT transfer declaration. He shall verify that the ICCAT transfer declaration is properly filled and transmitted to the master of the tug vessel.

    The tuna trap operator shall complete and transmit to its State the ICCAT transfer declaration at the end of the transfer operation to the fishing vessel, in accordance with the format set out in **Annex 3**

Caging Operations

82. The CPC under whose jurisdiction the farm for bluefin tuna is located shall submit within one week a caging report, validated by an observer, to the CPC whose flag vessels has fished the tuna and to the ICCAT Secretariat. This report shall contain the information referred to in the caging declaration as set out in the *Recommendation by ICCAT on Bluefin Tuna Farming* [Rec. 06-07].

    When the farming facilities authorized to operate for farming of bluefin tuna caught in the Convention area (hereafter referred to as FFBs) are located beyond waters under jurisdiction of CPCs, the provisions of the previous paragraph shall apply, *mutatis mutandis*, to CPCs where the natural or legal persons responsible for FFBs are located.

83. Before any transfer operation into a farm, the flag CPC of the catching vessel shall be informed by the competent authority of the farm State of the transfer into cage of quantities caught by catching vessels flying its flag. If the flag CPC of the catching vessel considers on receipt of this information that:

    a) the catching vessel declared to have caught the fish had not sufficient quota for bluefin tuna put into the cage,
    b) the quantity of fish has not been duly reported and not taken into account for the calculation of any quota that may be applicable, or
    c) the catching vessel declared to have caught the fish is not authorized to fish for bluefin tuna, it shall inform the competent authority of the farm State to proceed to the seizure of the catches and the release of the fish into the sea.

    The transfer operation shall not begin without the prior authorization of the catching vessel flag CPC.

84. The CPC under whose jurisdiction the farm for bluefin tuna is located shall take the necessary measures to prohibit placing in cages for farming or fattening bluefin tuna that are not accompanied by accurate, complete and validated documentation required by ICCAT.

85. The CPC under whose jurisdiction the farm is located shall ensure that transfer activities from cages to the farm shall be monitored by video camera in the water. This requirement shall not apply where the cages are directly fixed to the mooring system.

Trap activities

86. CPCs shall take the necessary measures to ensure the record of the catches after the end of every fishing operation and the transmission of these data simultaneously by electronic means or other means within 48 hours after the end of every fishing operation to the competent authority, which shall transmit these data without delay to the ICCAT Secretariat.

VMS

87. Without prejudice to paragraph 1 d) of Recommendation [06-07], CPCs shall implement a vessels monitoring system for their fishing vessels over 24 m, in accordance with the 2003 *Recommendation by ICCAT Concerning Minimum Standards for the Establishment of a Vessel Monitoring System in the ICCAT Convention Area* [Rec. 03-14].

    Without prejudice to paragraph 1d) of Recommendation [06-07], with effect from 1 January 2010 this measure shall be applied for their fishing vessels over 15 m.

    No later than 31 January 2008, each CPC shall communicate without delay messages pursuant to this paragraph to the ICCAT Secretariat, in accordance with the data exchange formats and protocols adopted by the Commission in 2007.

    The ICCAT Executive Secretariat shall make available as soon as possible the information received under this paragraph to CPCs with an active inspection presence in the Plan Area and to SCRS, at its request.

    On request from CPCs engaged in inspection at sea operations in the convention area in accordance with the ICCAT scheme of joint international inspection referred to in paragraphs 97 and 98 of this Recommendation, the ICCAT Secretariat shall make available the messages received under paragraph 3 of Recommendation [07-08] to all fishing vessels.

CPC Observer Program

88. Each CPC shall ensure observer coverage on its catching vessels actively fishing for bluefin tuna over 15 m in overall length of at least:

    - 20% of its active purse seine vessels between 15 m and 24 m in overall length;
    - 20% of its active pelagic trawlers,
    - 20% of its active longline vessels,
    - 20% of its active baitboats,
    - 100% during the harvesting process for tuna traps.

The observer tasks shall be, in particular, to:

a) monitor a catching vessel compliance with the present recommendation,
b) record and report upon the fishing activity, which shall include, inter alia, the following:
    - amount of catch (including by-catch), that also includes species disposition, such as retained on board or discarded dead or alive,
    - area of catch by latitude and longitude,
    - measure of effort (e.g., number of sets, number of hooks, etc.), as defined in the ICCAT Field Manual for different gears.
    - date of catch,
c) observe and estimate catches and verify entries made in the logbook,
d) sight and record vessels that may be fishing contrary to ICCAT conservation measures.

In addition, the observer shall carry out scientific work, such as collecting Task II data, when required by the Commission, based on the instructions from the SCRS.

In implementing this observer requirement, CPCs shall:

a) ensure representative temporal and spatial coverage to ensure that the Commission receives adequate and appropriate data and information on catch, effort, and other scientific and management aspects, taking into account characteristics of the fleets and fisheries;

b) ensure robust data collection protocols;

c) ensure observers are properly trained and approved before deployment;

d) ensure, to the extent practicable, minimal disruption to the operations of vessels fishing in the Convention area.

Data and information collected under each CPCs observer program shall be provided to the SCRS and the Commission, as appropriate, in accordance with requirements and procedures to be developed by the Commission by 2009 taking into account CPC confidentiality requirements.

For the scientific aspects of the program, the SCRS shall report on the coverage level achieved by each CPC and provide a summary of the data collected and any relevant findings associated with that data. SCRS shall also provide any recommendations to improve the effectiveness of CPC observer programs.

ICCAT Regional observer Program

89. An ICCAT Regional Observer Program shall be established to ensure an observer coverage of 100%:

- of purse seine vessels over 24 m during all the annual fishing season (**Annex 7**);
- of all purse seiners involved in joint fishing operations, irrespective of the length of the vessels. In this respect, an observer shall be present during the fishing operation;
- during all transfer of bluefin tuna to the cages and all harvest of fish from the cage.

Such purse seine vessels without an ICCAT regional observer shall not be authorized to fish or to operate in the bluefin tuna fishery.

90. An ICCAT Regional Observer Program shall ensure an observer presence during all transfer of bluefin tuna to the cages and all harvest of fish from the cage.

The observer tasks shall be, in particular, to:

- observe and monitor farming operation compliance with the *Recommendation by ICCAT on Bluefin Tuna Farming* [Rec. 06-07],
- validate the caging report referred to in paragraph 82,
- carry out such scientific work, for example collecting samples, as required by the Commission based on the directions from the SCRS.

Enforcement

91. CPCs shall take enforcement measures with respect to a fishing vessel, where it has been established, in accordance with its law that the fishing vessel flying its flag does not comply with the provisions of paragraphs 19 to 24, 27 to 29 and 64 to 68 (closed seasons, minimum size and recording requirements).

The measures may include in particular depending on the gravity of the offence and in accordance with the pertinent provisions of national law:

- fines,
- seizure of illegal fishing gear and catches,
- sequestration of the vessel,
- suspension or withdrawal of authorization to fish,
- reduction or withdrawal of the fishing quota, if applicable.

92. The CPC under whose jurisdiction the farm for bluefin tuna is located shall take enforcement measures with respect to a farm, where it has been established, in accordance with its law that this farm does not comply with the provisions of paragraphs 82 to 85 and 90 (caging operations and observers) and with the *Recommendation by ICCAT on Bluefin Tuna Farming* [Rec. 06-07].

    The measures may include in particular depending on the gravity of the offence and in accordance with the pertinent provisions of national law:

    - fines,
    - suspension or withdrawal of the record of FFBs,
    - prohibition to put into cages or market quantities of bluefin tuna.

Access to video records

93. Each CPC shall take the necessary measures to ensure that the video records of its fishing vessels and of its farms are made available to the ICCAT inspectors and ICCAT observers.

    The CPC under whose jurisdiction the farm for bluefin tuna is located shall take the necessary measures to ensure that the video records of its fishing vessels and of its farms are made available to its inspectors and its observers.

Market measures

94. Consistent with their rights and obligations under international law, exporting and importing CPCs shall take the necessary measures:

    - to prohibit domestic trade, landing, imports, exports, placing in cages for farming, re-exports and transhipments of eastern Atlantic and Mediterranean bluefin tuna species that are not accompanied by accurate, complete, and validated documentation required by this Recommendation and Recommendation [08-12] on a bluefin tuna catch documentation program.
    - to prohibit domestic trade, imports, landings, placing in cages for farming, processing, exports, re-exports and the transhipment within their jurisdiction, of eastern and Mediterranean bluefin tuna species caught by fishing vessels whose flag State either does not have a quota, catch limit or allocation of fishing effort for that species, under the terms of ICCAT management and conservation measures, or when the flag State fishing possibilities are exhausted, or when the individual quotas of catching vessels referred to in paragraph 9 are exhausted;
    - to prohibit domestic trade, imports, landings, processing, exports from farms that do not comply with the Recommendation *by ICCAT on Bluefin Tuna Farming* [Rec. 06-07].

Conversion factors

95. The conversion factors adopted by SCRS shall apply to calculate the equivalent round weight of the processed bluefin tuna.

Growth factors

96. Each CPC shall define growth factors to be applied to bluefin tuna farmed in its cages. It shall notify to ICCAT Secretariat and to the SCRS the factors and methodology used. The SCRS shall review this information at its annual meetings in 2009 and 2010 and shall report to the Commission. The SCRS shall further study the estimated growth factors and provide advice to the Commission for its annual meeting in 2010.

Part V
ICCAT Scheme of Joint International Inspection

97. In the framework of the multi-annual management plan for bluefin tuna, each CPC agrees, in accordance with Article 9, paragraph 3, of the ICCAT Convention, to apply the ICCAT Scheme of Joint International Inspection adopted during its Fourth Regular Meeting, held in November 1975 in Madrid[3], as modified in **Annex 8**.

[3] Note from the Secretariat: See Appendix II to Annex 7 in *Report for Biennial Period, 1974-75, Part II (1975).*

98. The Scheme referred to in paragraph 97 shall apply until ICCAT adopts a monitoring, control and surveillance scheme which will include an ICCAT scheme for joint international inspection, based on the results of the Integrated Monitoring Measures Working Group, established by Resolution 00-20.

Part VI
Final provisions

99. **Availability of data to the SCRS**

The ICCAT Secretariat shall make available to the SCRS all data received in accordance with the present Recommendation.

All data shall be treated in a confidential manner.

100. **Evaluation**

All the CPCs shall submit each year to the Secretariat regulations and other related documents adopted by them to implement this Recommendation. In order to have greater transparency in implementing this Recommendation, all the CPCs involved in the bluefin tuna chain shall submit each year, no later than 15 October, a detailed report on their implementation of this Recommendation.

101. **Cooperation**

All the CPCs involved in the bluefin tuna chain are encouraged to enter into bilateral arrangements in order to improve the compliance with the provisions of this Recommendation. These arrangements could notably cover exchanges of inspectors, joint inspections and data sharing.

102. **Repeals**

This Recommendation repeals paragraph 10 of Recommendation [06-07]; Recommendation [07-04] and paragraph 6 of Recommendation [07-08].

This Recommendation replaces Recommendation [06-05]. Paragraphs 50 and 51 of Recommendation [06-05] shall remain in force until the ICCAT Regional Observer Program referred to in paragraphs 89 and 90 is implemented.

Annex 1

Specific Conditions Applying to the Catching Vessels Referred to in Paragraph 28

1. CPCs shall limit:

   - The maximum number of its baitboats and trolling boats authorized to fish actively bluefin tuna to the number of the vessels participating in directed fishery for bluefin tuna in 2006.
   - The maximum number of its artisanal fleet authorized to fish actively bluefin tuna in Mediterranean to the number of the vessel participating in the fishery for bluefin tuna in 2008.
   - The maximum number of its catching vessel authorized to fish actively bluefin tuna in Adriatic to the number of the vessel participating in the fishery for bluefin tuna in 2008. Each CPC shall allocate individual quotas to the concerned vessels.

2. By 30 January each year, CPCs shall submit to ICCAT Secretariat, the number of catching vessels established pursuant to paragraph 1 of this Annex.

3. CPCs shall issue specific authorizations to the catching vessel referred to in paragraph 1 and shall transmit the list of such catching vessels to ICCAT Secretariat.

4. Any subsequent changes shall not be accepted unless a notified catching vessel is prevented from participation due to legitimate operational reasons or force majeure. In such circumstances CPC concerned shall immediately inform the ICCAT Executive Secretariat, providing:

   a) full details of the intended replacement of the catching vessel referred to in paragraph 3 of this Annex;
   b) a comprehensive account of the reasons justifying the replacement and any relevant supporting evidence or references.

5. Each CPC shall allocate no more than 7% of its quota for bluefin tuna among its baitboats and trolling boats, with up to a maximum of 100 t of bluefin tuna weighing no less than 6.4kg caught by baitboat vessels of an overall length of less than 17 m by derogation to paragraph 28 of this Recommendation.

6. Each CPC may allocate no more than 2% of its quota for bluefin tuna among its coastal artisanal fishery for fresh fish in the Mediterranean.

   Each CPC may allocate no more than 90% of its quota for bluefin tuna among its catching vessel in Adriatic for farming purposes.

7. Authorized catching vessels pursuant to paragraph 1 of this Annex shall only land bluefin tuna catches in designated ports. To this end, each CPC shall designate ports in which landing of bluefin tuna is authorized and communicate a list of these ports to the ICCAT Secretariat by 1 March each year.

   For a port to be determined as designated port, the port State shall specify permitted landing times and places. The port State shall ensure full inspection coverage during all landing times and at all landing places.

   On the basis of this information the ICCAT Secretariat shall maintain a list of designated ports on the ICCAT website for these fisheries.

8. Prior to entry into any designated port, authorized catching vessels in accordance with paragraph 4 of this Annex or their representative, shall provide the competent port authorities at least 4 hours before the estimated time of arrival with the following:

   a) estimated time of arrival,
   b) estimate of quantity of bluefin tuna retained on board,
   c) information on the zone where the catches were taken;

   Each landing shall be subjected to an inspection in port.

   Port state authorities shall keep a record of all prior notice for the current year.

9. CPCs shall implement a catch reporting regime that ensures that an effective monitoring of the utilization of each vessels quota.

10. Bluefin tuna catches may not be offered for retail sale to the final consumer, irrespective of the marketing method, unless appropriate marking or labeling indicates:

    a) the species, fishing gear used,
    b) the catch area and date.

11. Beginning 1 July 2007, CPCs whose baitboats, longliners, handliners and trolling boats are authorized to fish for bluefin tuna in the East Atlantic and Mediterranean shall institute tail tag requirements as follows:

    a) Tail tags must be affixed on each bluefin tuna immediately upon offloading.
    b) Each tail tag shall have a unique identification number and be included on bluefin tuna catch documents and written on the outside of any package containing tuna.

12. The master of the catching vessel shall ensure that any quantity of bluefin tuna landed in designated port shall be weighed before first sale or before being transported elsewhere from the port of landing.

Annex 2

Minimum specification for logbooks:

1. The logbook must be numbered by sheets.
2. The logbook must be filled in every day (midnight) or before port arrival
3. The logbook must be completed in case of at sea inspections
4. One copy of the sheets must remain attached to the logbook
5. Logbooks must be kept on board to cover a period of one-year operation.

Minimum standard information for logbooks:

1. Master name and address
2. Dates and ports of departure, Dates and ports of arrival
3. Vessel name, register number, ICCAT number and IMO number (if available). In case of joint fishing operations, vessel names, register numbers, ICCAT numbers and IMO numbers (if available) of all the vessels involved in the operation.
4. Fishing gear:
   a) Type FAO code
   b) Dimension (length, mesh size, number of hooks ...)
5. Operations at sea with one line (minimum) per day of trip, providing:
   a) Activity (fishing, steaming…)
   b) Position: Exact daily positions (in degree and minutes), recorded for each fishing operation or at noon when no fishing has been conducted during this day.
   c) Record of catches:
6. Species identification:
   a) by FAO code
   b) round (RWT) weight in kg per day
   c) number of pieces per day
7. Master signature
8. Observer signature (if applicable)
9. Means of weight measure: estimation, weighing on board and counting.
10. The logbook is kept in equivalent live weight of fish and mentions the conversion factors used in the evaluation.

Minimum information in case of landing, transhipment/transfer:

1. Dates and port of landing /transhipment/transfer
2. Products
   a) presentation
   b) number of fish or boxes and quantity in kg
3. Signature of the Master or Vessel Agent

Annex 3

Document No. **ICCAT Transfer/Transhipment Declaration**

Tug/Carrier vessel	**Fishing Vessel**	**Farm of destination**	**Trap**
Name of vessel and radio call sign:	Name of the vessel and radio call sign,		
Flag:	Flag:	Name	Name
Flag State authorization No.	Flag State authorization No.	ICCAT Register number	ICCAT Register number
National Register No.	National register No.		
ICCAT Register No.	ICCAT Register No.		
IMO No.	External identification:		
	Fishing logbook sheet No.		

	Day	Month	Hour	Year	|2_|0_|__|__|	F.V Master's/trap operator name:	Tug/Carrier Master's name:	LOCATION OF TRANSHIPMENT
Departure	|__|__|	|__|__|	|__|__|	from	|__________|			
Return	|__|__|	|__|__|	|__|__|	to	|__________|	Signature:	Signature:	
Tranfer/Transh.	|__|__|	|__|__|	|__|__|		|__________|			

For transhipment, indicate the weight in kilograms or the unit used (e.g. box, basket) and the landed weight in kilograms of this unit: |___| kilograms.
In case of transfer of live fish indicate number of unit and live weight

Port	Sea Lat.	Sea Long.	Species	Number of unit of fishes	Type of Product Live	Type of Product Whole	Type of Product Gutted	Type of Product Head off	Type of Product Filleted	Type of Product	further transfer / transhipments
											Date: Place/Position: Authorization CP No. Transfer vessel Master signature: Name of receiver vessel: Flag ICCAT Register No. IMO N° Master's signature Date: Place/Position: Authorization CP No. Transfer vessel Master's signature: Name of receiver vessel: Flag ICCAT Register No. IMO No. Master's signature

ICCAT Observer signature (if applicable).
Obligations in case of transfer/transhipment:

1. The original of the transfer/transhipment declaration must be provided to the recipient vessel (tug/processing/transport).
2. The copy of the transfer/transhipment declaration must be kept by the correspondent catching vessel or trap.
3. Further transfers or transhipping operations shall be authorized by the relevant CP which authorized the vessel to operate.
4. The original of the transfer/transhipment declaration has to be kept by the recipient vessel which holds the fish, up to the farm or the landing place.
5. The transfer or transhipping operation shall be recorded in the logbook of any vessel involved in the operation.

Annex 4

Allocation Scheme for 2007-2010

Recovery Plan for a four-year period (Unit: t)

	2007	*2008*	*2009*	*2010*
Albania			50.00	50.00
Algerie	1,511.27	1,460.04	1,117.42	1,012.13
China (People's Republic)	65.78	63.55	61.32	56.86
Croatia	862.31	833.08	641.45	581.51
Egypt			50.00	50.00
European Community*	16,779.55	16,210.75	12,406.62	11,237.59
Iceland	53.34	51.53	49.72	46.11
Japan	2,515.82	2,430.54	1,871.44	1,696.57
Korea	177.80	171.77	132.26	119.90
Libya	1,280.14	1,236.74	946.52	857.33
Maroc	2,824.30	2,728.56	2,088.26	1,891.49
Norway	53.34	51.53	49.72	46.11
Syria	53.34	51.53	50.00	50.00
Tunisie	2,333.58	2,254.48	1,735.87	1,573.67
Turkey	918.32	887.19	683.11	619.28
Chinese Taipei	71.12	68.71	66.30	61.48

*Fishing possibilities for EC-Malta and EC-Cyprus as follows: 2007: 355.59 t and 154.68 t, respectively, 2008: 343.54 t and 149.44 t, respectively.

Annex 5

Catch Report Form

ICCAT Weekly Catch Report											
							Caught				
Flag	*ICCAT Number*	*Vessel Name*	*Report Start date*	*Report End date*	*Report Duration (d)*	*Catch date*	*Weight (kg)*	*Number of Pieces*	*Average Weight (kg)*	*Attributed Weight in case JFO (kg)*

Annex 6

Joint Fishing Operation

Flag State	*Vessel Name*	*ICCAT No.*	*Duration of the Operation*	*Identity of the Operators*	*Vessels individual quota*	*Allocation key per vessel*	*Fattening and farming farm destination*	
							CPC	*ICCAT No.*

Date ………………………………………..

Validation of the flag State …………………………………..

Annex 7

ICCAT Regional Observer Program

1. Each CPC shall require its farms, its purse seine vessels over 24 m and its purse seine vessels involved in joint fishing operations to carry an ICCAT observer during all the fishing and harvesting period in the Convention area.

2. By 1 February each year, CPCs shall notify to the ICCAT Executive Secretariat a list of its observers.

3. The Secretariat of the Commission shall appoint the observers before 1 March each year, and shall place them into farms and on board the purse seine vessels flying the flag of Contracting Parties and of non-Contracting Cooperating Parties, Entities or Fishing Entities that implement the ICCAT observer program. An ICCAT observer card shall be issued for each observer.

4. The Secretariat shall issue a contract listing the rights and duties of the observer and the master of the vessel or farm operator. This contract shall be signed by both parties involved.

5. The Secretariat shall establish an ICCAT observer program manual.

Designation of the observers

6. The designated observers shall have the following qualifications to accomplish their tasks:

   - sufficient experience to identify species and fishing gear;
   - satisfactory knowledge of the ICCAT conservation and management measures assessed by a certificate provided by the CPCs and based on ICCAT training guidelines;
   - the ability to observe and record accurately;
   - a satisfactory knowledge of the language of the flag of the vessel or farm observed.

Obligations of the observer

7. Observers shall:

   a) have completed the technical training required by the guidelines established by ICCAT;
   b) be nationals of one of the CPCs and, to the extent possible, not of the farm State or flag State of the purse seine vessel;
   c) be capable of performing the duties set forth in point 8 below;
   d) be included in the list of observers maintained by the Secretariat of the Commission;
   e) not have current financial or beneficial interests in the bluefin tuna fishery.

8. The observer tasks shall be in particular:

   a) As regards observers on purse-seine vessels, to monitor the purse seine vessels' compliance with the relevant conservation and management measures adopted by the Commission. In particular the observers shall:

      i) record and report upon the fishing activities carried out;
      ii) observe and estimate catches and verify entries made in the logbook;
      iii) issue a daily report of the purse seiner vessels' transfer activities;
      iv) sight and record vessels which may be fishing in contravention to ICCAT conservation and management measures;
      v) record and report upon the transfer activities carried out;
      vi) verify the position of the vessel when engaged in transfer;
      vii) observe and estimate products transferred, including through the review of video recordings;
      viii) verify and record the name of the fishing vessel concerned and its ICCAT number;
      ix) carry out scientific work such as collecting task II data when required by the Commission, based on the directives from the SCRS.

b) As regards observers in the farms, to monitor the farms' compliance with the relevant conservation and management measures adopted by the Commission. In particular the observers shall:

   i) verify the data contained in the transfer declaration and caging declaration, including through the review of video records;
   ii) certify the data contained in the transfer declaration and caging declaration;
   iii) issue a daily report of the farms' transfer activities;
   iv) countersign the transfer declaration and caging declaration;
   v) carry out such scientific work, for example collecting samples, as required by the Commission, based on the directives from the SCRS.

c) establish general reports compiling the information collected in accordance with this paragraph and provide the master and farm operator the opportunity to include therein any relevant information.
d) submit to the Secretariat the aforementioned general report within 20 days from the end of the period of observation.
e) exercise any other functions as defined by the Commission.

9. Observers shall treat as confidential all information with respect to the fishing and transfer operations of the purse seiners and of the farms and accept this requirement in writing as a condition of appointment as an observer;

10. Observers shall comply with requirements established in the laws and regulations of the flag or farm State which exercises jurisdiction over the vessel or farm to which the observer is assigned.

11. Observers shall respect the hierarchy and general rules of behavior which apply to all vessel and farm personnel, provided such rules do not interfere with the duties of the observer under this program, and with the obligations of vessel and farm personnel set forth in paragraph 12 of this program.

Obligations of the flag States of purse seine vessels and farm States

12. The responsibilities regarding observers of the flag States of the purse seine vessels and their masters shall include the following, notably:
   a) Observers shall be allowed to access to the vessel and farm personnel and to the gear, cages and equipment;
   b) Upon request, observers shall also be allowed access to the following equipment, if present on the vessels to which they are assigned, in order to facilitate the carrying out of their duties set forth in paragraph 8:

      i) satellite navigation equipment;
      ii) radar display viewing screens when in use;
      iii) electronic means of communication;

   c) Observers shall be provided accommodations, including lodging, food and adequate sanitary facilities, equal to those of officers;
   d) Observers shall be provided with adequate space on the bridge or pilot house for clerical work, as well as space on deck adequate for carrying out observer duties; and
   e) The flag States shall ensure that masters, crew, farm and vessel owners do not obstruct, intimidate, interfere with, influence, bribe or attempt to bribe an observer in the performance of his/her duties.

The Secretariat, in a manner consistent with any applicable confidentiality requirements, is requested to provide to the farm State or flag State of the purse seine vessel, copies of all raw data, summaries, and reports pertaining to the trip. The Secretariat shall submit the observer reports to the Compliance Committee and to the SCRS.

Observer fees

a) The costs of implementing this program shall be financed by the farm operators and purse seiner's owners. The fee shall be calculated on the basis of the total costs of the program. This fee shall be paid into a special account of the ICCAT Secretariat and the ICCAT Secretariat shall manage the account for implementing the program;
b) No observer shall be assigned to a vessel or farm for which the fees, as required under subparagraph a), have not been paid.

Annex 8

ICCAT Scheme of Joint International Inspection

Pursuant to paragraph 3 of Article IX of the Convention, the ICCAT Commission recommends the establishment of the following arrangements for international control outside the waters under national jurisdiction for the purpose of ensuring the application of the Convention and the measures in force thereunder:

I. Serious violations

1. For the purposes of these procedures, a serious violation means the following violations of the provisions of the ICCAT conservation and management measures adopted by the Commission:

    a. fishing without a license, permit or authorization issued by the flag CPC,
    b. failure to maintain sufficient records of catch and catch-related data in accordance with the Commission's reporting requirements or significant misreporting of such catch and/or catch-related data;
    c. fishing in a closed area;
    d. fishing during a closed season;
    e. intentional taking or retention of species in contravention of any applicable conservation and management measure adopted by the ICCAT;
    f. significant violation of catch limits or quotas in force pursuant to the ICCAT rules;
    g. using prohibited fishing gear;
    h. falsifying or intentionally concealing the markings, identity or registration of a fishing vessel;
    i. concealing, tampering with or disposing of evidence relating to investigation of a violation;
    j. multiple violations which taken together constitute a serious disregard of measures in force pursuant to the ICCAT;
    k. assault, resist, intimidate, sexually harass, interfere with, or unduly obstruct or delay an authorized inspector or observer;
    l intentionally tampering with or disabling the vessel monitoring system;
    m. such other violations as may be determined by the ICCAT, once these are included and circulated in a revised version of these procedures;
    n. fishing with assistance of spotter planes;
    o. interference with the satellite monitoring system and/or operates without VMS system;
    p. transfer activity without transfer declaration.

2. In the case of any boarding and inspection of a fishing vessel during which the authorized inspectors observe an activity or condition that would constitute a serious violation, as defined in paragraph 1, the authorities of the inspection vessels shall immediately notify the authorities of the fishing vessel, directly as well as through the ICCAT Secretariat.

3. The flag State CPC shall ensure that, following the inspection referred to in paragraph 2 of this Annex, the fishing vessel concerned ceases all fishing activities. The flag State CPC shall require the fishing vessel to proceed immediately to a port designated by it, and where an investigation shall be initiated.

    If the vessel is not called to port; the CPC must provide due justification in a timely manner to the Executive Secretary, who shall made it available on request to other Contracting parties

II. Conduct of inspections

4. Inspection shall be carried out by inspectors of the fishery control services of Contracting Governments. The names of the inspectors appointed for that purpose by their respective governments shall be notified to the ICCAT Commission;

5. Ships carrying inspectors shall fly a special flag or pennant approved by the ICCAT Commission to indicate that the inspector is carrying out international inspection duties. The names of the ships so used for the time being, which may be either special inspection vessels or fishing vessels, shall be notified to the ICCAT Commission, as soon as may be practical;

6. Each inspector shall carry an identity document supplied by the authorities of the flag State in the form shown in paragraph 17 of this Annex and giving him an appointment stating that he has authority to act under arrangements approved by the ICCAT Commission. This identity document shall be valid for a minimum of five years;

7. Subject to the arrangements agreed under paragraph 12 of this Annex, a vessel employed for the time being in fishing for tuna or tuna-like fishes in the Convention Area outside the waters within its national jurisdiction shall stop when given the appropriate signal in the International Code of Signals by a ship carrying an inspector unless it is actually carrying out fishing operations, in which case it shall stop immediately once it has finished such operations. The master[1] of the vessel shall permit the inspector, who may be accompanied by a witness, to board it. The master shall enable the inspector to make such examination of catch or gear and any relevant documents as the inspector deems necessary to verify the observance of the ICCAT Commission's recommendations in force in relation to the flag State of the vessel concerned and the inspector may ask for any explanations that he deems necessary;

8. On boarding the vessel an inspector shall produce the document described in paragraph 6 of this Annex. Inspections shall be made so that the vessel suffers the minimum interference and inconvenience and the quality of the fish does not deteriorate. An inspector shall limit his enquiries to the ascertainment of the observance of the ICCAT Commission's recommendations in force in relation to the flag State of the vessel concerned. In making his examination an inspector may ask the master for any assistance he may require. He shall draw up a report of his inspection in a form approved by the ICCAT Commission. He shall sign the report in the presence of the master of the vessel who shall be entitled to add or have added to the report any observations which he may think suitable and must sign such observations. Copies of the report shall be given to the master of the vessel and to the inspector's government, which shall transmit copies to the appropriate authorities of the flag State of the vessel and to the ICCAT Commission. Where any infringement of the recommendations is discovered the inspector should, where possible, also inform the competent authorities of the flag State, as notified to the ICCAT Commission, and any inspection ship of the flag State known to be in the vicinity;

9. Resistance to an inspector or failure to comply with his directions shall be treated by the flag State of the vessel in a manner similar to resistance to any inspector of that State or a failure to comply with his directions;

10. Inspector shall carry out their duties under these arrangements in accordance with the rules set out in this recommendation but they shall remain under the operational control of their national authorities and shall be responsible to them;

11. Contracting Governments shall consider and act on reports of foreign inspectors under these arrangements on a similar basis in accordance with their national legislation to the reports of national inspectors. The provisions of this paragraph shall not impose any obligation on a Contracting Government to give the report of a foreign inspector a higher evidential value than it would possess in the inspector's own country. Contracting Governments shall collaborate in order to facilitate judicial or other proceedings arising from a report of an inspector under these arrangements;

12. a) Contracting Governments shall inform the ICCAT Commission by 1 March each year of their provisional plans for participation in these arrangements in the following year and the Commission may make suggestions to Contracting Governments for the coordination of national operations in this field including the number of inspectors and ships carrying inspectors;

    b) the arrangements set out in this recommendation and the plans for participation shall apply between Contracting Governments unless otherwise agreed between them, and such agreement shall be notified to the ICCAT Commission:
    Provided however, that implementation of the scheme shall be suspended between any two Contracting Governments if either of them has notified the ICCAT Commission to that effect, pending completion of an agreement;

[1] Master refers to the individual in charge of the vessel.

13. a) the fishing gear shall be inspected in accordance with the regulations in force for the subarea in which the inspection takes place. The inspector will state the nature of this violation in this report;

b) inspectors shall have the authority to inspect all fishing gear in use or that fishing gear on deck ready for use;

14. The inspector shall affix an identification mark approved by the ICCAT Commission to any fishing gear inspected which appears to be in contravention of the ICCAT Commission's recommendations in force in relation to the flag State of the vessel concerned and shall record this fact in his report;

15. The inspector may photograph the gear in such a way as to reveal those features which in his opinion are not in conformity with the regulation in force, in which case the subjects photographed should be listed in the report and copies of the photographs should be attached to the copy of the report to the flag State;

16. The inspector shall have authority, subject to any limitations imposed by the ICCAT Commission, to examine the characteristics of catches, to establish whether the ICCAT Commission's recommendations are being complied with.

He shall report his findings to the authorities of the flag State of the inspected vessel as soon as possible. (*Report for Biennial Period, 1974-75, Part II*).

17. New proposed model Identity Card for inspectors.

Dimensions: Width 10.4cm, Height 7cm

INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNA

ICCAT

Inspector Identity Card

Photograph

Contracting Party:

Inspector Name:

Card nº:

Issue Date: Valid five years

ICCAT

The holder of this document is an ICCAT inspector duly appointed under the terms of the Scheme of Joint International Inspection and Surveillance of the International Commission for the Conservation of the Atlantic Tuna and has the authority to act under the provision of the ICCAT Control and Enforcement measures.

………………………… ICCAT Executive Secretary Issuing Authority

………………………… Inspector

09-06 **BFT**

RECOMMENDATION AMENDING RECOMMENDATION 08-05 TO ESTABLISH A MULTIANNUAL RECOVERY PLAN FOR BLUEFIN TUNA IN THE EASTERN ATLANTIC AND MEDITERRANEAN

THE INTERNATIONAL COMMISSION FOR THE CONSERVATION
OF ATLANTIC TUNAS (ICCAT) RECOMMENDS THAT:

Total Allowable Catch (TAC) and associated conditions

1. The total allowable catches for eastern Atlantic and Mediterranean bluefin tuna shall be set at 13,500 t in 2010. The allocation scheme established by Recommendation 08-05 shall remain unchanged.

2. The SCRS shall present a Kobe II strategy matrix reflecting recovery scenarios of eastern Atlantic and Mediterranean bluefin tuna in accordance with the multiannual recovery plan of the present Recommendation.

3. The Commission shall establish at its 2010 meeting a three-year recovery plan for 2011-2013 with the goal of achieving B_{MSY} through 2022 with at least 60% of probability, on a basis of the SCRS advice described in paragraph 2 above.

4. If the SCRS stock assessment detects a serious threat of fishery collapse, the Commission shall suspend all the fisheries for eastern Atlantic and Mediterranean bluefin tuna in 2011. Contracting Party, and Cooperating non-Contracting Party, Entity or Fishing Entity (hereafter referred to as CPCs) shall immediately intensify research activities so that SCRS can conduct further analysis and present recommendations on conservation and management measures necessary to resume the fisheries.

Closed fishing season

5. Purse seine fishing for bluefin tuna shall be prohibited in the eastern Atlantic and Mediterranean during the period from 15 June to 15 May.

6. The bad weather clause allowing for a possible extension of up to 5 days until 20 June (paragraph 21 of Rec. 08-05) shall be cancelled.

Further reduction of fishing capacity

7. Without prejudice to paragraph 45 of Rec. 08-05, each CPC shall reduce its fishing capacity referred to in paragraphs 42, 43 and 44 of Rec. 08-05 so as to ensure that the discrepancy between its fishing capacity and its fishing capacity commensurate with its allocated quota in 2011, 2012 and 2013, in accordance with the methodology approved at the 2009 annual meeting, shall be reduced by:

   a) at least 50% in 2011
   b) 20% in 2012
   c) 5% in 2013

8. Management plans on fishing capacity for the remaining period shall be submitted annually for discussion and approval by the Commission.

Joint fishing operations

9. For each CPC, the number of joint fishing operations between CPCs from 2010 shall be limited to the level of 2007, 2008 or 2009. Before the start of the fishing season, each concerned CPC shall notify the number of its joint fishing operations with other CPCs to the ICCAT Secretariat.

Inter-sessional meeting on compliance

10. The Commission shall review and determine each CPC´s compliance, in particular that with paragraph 1 above and paragraph 46 of Recommendation 08-05, at its special session before the 2010 fishing season starts.

11. The Commission shall decide on the interim suspension or reduction of quota for the declared non compliant CPC, depending on the extent of the established non-compliance.

06-07 **BFT**

RECOMMENDATION BY ICCAT ON BLUEFIN TUNA FARMING

*TAKING INTO ACCO*UNT the increasing development of bluefin tuna farming activities, especially in the Mediterranean;

*RECALLIN*G the conclusions of 6th Ad Hoc GFCM/ICCAT Joint Working Group Meeting on Stocks of Large Pelagic Fishes in the Mediterranean Sea relative to the effects of the bluefin tuna farming and on the solutions that could be studied to regulate this activity;

*CONSIDERIN*G the advice of the 2001 Standing Committee on Research and Statistics (SCRS) on effects of bluefin tuna farming in the Mediterranean on the collection of data and consequently on stock assessment procedures;

*DESIRIN*G to gradually implement effective management measures that permit the development of bluefin tuna farming in a responsible and sustainable manner in relation to the management of bluefin tuna;

NOTING the potential advantages of the use of underwater video monitoring in estimating the number of fish,

CONSIDERING the on-going work to establish a Bluefin Tuna Catch Documentation Programme,

THE INTERNATIONAL COMMISSION FOR THE CONSERVATION
OF ATLANTIC TUNAS (ICCAT) RECOMMENDS THAT:

1. Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities (hereafter referred to as CPCs) whose flag vessels fish or transfer quantities of bluefin tuna to cages for farming shall undertake the necessary measures:

   a) to require that the captains of vessels (including tugs and towing vessels) carrying out transfer operations of bluefin tuna for caging maintain vessel logs and report the quantities transferred and the number of fish as well as the date, place of harvest and name of the vessel and of the company responsible for the caging. This detailed information shall be entered into a register which shall contain details of all the transhipments carried out during the fishing season. This register shall be kept onboard and be accessible at any time for control purposes.

   b) to require the reporting of the total amount of the transfers of bluefin tuna including loss in quantity and number during the transportation to the cages by farm for fattening and farming, carried out by their flag vessels.

   c) to set up and maintain a list of their flag vessels that fish for, provide or transport bluefin tuna for farming purposes (name of the vessel, flag, license number, gear type), i.e., fishing boat, transport vessel, vessels with pools, etc.

   d) to equip these tugs and towing vessels with an operational satellite tracking and monitoring system (VMS).

2. The CPCs under whose jurisdiction the farms for bluefin tuna are located in the Convention area shall adopt the necessary measures to:

   a) assign an identifiable different number to each cage of its farming facility.

   b) ensure that a caging declaration is submitted to the farming CPCs by the operator for further submission to the Commission in accordance with the ICCAT format in the attached **Annex**, on each fishing or transport vessel that participated in the transfer of tuna to cages for fattening, including the quantities of bluefin tuna destined for farming. This declaration shall include information relative to the validation numbers and dates of the bluefin tuna statistical document(s), the quantities (in t) of fish transferred to the cages, the number of fish, loss during transportation, the date, the place, the location of the catch, the name of the vessel, fishing methods used, as well as its flag and license number;

c) ensure that the tuna farms and the national scientific institutes obtain data as specified in the following paragraph on the size composition of the fish caught as well as the date, time and area of catch and the fishing method used, in order to improve statistics for stock assessment purposes;

To this end, establish a sampling program for the estimation of the numbers-at-size of the bluefin tuna caught which requires notably that size sampling (length or weight) at cages must be done on one sample (=100 specimens) for every 100 t of live fish, or on a 10% sample of the total number of the caged fish. Size samples will be collected during harvesting[1] at the farm and on the dead fish during transport, following the ICCAT methodology for reporting Task II. The sampling should be conducted during any harvesting, covering all cages. Data must be transmitted to ICCAT, by 31 July for the sampling conducted the previous year.

d) ensure the reporting of the quantities of bluefin tuna placed in cages and of estimates of the growth and mortality while in captivity and of the amounts sold (in t);

e) set up and maintain a registry of the farming facilities under their jurisdiction;

f) each CPC referred to in this paragraph shall nominate a single authority responsible for coordinating the collection and verification of information on caging activities and for reporting to and cooperating with the CPC whose flag vessels have fished the caged tuna.

This single authority shall submit, to the CPCs whose flag vessels have fished the caged tuna, a copy of each caging declaration referred to in paragraph 2a and of its supporting Bluefin Tuna Statistical Document, within one week after the completion of the transfer operation of bluefin tuna into cages.

3. CPCs mentioned in paragraphs 1 and 2 shall take the appropriate measures to verify the accuracy of the information received and shall cooperate to ensure that quantities caged are consistent with the reported catches (logbook) amount of each fishing vessel.

4. The CPCs that export farmed bluefin tuna products shall ensure that these products be accompanied by the ICCAT Bluefin Tuna Statistical Document and, where appropriate, that these products be identified as "farmed" with cage number of 2 a) and ICCAT FFB Record Number on the ICCAT Bluefin Tuna Statistical Document.

5. The CPCs shall transmit, each year, to the Executive Secretary, prior to 31 August:

- the total amount of the transfer of bluefin tuna by farm 1 b).
- the list of flag vessels provided for in paragraph 1c),
- the results of the program referred to in paragraph 2 c),
- the quantities of bluefin tuna placed in cage and estimate of the growth and mortality by farm 2 d),
- the quantities of bluefin tuna caged during the previous year,
- the quantities by sourcing of origin marketed during the previous year.

6. The CPCs mentioned in this recommendation as well as the Contracting Parties that import bluefin tuna shall cooperate, particularly through the exchange of information.

7. The Commission shall request non-Contracting Parties that farm bluefin tuna in the Convention area to cooperate in the implementation of this recommendation.

8. Based on the information referred to in paragraph 4 on the Bluefin Tuna Statistical Document reports and the Task I data, the Commission shall review the effectiveness of these measures.

[1] For fish farmed more than one year, other additional sampling methods should be established.

9. a) The Commission shall establish and maintain an ICCAT record of farming facilities authorized to operate for farming of bluefin tuna caught in the Convention area (hereafter referred to as FFBs). For the purposes of this recommendation, FFBs not entered into the record are deemed not to be authorized to operate for farming of bluefin tuna caught in the Convention area.

   b) Each CPC under whose jurisdiction FFBs are located shall submit electronically, where possible, to the ICCAT Executive Secretary by 31 August 2004 the list of its FFBs that are authorized to operate for farming of bluefin tuna. This list shall include the following information:

   - name of the FFB, register number,
   - names and addresses of owner (s) and operator (s),
   - location,
   - farming capacity (in t)

   c) Each CPC shall notify the Executive Secretary, after the establishment of the ICCAT record of FFBs, of any addition to, any deletion from and/or any modification of the ICCAT record of FFBs at any time such changes occur.

   d) The ICCAT Executive Secretary shall maintain the ICCAT record of FFBs, and take any measure to ensure publicity of the record through electronic means, including placing it on the ICCAT website, in a manner consistent with confidentiality requirements noted by CPCs.

   e) The CPCs under whose jurisdiction FFBs are located shall take the necessary measures to ensure that their FFBs comply with the relevant ICCAT measures.

   f) To ensure the effectiveness of ICCAT conservation and management measures pertaining to bluefin tuna:

      i) CPCs under whose jurisdiction FFBs are located shall validate Bluefin Tuna Statistical Documents only for the farms on the ICCAT record of FFBs,

      ii) CPCs shall require farmed bluefin tuna, when imported into their territory to be accompanied by the Bluefin Tuna Statistical Document.

      iii) CPCs importing farmed bluefin tuna and the States that authorize the FFB shall cooperate to ensure that the Bluefin Tuna Statistical Documents are not forged or do not contain misinformation.

   g) Each CPC shall take the necessary measures, under their applicable legislation, to prohibit the imports and sale of bluefin tuna into and from farms not registered in the ICCAT record of farming facilities authorised to operate as well as those that do not respect the sampling requirements foreseen in paragraph 2c and/or do not participate in the sampling programme referred to in paragraph 2c.

10. a) The Commission shall establish and maintain an ICCAT record of vessels that fish for, provide or transport bluefin for farming, i.e., fishing boats, transport vessels, vessels with pools, etc.

   For the purpose of this recommendation the vessels not entered into the record are deemed not to be authorized to fish for, provide or transport bluefin tuna for farming.

   b) Each CPC shall submit, electronically where possible, to the ICCAT Executive Secretary by 31 August 2006 the list of the vessels that are authorized to operate for farming of bluefin tuna. This list shall include the following information:

   - name of the vessel, registry number
   - previous flag (if any)
   - previous name (if any)
   - previous details of deletion for other registers (if any)
   - international radio call sign (if any)
   - type of vessels, length and gross registered tonnage (GRT)

- name and address of owner(s) and operator(s)
- gear used
- time period authorised for fishing and/or providing or transporting bluefin tuna for farming.

c) Each CPC shall promptly notify, after the establishment of the initial ICCAT record, the ICCAT Executive Secretary of any addition to, any deletion from and/or any modification of the ICCAT record and any time such changes occur.

d) The ICCAT Executive Secretary shall maintain the ICCAT record and take any measure to ensure publicity of the record and through electronic means, including placing it on the ICCAT website in a manner consistent with confidentiality requirement noted by CPCs.

11. Each CPC shall take the necessary measures so that the FFBs do not receive bluefin tuna from vessels that are not included in the ICCAT record (fishing vessels, transport vessels, vessels with pools, etc.

12. The SCRS shall undertake trials to identify growth rates including weight gains during the fattening or caging period.

13. This Recommendation replaces the *Recommendation by ICCAT to Amend the Recommendation on Bluefin Tuna Farming* [Rec. 05-04].

ICCAT DECLARATION ON CAGING

Vessel name	Flag	Registration Number Identifiable cage number	Date of catch	Place of catch Longitude Latitude	Bluefin Tuna Statistical Document validation number	Bluefin Tuna Statistical Document date	Date of caging	Quantity placed in cage (t)	Number of fish placed in cage for fattening	Size composition	Fattening facility *

*Facility authorized to operate for fattening of bluefin tuna caught in the Convention area.

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07-08 **GEN**

RECOMMENDATION BY ICCAT CONCERNING DATA EXCHANGE FORMAT AND PROTOCOL IN RELATION TO THE VESSEL MONITORING SYSTEM (VMS) FOR THE BLUEFIN TUNA FISHERY IN THE ICCAT CONVENTION AREA

IN ACCORDANCE WITH paragraph 49 of the *Recommendation by ICCAT to Establish a Multı-annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 06-05];

THE INTERNATIONAL COMMISSION FOR THE CONSERVATION
OF ATLANTIC TUNAS (ICCAT) RECOMMEMDS THAT:

1. Each flag Contracting Party, Cooperating non-Contracting Party, Entity or Fishing Entity (hereinafter referred to as "CPCs") shall implement a vessel monitoring system (VMS) for its bluefin tuna fishing vessels referred to in paragraph 49 of the *Recommendation by ICCAT to Establish a Multı-annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 06-05], in accordance with the *Recommendation by ICCAT Concerning Minimum Standards for the Establishment of a Vessel Monitoring System in the ICCAT Convention Area* [Rec. 03-14].

2. The autonomous system referred to in paragraph 1(a) of the *Recommendation by ICCAT Concerning Minimum Standards for the Establishment of a Vessel Monitoring System in the ICCAT Convention Area* [Rec. 03-14] shall be in conformity with the specifications and schedule set out in **Annex 1**.

3. Each CPC shall communicate electronically the messages pursuant to paragraph 1 here above to the ICCAT Secretariat. In the event of technical malfunction, the messages shall however be transmitted electronically to the ICCAT Secretariat within 24 hours of receipt.

4. Not later than 31 January 2008, the CPCs shall transmit the messages to the ICCAT Secretariat every six hours at least when operating in the ICCAT Convention area. The messages should be sequentially numbered (with a unique identifier) in order to avoid duplication.

5. Each CPC shall ensure that the messages transmitted by their corresponding Fishing Monitoring Centre (hereinafter referred to as "FMCs") to the ICCAT Secretariat shall be in accordance with the data exchange format set out in **Annex 2**.

6. CPCs engaged in inspection at sea operations in the Convention area in accordance with the ICCAT Scheme of Joint International Inspection referred to in paragraphs 56 and 57 of the *Recommendation by ICCAT to Establish a Multı-annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 06-05] shall request the ICCAT Secretariat to make available the messages received under paragraph 3 for all fishing vessels within 100 n miles of the inspection vessel(s) at sea.

7. CPCs shall take the necessary measures to assure that all messages shall be treated in a confidential manner, and be limited for the inspection at sea operations referred to in paragraph 6. The ICCAT Secretariat shall ensure the confidential treatment of the messages received. Data three years old or more shall be available to the SCRS for scientific purposes, given due consideration of data confidentiality.

Annex 1

1. Each CPC shall establish and operate fishing monitoring centres, hereinafter referred to as "FMC", which shall monitor the fishing activities of vessels flying their flags. The FMC shall be equipped with computer hardware and software enabling automatic data processing and electronic data transmission. Each CPC shall provide for back-up and recovery procedures in case of system failures.

2. The CPC of the vessel shall take the necessary measures to ensure that the data received from its fishing vessels to which VMS applies are recorded in computer readable form for a period of three years.

3. The satellite tracking devices installed on board the fishing vessels shall ensure the automatic transmission to the FMC of the flag CPC, at all applicable times.

4. Each CPC shall take the necessary measures to ensure that its FMC receives the requested VMS data.

Annex 2

Format for the Communication of VMS messages by fishing vessels

A. Content of the position message

Data element	**Field code**	**Mandatory /optional**	**Remarks**
Start record	SR	M	Message detail; indicates start of record
Address	AD	M	Destination: ICCAT
Sequence No.	SQ	M[1]	Message detail; message serial number in current year
Type of message	TM[2]	M	Message detail; "POS" as Position message to be communicated by VMS or other means by vessels with a defective satellite tracking device
Radio call sign	RC	M	Vessel registration detail; international radio call sign of the vessel
Trip No.	TN	O	Activity detail; fishing trip serial number in current year
Vessel name	NA	O	Vessel registration detail; name of the vessel
Contracting Party internal reference No.	IR	O	Vessel registration detail. Unique Contracting Party vessel number as flag State 3-alpha country code followed by number
External registration No.	XR	O	Vessel registration detail; the side number of the vessel or IMO number in the absence of a side number
Latitude	LA	M[3]	Activity detail; position at time of transmission
Longitude	LO	M[3]	Activity detail; position at time of transmission
Latitude (decimal)	LT	M[4]	Activity detail; position at time of transmission
Longitude (decimal)	LG	M[4]	Activity detail; position at time of transmission
Date	DA	M	Message detail; date of transmission
Time	TI	M	Message detail; time of transmission
End of record	ER	M	System detail; indicates end of the record

[1] Optional in case of a VMS message.
[2] Type of message shall be "ENT" for the first VMS message from the Convention area as detected by the FMC of the Contracting Party. Type of message shall be "EXI" for the first VMS message from outside the Convention area as detected by the FMC of the Contracting Party, and the values for latitude and Longitude are, in this type of message, optional.
Type of message shall be "MAN" for reports communicated by vessels with a defective satellite tracking device.
[3] Mandatory for manual messages.
[4] Mandatory for VMS messages.

B. Structure of the position message:

Each data transmission is structured as follows:

- Double slash (//) and the characters "SR" indicate the start of a message.
- A double slash (//) and field code indicate the start of a data element.
- A single slash (/) separates the field code and the data.
- Pairs of data are separated by space.
- The characters "ER" and a double slash (//) indicate the end of a record.

09-11 **SDP**

RECOMMENDATION BY ICCAT AMENDING THE RECOMMENDATION 08-12 ON AN ICCAT BLUEFIN TUNA CATCH DOCUMENTATION PROGRAM

RECOGNIZING the situation of Atlantic bluefin tuna stocks and the impact that market factors have on the fishery;

TAKING INTO ACCOUNT the rebuilding plan for western Atlantic bluefin tuna and the recovery plan for eastern Atlantic and Mediterranean bluefin tuna that ICCAT has adopted, including the need for complementary market related measures;

RECOGNIZING the necessity to clarify and improve the implementation of the bluefin tuna catch documentation scheme, providing detailed instructions for the issuance, numbering, completion and the validation of the bluefin tuna catch document,

THE INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS (ICCAT) RECOMMENDS THAT:

PART I
GENERAL PROVISIONS

1. Each Contracting Party, Cooperating non-Contracting Party, Entity and Fishing Entity (hereafter referred to as CPCs) shall take the necessary steps to implement an ICCAT Bluefin Tuna Catch Documentation Scheme for the purpose of identifying the origin of any bluefin tuna in order to support the implementation of conservation and management measures.

2. For the purpose of this Program:

   a) "Domestic trade" means:

      – trade of bluefin tuna harvested in the ICCAT Convention area by a vessel or trap, which is landed in the territory of the CPC where the vessel is flagged or where the trap is established, and
      – trade of farmed bluefin tuna products originating from bluefin tuna harvested in the ICCAT Convention area by a vessel which is flagged to the same CPC where the farm is established, which is supplied to any entity in this CPC, and
      – trade between the Member States of the European Community of bluefin tuna harvested in the ICCAT Convention area by vessels flagged to one Member State or by a trap established in one Member State.

   b) "Export" means:

      Any movement of bluefin tuna in its harvested or processed form (including farmed) from the territory of the CPC where the fishing vessel is flagged or where the trap or farm is established to the territory of another CPC or non-Contracting Party, or from the fishing grounds to the territory of a CPC which is not the flag CPC of the fishing vessel or to the territory of a non-Contracting Party.

   c) "Import" means:

      Any introduction of bluefin tuna in its harvested or processed form (including farmed) into the territory of a CPC, which is not the CPC where the fishing vessel is flagged or where the trap or the farm is established.

   d) "Re-export" means: Any movement of bluefin tuna in its harvested or processed form (including farmed) from the territory of a CPC where it has been previously imported.

e) "flag State" means the State where the fishing vessel is flagged; "trap State" means the State where the trap is established; and "farm State" means the State where the farm is established.

3. CPCs shall require a completed Bluefin Tuna Catch Document (BCD) for each bluefin tuna:
   a) landed at its ports,
   b) delivered to its farms, and
   c) harvested from its farms.

   Each consignment of bluefin tuna domestically traded, imported into or exported or re-exported from its territories shall be accompanied by a validated BCD, except in cases where paragraph 12(c) applies and, as applicable, an ICCAT transfer declaration or a validated Bluefin Tuna Re-export Certificate (BFTRC). Any such landing, transfer, delivery, harvest, domestic trade, import, export or re-export of bluefin tuna without a completed and validated BCD or a BFTRC shall be prohibited.

4. In order to support an effective BCD, CPCs shall not place bluefin tuna into a farm not authorized by the CPC or listed in the ICCAT record.

5. Farm CPCs shall ensure that bluefin tuna catches are placed in separate cages or series of cages and partitioned on the basis of flag CPC origin. By derogation, if the bluefin tuna are caught in the context of a joint fishing operation, farm CPCs shall ensure that bluefin tuna are placed in separate cages or series of cages and partitioned on the basis of joint fishing operations.

6. Farm CPCs shall ensure that bluefin tuna are harvested from farms in the same year in which they were caught, or before the beginning of the purse seiners fishing period, if harvested in the following year. In the case where harvesting operations are not completed before this date, farm CPCs shall complete and transmit an annual carry-over declaration to the ICCAT Secretariat within 15 days after this date. Such declaration shall include:

   – quantities (expressed in kg) and number of fish intended to be carried over,
   – year of catch,
   – size composition,
   – flag CPC, ICCAT number and name of the catching vessel,
   – references of the BCD corresponding to the catches carried over,
   – name and ICCAT number of the fattening facility,
   – cage number, and
   – information on harvested quantities (expressed in kg), when completed.

7. Quantities carried over in accordance with paragraph 6 shall be placed in separate cages or series of cages in the farm on the basis of the catch year.

8. Each CPC shall provide BCD forms only to catching vessels and traps authorized to fish bluefin tuna in the Convention area, including as by-catch. Such forms are not transferable. Each BCD form shall have a unique document identification number. Document numbers shall be specific to the flag or trap State and assigned to the catching vessel or trap.

9. Domestic trade, export, import and re-export of fish parts other than the meat (i.e., heads, eyes, roes, guts and tails) shall be exempted from the requirements of this Recommendation.

PART II
VALIDATION OF BCDs

10. The catching vessel master or trap operator, or its authorized representative, or the operator of farms, or the authorized representative of the flag, farm, or trap State, shall complete the BCD by providing the required information in appropriate sections and request validation in accordance with paragraph 12 for a BCD for catch landed, transferred to cages, harvested, transhipped, domestically traded or exported on each occasion that it lands, transfers, harvests, tranships, domestically trades or exports bluefin tuna.

11. A validated BCD shall include, as appropriate, the information identified in **Annex 1** attached. A BCD format is attached as **Annex 2**. Instructions for the issuance, numbering, completion and validation of the BCD are attached as **Annex 3**. In cases where a section of the BCD format does not provide enough room to completely track movement of BFT from catch to market, the needed information section of the BCD maybe expanded as necessary and attached as an annex using the original BCD format and number. The authorized representative of the CPC shall validate the annex as soon as possible but not later than the next movement of BFT.

12. a) The BCD must be validated by an authorized government official, or other authorized individual or institution, of the flag State of the catching vessel, the State of the seller/exporter, or the trap or farm State that caught, harvested, domestically traded or exported the bluefin tuna.

b) The CPCs shall validate the BCD for all bluefin tuna products only when all the information contained in the BCD has been established to be accurate as a result of the verification of the consignment, and only when the accumulated validated amounts are within their quotas or catch limits of each management year, including, where appropriate, individual quotas allocated to catching vessels or traps, and when those products comply with other relevant ICCAT provisions of the conservation and management measures.

c) Validation under 12(a) shall not be required in the event that all bluefin tuna available for sale are tagged by the flag State of the catching vessel or the trap State that fished the bluefin tuna.

d) Where the bluefin tuna quantities caught and landed are less than 1 metric ton or three fish, the logbook or the sales note may be used as a temporary BCD, pending the validation of the BCD within seven days and prior to export.

PART III
VALIDATION OF BFTRCs

13. Each CPC shall ensure that each bluefin tuna consignment which is re-exported from its territory be accompanied by a validated Bluefin Tuna Re-export Certificate (BFTRC). In cases where bluefin tuna is imported live, the BFTRC shall not apply.

14. The operator who is responsible for the re-export shall complete the BFTRC by providing the required information in its appropriate sections and request its validation for the bluefin tuna consignment to be re-exported. The completed BFTRC shall be accompanied by a copy of the validated BCD(s) relating to the bluefin tuna products previously imported.

15. The BFTRC shall be validated by an authorized government official or authority.

16. The CPC shall validate the BFTRC for all bluefin tuna product only when:
    a) all the information contained in the BFTRC has been established to be accurate,
    b) the validated BCD(s) submitted in support to the BFTRC had been accepted for the importation of the products declared on the BFTRC and
    c) the products to be re-exported are wholly or partly the same product on the validated BCD(s).
    d) a copy of the BCD(s) shall be attached to the validated BFTRC.

17. The validated BFTRC shall include the information identified in **Annex 4** and **Annex 5** attached.

PART IV
VERIFICATION AND COMMUNICATION

18. Each CPC shall communicate a copy of all validated BCDs or BFTRCs, except in cases where paragraph 12(c) applies, within five working days following the date of validation, or without delay where the expected duration of the transportation should not take more than five working days, to the following:

a) the competent authorities of the country where the bluefin tuna will be domestically traded, or transferred into a cage or imported, and
b) the ICCAT Secretariat.

19. The ICCAT Secretariat shall extract from the validated BCDs or BFTRCs communicated under paragraph 18 above the information marked with an asterisk (*) in **Annex 1** or **Annex 4** and enter this information in a database on a password protected section of its website, as soon as practicable.

    At its request, the SCRS shall have access to the catch information contained in the database, except the vessel or trap names.

PART V
TAGGING

20. CPCs may require their catching vessels or traps to affix a tag to each bluefin tuna preferably at the time of kill, but no later than the time of landing. Tags shall have unique country specific numbers and be tamper proof. The tag numbers shall be linked to the BCD and a summary of the implementation of the tagging program shall be submitted to the ICCAT Secretariat by the CPC. The use of such tags shall only be authorized when the accumulated catch amounts are within their quotas or catch limits of each management year, including, where appropriate, individual quotas allocated to vessels or traps.

PART VI
VERIFICATION

21. Each CPC shall ensure that its competent authorities, or other authorized individual or institution, take steps to identify each consignment of bluefin tuna landed in, domestically traded in, imported into or exported or re-exported from its territory and request and examine the validated BCD(s) and related documentation of each consignment of bluefin tuna. These competent authorities, or authorized individuals or institutions, may also examine the content of the consignment to verify the information contained in the BCD and in related documents and, where necessary, shall carry out verifications with the operators concerned.

22. If, as a result of examinations or verifications carried out pursuant to paragraph 21 above, a doubt arises regarding the information contained in a BCD, the final importing State and the CPC whose competent authorities validated the BCD(s) or BFTRCs shall cooperate to resolve such doubts.

23. If a CPC involved in trade of bluefin tuna identifies a consignment with no BCD, it shall notify the findings to the exporting State and, where known, the flag State.

24. Pending the examinations or verifications under paragraph 21 to confirm compliance of the bluefin tuna consignment with the requirements in the present Recommendation and any other relevant Recommendations, the CPCs shall not grant its release for domestic trade, import or export, nor, in the case of live bluefin tuna destined to farms, accept the transfer declaration.

25. Where a CPC, as a result of examination or verifications under paragraph 21 above and in cooperation with the validating authorities concerned, determines that a BCD or BFTRC is invalid, the domestic trade, import, export or re-export of the bluefin tuna concerned shall be prohibited.

26. The Commission shall request the non-Contracting Parties that are involved in domestic trade, import, export or re-export of bluefin tuna to cooperate with the implementation of the Program and to provide to the Commission data obtained from such implementation.

PART VII
NOTIFICATION AND COMMUNICATION

27. Each CPC that validates BCDs in respect of its flag catching vessels, traps or farms in accordance with paragraph 12(a), shall notify the ICCAT Secretariat of the government authorities, or other authorized individuals or institutions (name and full address of the organization(s) and, where appropriate, name and

title of the validating officials who are individually empowered, sample form of document, sample impression of stamp or seal, and as appropriate tag samples) responsible for validating and verifying BCDs or BFTRCs. This notification shall indicate the date at which this entitlement comes into force. A copy of the provisions adopted in national law for the purpose of implementing the bluefin tuna catch documentation program shall be communicated with the initial notification, including procedures to authorize nongovernmental individuals or institutions. Updated details on validating authorities and national provisions shall be communicated to the ICCAT Secretariat in a timely fashion.

28. The information on validating authorities transmitted by notifications to the ICCAT Secretariat shall be placed on the password protected page of the database on validation held by the ICCAT Secretariat. The list of the CPCs having notified their validating authorities and the notified dates of entry into force of the validation shall be placed on a publicly accessible website held by the ICCAT Secretariat. CPCs are encouraged to access this information to help verify the validation of BCDs and BFTRCs.

29. Each CPC shall notify to the ICCAT Secretariat the points of contact (name and full address of the organization(s)) that should be notified when there are questions related to BCDs or BFTRCs.

30. Copies of validated BCDs and notification pursuant to paragraphs 27, 28 and 29 shall be sent by CPCs to the ICCAT Secretariat, by electronic means, whenever possible.

31. The Commission shall consider the introduction of an electronic system as informed by results reported to the Commission from the electronic statistical document pilot programs conducted by CPCs in accordance with *Recommendation by ICCAT on an Electronic Statistical Document Pilot Program* [Rec. 06-16]. Those CPCs which implement an electronic system in advance of the Commission shall ensure the electronic system meets the requirements of this measure and has the ability to produce paper copies upon request of national authorities from the exporting and importing Parties.

32. Copies of BCDs shall follow each part of split shipments or processed product, using the unique document number of the BCD to link them.

33. CPCs shall keep copies of documents issued or received for at least two years.

34. CPCs shall provide to the ICCAT Secretariat a report each year by October 1 for the period from July 1 of the preceding year to June 30 of the current year to provide the information described in **Annex 6**.

    The ICCAT Secretariat shall post these reports on the password protected section of the ICCAT website, as soon as practicable.

    At its request, the SCRS shall have access to the reports received by the ICCAT Secretariat.

35. The *Recommendation by ICCAT Amending Recommendation 07-10 on an ICCAT Bluefin Tuna Catch Document Program* [Rec. 08-12] is repealed and replaced by this Recommendation.

Annex 1

Data to be Included in Bluefin Tuna Catch Document (BCD)

1. ICCAT Bluefin tuna catch document number*

2. Catch Information
Vessel or trap name*****
Flag State*
ICCAT Record No.
Date, area of catch and gear used*
Number of fish, total weight, and average weight*[1]
ICCAT Record number of Joint Fishing Operation (if applicable)*
Tag No. (if applicable)
Government validation
Name of authority and signatory, title, signature, seal and date

3. Trade Information for live fish trade
Product description
Exporter/Seller information
Transportation description
Government validation
Name of authority and signatory, title, signature, seal and date
Importer/buyer

4. Transfer information
Towing vessel description
ICCAT Transfer Declaration No.
Vessel name, flag
ICCAT Record No.
Number of fish dead during transfer
Total weight of dead fish (kg)
Towing cage description
Cage number

5. Transshipment information
Carrier vessel description
Name, Flag State, ICCAT Record No., Date, Port name, Port state, position
Product description
(F/FR; RD/GG/DR/FL/OT)
Total weight (NET)
Government validation
Name of authority and signatory, title, signature, seal and date

6. Farming information
Farming facility description
Name, flag of farm*, ICCAT FFB No.* and location of farm
Participation in national sampling program (yes or no)
Cage description
Date of caging, cage number
Fish description
Estimates of number of fish, total weight, and average weight*[1]
ICCAT regional observer information

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*See Paragraph 19.
[1] Weight shall be reported by round weight where available. If round weight is not used, specify the type of product (e.g., GG) in the "Total Weight" and "Average Weight" section of the form.

Name, ICCAT No., signature
Estimated size composition (<8 kg, 8-30 kg, >30 kg)
Government validation
Name of authority and signatory, title, signature, seal and date

7. Harvesting information
Harvesting description
Date of harvest*
Number of fish, total (round) weight, and average weight*
Tag numbers (if applicable)
ICCAT regional observer information
Name, ICCAT No., signature
Government validation
Name of authority and signatory, title, signature, seal and date

8. Trade information
Product description
(F/FR; RD/GG/DR/FL/OT)[2]
Total weight (NET)*
Exporter/Seller information
Point of export or departure*
Export company name, address, signature and date
State of destination*
Description of transportation (relevant documentation to be attached)
Government validation
Name of authority and signatory, title, signature, seal and date
Importer/buyer information
Point of import or destination*
Import company name, address, signature and date[3]

[2] When different types of products are recorded in this section, the weight shall be recorded by each product type.
[3] DATE to be filled by IMPORTER/BUYER in this section is the date of signature.

Annex 2

Bluefin Tuna Catch Document Form

1. ICCAT BLUE FIN TUNA CATCH DOCUMENT (BCD)	N° CC-YY-XXXXXX	1/2

2. CATCH INFORMATION

VESSEL/TRAP

NAME :		FLAG	ICCAT RECORD No.

CATCH DESCRIPTION

DATE (ddmmyy)		AREA		GEAR	
No. of FISH		TOTAL WEIGHT (kg)		AVERAGE WEIGHT (kg)	
TAGS No. (if applicable)		ICCAT RECORD No. of Joint Fishing Operation (if applicable)			

GOVERNMENT VALIDATION

NAME OF AUTHORITY		SEAL
TITLE		
SIGNATURE		
DATE		

3. TRADE INFORMATION FOR LIVE FISH TRADE

PRODUCT DESCRIPTION

LIVE WEIGHT (kg)		No. of FISHES		ZONE	

EXPORTER/SELLER

PT EXPORTATION/ DEPARTURE	COMPANY		ADDRESS		
FARM OF DESTINATION		STATE		ICCAT FFB No.	
SIGNATURE					
DATE					

TRANSPORTATION DESCRIPTION	(Relevant documentation to be attached)

GOVERNMENT VALIDATION

NAME OF AUTHORITY		SEAL
TITLE		
SIGNATURE		
DATE		

IMPORTER/BUYER

COMPANY		PT IMPORTATION / DESTINATION (city, country, State)	
ADDRESS			
DATE OF SIGNATURE		SIGNATURE	

ANNEX(ES): YES / NO (circle one)

4. TRANSFER INFORMATION

TOWING VESSEL DESCRIPTION

ICCAT TRANSFER DECLARATION No.					
NAME		FLAG		ICCAT RECORD No.	
No. of FISH DEAD DURING TRANSFER			TOTAL WEIGHT OF DEAD FISH (kg)		

TOWING CAGE DESCRIPTION	CAGE No.	

ANNEX(ES): YES / NO (circle one)

5. TRANSHIPMENT INFORMATION

CARRIER VESSEL DESCRIPTION

NAME		FLAG		ICCAT RECORD No.	
DATE(ddmmyy)		PORT NAME		PORT STATE	
POSITION (LAT/LONG)					

PRODUCT DESCRIPTION (Indicate net weight in kg for each type of product)

F	RD (kg)		GG (kg)		DR (kg)		FL (kg)		OT(kg)		TOTAL WT F (kg)	
FR	RD (kg)		GG (kg)		DR (kg)		FL (kg)		OT(kg)		TOTAL WT FR (kg)	

GOVERNMENT VALIDATION

NAME OF AUTHORITY		SEAL
TITLE		
SIGNATURE		
DATE		

ANNEX(ES): YES / NO (circle one)

ICCAT BLUE FIN TUNA CATCH DOCUMENT (BCD)	N° CC-YY-XXXXXX	2/2

6. FARMING INFORMATION

FARMING FACILITY DESCRIPTION	NAME		STATE		ICCAT FFB No.	
	SAMPLING NATIONAL PROGRAM ? Yes or No (circle one)		LOCATION			
CAGE DESCRPTION	DATE(ddmmyy)		CAGE No.			
FISH DESCRIPTION	No. OF FISH		TOTAL WEIGHT (kg)		AVERAGE WEIGHT (kg)	
ICCAT REGIONAL OBSERVER INFO.	NAME		ICCAT No.		SIGNATURE	
	SIZE COMPOSITION	< 8 Kg		8-30 Kg		> 30 Kg

GOVERNMENT VALIDATION

NAME OF AUTHORITY		SEAL
TITLE		
SIGNATURE		
DATE		
ANNEX(ES): YES / NO (circle one)		

7. HARVESTING INFORMATION

HARVESTING DESCRIPTION

DATE (ddmmyy)		FISH No.		TOTAL ROUND WEIGHT (kg)	
AVERAGE WEIGHT (kg)		TAG No. (if applicable)			

ICCAT REGIONAL OBSERVER INFO.	NAME		ICCAT No.		SIGNATURE

GOVERNMENT VALIDATION

NAME OF AUTHORITY		SEAL
TITLE		
SIGNATURE		
DATE		

8. TRADE INFORMATION

PRODUCT DESCRIPTION (Indicate net weight in kg for each type of product)

F	RD (kg)		GG (kg)		DR (kg)		FL (kg)		OT(kg)		TOTAL WT F (kg)	
FR	RD (kg)		GG (kg)		DR (kg)		FL (kg)		OT(kg)		TOTAL WT FR (kg)	

EXPORTER/SELLER

PT EXPORTATION/ DEPARTURE	COMPANY	ADDRESS
STATE OF DESTINATION		
SIGNATURE		
DATE		

TRANSPORTATION DESCRIPTION	(Relevant documentation to be attached)

GOVERNMENT VALIDATION

NAME OF AUTHORITY		SEAL
TITLE		
SIGNATURE		
DATE		

IMPORTER/BUYER

COMPANY		PT IMPORTATION / DESTINATION (city, country, State)	
ADDRESS			
DATE		SIGNATURE	
ANNEX(ES): YES / NO (circle one)			

Annex 3

Instructions for the issuance, the numbering, the completion and the validation of the Bluefin Tuna Catch Document (BCD)

1. GENERAL PRINCIPLES

(1) Language

If a language other than an official ICCAT language (English, French and Spanish) is used in completing the BCD, the English translation shall be attached to this document.

(2) Numbering

CPCs shall develop unique numbering system for BCDs using their ICCAT country code or ISO code in combination with at least a 8-digit number, of which at least two digits will indicate the year of catch.

Example: CA-09-123456 (*CA stands for Canada*)

In case of split shipments, or processed products, copies of the original BCD shall be numbered by supplementing the number of the original BCD with a 2-digit number.

Example: CA-09-123456-*01*, CA-09-123456-*02*, CA-09-123456-*03*, etc.

The numbering shall be sequential and preferably printed. The serial numbers of blank BCDs issued shall be recorded by the name of the recipient.

2. CATCH INFORMATION

(1) Completion

(a) *General principles:*

This section is applicable to all catches of bluefin tunas.

The master of the catching vessel or the trap operator or their authorised representative or the authorised representative of the flag or trap State shall be responsible for the completion and the request for validation of the CATCH INFORMATION section.

CATCH INFORMATION section shall be completed no later than the end of transfer, transhipment or landing operation.

Remark: in case of joint fishing operation, as defined by paragraph 2(f) of ICCAT Recommendation 08-05, the master of each catching vessel involved in the joint fishing operation shall complete a BCD form for each catch.

(b) *Specific instructions:*

"FLAG": indicate the flag or trap State.

"ICCAT Record No": indicate the ICCAT number of the catching vessel or trap authorised to fish bluefin tuna in the ICCAT Convention area. This information is not applicable to catching vessels which fish bluefin tuna as by-catch.

"GEAR": indicate the fishing gear using the following codes:

BB	Baitboat
GILL	Gillnet
HAND	Handline
HARP	Harpoon
LL	Longline
MWT	Mid-water trawl
PS	Purse seine
RR	Rod and reel
SPHL	Sport handline
SPOR	Sport fisheries unclassified
SURF	Surface fisheries unclassified
TL	Tended line
TRAP	Trap
TROL	Troll
UNCL	Unspecified methods
OT	Other type

"TOTAL WEIGHT": indicate the round weight in kilograms. If round weight is not used at the time of catch, indicate the type of product (e.g. GG). In case of joint fishing operation, quantity reported shall correspond to the allocation key defined for each catching vessel.

"AREA": indicate Mediterranean, western Atlantic, eastern Atlantic or Pacific.

"TAGS No (if applicable)": additional lines may be added to allow the listing of each tag number by individual fish.

(2) Validation

The flag or trap State shall be responsible for the validation of the CATCH INFORMATION section unless bluefin tuna are tagged in accordance with Paragraph 20 of the Recommendation.

3. TRADE INFORMATION FOR LIVE FISH TRADE

(1) Completion

(a) *General principles:*

This section is only applicable to export of live bluefin tunas.

The master of the catching vessel or his authorised representative or the authorised representative of the flag State shall be responsible for the completion and the request for validation of the TRADE INFORMATION FOR LIVE FISH TRADE section.

The TRADE INFORMATION FOR LIVE FISH TRADE section shall be completed before the first transfer operation, i.e. the transfer of fish from the catching vessel net to the transport cage.

Remark: in case that a quantity of fish dies during the transfer operation and is domestically traded or exported, the original BCD (CATCH INFORMATION section completed shall be copied for the fish, and TRADE INFORMATION section of the copied BCD shall be completed by the master of the catching vessel or his authorised representative or the authorised representative of the flag State and transmitted to the domestic buyer/importer. Government validation of this copy shall guarantee that it is a valid copy and has been recorded by authorities of the CPC. Without the government validation, any BCD copy is null and void.

(b) *Specific instructions:*

"ZONE": indicate the area of transfer, Mediterranean, western Atlantic, eastern Atlantic or Pacific.

"POINT OF EXPORT/DEPARTURE": indicate the CPC name of the fishery zone where the bluefin tuna were transferred or indicate "high seas" otherwise.

"TRANSPORTATION DESCRIPTION": attach any relevant document certifying the trade.

(2) Validation

The flag State shall not validate documents where the CATCH INFORMATION section is not completed.

4. TRANSFER INFORMATION

(1) Completion

(a) *General principles:*

This section is only applicable to live bluefin tunas.

The master of the catching vessel or his authorised representative or the authorised representative of the flag State shall be responsible for the completion of the TRANSFER INFORMATION section.

The TRANSFER INFORMATION section shall be completed no later than the end of the first transfer operation, i.e. the transfer of fish from the catching vessel net to the transport cage.

At the end of the transfer operation, the master of the catching vessel shall provide the BCD (CATCH INFORMATION, TRADE INFORMATION FOR LIVE FISH TRADE and TRANSFER INFORMATION sections completed and, where applicable, validated) to the master of the tug vessel.

The completed BCD shall accompany the transfer of fish during transport to farm, including transfer of live bluefin tuna from the transport cage to another transport cage or transfer of dead bluefin tuna from the transport cage to an auxiliary vessel.

Remark: in case that some fish die during the transfer operation, the original BCD (CATCH INFORMATION, TRADE INFORMATION FOR LIVE FISH TRADE and TRANSFER INFORMATION sections completed and, where applicable, validated) shall be copied, and TRADE INFORMATION section of the copied BCD shall be completed by the domestic seller/exporter or his authorised representative or the authorised representative of the flag State and transmitted to the domestic buyer/importer. Government validation of this copy shall guarantee that it is a valid copy and has been recorded by authorities of the CPC. Without the authorized government validation, any BCD copy is null and void.

(b) *Specific instructions:*

"No. OF FISH DEAD DURING TRANSFER" and "TOTAL WEIGHT OF DEAD FISH": information completed (if applicable) by the master of the tug vessel.

"CAGE No.": indicate each number of cages in the case of a tug vessel having more than one cage.

(2) Validation

Validation of this section is not required.

5. TRANSSHIPMENT INFORMATION

(1) Completion

(a) *General principles:*

This section is only applicable to dead bluefin tunas.

The master of the transhipping fishing vessel or his authorised representative or the authorised representative of the flag State shall be responsible for the completion and the request for validation of the TRANSHIPMENT INFORMATION section.

The TRANSHIPMENT INFORMATION section shall be completed at the end of the transhipment operation.

(b) *Specific instructions:*

"DATE": indicate the date of the transhipment.

"PORT NAME": indicate the designated port of transhipment.

"PORT STATE": indicate the CPC of the designated port of transhipment.

(2) Validation

The flag State shall not validate documents where the CATCH INFORMATION section is not completed and validated.

6. FARMING INFORMATION

(1) Completion

(a) *General principles:*

This section is only applicable to live caged tunas.

The master of the tug vessel shall provide the BCD (CATCH INFORMATION, TRADE INFORMATION FOR LIVE FISH TRADE and TRANSFER INFORMATION sections completed and, where applicable, validated) to the farm operator at the time of caging.

The farm operator or his authorised representative or an authorized representative of the farm CPC shall be responsible for the completion and the request for validation of the FARM INFORMATION section.

The FARM INFORMATION section shall be completed at the end of the caging operation.

(b) Specific instructions:

"CAGE No": indicate each number of cage.

"ICCAT Regional Observer Information": indicate name, ICCAT # and signature.

(2) Validation

The farm State shall be responsible for the validation of the FARM INFORMATION section.

The farm State shall not validate BCDs where the CATCH INFORMATION, TRADE INFORMATION FOR LIVE FISH TRADE and TRANSFER INFORMATION sections are not completed and, where applicable, validated.

7. HARVESTING INFORMATION

(1) Completion

(a) *General principles:*

This section is only applicable to dead farmed tunas.

The farm operator or his authorised representative or an authorized representative of the farm CPC shall be responsible for the completion and the request for validation of the HARVEST FROM FARM INFORMATION section.

The HARVESTING INFORMATION section shall be completed at the end of the harvesting operations.

(b) *Specific instructions:*

"TAGS No (if applicable)": additional lines may be added to allow the listing of each tag number by individual fish.
"ICCAT Regional Observer Information": indicate name, ICCAT # and signature.

(2) Validation

The farm CPC shall be responsible for the validation of the HARVESTING INFORMATION section.

The farm State shall not validate BCDs where the CATCH INFORMATION, TRADE INFORMATION FOR LIVE FISH TRADE, TRANSFER INFORMATION and FARMING INFORMATION sections are not completed and, where applicable, validated.

8. TRADE INFORMATION

(1) Completion

(a) *General principles:*

This section is applicable to dead bluefin tunas.

The domestic seller or exporter or their authorised representative or an authorized representative of the State of the seller/exporter shall be responsible for the completion and the request for validation of the TRADE INFORMATION section.

The TRADE INFORMATION section shall be completed prior to the fish being domestically traded or exported.

(b) *Specific instructions:*

"TRANSPORTATION DESCRIPTION": attach any relevant document certifying the trade.

(2) Validation

The State of the seller/exporter shall be responsible for the validation of the TRADE INFORMATION section unless bluefin tuna are tagged in accordance with Paragraph 20 of the Recommendation.

Remark: in cases where more than one domestic trade or export results from a single BCD, a copy of the original BCD shall be validated by the State of the domestic seller or exporter and shall be used and accepted as an original BCD. Government validation of this copy shall guarantee that it is a valid copy and has been recorded by authorities of the concerned CPC. Without the authorized government validation, any BCD copy is null and void.

In cases of re-export, the RE-EXPORT CERTIFICATE (**Annex 5**) shall be used to track further movements, which shall be related to the catch information of the original BCD of the catch via the original BCD number.

When bluefin tuna is caught by a CPC using the tagging system, exported dead to a country, and re-exported to another country, the BCD accompanying the re-exported certificate does not have to be validated. However, the re-exported certificate shall be validated.

After import, a bluefin tuna may be divided into several pieces, which then may be subsequently exported. The re-exporting country shall confirm that the re-exported piece is part of the original fish accompanied by the BCD.

Annex 4

Data to be Included in the Bluefin Tuna Re-export Certificate (BFTRC)

1. Document number of the BFTRC*

2. Re-export section
Re-exporting CPC/Entity/Fishing Entity
Point of re-export*

3. Description of imported bluefin tuna
Product type F/FR RD/GG/DR/FL/OT[4]
Net weight (kg)*
BCD number(s) and date(s) of importation*
Flag(s) of fishing vessel(s) or state of establishment of the trap, where appropriate

4. Description of bluefin tuna to be re-exported
Product type F/FR RD/GG/DR/FL/OT*[4]
Net weight (kg)*
Corresponding BCD number(s) from section 3
State of destination

5. Statement of re-exporter
Name
Address
Signature
Date

6. Validation by governmental authorities
Name and address of the authority
Name and position of the official
Signature
Date
Government seal

7. Import section
Statement by the importer in the CPC of import of the bluefin tuna consignment
Name and address of the importer
Name and signature of the importer's representative and date
Point of import: City and CPC*

Note: Copies of the BCD(s) and Transport document(s) shall be attached.

[4]When different types of products are recorded in this section, the weight shall be recorded by each product type.

Annex 5

1. DOCUMENT NUMBER	**ICCAT BLUEFIN TUNA RE-EXPORT CERTIFICATE**

2. RE-EXPORT SECTION:

RE-EXPORTING COUNTRY/ENTITY/FISHING ENTITY

POINT OF RE-EXPORT

3. DESCRIPTION OF IMPORTED BLUEFIN TUNA

Product Type *F/FR RD/GG/DR/FL/OT*		Net Weight (kg)	Flag CPC	Date of import	BCD No.

4. DESCRIPTION OF BLUEFIN TUNA FOR RE-EXPORT

Product Type *F/FR RD/GG/DR/FL/OT*		Net Weight *(kg)*	Corresponding BCD number

F=Fresh, FR=Frozen, RD=Round, GG=Gilled & Gutted, DR=Dressed, FL=Fillet,
OT=Others (Describe the type of product:)

STATE OF DESTINATION:

5. RE-EXPORTER STATEMENT:
I certify that the above information is complete, true and correct to the best of my knowledge and belief.

Name **Address** **Signature** **Date**

6. GOVERNMENT VALIDATION:
I validate that the above information is complete, true and correct to the best of my knowledge and belief.

Name & Title **Signature** **Date** **Government Seal**

7. IMPORT SECTION
IMPORTER STATEMENT:
I certify that the above information is complete, true and correct to the best of my knowledge and belief.

Importer Certification
Name **Address** **Signature** **Date**

Final Point of Import: City **State/Province** **CPC** .

NOTE: IF A LANGUAGE OTHER THAN ENGLISH IS USED IN COMPLETING THIS FORM, PLEASE ADD THE ENGLISH TRANSLATION ON THIS DOCUMENT.

Note: Valid transport document and copies of the BCDs shall be attached.

Annex 6

Report on the Implementation of the ICCAT Bluefin Tuna Catch Documentation Programme

Reporting CPC:

Period of reference: 1 July [2XXX] to 30 June [2XXX]

1. Information extracted from BCDs

- number of BCDs validated
- number of validated BCDs received
- total amount of bluefin tuna products traded domestically, with breakdown by fishing areas and fishing gears
- total amount of bluefin tuna products imported, exported, transferred to farms, re-exported with breakdown by CPC of origin, re-export or destination, fishing areas and fishing gears
- number of verifications of BCDs requested to other CPCs and summary results
- number of requests for verifications of BCDs received from other CPCs and summary results
- total amount of bluefin tuna consignments subject to a prohibition decision with breakdown by products, nature of operation (domestic trade, import, export, re-export, transfer to farms), reasons for prohibition and CPCs and/or non-Contracting Parties of origin or destination

2. Information on cases under Part VI paragraph 21.

- number of cases
- total amount of bluefin tuna with breakdown by products, nature of operation (domestic trade, import, export, re-export, transfer to farms), CPCs or other countries referred to in Part VI paragraph 21.

REPORT OF THE 2008 ATLANTIC BLUEFIN TUNA STOCK ASSESSMENT SESSION

(Madrid, Spain – June 23 to July 4, 2008)

1. Opening, adoption of the Agenda and meeting arrangements

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

Dr. G. Scott (USA) served as overall meeting Coordinator on behalf the General Coordinator, Dr. J. Powers. Drs. C. Porch (USA) and J-M. Fromentin (EC-France) served as co-Chairmen for the western and eastern stocks, respectively. Dr. Scott welcomed meeting participants ("the Group") and proceeded to review the Agenda, which was adopted with minor changes **(Appendix 1)**. In reviewing the Agenda, Dr. Scott reminded participants that the meeting responded to the request from the Commission contained in the *Recommendation by ICCAT to Establish a Multi-annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 06-05] and that it had been prepared in the Bluefin Workplan for 2008 **(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**.

The following participants served as Rapporteurs for various sections of the report:

Section	*Rapporteurs*
1, 13	P. Pallarés
2, 12	G. Scott
3	E. Rodríguez-Marín
4	J. Neilson, A. Boustany, E. Rodríguez-Marín
5	P. Kebe, C. Palma, C. Brown, J-M. Fromentin, V. Restrepo
6	N. Miyabe, W. Ingram, G. Diaz, M. Ortiz
7	H. Arrizabalaga, V. Restrepo, S. Cass-Calay, M. McAllister, C. Porch, N. Taylor, J. Neilson, G. Scott
8	H. Arrizabalaga, V. Restrepo, S. Cass-Calay, C. Porch, M. Ortiz, M. McAllister, N. Taylor
9	J. Ortiz de Urbina, G. Diaz
10	J-M. Fromentin, V. Restrepo, S. Cass-Calay, C. Porch, M. Ortiz, M. McAllister, N. Taylor
11	J-M. Fromentin, V. Restrepo, G. Scott, Y. Takeuchi

2. Review of the Rebuilding Plans for Atlantic and Mediterranean bluefin tuna and previous SCRS advice

The Commission's Rebuilding Plans for Atlantic and Mediterranean bluefin were reviewed.

Recommendation 06-05 calls for a 15-year rebuilding period, starting in 2007, with the objective of recovering the stock to B_{MSY} with greater than 50% probability. A number of technical measures, including minimum size, fishery closures, and TACs were implemented in the Plan, which also calls for SCRS to monitor and advise the Commission on the odds of the Plan's objectives being met based upon available data. Based upon information available in 2007, the SCRS advised that overall, preliminary results indicate that the measures adopted in the Plan were a step in the right direction, but were unlikely to fully fulfill the objective of the plan to rebuild to the MSY level in 15 years with greater than 50% probability. The SCRS advised that this depends on several factors, particularly how well regulations are implemented (including a severe reduction in fishing effort by 2023) and future recruitment. If implementation is perfect and if future recruitment is at about the 1990s level and is unaffected by recent spawning biomass level, there is about 50% probability of rebuilding by 2023 under the current regulations. The SCRS advised, however, perfect implementation is unlikely because, even with perfect enforcement, the Committee thinks that it is not feasible to avoid totally discard mortality of small fish (in excess of tolerance) and while continually and severely reducing fishing effort to very low levels to achieve the objectives of the Rebuilding Plan. With other plausible assumptions (either imperfect implementation or recruitment that decreases from recent levels as spawning biomass decreases, or both) the objectives of the Rebuilding Plan will not be met without further adjustments.

The *Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program* [Rec. 06-06] calls for a 20-year rebuilding period starting in 1999 with the objective of recovering the stock to B_{MSY} with at least a 50% probability by the end of the Plan's time frame (through 2018). A number of technical measures, including TACs, were implemented in this Plan which also calls for SCRS to monitor and advise the Commission on the odds of the Plan's objectives being met based upon available data. Based upon an assessment of western stock status conducted in 2006, the SCRS advised Rec. [06-06] was expected to result in a rebuilding of the stock towards the Convention objective with fishing mortality rates at about the estimated MSY level. The SCRS also cautioned that new evidence suggested that current regulations may be insufficient to achieve the objectives. However, the Committee would be unable to further evaluate this until the next assessment. The ability to achieve the Convention objectives would be further hampered by future use of accumulated unused quota, particularly given the large amount involved for western bluefin tuna.

3. Consideration of the findings and recommendations of the World Symposium for the Study into the Stock Fluctuation of Northern Bluefin Tunas (*Thunnus thynnus* and *Thunnus orientalis*), including the Historic Periods

The SCRS Chairman summarized the Symposium held in Santander in April 2008. The aim of the Symposium was to provide a deeper investigation into the historical events that took place decades ago in various bluefin tuna fisheries and to use this information to improve the_current management of Atlantic bluefin tuna. The Symposium was organized into various sessions in relation to different geographic areas, fisheries and time periods. In addition to the Atlantic bluefin tuna biology and history of the fisheries, the Pacific and southern bluefin tuna historical changes in distribution and abundance were also considered (*T. orientalis* and *T. maccoyii*). As a general conclusion, it was agreed that there are important dynamics in the Atlantic bluefin fisheries that took place prior to 1970, which should be incorporated into our overall analysis and be utilized to shape our scientific advice to the Commission. It was also concluded that the incorporation of more historical information could better inform us about stock productivity and abundance levels.

The historical analysis of Atlantic bluefin fisheries showed that its captures date back to ancient times. The species has been exploited for centuries in the Mediterranean Sea and at the entrance of the Gibraltar Straits. Since the 1920s, it has been increasingly exploited in the northeast Atlantic. Large changes have been observed since then and there were several extinctions/discoveries of important fishing grounds in the Mediterranean as well as in the East Atlantic during the 20th century. Bluefin tuna are now absent or rare from formerly occupied habitats, such as the North Sea, Norwegian Sea, Black Sea, Sea of Marmara, off the coast of Brazil and Bermuda and certain locations off the northeastern American coasts, while high catches have been recently made_in new areas, such as the eastern Mediterranean, the Gulf of Syrta and the central North Atlantic. The reasons for these changes in spatial and temporal patterns remain unclear and are likely to result from interactions between biological, environmental, trophic and fishing processes.

Strong connection was found between the Nordic fisheries and the northeast Atlantic traps, based on catch-at-length and catch-at-age analysis. The abundance of exceptionally large cohorts could also be found concurrently in some juvenile fisheries located in different areas. The role of learning of migration patterns by young tuna from older tuna was discussed, as well as the necessity for overlap of spatial distributions of young and old tuna. However, the mechanisms by which learning is accomplished are unclear. Atlantic bluefin tuna might be seen as a metapopulation constituted by sub-populations that have varied in size in response to environmental changes and overfishing.

Pacific bluefin tuna populations have also had large fluctuations in the past 50 years, both in recruitment and spawning stock size. Information was also provided during the Symposium about experience with captive Pacific bluefin tuna, which indicate spawning does not always take place annually, that egg quality is likely the same between young and medium-old adult Pacific bluefin tuna, and that a rapid increase of sea surface temperature to 24ºC triggers spawning. In the late 1970s, southern bluefin tuna suffered a fishery collapse along with a considerable reduction in the juvenile component of the stock, which was attributed to high exploitation rates. Changes in the distribution and movement patterns of juveniles have also been documented.

The Group recognized that there were very important Atlantic bluefin tuna fisheries before the reference period used in previous population analysis (1970). In consequence, it was decided to investigate, in a preliminary manner, the inclusion of historical data into the population analysis. Specifically, the Group included catch and size data from the middle 1950s for the East and Mediterranean stock and from 1960s for the west stock as an exploratory analysis to obtain improved estimation of stock productivity. However, appropriate methodologies for incorporating historical information with different statistical characteristics into our stock assessment can only be achieved over a much longer period. It is furthermore of key importance for SCRS to have full access to all historical fishery data collected on bluefin tuna, especially those from the early years of the 20th century. This data mining should, for instance, target the recovery of all the historical data collected (published and unpublished) on the North Sea fisheries, from the various traps active in the Atlantic and the Mediterranean Sea and the various bluefin fisheries that have been active during the period, but not recorded in the ICCAT database. In addition, it is necessary to move away from using VPA models and use instead integrated statistical models that can make direct use of sparse data.

4. New biological information, including results from tagging, microconstituent analysis, growth and reproductive studies, and other studies pertinent to the assessment

The Group received four working papers, which included contributions pertaining to growth (both in the wild and in captivity), information on the consequences of different growth models on management advice, and electronic tagging results. The Group also received a presentation on natal origin as indicated from otolith microchemistry. Apart from these new contributions, a summary of the current assumptions concerning life history attributes as used in the assessment is provided in the table below for the West Atlantic and East Atlantic and Mediterranean stocks:

Life history attribute	*Assumption used by the SCRS*	*Source (ICCAT Manual)*	*Notes*
Growth (length at age)	von Bertalanffy growth West: K=0.079; L_∞=382; t_0= -0.707 East & Med: K= 0.093; L_∞=319; t_0=-0.093	Turner and Restrepo[1] (1994) ICCAT (2006) Cort (1991)	Research in progress will likely refine the current growth model (see Section 4.1).
Growth (length-weight)	West: Area and season specific conversions are used, East & Med. < 101 cm: $W=2.95.10^{-5}*FL^{2.899}$ East & Med. >100 cm: $W=1.96.10^{-5}*FL^{3.009}$	ICCAT conversion factors ICCAT (2006)	Trend of declining condition noted in southern Gulf of St. Lawrence (SCRS/ 2008/083) and the Gulf of Maine implies a need for updated conversions in the west.
Natural mortality	West - M assumed age-independent (=0.14yr^{-1}) East & Med. Starting at age 1: 0.49, 0.24, 0.24, 0.24, 0.24, 0.20, 0.175, 0.15, 0.125, 0.10	ICCAT (1997)	ICCAT 1997. An age-specific vector for M is applied for ages 1 to 10+, (ICCAT 1997).
Longevity	East: > 20 yr West: 32 yr	Fromentin and Fonteneau (2001) Neilson and Campana (in press)	Based on tagging data. Based on radiocarbon traces.

[1] For the central North Atlantic, either the east or west growth model has been used to construct the catch at age in that area.

Maturity	West 50% maturity: Age 8 (190 cm / 120 kg). East & Med. 50% maturity: Age 4 (115 cm / 30 kg).	Baglin (1982) ICCAT 1997 (being confirmed by more recent studies)	Diaz and Turner (2007) and others suggest later age at 50% maturity (age 11-12), but Goldstein *et al.* (2007) suggest for the west asynchronous reproductive schedule and smaller size at maturity.
Spawning Area	West: Gulf of Mexico. East & Med.: Around Balearic Islands, Tyrrhenian Sea, central Mediterranean and Levantine Sea.	Multiple sources, see Rooker *et al.* (2007) and Fromentin and Powers (2005) or Mather *et al.* (1995) for reviews.	Other spawning areas have been hypothesized, but not yet demonstrated.
Spawning season	West: mid-April to mid-June. East & Med.: mid-May to mid-July.	As above.	

4.1 Growth

SCRS/2008/084 presented models fitted to recent samples of Atlantic bluefin tuna on the basis of annulus interpretations in otoliths. Samples were aggregated based upon whether individuals originated in western or eastern nursery systems using otolith stable isotope analysis. A model fit to recent year-classes (after 1970) for western captured, western-origin Atlantic bluefin tuna yielded von Bertalanffy coefficients of K=0.20; L_∞=257; and t_0=0.83. These coefficients are substantially different than those from the Turner and Restrepo model based on conventional tagging and modal progression data (K=0.08; L_∞=382; t_0= -0.71), and the corresponding growth curve predicts very different lengths at age for fish younger than age 4 or older than age12. Growth models were also fit for the eastern population, but coefficients were probably biased due to the small sample size and the truncated size range in the samples. Given the established accuracy of direct age estimates from otoliths and the feasibility of complementary age and natal assignment determinations using the same prepared otoliths, the authors recommended that future assessments be based upon direct ageing of otoliths over other approaches. For the current assessment, they recommended use of the western capture - western origin subset as being the most representative of western bluefin tuna growth patterns.

The Group requested more information on the computational details, which was subsequently provided by the authors, along with the original data. It was recommended that the new information from direct ageing be combined with length-frequency samples, to better describe growth over a more complete age range. The Group also expressed concern that the estimates of L_∞ appeared too small, and would not be able to accommodate occurrences of large bluefin tuna, as have occurred historically. It was noted that in the context of rebuilding efforts, it is important to characterize productivity correctly. Finally, it was asked what birth date convention was used by the authors.

The presenting author consulted by email with some of the co-authors to attempt to address some of the concerns raised above. Concerning the value of L_∞ appearing too small, the authors noted that the current description of growth may have been limited by the absence of older fish. Preliminary von Bertalanffy fits conducted by the authors with larger, older Canadian samples yielded an L_∞ of 280 cm. The authors also noted that there is a view that L_∞ should reflect the average largest fish, not the largest fish ever seen. Concerning the birthdate convention, the authors assumed a spring-summer birthdate. Fish included in the analyses were samples captured during summer-fall months.

The Group saw the benefit of basing growth models on otolith data, as these samples could more reliably be assigned to a stock than can conventional tag data used in Turner and Restrepo (1994). The major concern was that it appeared as though the largest and smallest size classes were under-represented in the sampling. Additional otolith samples from large fish have been collected and are being analysed. These new data will be incorporated into the growth model. In addition, the authors will attempt to collect and analyse otolith samples from fish throughout the size ranges in the future. The Group decided to explore the results of combining different data sets and using different error assumptions to estimate growth curves (see **Appendix 5**).

SCRS/2008/091 examined the implications of the growth curve presented in SCRS/2008/084 to the stock assessment of western Atlantic bluefin tuna and its corresponding management advice. The new growth curve was used to convert the catch-at-size matrix from the 2006 assessment (Anon. 2007) into an alternative catch-at-age matrix through application of the SCRS age-slicing algorithm. The base-case VPA model and associated projections from the 2006 assessment were then repeated with this alternative catch-at-age. The results suggest a more optimistic appraisal of stock status, but are dependent on VPA parameter specifications that were based on the results from the current growth curve. It is recommended that (1) the otolith data used to estimate the new growth curve parameters be augmented with samples from small fish and (2) the terminal-year, F-ratio, natural mortality and maturity specifications be re-examined if the proposed otolith-based growth curve is to be adopted.

The Group agreed that significant progress has been made in updating the growth curve used by the SCRS. Given the expected changes in the growth model, there will likely be a need to revise the current benchmark calculations. Having direct age estimates throughout the age range would also be helpful for the estimation of the von Bertalanffy parameters, rather than the explorations presented here, which necessitated the combination of data sets with disparate error structure.

The Group strongly encouraged further age and growth work based on direct ages from otoliths, including incorporation of both younger and older ages. It was further noted that given the considerable consequences of variations in growth on management advice as demonstrated in SCRS/2008/091, a program of biological sampling of the catch and routine age determinations is urgently needed to provide more realistic estimates of stock productivity.

4.2 Movement and migrations

SCRS/2008/092 presented information from 15 bluefin tuna that were satellite and archival tagged in the Gulf of St. Lawrence, Canada, during October 2007. The objective was to examine the movements and spawning migrations of bluefin tuna from this late summer/autumn foraging assemblage. Preliminary results from this experiment were presented. All bluefin tuna were brought onboard the vessel, irrigated, tagged, measured and released. Bluefin tuna ranged in size from 235 to 302 cm curved fork length. Three tags were programmed to pop-up shortly post-release, after 3, 30, and 60 day intervals, to demonstrate survivorship and short-term success of the tagging operations. The remaining tags were set for longer durations in order to examine where the tuna were during the breeding season. To date, of the six tags that remained on fish beyond the onset of the breeding season, three have popped up in the Gulf of Mexico and three in the western North Atlantic. A single fish that carried a long-term tag had a premature release program activated suggesting the fish died shortly after release. The tagging data support the hypothesis that strong linkages exist between the Gulf of St. Lawrence fish, the North Carolina foraging grounds and the Gulf of Mexico spawning grounds. To date, none of the fish has a geoposition in the eastern Atlantic management unit.

The Group enquired about size-related aspects of transatlantic migration. It was noted that all marked fish were large and of presumed spawning age, so there were limited possibilities for addressing size-related aspects of migration within this particular study. The Group noted for the Pacific congener there is evidence of skipped spawning from studies of captive fish, and enquired if any evidence was available for Atlantic bluefin tuna from satellite and archival tagging efforts to date. In response, it was noted that there was evidence (fish of the right size in the right location that exhibited behaviour indicative of spawning) of repeated annual spawning for up to five years in the Mediterranean, and three years in the Gulf of Mexico. Skipped spawning was not observed in any of these fish for which multi-year tracks were obtained. The Group asked if there were prospects of a physiological tag (eg. measuring hormone level) that could measure spawning activity. In response, it was noted that such technology was not yet available, and inferences of spawning were made from behavioural observations obtained from the electronic tags, as well as examining the tracks of fish with respect to known spawning areas and environmental conditions (sea surface temperatures >24ºC). The Group noted that observations from bluefin in captivity could help refine the characterization of spawning activity. It was noted that researchers involved in the tagging program had been in contact with Japanese, Australian and American colleagues regarding spawning behaviour of tunas observed in captivity.

4.3 Stock structure

The Group also received a presentation that showed how otolith microchemistry can be used to determine natal origin. The results demonstrated otolith $\delta^{13}C$ and $\delta^{18}O$ values of yearling bluefin tuna from eastern (Mediterranean Sea) and western (Gulf of Mexico) spawning areas were distinct and served as natal tags to assess population origin. Analysis of otolith cores for adults on spawning grounds supported philopatry to both eastern and western spawning areas. Adolescent and adult bluefin tuna collected from the U.S. Mid-Atlantic were comprised of both populations with the percent of fish originating in the Mediterranean Sea decreasing with increasing size or age. In contrast, large adults foraging areas in the northwest Atlantic (Gulf of Maine and Gulf of St. Lawrence) waters were almost entirely from the western population. Findings support natal homing to both spawning areas, and highlight the substantial subsidy of adolescents from the eastern population to most of the foraging and fishing regions in the western Atlantic.

The Group requested more information on the precision of the estimates of natal origin. In particular, they noted that the apparent movement of a significant fraction of the western stock into the Mediterranean has considerable implications. A potential problem is that the maximum likelihood composition estimator can be biased when the stocks differ greatly in local abundance, with the near-zero contributor tending to be overestimated (Millar 1987). By correspondence, the lead author provided information that indicated the range of actual western contribution to the Mediterranean could be as low as nil, which is more consistent with genetic investigations (Carlsson *et al.* 2007, Boustany *et al.* 2007). The Group asked if otoliths from larvae or post-larvae could be used for this type of analyses. The authors responded that with current methods, this would necessitate pooling of otoliths from individual fish.

For the analyses of mixing, the following information (determined from samples collected opportunistically from 1995-2005) was used:

Western samples (Mid-Atlantic bight)						*Eastern samples (Mediterranean)*					
Location	*CFL (cm)/age*	*n*	*East*	*West*	*Std*	*Location*	*Age*	*n*	*East*	*West*	*std*
MAB	69-119	46	0.62	0.38	0.12	Med	age 10	94	0.957	0.043	0.032
MAB	120-151	50	0.56	0.44	0.10	Med	age 5-9	38	0.955	0.045	0.045
MAB	185+	34	0.17	0.83	0.12						
GOM	age 10+	42	0.01	0.99	0.02						
Gulf Maine	age 10+	72	0.02	0.98	0.03						
Gulf SL	age 10+	39	0.00	1.00	0.00						

4.4 Summary of bluefin biology

Atlantic bluefin tuna (BFT) mainly live in the pelagic ecosystem of the entire North Atlantic and its adjacent seas, primarily the Mediterranean Sea. BFT have a wide geographic distribution and live permanently in temperate Atlantic waters. Archival tagging and tracking information confirmed that BFT can sustain cold as well as warm temperatures while maintaining stable internal body temperature. Until recently, it was assumed that BFT preferentially occupy the surface and sub-surface waters of the coastal and open-sea areas, but archival tagging and ultrasonic telemetry show that BFT frequently dive to depths of 500 m to 1000 m. BFT is also a highly migratory species that seems to display a homing behaviour and spawning site fidelity in both the Mediterranean Sea and Gulf of Mexico, which constitute the two main spawning areas being clearly identified today. Less is known about feeding migrations within the Mediterranean and the North Atlantic, but results from electronic tagging indicated that BFT movement patterns vary considerably between individuals, years and areas. The appearance and disappearance of important past fisheries further suggest that important changes in the spatial dynamics of BFT may also have resulted from interactions between biological factors, environmental variations and fishing. Although the Atlantic BFT population is managed as two stocks, separated by the 45°W meridian, its population structure remains poorly understood and needs to be further investigated. Recent genetic and microchemistry studies as well as work based on historical fisheries tend to indicate that BFT population structure is complex.

Currently, our understanding is that BFT in the Mediterranean mature at 4-5 years of age (approximately 25 kg) and at about 8 years of age (approximately 140 kg) in the Gulf of Mexico (albeit age-at-maturity is still debated in the West). Juvenile and adult BFT are opportunistic feeders (as are most predators) and their diet can include jellyfish and salps, as well as demersal and sessile species such as, octopus, crabs and sponges. However, in general, juveniles feed on crustaceans, fish and cephalopods, while adults primarily feed on fish such as herring, anchovy, sand lance, sardine, sprat, bluefish and mackerel. Juvenile growth is rapid for a teleost fish (about 30 cm/year), but slower than other tuna and billfish species. Fish born in June attain a length of about 30-40 cm and a weight of about 1 kg by October. After one year, fish reach about 4 kg and 60 cm long. Growth in length tends to be lower for adults than juveniles, but growth in weight increases. At 10 years old, a BFT is about 200 cm and 150 kg and reaches about 300 cm and 400 kg at 20 years. However, there remain large uncertainties about BFT growth curves.

In the 2006 stock assessment conducted by the SCRS, there was noted a need to integrate recent and anticipated advances in otolith microconstituent analyses, age determination, archival tagging and genetics into the next assessment and management evaluation processes. While more work needs to be completed, the SCRS has achieved important progress towards that goal. Concerning age determination, the SCRS received new information that presented a novel approach for determining age and area of natal origin from the same otolith, allowing construction of area-specific growth curves. The preliminary results diverge considerably from the age-length relationship used by the SCRS for the western stock, and could have significant impacts for estimates of stock productivity.

The information on natal origin derived from otolith microchemistry received by the SCRS indicated that there is an increasing contribution of eastern origin fish to the western fisheries with decreasing average size of the fish in the catch (*i.e.* up to 62% for fish in the 69-119 cm size class). In contrast, other western fisheries supported by the largest size classes had minimal or no eastern component in the catch.

5. Catch data, including size frequencies and fisheries trends

Annual bluefin nominal catches (Task I) from 1950 to 2007 were presented by the Secretariat and summarized in **Table 1** and **Figures 1** and **2**. **Figures 3** and **4** show the spatial distribution of bluefin catches (1950-2006) by gear and decade. **Figure 5** shows the reported annual bluefin catches by area and main gear.

The catch-at-size data set for the western and eastern stock prepared in advance by the Secretariat was reviewed by the Group. Substitution rules tabulated in SCRS/2008/102 contain the detailed procedures used for the substitution and the extrapolation made when no size sample was submitted.

In the case of the western stock, the available data included catch, effort and size statistics through 2007, while for the eastern stock, data for 2007 were unavailable for analysis during the assessment session (see the letter of the SCRS Chair dated 27/06/2008, ICCAT Circular 1226/08, attached to this report as **Appendix 6**). There are considerable data limitations for the eastern stock for the recent period. These include poor temporal and spatial coverage for detailed size and catch-effort statistics for many fisheries, especially in the Mediterranean. Substantial under-reporting of total catches is also evident.

5.1 *Fishery trends – East*

Several papers about fishery, fishery data and CPUEs were presented at the meeting. Summaries of documents relative to fishery trends are presented below.

Document SCRS/2008/096 deals with the reconstruction of the size composition of bluefin tuna caught by the Moroccan Atlantic traps from biological scraps (mainly heads), using a linear relationship between the fork length and the head length established for this species. In 2006, scraps from 209 individuals were sampled to estimate the size structure of BFT catches. Results show that there is a strong correlation between the head length and the length between the tip of the snout and the posterior limit of the pre-operculum, as well as between the fork length and the head length. A comparison of the same relationship in the other trap fisheries was also provided. On the basis of these studies, the Group discussed the possible enhancement of this type of data collection especially in the Mediterranean Sea (Section 11.1 includes a recommendation reflecting this discussion).

SCRS/2008/104 presented information on the total catch, timing of harvest and size composition of bluefin tuna caught in Tunisian pens between 2005 and 2007. Wild tuna caught by Tunisian purse seiners are used in the fattening operations. The study reported that 5,665 were fish sampled, of which 3,275 had both weight and length data from the same fish. Annual length-weight relationships for fattened fish are reported, and size composition information presented. It is demonstrated that Tunisian farms are targeting spawning fish, with more than 98% of the total sampled fish which are larger than the length at first maturity.

Considering that only about 15% of the 2007 Task I data were reported in due time to the Secretariat, **Figure 1** shows patterns of bluefin catch by main areas based on Task I data for the 1970-2006. From 1950 until the early 1960s, catches of bluefin tuna mostly took place in the northeast Atlantic and then in the Mediterranean Sea. In the mid-1960s, a new fishing ground was found in the tropical West Atlantic while the northeast Atlantic fisheries strongly declined (especially in the North Sea and Norwegian Sea, see SCRS/2008/Santander). From the mid-1960s until the mid-1970s, the catches were about 6,000 to 9,000 t/year in the three areas. Since 1982, the West Atlantic catches were limited to around 2,500 t/year, while the catches in the East Atlantic remained at the same level of about 9,000 t/year. From the early 1980s until the mid-1990s, the catches in the Mediterranean Sea have steadily increased, from about 10,000 t/year to almost 40,000 t/year. Although, there is a substantial decrease in the reported catch of the Mediterranean Sea over the last decade (at about 24,000 t/year), the SCRS strongly believes that these lower catches mostly reflect underreporting and that current catches are probably more than 43,000 t/year (see below "trade statistics" section, Section 9 and Anon. 2007).

Figures 1 and 5 show patterns of bluefin catch by main gears. Since 1950, the baitboat fisheries that mostly catch juvenile fish in the northeast Atlantic appear to be rather stable. The longlines displayed two peaks, the former in the tropical West Atlantic (especially offshore Brazil) and the latter in the Mediterranean Sea and secondarily in the central Atlantic. Catches have, however, slowly declined over the last decade. The trap that was the major gear in the East Atlantic and Mediterranean Sea steadily declined during the 1960s. From the 1970s to nowadays, trap catches mostly varied between 2,000 and 4,500t/year and have almost completely disappeared from the Mediterranean Sea. Catches from purse-seiners were mostly coming from the Northeast Atlantic during the 1950s and early 1960s. While these fisheries declined in the following years, this gear arose in the Mediterranean Sea and has become the major gear used for harvesting bluefin tuna in the Mediterranean (up to 85% of the reported catches in the Mediterranean Sea).

Regarding seasonality, estimates of temporal pattern in monthly catches of spawning size (> 130 cm FL) and juvenile (< 130 cm FL) bluefin tuna in the East Atlantic and Mediterranean fisheries were updated based on the 2005 and 2006 catches **(Figure 6)**.

In general, monthly catch patterns are very similar to those previously estimated. For the Mediterranean, juvenile bluefin tuna catches occur throughout the year, with a peak at the beginning of the second quarter. As regards spawning size fish, the bulk of the catch occurs during the second quarter.

East Atlantic juveniles are caught from May to November with two peaks around June and September. For the spawning size fish, the bulk of the catch is made in the second quarter of the year although there is still a significant amount of catch during the last quarter.

The tremendous recent expansion of the purse seine (PS) fleet in the Mediterranean is related to the farming activity, a feature that is not obviously reflected by the reported catch of that gear. In 1997, only 200 t of Mediterranean BFT were put into cages, whereas previously the SCRS estimated that up to 20,000 to 25,000 t were farmed each year since 2003 (some estimates being conservative in comparison to those of WWF, which reach 30,000 t in 2004 and 2005, and which also appear to be possible). This tremendous development of farming activity in the Mediterranean over the last few years has induced a concomitant development of new PS fisheries and a considerable modernization of the traditional PS fleets. This worrying development in a context of overexploitation potential has further led to a quick and spatial expansion of the PS fleets in the Mediterranean, especially in the central and eastern Mediterranean **(Figure 3)**. Consequently, the vast area of the Mediterranean nowadays were covered by BFT fishing over its entire surface, a situation that has never been encountered in the past and that is of high concern since there appears to no longer exist any refuge for BFT in the Mediterranean during the spawning season.

Summarizing, it is very well known that introduction of farming activities in the Mediterranean in 1997 and good market conditions resulted in rapid changes in the Mediterranean fisheries for bluefin tuna, mainly due to increasing purse seine catches. In the last few years, nearly all of the declared Mediterranean bluefin fishery production is exported overseas. Declared catches in the East Atlantic and Mediterranean reached a peak of over 50,000 t in 1996 and, then decreased substantially, stabilizing around TAC levels established by ICCAT for the most recent period. Both the increase and the subsequent decrease in declared production occurred mainly for the Mediterranean. In 2006, declared catch was about 30,650 t for the East Atlantic and Mediterranean, of which about 23,100 t were declared for the Mediterranean (2007 catch reports were unavailable at the time of the meeting). Information available reinforces our belief that catches of bluefin tuna from the eastern Atlantic and Mediterranean have been seriously under-reported in recent years (see Sections 5.3.3 and 9.1).

5.2 Fishery trends – West

The total catch for the West Atlantic including discards has generally been relatively stable since 1982 due to the imposition of quotas. However, since a total catch level of 3,319 t in 2002 (the highest since 1981), total catch in the West Atlantic has declined steadily to a level of 1,624 t in 2007 **(Figure 7)**. This decline is primarily due to considerable reductions in catch levels for U.S. fisheries. It is noted that several additional CPCs have reported at least some West Atlantic bluefin tuna catches during the previous five years, but did not report in 2007. However, the total reported from these flags has averaged only 44 t during this period.

CANADA: Canadian bluefin tuna fisheries currently operate in several geographic areas off the Atlantic coast from July to November, when bluefin tuna have migrated into Canadian waters. The spatial distribution of the Canadian fisheries has not changed significantly, but there were anecdotal reports of tuna occurring in areas where they have not been observed in many years (for example, the Baie des Chaleurs in the western Gulf of St. Lawrence). The size composition of the catch in the southern Gulf of St. Lawrence over the past 5-6 years has generally followed a declining trend that has recently stabilized, and is now increasing. The condition (Fulton's K) of individual fish in the southern Gulf of St. Lawrence has been following a declining trend and is now at the lowest value in the series. The Canadian bluefin tuna catches (landings and discards) in 2002 were 641 t, the highest level since 1978 at the time. Catches for 2003-2007 totaled 571, 552, 600, 735 and 491 t, respectively. The 2006 catch was the highest recorded since 1977. The 2007 landings by gear were: 17 t by harpoon, 58 t by longline, 389 t by rod and reel, 23 t by tended line and 4 t by trap.

UNITED STATES: The U.S. bluefin fishery continues to be regulated by quotas, seasons, gear restrictions, limits on catches per trip, and size limits designed, to varying degrees, to conform to ICCAT recommendations. The catches (landings and discards) of U.S. vessels fishing in the northwest Atlantic (including the Gulf of Mexico) in 2002 reached 2014 t of bluefin tuna, the highest level since 1979. However, catches in 2003-2007 declined precipitously, to 1644, 1066, 848, 615, and 849 t, respectively. The 2007 catches, including dead discards, by gear were: 28 t by purse seine, 23 t by harpoon, 164 t by longline (of which 81 t were incidental catches from the Gulf of Mexico), and 634 t by rod and reel (of which, 399 t was the preliminary estimate for bluefin less than 145 cm SFL from off the northeastern United States).

JAPAN: Japan uses longline gear to catch bluefin tuna in the Atlantic Ocean. The overall number of boats engaged in bluefin fishing has declined from more than 100 boats in recent years to about 50 boats in 2007, of which about 20 boats were operated in the West Atlantic. Recent catches in the west (about 300-600 t) have fluctuated mostly due to the quota adjustment. Operational pattern did not change much in the West Atlantic. Fishing starts in August but in the east Atlantic in the waters off Iceland to Ireland. Thereafter, they move westward and reach the West Atlantic at around late November to early December. The fishing usually stops in January but in some years it extends to February. The West Atlantic bluefin tuna catch (landings and discards) of the Japanese longline fleet in 2007 was 277 t, the lowest level since 1981 with the exception of 57 t in 2003.

5.3 Catch and size data – East

5.3.1 Nominal catches

It was noted that the ICCAT Task I for the years 1950-1979 contain important catch for EC-Greece with an average of 710 t by year. The Group felt that for those years there were no fisheries in Greece targeting bluefin and decided to remove those time series from the scientific calculation and asked the Secretariat to flag the information in its database and try to find the origin of this data.

New catch figures for Denmark for the years 1938-1988, Sweden for 1937-1962, Germany for 1947-1962 and Norway for 1927-1974 were made available during the session (see BFT Symposium Report) and the Group approved the decision to revise the historical catch time series for those countries. The Japanese catches reported in two different longline fisheries (mother boat and single boat operation) were aggregated into only one gear.

On the first day of the meeting, only 3,816 t of the 2007 nominal catches (Task I) were reported to the Secretariat by the following three Contracting Parties: Japan, Croatia and Turkey. According to the low level of catches reported in the eastern Atlantic and Mediterranean area for the year 2007, the Group expressed grave concern about the compliance of reporting statistical data by the contracting parties. n particular, the Group considered that these scarce data did not allow evaluation of the progress of the 2006 Recovery Plan for Bluefin Tuna in the astern Atlantic and Mediterranean, as was requested by the Commission. The concern of the Group was expressed through a letter addressed to the Commission Chairman (see **Appendix 6**). Nevertheless, to make up for the lack of data in 2007 it was decided to examine 2007 catch levels reported to the Compliance Committee during the 2007 Commission meeting to compare with other sources of information.

5.3.2 Size frequencies

During the session, six important historical size sampling data sets were submitted to the Group for the first time: Germany for years 1952 to 1962, EC-Italy/Trap for 1956 to 1984, Norway/PS for 1956 to 1981, Morocco/Hand for 2000 to 2006 and Morocco/Trap for 2006 to 2007, Turkey/PS for 1992 to 2003 and a new sample from Spanish BB in 1956. The availability of those new data influenced the Group to create the catch at size and catch at age for the eastern stock starting in 1955. After examination of the catch size distribution, it was decided to remove all the time series from Moroccan PS and Tunisian trap of Monastir which showed an unusually large amount of small fish and to substitute it by Spanish baitboat and Italian trap, respectively, which the Group believes better reflects the actual size distribution of these catches. Catch at age generated from this catch at size is shown in **Figure 8**.

In addition to the analyses of size data submitted as Task II, the Group estimated the coverage of the bluefin farming sampling scheme established by the *Recommendation by ICCAT on Bluefin tuna Farming* [Rec. 06-07]. Results are shown in **Appendix 7** as well as the procedure used.

5.3.3 Trade statistics evaluations

The Committee has previously observed that in spite of declared levels in official statistics, the volume of catch taken in recent years likely significantly exceeded TAC levels and probably was close to the levels reported in the mid-1990s. As only about 15% of the 2007 AC for eastern Atlantic and Mediterranean bluefin was officially submitted in time to be considered in the assessment, our belief that catches of bluefin tuna from the eastern Atlantic and Mediterranean have been seriously under-reported in recent years has been reinforced. It has been observed that nearly all of the declared Mediterranean bluefin fishery production is exported overseas, leaving little of the declared volumes for domestic consumption, which are believed to be substantial.

Although the Japanese market remains a primary recipient for Atlantic bluefin tuna production, it is no longer the only available market for bluefin and tracking trade through the various markets is difficult to accomplish. Nonetheless, the Group examined the information reported through various market data sources in an attempt to further refine estimates of the volume of bluefin exported from the Mediterranean and eastern Atlantic fisheries. We examined the BFT statistical documents held at ICCAT for the most recent period to compare against Task I official reports available for the assessment. Due to the lag between the time of export/import and the time of capture because of farming practices, only a portion of the 2007 capture volumes can be estimated from this comparison, since import statistics for the first part of 2008 are not yet available at ICCAT. To estimate the live-weight of bluefin being exported from the Mediterranean to the Japanese and U.S. markets, the average gain for fish held in cages for six months needs to be known. In the past, the SCRS has used a 25% gain in weight for fish held in cages for six months (taking into account that a small proportion of fish coming from the Adriatic were of small size and proportionally gained much more weight than large fish). During the present meeting, the Group was able to reestimate the gain, using samples of farmed fish for which both weight and length are available (see Section 5.3). As this estimate was significantly different, i.e. 14.5%, the estimates of live weight were computed under the two assumptions, gains of 14.5% and 25%, respectively **(Table 2)**. Estimates of live-weight bluefin from farms varied between 27,148 and 34,198 t/year depending on the assumption and year. Task I data for 2004 to 2006 (2007 being unavailable) ranged from 23,154 t to 26,697 t, so that the differences between the two estimates would indicate an underreporting of 1,000 to 7,000 t/year.

Japanese and U.S. market import statistics were also examined independently. In the Japanese market case, the import volumes from May 2007 to April 2008 were taken to represent catches made in the eastern Atlantic and Mediterranean. As above, two assumptions about the average growth of bluefin held in cages were applied. In this case, the Japanese market statistics support a range of 24,000-27,000 t of estimated live weight of bluefin caught in the eastern Atlantic and Mediterranean during 2007. Likewise, U.S. import statistics were examined and in 2007 it is estimated that on the order of 600 t live weight of bluefin were imported from catches made in the eastern management zone and not re-exported to other markets. No information was yet available for 2008 and so a complete view of 2007 catches imported cannot be made from the available data. In total, taking into account the Japanese catch in the eastern Atlantic and Mediterranean but not accounting for domestic consumption by exporting countries, indicates the 2007 catch level from the eastern Atlantic and Mediterranean was in excess of TAC, although the amount in excess could not be estimated without additional information and assumption.

Scientists from the World Wildlife Fund (WWF) attended the meeting as observers. Information pertinent to estimating potential recent catch levels in the Mediterranean held within a document prepared by WWF, entitled "Race for the Last Bluefin Tuna" (March 2008) was presented by the authors. In 2006, WWF estimated total catches on the eastern Atlantic stock of bluefin tuna in 2005 at more than 50,000 t. A new assessment produced by Advanced Tuna Ranching Technologies (ATRT) and supported by WWF and Greenpeace in 2007 confirmed this figure for the following years of 2006 and 2007. For 2006, the study relied on complete official statistics on international trade for the year, including ICCAT statistical documents supplemented with Eurostat trade data. Trade figures inferred were crosschecked against databases from national trade and custom agencies in Spain, France, Malta, Italy, United States, Japan, Korea and Tunisia, and fine tuned with reliable catch and caging data when appropriate. Total estimated catches of BFT (wild round weight) in the east Atlantic and the Mediterranean from this WWF and Greenpeace study amounted to 58,681 t for the year 2006. For 2007, this study was based on direct field assessments of Mediterranean tuna farms in 2006 and 2007, supplemented with Eurostat trade data (from January to July 2007) and official reports of catches and industry estimates collected until August 30, 2007. Total estimated catches of BFT (wild round weight) in the East Atlantic and Mediterranean amounted to 56,149 t for the year 2007.

Discussion of the methods applied and results given in the document was mostly devoted to checking the sources of information and methodologies used for estimating catch potentials. In the 2006 and the current bluefin tuna assessment (see Section 9), the SCRS had already considered misreporting of about the same magnitude identified in the WWF report for somewhat earlier periods. The Group has asked to WWF scientists to consider different scenarios about domestic consumption, conversion factors, different approaches (all being based on the same source of information coming from ICCAT, Japanese and U.S. trade data and Eurostat) to avoid double counting due to simultaneous exports of belly meat together with filets. The comparison results in estimates of the 2007 catch level in the eastern Atlantic and Mediterranean was on the order of 39,000 to 56,000 t, i.e. values that largely exceed the TAC. Spreadsheets supporting these calculations are held at the ICCAT Secretariat as part of the record of the 2008 bluefin tuna stock assessment.

The WWF estimates of 2006 and 2007 catches coincided in general with those made by the Group on the basis of active capacity (see Section 9). They are substantially higher than the Group estimates when summing estimated catches from **Table 2** (i.e. farmed bluefin tuna in the Mediterranean) with East Atlantic catch (i.e. 7,493 t in 2006) which results in a total catch of estimate of between 36,584 and 41,691 t. Note, however, the Group assumed that all catches from the Mediterranean Sea go into cages, which is a very conservative assumption.

In conclusion, the Group still believes that significant underreporting has occurred in 2006 and 2007 (note that the EU has reported a 4,400 t quota overshoot in 2007). Consequently, the Group estimates that the 2006 and 2007 catches were more likely at a comparable level of those of previous years, i.e. 50,000 t, or even higher (see Section 9 and Anon. 2007). As has been expressed several times in past SCRS Reports, this is particularly worrying since such large under-reporting partially impairs our ability to assess the stock with methods that do not assume observation errors. This does not prevent development of scientific advice, but this development has to be supplemented with different indicators and methodological approaches (including more robust ones, such the yield-per-recruit, year-class curves, etc.) It is imperative that CPCs provide accurate Task I and Task II data to the SCRS if they want to have improved and more precise stock status evaluations and advice.

5.4 Catch data – West

5.4.1 Nominal catches

The 2005-2007 reported catches (including estimated discards) for the West Atlantic were 1,869, 1,811, and 1624 t, respectively. Catches for each of these last three years are lower than for any prior year since 1982, and each is considerably lower than the average catches of about 2,500 t that have been reported during 1983-2004. The Untied States, Canada, Mexico and Japan reported catches for 2007 in the West Atlantic. After reviewing information presented by the Secretariat, it was decided to move the Portuguese baitboat catch in 2005 and 2006 from the western to the eastern stock. Catches reported in unclassified gear for Canada during the years 1960 to 1969 was reclassified as trap gear and U.S. longline discards for 1987-1991 were revised by U.S. national scientists. The Task I catch data, as reported in **Table 1** and **Figures 1** and **2**, were approved.

5.4.2 Catch-at-size (CAS) and catch-at-age (CAA)

The substitution scheme proposed by the Secretariat for western Atlantic bluefin tuna to update the CAS used at the 2000 assessment session, up to and including 2001 is detailed in SCRS/2008/102. A few changes were proposed to western catch-at-size data. The modifications affected U.S. longline (2004), U.S. rod and reel (1992), and U.S. longline discard (1986). Fleets which had been defined in earlier catch at size data sets as unclassified were broken down into the following countries: Argentina, Uruguay, Brazil, Cuba, Chinese Taipei and Korea.

Following a careful scrutiny of the data in both stocks, and with the availability of new size sample data presented during the first day of the meeting, the Group decided to undertake an important revision in the nominal catch data and, consequently, in the catch at size. The overall catch at size for the west is shown in **Figure 9**.

The same age slicing procedure used for several years was again employed to convert CAS to CAA. That procedure uses the growth curve from Turner and Restrepo (1994) and empirical modal separation for ages 1-3, where appropriate. A summary of the results is shown in **Table 3** for the West Atlantic (Areas 1+2) and in **Figures 10 and 11**. Weights at age from the age-slicing for the west are shown in **Table 4**. Three scenarios for boundaries were defined using the areas defined in the Report of the ICCAT Workshop on Bluefin Mixing (Anon. 2002). The CAA was defined separately for Area 3 **(Table 5)** using the CAS for Japanese LL, which represents nearly all the catch in that area. The eastern stock age slicing procedures were applied to the Area 3 CAS data provided by national scientists for years 2002-2007. The resulting CAA data were appended to CAA data for 1970-2001 that were available for the 2006 bluefin tuna stock assessment. It should be noted that the CAA data for Japanese longline in Area 3 2002-2007 were updated by the Secretariat based on the CAS submitted to the Secretariat from Japan before the meeting. CAA data for Japanese longline in Area 3 until 2001 was carried over from the CAA used at the 2006 assessment. The Group noted that there were major discrepancies between the Area 3 CAA carried over from the 2006 assessment and that used for the 2002 assessment. The reasons for this were unclear, but a possible explanation is that differing decisions were made on the geographic separation of catches between areas.

5.5 Mixing variants

The Group discussed the implications of the otolith microconstituent study reviewed in Section 4.3, which estimated that a substantial proportion of the bluefin sampled from western catches were of eastern origin. Unfortunately, the available samples were insufficient to determine the relative proportions of eastern and western fish in the catches for each year, so it was not possible to adjust the CAA directly. Instead, the Group agreed that it was more appropriate to examine the implications of the proportion estimates within the context of a mixing analysis (e.g., the two-box overlap VPA).

6. Relative abundance indices and other fishery indicators

6.1 Relative abundance indices – East

6.1.1 Primary indices

The Group reviewed the available information on abundance indices. The indices that were presented at the last assessment meeting were all updated. Those are indices from Spanish trap, Moroccan trap, Spanish baitboat fishery in Bay of Biscay and Japanese longline fishery in the east Atlantic and Mediterranean. Original CPUE and scaled CPUE to its mean value and CVs, when they are calculated, are given in **Table 6** and **Figure 12**.

SCRS/2008/099 derived GLM-standardized indices of abundance for large bluefin tuna (6+) in the Spanish traps close to the Strait of Gibraltar from 1981 to 2007. This index was discussed since the 2002 Atlantic Bluefin Tuna Stock Assessment Session (Anon, 2003). At the last assessment in 2006, it was standardized with a GLM with a negative binomial error assumption and included variables of trap, year and season (May and total duration). Discussion was made similarly on the possible inclusion of the environmental information such as water temperature because the movements of the fish are often triggered by the changes in oceanographic conditions. Finally accepted model includes only factors of year and trap with aggregated catches for whole season.

SCRS/2008/098 provided a CPUE series from 1986 to 2006 from the Moroccan trap fishery for fish over 10 years old at the mouth of the Strait of Gibraltar. This is resulted from the recommendation made in 2006, and was extended back to 1986 (last time it covered only to 1998). As agreed at the 2006 meeting, this index was also standardized using a negative binomial error assumption. The model includes the same variables as for Spanish study. When compared, both series showed a complementary pattern which might be interpreted as resulting from bluefin tuna migration closer to the Spanish or the Moroccan coasts. In combination, though, the Spanish and Moroccan trap CPUEs showed lower abundance during 1992-1996 and after 2002, although the latter years are slightly higher than 1992-1996. The Group also agreed to combine both two indices into a single trap CPUE index, using a negative binomial error assumption. The results being satisfactory, the group decided to use this index for the tuning of the VPA.

SCRS/2008/100 updated standardized CPUE indices from Spanish baitboat fishery in the Bay of Biscay for 1975 to 2007. Standardization was carried out using generalized linear mixed models. Catch and effort data on bluefin tuna were prepared on trip basis; catches that are classified by commercial category were converted to ages by applying seasonal age length keys to the length distribution of commercial category. In this update the age was assigned to each commercial category so that the indices should represent the year class strength. This is because the fishery takes a variety of fish size from age 1 to over age 5. On the other hand, there are many zero catch observations, and therefore a delta-lognormal model was applied. The model finally selected following explanatory factors: Year, Age, Month and Year × Age fixed factors, plus a selection of other factors that significantly contributed for reducing deviance in the aggregated model. All Year interactions besides the Year × Age factor were considered as random variable. CVs of the standardized index are less variable than the previous one (from 1975 to 2004), but still some variability are found for the last years when the larger vessels were built and were included in the analysis. The revised age length keys seem to be reducing variability in CVs during the study period. The standardized indices indicated large annual fluctuation without a strong tendency, although the most recent peaks are relatively lower than the previous peaks.

SCRS/2008/103 provided standardized CPUE from the Japanese longline fishery in the East Atlantic (Area 5) and the Mediterranean Sea, from 1975 to 2006. Set by set data from longline boats including available chartering activities are used. Due to the short fishing season in these two areas, data were limited to April and May. Other factors included are geographic area, materials for main and branch lines and number of hooks between floats. The Group also developed the index for Mediterranean Sea (Area 6). The age of fish assigned are 4 years old and older, as the occurrence of fish of ages 5 to 7 is not rare, and in the VPA fishes older than 4 years old were used as partial catches of this fishery. The indices were standardized by delta-lognormal models with random effects for month × area interactions. The relative abundance index for the East Atlantic and Mediterranean showed relatively large fluctuations until the mid-1980s, and then exhibited a regular decline, reaching its lowest level in the late-1990s. After that it reached somewhat low peak in 2002 and higher peak in 2006 that is slightly lower than the highest peak. Getting the overall abundance index from the Japanese longline fishery for the total eastern Atlantic and Mediterranean Sea was suggested. However, the fishing seasons are different depending on the area, and the years of the fishing are also different. Giving these situations, it would require some ways of combining all information, such as area-season weighting for the total East Atlantic. The Group did not have enough time to conduct this analysis and it is left for future consideration.

6.1.2 Historical indices

The Group also reproduced two historical nominal CPUEs for the purpose of conducting an historical VPA going back to 1955. French and Spanish baitboat indices were calculated from the ICCAT Task II data for 1952-1977. Also, Norwegian purse seine CPUE (yields divided by the number of vessels) for 1955-86 given in Fromentin and Restrepo (SCRS/2008/093, Figure 1c) was used. Therefore, these two indices are considered to be nominal CPUE. With regard to the PS CPUE for 1963, Norwegian scientist pointed out that this data point should not be used because fishing effort (number of boat) for that year did not reflect the actual effort.

6.1.3 Needs of information from the purse seine fishery and from the Mediterranean Sea

In the Mediterranean, more than 85% of the total catches were made by the purse seine fishery during the recent years. The nominal CPUE index from the French PS fleet that has been used until 1998 has not been updated due to various severe limitations (see Anon. 2007, Section 5.1), so that the Group has no catch rate information on the PS fisheries. To conduct more precise and reliable assessments, it is necessary to obtain information about the catch composition, effort (e.g. day-at-sea, day of active fishing, etc.), the spatial distribution (e.g. VMS) and the technological equipments of the PS fisheries operating in the Mediterranean Sea. This issue was already pointed out many years ago and repeatedly raised in various ICCAT reports without success.

In addition to this information, the Group also stressed the strong need for fisheries-independent indices (especially in the Mediterranean Sea), as this is currently available for many stocks assessed by ICES or GFCM. European and Mediterranean scientists have recently conducted over several years and with success aerial surveys (see Fromentin, *et al.* 2003) or larval surveys (see García *et al*, 2005). These surveys have been stopped due to a lack of funding which is really unfortunate and the Group recommended that such monitoring be more strongly supported by ICCAT and/or CPCs.

6.1.4 Abundance indices used in the VPA runs

Abundance indices used in VPA analyses were shown in **Figure 13 East**. Spanish baitboat indices for both ages 2 and 3 indicate relatively large fluctuation between 1 to 5 years. The first nine years and the last five years of the two indices were lower than remaining part. Japanese longline index and combined trap index were similar between 1981 and 1996 as well as the most recent five years. However, they are quite different between 1997 and 2001.

CPUE indices starting in the early-1950s (Norwegian PS CPUE and French baitboat CPUE) were simple (nominal) CPUE because they were obtained by total catches divided by the total effort. They exhibit considerable fluctuations and there was no strong tendency except that the Norwegian CPUE declined by nearly 50% after 1975. These two indices were used in the VPA runs that start since 1955 in addition to the previous Indices.

In summary, available indicators from small fish fisheries in the Bay of Biscay did not show any consistent trend since the mid-1970s. This result is not particularly surprising because of strong inter-annual variation in year class strength. Indicators from longliners and traps targeting large fish (spawners) in the East Atlantic and the Mediterranean Sea displayed a recent increase after a general decline since the mid-1970s. The Group found it difficult to derive any clear conclusion from fisheries indicators in the absence of more precise information about the catch composition, effort and spatial distribution of the Purse Seine fisheries (which represent more than 60% of the total recent reported catch). Fisheries-independent indicators and a large scale tagging program in the Mediterranean Sea are also strongly needed to fill major gaps of scientific information.

6.2 Relative abundance indices – West

The indices used in the previous assessment of western Atlantic bluefin (Table 9, Figure 20 in the Report of the 2006 ICCAT SCRS Bluefin Tuna Stock Assessment Session in Anon. 2007) were updated, where possible, for the current assessment (**Table 7, Figure 14**). Several indices were revised using data and methods that were believed to be more appropriate. In addition, several new indices were developed from Japanese longline CPUE including two that extended back into the 1960s (one for Brazil and one for Florida and the Bahamas).

Document SCRS/2008/083 provided standardized relative abundance indices for Canadian bluefin tuna fisheries in the Gulf of St. Lawrence (1981-2007) and off southwest Nova Scotia (1988-2007) based on data from commercial log records. Methods used were as in the 2006 bluefin tuna stock assessment. CPUEs in the Gulf of St. Lawrence have increased slightly from 1997 to 2003, rapidly increased in 2004 and have remained high since then. The catch rates in 2007 are the highest in the time series, almost three times larger than the series average (**Figure 14**). The southwest Nova Scotia series has had a fairly stable trend through the mid- to late-1990s. While year 2000 showed the lowest value on record, catch rates have been following a slightly increasing trend since then. The 2007 catch rates are close (0.98) to the series average (**Figure 14**).

The Group asked if there were recent technological developments in this fishery, but there was no information of such changes. However, it was noted that the management system changed from a competitive quota to a fleet quota in 2004. The possible consequences for the catch rate series were not clear. The Group observed that the good catch rates in the Gulf of St. Lawrence may reflect the passage of a single year-class. The Group commented that there was considerable interest in bluefin tuna population declines and recoveries, and should the early signs of recovery of bluefin tuna in the western Gulf of St. Lawrence continue, it would be desirable to carefully document the event if possible. The possibility of combining Canadian indices with U.S. indices was considered but not accepted due to differing age composition among the different fisheries supporting the indices, and the desire to retain the ability to examine finer-scale spatial dynamics.

During the meeting, the Group compared an age-length key constructed from fish > 200 cm as reported in Hurley and Iles (1983) to the length-frequency information for the southern Gulf of St. Lawrence (SCRS/

2008/083). While the year-classes documented in Hurley and Iles (1983) are from earlier years, the data give information on expected variation in length at age for that fishery. The Group concluded that the data are not inconsistent with the possibility that the current fishery (and high catch rates) is supported by only a few (or even one) year classes/class, given the observed variation in length at age.

Document SCRS/2008/103 presented Generalized Linear Model analyses of catch rates for the Japanese longline fishery using different combinations of data from the western, central, and eastern Atlantic and the Mediterranean areas. The Group requested that the Area 2 index (see SCRS/2008/103, Figures 2 and 3) be redeveloped without including 2007 data because these data were considered not to be representative of the entire fleet (e.g., very few 2007 observations were available for the assessment; only few of the traditional fishing areas were represented; the data possibly corresponded to a non-random sample of vessels that fished in previous years; the data included only one of two types of branch line and one of two types of main line used by the Japanese fleet; most of the fishing effort in 2007 was in the month of February whereas most effort in other years was not). The Group also requested the development of:

1) An alternative index for fishing Area 3 including data only from (sub) Areas 31+32.
2) An alternative index for (sub) Areas 17 and 18, which was considered to be primarily a WBFT index.
3) Two historical indices, one based on Japanese longline catch and effort data from Brazil and the other based on data from the east coast of Florida (U.S.) and the Bahamas.

In response to the request from the Group, indices for Area 3 (Areas 31 and 32) and off Nova Scotia (Areas 17 and 18) were estimated using a delta-lognormal approach and including the interactions Month*Area as random effects. All estimated indices are shown in **Figure 14**. The indices in Area 3 showed a similar annual trend to the index for the central Atlantic. The index off Nova Scotia fluctuated without a discernible trend and it showed large coefficients of variation after 2000 due to a low number of observations. The West Atlantic index (Area 2) exhibited considerable fluctuations also without any trend. The abundance index for the central Atlantic was high in 1996, decreased in 1997 and 1998, and then recovered to an average level from 1999 through 2006. Historical abundance indices for off the Brazilian coast and off Florida/Bahamas were estimated for the periods 1960-1970 and 1964-1971, respectively, also using a delta-lognormal approach. The index off the Brazilian coast exhibited a sudden increase in 1962 and peaked in 1963. The abundance index off Florida/Bahamas reached its highest value in 1965 and showed thereafter a gradual decrease until the end of the time series in 1970.

Miller (2007) presented larval indices standardized in terms of the abundance of day-old larvae per 100 m^2 of water sampled. Due to the large frequency of zero catches during ichthyoplankton surveys, especially in later years, this index was developed using a zero-inflated delta-lognormal model. This model is a mathematical combination of yearly catch estimates from two distinct generalized linear models: a zero-inflated binomial model which describes the proportion of positive catch values and a lognormal model which describes the variability in nonzero catch data. Covariates, including time of day, time of month, area sampled and year, were tested for inclusion in both sub-models. The results of this approach indicated a strong decrease in larval catch rates from the beginning of the time series with the lowest value in 2005 (**Figure 14**). The Group agreed to use the indices resulting from this zero inflated delta lognormal model in the continuity and base case assessment scenarios.

Document SCRS/2008/085 presented relative indexes of abundance for the U.S. pelagic longline fleet in the Gulf of Mexico using self reported logbook data. All indexes were standardized using the delta-lognormal method. These indexes included one index that extended the time series of the index used in the 2006 BFT assessment (‘continuity’ index). The variables considered in this index were Year, Month and Zone. The four other indices presented (‘alternative’ indices) differed from the ‘continuity’ case in that they were constructed using different temporal and spatial restrictions. These ‘alternative’ indices were restricted to the Gulf of Mexico and only included data for the months of March-June, while the ‘continuity’ index included both the Gulf of Mexico and the Florida East coast and used data for the months of January to May. The ‘alternative’ indexes also tested two additional variables named (1) ‘Observed’ and (2) ‘Technology’. The variable ‘observed’ indicated if the longline fishing set was ‘observed’ by a scientific observer onboard of the fishing vessels, and the variable ‘Technology’ (levels ‘High’, ‘Low’, ‘Unknown’) assigned categories to fishing vessels based on information collected by observers. The four alternative indices were: (1) index estimated using only sets that were observed by scientific observes onboard of fishing vessels, (2) index estimated using sets that were not observed, (3) index estimated using all sets (observed and non-observed), and (4) index estimated by splitting the time series between 1987-1998 and 1999 and 2007. Diagnostic plots showed for all indices that the assumptions of normality were not fully met. Except for the index that only used the observed sets, the other indices show similar trends and values. Generally, standardized catch rates were high and variable between 1987 and 1991 and showed a sharp decline in 1992. Lowest values were observed in 1995 followed by an increasing trend that peaked in 2004. The years 2005 and 2006 showed new declines followed by a recovery in 2007. The index that only used observer data showed lower levels than the other indexes between 1992 and 1997, and relatively higher values after 1999. All five indices were within the 95% confidence interval of any of the indexes.

The testing for inclusion in the models of the variables ‘Observed’ and ‘Technology’ raised some concerns with the Group. First, the proportion of observations in each level of the variable ‘Technology’ is far from constant among years and some years are dominated by the level ‘unknown’, secondly the proportion of ‘observed’ sets is, in almost all years, very low resulting in an unbalanced design. The final model adopted by the Group for the assessment used only data from the Gulf of Mexico during months 1-6 and included only the variables Year, Month, and Zone. The final models for this index were:

Prop. Pos. = Year + Month + Zone + Year*Month + Year*Zone
Positive Catch rates = Year + Zone + Month

A second index was also produced using the same area (Gulf of Mexico) and months as the previous index, but including the variable ‘Observed’ and splitting the series between 1987-1998 and 1999-2007. This second index was used in a VPA sensitivity run. The final models for this index were:

1987-1998
Prop. Pos. = Year + Month + Zone + Year*Month + Year*Zone
Positive Catch rates = Year + Zone

1999-2007
Prop. Pos. = Year + Month + Observed + Year*Month + Year*Observed
Positive Catch rates = Year + Month + Zone + Year*Month

All first term interactions with the factor Year were modeled as random effects.

SCRS/2008/088 presented indices of abundance of bluefin tuna from the U.S. rod and real/handline fisheries off the northeast United States. Individual trip rod and reel/handline catch per unit effort data, collected through interviews with fishermen, were used to estimate standardized catch rates considering factors such as time of year, area fished, boat type, fishing method, fishery open/closed status, bag limits and target. Models were developed for all size categories of bluefin tuna (except for those <66 cm SFL), implementing a delta-Poisson approach in which catch rates are considered as a product of binomially distributed probabilities of a positive catch and Poisson distributed positive catch rates. Seven indices of abundance of bluefin tuna from the U.S. rod and reel fishery are presented. These indices are calculated separately by size category and for two distinct time periods 1980-1992 and 1993-2007. The indices for the early period include a series for small bluefin (<145 cm SFL) for 1980-1992 and for large bluefin (>195 cm SFL) for 1983-1992; these are presented unchanged from previous analyses. Also presented unchanged are the indices for 145-177 cm SFL bluefin and large bluefin (>195 cm SFL, 1983-2001). For the period 1993-2007, indices are updated for 66-114 cm, 115-144 cm, and >177 cm SFL bluefin. The distinct periods were defined because changes in survey data collection implemented in 1993 permitted separation of the catches into the smaller size intervals and because regulatory and management changes imposed different daily limits and fishery closures for those size categories.

It was pointed out that a modal progression pattern can be seen in recent years for the smaller size categories. Individuals in the 66-114 cm size range (generally ages 2-3) showed a local relative abundance peak during 2004-2005, while 115-144 cm individuals (generally ages 4-5) exhibited a local relative abundance peak during 2006-2007, a shift of 2 years which may be consistent with expectations of one (or possibly two) relatively larger cohorts. However, similar patterns are not consistently clear in other years or across other size categories. It was noted that modal progression patterns will be obscured by a large size range of individuals within a category.

Document SCRS/2008/088 also included an index for large bluefin (>195 cm) for the years 1983-2001. This index was available, but has not been used since the 2002 assessment because an important regulatory change occurred during the series: the large-medium (178-195 cm) and large (>195 cm) size classes were combined. This regulatory change appeared to have caused changes in the way size category and targeting was reported. Consequently, the 2002 working group (Anon. 2003) recommended the use of a substitute index, bluefin >177 cm for the years 1993 and later. This decision was discussed and upheld by the 2006 working group and it was carried forward for this assessment.

The Group noted that the otolith microchemistry results (reviewed in Section 4.3) suggest that the U.S. rod and reel indices for fish under 150 cm CFL may be confounded by trends in the eastern population. The same may also be true of the Japanese longline index for the NW Atlantic. Unfortunately, the available information was insufficient to determine the relative proportions of eastern and western fish in the catches by year, so it was not possible to adjust the catch at age or the affected indices of abundance. The Group therefore suggested a sensitivity analysis where these indices were excluded from the analysis.

There were two other CPUE indices that were used in the last two assessments but that were not update for this assessment. These included Japanese longline CPUE indices for the Gulf of Mexico (SCRS/2002/012) and tagging indices (Anon. 2003). The Group decided to incorporate these indices to the assessment.

7. Methods and other data relevant to the assessment

7.1 Methods – East

For reasons of continuity, the Group decided to run again a VPA ("VPA-2BOX v. 3.01", available from www.iccat.int) as was done in the 2002 and 2006 assessments.

VPA specifications

Notwithstanding the uncertainties in the catch at age and abundance index data, described elsewhere, the Group decided to run ADAPT VPA (as implemented in VPA-2box) again as it did for the 2002 assessment. The primary purpose of this exercise was to develop a recent selectivity pattern for use in further projections.

Following trials 1 and 2 in the 2006 assessment, the baitboat ages 2 and 3, combined index for Spanish and Moroccan traps and Japanese longline indices (**Table 6**) were used to tune the VPA, for the period of 1970-2006 data, with equal weighting of the indices. In all cases, terminal year Fs were estimated for ages 2 to 9, and F at age 1 was set to 0.75*F2. Penalties were imposed so that the selectivities for ages 2-9 did not vary too much in an unconstrained fashion during the last few years (see SCRS/2008/089 and text below).

Different model specifications were made (see below). RUN 1 used an F-ratio fixed to 1.0 (run 2 of the 2006 assessment). RUN 2 used a penalty for changes in selectivity in the likelihood for the last two years (sd=0.4). In RUN 3, a slightly less severe constraint was applied to the selectivity of the last 4 years (sd=0.5). Based on inspection of older fish catch at age, as well as the F-ratio pattern (F_{10+}/F_9) coming out of preliminary runs allowing for a random walk in the F-ratio, RUN 4 considered 3 periods with different F- ratios (1.0 for the 1970-1984 period, 0.6 for the 1985-1994 period and 1.2 for 1995-2006 period), as well as a constraint on the last four years' selectivities (sd=0.75). RUN 5 was equal to RUN 4, except that the 1998-2006 purse seine catch at age was adjusted so that the total catch equaled 50,000 t, to take account of underreporting. This was achieved by finding the constant γ for each year so that

$$\gamma \sum PS_a w_a + \sum O_a w_a = 50000$$

where PS and O are the catches of purse seine and all other gears combined, respectively.

The Group noted that some of the preliminary outcomes estimated lower biomass levels than the ones that would allow the high catch levels estimated for 2007. In order to fix that inconsistency, the Group added two additional runs: RUN 6 was exactly the same as RUN 4, with the exception that the CAA in 2006 was carried over to the CAA in 2007. RUN 7 was the same as RUN 5, but the CAA in 2007 was assumed to represent 60,000 t with the same age structure as 2005-2006. (Note that 2007 Task I and Task II were not available for the assessment).

An alternative dataset that dates back to 1955 was also constructed for the VPA, adding the historical French baitboat and Norwegian purse seine nominal CPUE indices for tuning. RUNS 8 to 14 were made similar to runs 1 to 7, except that they expanded back to 1955.

Model specifications for the VPA fits to eastern Atlantic and Mediterranean bluefin.

	RUN 1	*RUN 2*	*RUN 3*	*RUN 4*	*RUN 5*	*RUN 6*	*RUN 7*
Time period	*70-06*	*70-06*	*70-06*	*70-06*	*70-06*	*70-07*	*70-07*
F-ratio	70-06:1	70-06:1	70-06:1	70-84:1; 85-94: 0.6; 95-06: 1.2	70-84: 1; 85-94: 0.6; 95-06: 1.2	70-84: 1; 85-94: 0.6; 95-06: 1.2	70-84: 1; 85-94: 0.6; 95-06: 1.2
Selectivity penalty	no	2 years, sd=0.4	4 years, sd=0.5	4 years, sd=0.75	4 years, sd=0.75	4 years, sd=0.75	4 years, sd=0.75
CAA 1998-2006	reported	reported	reported	reported	50,000 t	reported	50,000 t
CAA 2007						CAA2006	60,000 t

	RUN 8	*RUN 9*	*RUN 10*	*RUN 11*	*RUN 12*	*RUN 13*	*RUN 14*
Time period	*55-06*	*55-06*	*55-06*	*55-06*	*55-06*	*55-07*	*55-07*
F-ratio	70-06:1	70-06:1	70-06:1	70-84: 1; 85-94: 0.6; 95-06: 1.2	70-84: 1; 85-94: 0.6; 95-06: 1.2	70-84: 1; 85-94: 0.6; 95-06: 1.2	70-84: 1; 85-94: 0.6; 95-06: 1.2
Selectivity penalty	no	2 years, sd=0.4	4 years, sd=0.5	4 years, sd=0.75	4 years, sd=0.75	4 years, sd=0.75	4 years, sd=0.75
CAA 1998-2006	reported	reported	reported	reported	50,000 t	reported	50,000 t
CAA 2007						CAA2006	60,000t

It should be noted that in all cases examined, the fit to the available CPUE indices was relatively poor (similar to the past assessments). However, the fit to the Japanese longline index improved under time varying F ratio assumptions (in comparison to fixed F ratio, **Figure 15**), and the retrospective patterns were improved when the F of the last 4 years was constrained. Based on these criteria, the group selected RUNs 6, 7, 13 and 14 as most satisfactory.

In addition to the VPA runs, the Group also decided to update the year-class-curve analyses to estimate total mortality with another methodological approach (see Anon. 2007 and Fromentin *et al.* 2007). The analyses have been performed on 1975-2006 Japanese CPUE data, but have not been updated on trap fisheries as the catch-at-size for 2006 and 2007 were unavailable.

7.2 Methods – West

ADAPT-VPA applied to the West Atlantic

The parameter specifications used in the 2008 VPA base model were generally the same as those used in the 2006 base-case assessment with the exception of the specification of terminal year fishing mortality rates, and the accommodation of the increased number of years. A general description of the model parameters appears below and in **Table 8**.

Virtual population analyses (VPA) require the estimation or assumption of terminal year fishing mortality rates (F). Assessments conducted since 1994 have all assumed the following relative vulnerability (partial recruitment) schedule for the terminal year:

$$F_{age\ 1} = 0.318*F_{age\ 2};\ F_{age\ 3} = F_{age\ 2};\ F_{age\ 5} = F_{age\ 4};\ F_{age\ 7} = F_{age\ 6};\ F_{age\ 9} = F_{age\ 8}$$

where $F_{age\ i}$ is the fishing mortality rate at a given age and only F_{age2}, F_{age4}, F_{age6} and F_{age8} are estimated. For this assessment, the Group preferred instead to apply the method examined in document SCRS/2008/089, wherein the terminal Fs for ages 1-9 are all estimated subject to a constraint that restricts the amount of change in the vulnerability pattern during the most recent three years (with a standard deviation of 0.5).

The oldest age class represents a plus group (ages 10 and older) and the corresponding terminal fishing mortality rate is specified as the product of $F_{age\ 9}$ and an estimated 'F-ratio' parameter that represents the ratio of $F_{age\ 10}$ to $F_{age\ 9}$ (assumed to be invariant since 1981). For the 2006 base model, the F-ratio was pre-specified at 1.0 for the period 1970-1973, estimated by a single parameter for the period 1974-1981 then estimated using a second parameter during the most recent period (1982-2007) subject to a penalty term included in the likelihood function:

$$-\ell n L = \frac{(\ell n \tilde{r}_y - \ell n \hat{r}_y)^2}{2(\sigma_r)^2}$$

where $\tilde{r}_y$ is the expected F-ratio for the most recent period (taken to be the value assumed for the 1996 base case assessment, 1.14), $\hat{r}_y$ is the corresponding model estimate, and σ_r is the standard deviation of the "prior" distribution (assumed to be 0.25).

The indices of abundance were fitted assuming a lognormal error structure and equal weighting (i.e., the coefficient of variation was represented by a single estimated parameter for all years and indices). The catchability (scaling) coefficients for each index were assumed constant over the duration of that index and estimated by the corresponding concentrated likelihood formula (except as indicated otherwise below).

The natural mortality rate was assumed age-independent (=0.14 yr^{-1}) as in previous assessments.

Runs for the West Atlantic

The indices included in the various model runs are summarized in **Table 9**. A general description of the model settings follows:

- Continuity Run: To facilitate comparison of the 2008 assessment results to the 2006 assessment, a run was specified which used essentially the same abundance indices (Section 6.2) and model specifications as selected in 2006. Note that the continuity run was the only run that applied the assumed terminal-year vulnerability schedule of the 2006 assessment.

- Base Run: This run used the same indices and model specifications as the continuity run with the exception of the vulnerability schedule which was estimated subject to a penalty term (SCRS/2008/089).

- Case 2: To examine the implications of removing western indices thought to include catches of eastern origin bluefin, Case 2 eliminated three U.S. rod and reel indices that reference bluefin tuna <145 cm FL. In addition, the western Atlantic Japanese longline index (Area 2) was replaced by the Japanese longline index from the northwest Atlantic (Areas 17 and 18). All other settings were unchanged from the base run.

- Case 3: To consider the implications of bluefin in the Central Area (see SCRS/2008/103) belonging to the western stock, the Group decided to rerun the base case assessment for the situation where catches in Area 3 (essentially the area between 45 and 30°W - see **Figure 3**) were treated as coming entirely from the western stock, and accordingly aged by means of the growth curve for bluefin in the west. For this run, the Japanese standardized LL index for Area 3 (Areas 31 and 32) was used in addition to the corresponding index for Area 2. All other settings were unchanged from the base run.

- Case 4: This run examined the effect of extending the time series back to 1960. The other models begin in 1970. To facilitate this effort, two historical indices were constructed at the 2008 BFT assessment meeting, one of Japanese longline catches off Florida (USA) and a second from Japanese longline catches off Brazil. The selectivity-at-age of these indices was estimated using the fleet specific catch-at-age from the western Atlantic Japanese longline catches. Inasmuch as the catch at size information is sparse prior to 1970, the F-ratio specifications were modified somewhat; being fixed at 1.0 for years 1960-1969 estimated by a single parameter for years 1970-1981, and estimated by a second parameter for years 1982-2007. All other settings were unchanged from the base run.

- Case 5: This case examined the effect of splitting the U.S. Gulf of Mexico pelagic longline index into two series (SCRS/2008/085). The first (1987-1998) corresponds to catch rates before the initiation of the observer program, the second (1999-2007) corresponds to the higher catch rates typically observed during the observer program. All other settings were unchanged from the base run.

- Case 6: To determine the effect of allowing the F-ratio ($F_{y,10+}$ / $F_{y,9}$) to vary in recent years, the F-ratio was estimated by a single parameter for 1982-1990 using the same Bayesian prior as was used for the base case (μ = 1.14, SD=0.25), but then allowed to vary annually using a random walk from the 1990 estimate (SD = 0.1). All other settings were unchanged from the base run.

- Case 7: This case examined the effect of estimating index selectivities from partial catches using the Powers and Restrepo approach rather than the Butterworth and Geromont method. The Powers and Restrepo approach allows index selectivity to vary annually, but assumes that fleet specific catches-at-age are known precisely. In that formulation, the selectivities can change by year, therefore it was necessary to allow the catchability coefficients to vary by year as well (in this case a random walk with low standard deviation of 0.05).

- Case 8: This case examines the effect of estimating an additional F-ratio as a frequentist parameter (initial estimate = 1.14) during recent years (2002-2007). All other settings were unchanged from the base run.

- Case 9: The Canadian Gulf of St. Lawrence catch rate series was developed to index the abundance of bluefin age 13+. The trends for this index are far more optimistic than any of the other indices for recent years. Since the VPA includes ages 1-10+ only, the index was adjusted to age 10+ and used an annually varying vulnerability for Age 10+ that was calculated using the total catch of Ages 13+ divided by the total catch of Ages 10+. This specification may have different implications than the time-invariant vulnerability vectors estimated (or assumed) for all other indices. More importantly, the index represents a small area located near the northern tip of the range of western bluefin tuna, and concern was expressed that it may represent local changes in availability of older fish more than the overall abundance of those age classes. It was noted that the trends of this index are very different from other indices that older, predominantly western fish (U.S. longline and larval surveys in the Gulf of Mexico). To examine the influence of this index, and the potential impact of a misspecification, this run eliminated the Canadian GSL index from the model. ll other settings were unchanged from the base run.

7.3 Methods – mixing variants

ADAPT-VPA applied to the East and West Atlantic to account for mixing

As a sensitivity analysis, several two-box VPA models were run estimating the levels of migration of eastern origin fish to the west and western origin fish to the east. The boundary between the two areas was assumed to be 45°W. The catch and index data used for the east box were the same as the eastern run with catches adjusted to account for under-reporting. The catch and index data used for the western box were the same as for the West Atlantic area Base case. Note that fish caught in the East Atlantic (i.e., in the eastern management area) were assigned to age categories according to the eastern growth curve, while fish caught in the West Atlantic (i.e., in the western management area) were assigned to age categories according to the western growth curve. Thus, under a mixing hypothesis, some fish are incorrectly aged.

The specifications of the two-box model were the same as the eastern adjusted-catch case and the western base-case with the exception that the vulnerability constraint was applied over four years using a standard deviation of 0.75 (consistent with the eastern base-case as opposed to 3 years with standard deviation 0.5 used for the western base-case). This change was found to make little difference to the estimates for the west (without migration). Migration was assumed to follow the overlap model, meaning that fish return to their natal area to spawn, and a specified percentage of the fish from each stock are in the other area each year.

Two types of data were used to estimate the movement coefficients (overlap fractions) in the two-box VPA: the mixing proportion estimates described in Section 4.1, (based on otolith microconstituent analyses) and conventional tagging data. The mixing proportion estimates were fit by the two-box model assuming they were approximately lognormal distributed with standard deviations equal to the values given in Section 4.3. Several of the proportion estimates were based on samples collected over several years. To reflect this in the two-box model, the same proportion values were input for each of the sampled years, but the input for each year was down weighted commensurate with the number of years (by increasing the standard deviation so that the weight given to the likelihood for the combined years was the same as for the actual point estimate).

Additional runs were made using the conventional tagging data described in **Appendix 8**. The tagging data were assumed to be approximately multinomial distributed. Tags at liberty less than 30 days were ignored. The use of tagging data necessitates specifying a number of additional parameters such as mis-reporting, tag shedding, and incomplete mixing of tags. The specifications used here were similar to those outlined in Porch *et al.* (2001), but were modified by a subgroup of scientists familiar with eastern and western BFT tagging programs to better account for recent and historical changes in tagging activities.

It was not possible to run projections with the 2-box model at the meeting. There were many analytical nuances associated with different data types, model configurations and CPUE series. Because of time limits, these nuances could not be evaluated with the exhaustive rigour that they merit. Therefore modeling results were not considered reliable enough to include in stock- assessment projections and reconstructions. Nevertheless, preliminary results indicate that considering mixing in our analyses has significant effects on perceived western-stock status (as was previously thought) and possibly now also for eastern-stock status.

Alternative mixing models

SCRS/2008/097 presented a preliminary version of a spatial, Multi-stock Age-Structured Tag-integrated stock assessment model (MAST) of Atlantic bluefin tuna. The model is not yet considered reliable enough to include fitting results or projections but a brief description of it is included here to illustrate what it can do. Readers can consult SCRS/2008/097 for details of the models assumptions, data sources, and fitting procedures. MAST models eastern and western Atlantic bluefin tuna stocks simultaneously in four areas, with quarterly time steps. MAST estimates F_{MSY} and MSY as leading parameters. Each stock is modeled as having specific growth, movement, maturity and natural mortality parameters.

Building and attempting to fit MAST to data have helped to identify research priorities for ICCAT's assessment of Atlantic bluefin tuna if it intends to undertake assessments at fine temporal and spatial resolution. These include: obtaining of stock composition data for tagged fish and for catches on a more regular basis; longer and finer temporal and spatial scale time series of CPUE indices, and generally more data of all types from the East. Being able to designate mark-recapture observations by stock with genetic techniques is a high priority. MAST reaches back to 1950 to do its stock reconstructions and operates at quarterly time steps by area. These stock reconstructions would be facilitated by CPUE series at this same level of resolution that also reach back to the 1950s.

The use of a model of this type requires a thorough analysis of potential biases produced by the non-random sampling properties of existing tagging programs but also of how model areas are designated. Even without having done such an analysis it can be said that more tag and stock-composition data are needed in the East. In the multi-stock context, uncertainties about one stock, be they stock size, movement rates or fishing mortalities will propagate to the other. The Group looks forward to these simulation studies being done in order to evaluate this model's performance but also, to guide data collection and research recommendations with particular respect to the value of different kinds of information such as different tag types, stock composition and CPUE data in resolving key uncertainties. In discussions following, the Group noted that best measure of model performance should focus on how well fishing mortality, not other nuisance parameters can be determined.

On the whole, the Group felt that the approach appeared to address a number of issues that have been raised in the past concerning stock mixing (Anon. 2002) and a more appropriate biological description of the system. The spatial and temporal resolution that will be possible with this model will be limited by the resolution of the available data.

7.4 Methods – Regulatory analyses

Comparisons of size frequency distributions with existing minimum size regulations were carried out at the meeting.

7.5 Methods for integration of management advice across multiple hypotheses

Due to gaps in and sparseness of available data for stock assessment and the high dimensionality of fisheries for and the biology of Atlantic bluefin tuna, there remains considerable uncertainty over hypotheses concerning stock dynamics, interpretations of available data and fleet behaviors (e.g., SCRS/2008/094; SCRS/2008/097; SCRS/2008/101). While it has long been considered a requirement for stock assessments to account for such uncertainties, the integration of management advice across multiple hypotheses is not a straightforward matter.

And while there has been much discourse concerning uncertainties in past stock assessments of Atlantic bluefin tuna (e.g., McAllister *et al.* 2001; Anon. 2002), this issue remains deserving of further close attention by Atlantic bluefin tuna stock assessment scientists and managers.

SCRS/2008/101 explored, using computer simulations, the importance of stock-recruitment assumptions in evaluations of the potential biological outcomes of management regulations for eastern Atlantic bluefin tuna. Alternative hypotheses for the steepness of the Beverton-Holt (BH) stock-recruit model, the form of recruitment variability and parental effects regarding the relative contribution to spawning stock of different age groups of adult bluefin tuna over and above their mass-at-age were considered. Depending on the assumption about BH steepness, the stock was computed to be at 20-60% of unfished spawning stock biomass (SSB) in 1970 after the model had reached a long-term equilibrium before incorporating the annual catch-at-age data from 1970 onwards. The potential future stock trajectories under the recently adopted ICCAT [Rec. 06-05] were investigated under various combinations of these alternative hypotheses. It was found that the simulated stock trajectories were highly sensitive to the assumed recruitment hypotheses with the stock trajectories ranging from rapid severe depletion to rapid recovery to Bmsy. It was concluded that due to potential large unaccounted for historic shifts in fishery selectivity-at-age and potential biases in VPA stock reconstructions "we are unable to properly estimate the stock-recruitment relationship for the East Atlantic and Mediterranean bluefin tuna stock. Consequently, it is crucial to clearly state recruitment assumptions when an advice is given and to consider a significant range of contrasting and realistic stock-recruitment relationships".

Interest was expressed in extending the VPA back to the 1950s to add to the time series of stock-recruit data for the estimation of stock-recruit model parameters. It was mentioned that catch-at-length data from 1950s and 1960s fisheries, e.g., off of Norway were likely to be of high quality since many fish captured from this fishery were sampled. While summary results demonstrated high contrasts in the simulated potential outcomes under the different hypotheses, there were requests for some further comparisons to be shown, e.g., keeping steepness and stochasticity assumptions constant and showing results with and without the parental effects on reproductive output. The potential for there to exist parental effects on reproductive potential was considered to be of concern due to the recent increased targeting on very large-sized fish presumably as a response to the recently implemented ICCAT [Rec. 06-05]. The failure to find any parental effects in captive Pacific bluefin tuna was mentioned but the extent to which this finding could be generalized was questioned since it was only limited observations made over relatively few years. Due to the paucity of data and research on potential parental effects in wild bluefin tuna, further interest was expressed in the establishment of new research programs on bluefin tuna reproductive biology to test hypotheses on parental effects. In summary, the paper provided strong support for the current and future stock assessments to carry out and present projection results under a set of "contrasting and realistic" hypotheses about the stock-recruit function. A summary of discussions on approaches to provide weights on and present as a basis for management advice results from model runs based on alternative hypotheses is provided further below.

SCRS/2008/094 presented results from computer simulations that evaluated the performance of alternative management methods under alternative hypothesis for the apparent long-term fluctuations in Mediterranean trap landings that have gone on for centuries. The authors used a management strategy evaluation approach. The two alternative hypotheses included either long-term cycles in the carrying capacity of the stock-recruit function or long-term cycles in migration patterns and availability to the fishery. The alternative management reference points considered included MSY, $F_{0.1}$, F_{MAX}, $F_{x\%SPR}$, F_{MSY}. The management control procedures considered included ones using $F_{0.1}$ and a minimum size limit.

ADAPT VPA estimates of abundance (N) and fishing mortality rates (Fs) were unbiased under the carrying capacity fluctuation (CCF) hypothesis but showed marked biases in the trends and magnitudes of estimates of F and N under the migration fluctuation (MF) hypothesis. The estimates of yield and stock biomass reference points showed considerably more bias than the F-based reference points. Among the F-based reference points, the $F_{0.1}$ reference point appeared to provide the most precise and least biased proxy for the true F_{MSY}. The average ratio of F to $F_{0.1}$reference points were relatively stable under the CCF hypotheses but depended strongly on the phase under the MF hypothesis. Management strategies based on $F_{0.1}$ tended to provide higher stock biomass than other policies under the different hypotheses for the phase and cause of long-term catch fluctuation. The minimum size limit policy tended to provide slightly lower stock biomass than the $F_{0.1}$ policy but higher yields. The status quo policy appeared to perform poorly compared with other policies in both respects. The performance of all three policies was strongly affected by about the current phase of the historic cycle under the two hypotheses for the cause of historic cycling of trap catches. The paper also indicated that policy performance was highly sensitive to implementation error but less so to misreporting of commercial fishery statistics.

It was suggested that this paper might provide further justification for utilizing $F_{0.1}$as a proxy for F_{MSY} in harvest control procedures. However, not all members of the Group agreed that this paper provided sufficient evidence for a general recommendation to be made to ICCAT to use $F_{0.1}$as a proxy for ICCAT's F_{MSY} reference points. This was partly because there may still be some room for improvement in the estimation of MSY based reference points (e.g., via Bayesian estimation methods and the implications of uncertainty over growth and natural mortality rates could also be further explored).

Some also pointed out that while uncertainty over explanations for historic fluctuations in trap catches might never be resolved, current and recent fisheries data and scientific research methods and possibly new spatially structured assessment models could help to test whether recent (e.g., past few decades) migration patterns varied such that they could affect recent availability of bluefin tuna to fishing gear in the Mediterranean Sea. Therefore, it may be possible in the near future to reduce or eliminate this historic source of uncertainty in the evaluation of the performance of candidate management methods. It was commented that long-term variation in catches or apparent abundance in a given fishery could be caused by other factors than external driving forces on migration and carrying capacity and, for example, could potentially be explained by interactions between fisheries exploitation and density-dependent properties of dome-shaped stock-recruit functions such as the Ricker model. It was also mentioned that while minimum size limits or other types of size limit restrictions could be found to perform well in simulation evaluations, there has been a history of imperfect implementation of minimum size regulations and that strict enforcement of such regulations has in the past been very difficult to achieve in bluefin tuna and numerous other fisheries and in some instances have failed due to this (e.g., Kuikka *et al.* 1999).

SCRS/2008/013 reported on the Joint Canada-ICCAT 2008 Workshop on the Precautionary Approach for Western Bluefin Tuna (Halifax, Nova Scotia, 17-20). The objectives of the meeting were to review the production dynamics of western bluefin tuna as determined from the 2006 assessment, as a case study. For this stock, the meeting reviewed generic harvest strategies consistent with the ICCAT Convention and the Precautionary Approach. The meeting also considered alternative fishing mortality and biomass references, and documented the advantages of the Precautionary Approach for this stock. The meeting first focused on identifying possible systematic biases in the assessment. As noted in previous meetings, the stock assessments for western bluefin tuna tend to underestimate the terminal year biomass, yet retrospective comparison of projections indicate that the forecasts were overly optimistic. Some potential reasons for this were explored at the meeting, and subsequently (see, for example, SCRS/2008/089). The meeting considered alternative harvest strategies, and illustrated some that included varying F reference levels as biomass declines. An example is shown in **Figure 16**, along with the current trajectory for the stock. The meeting also noted that estimates of proxies for F reference points were much less sensitive to assumptions about recruitment than were estimates of proxies for B_{ref} and B_{lim} (see also SCRS/2008/094). This relative insensitivity of F reference points to indeterminacy of the S-R relationship can be used to advantage to devise harvest strategies that may permit rebuilding to historical biomass for a modest level of foregone yield. A further important conclusion of the Workshop was that the current F_{ref} proxy used by the SCRS for advising the Commission (F_{MAX}) approximated the F-level which, given the available information about spawning stock size and recruitment levels for western bluefin tuna, was expected to keep the stock at recent levels, on average, and was not likely to promote rebuilding to biomass levels considered to be consistent with the Convention Objective. The Workshop concluded that an F_{MAX} based fishery management strategy for western bluefin tuna was not consistent with the rebuilding intention of the Precautionary Approach. Alternative proxies, such as $F_{0.1}$ or $F_{95\%MSY}$, which result in only slightly lower yields, would provide higher odds of rebuilding western bluefin tuna and could be considered to be consistent with the Precautionary Approach. FAO (2001) which has addressed "*Research Implications of Adopting the Precautionary Approach to Management of Tuna Fisheries*" was recommended for further reading on this topic.

It was generally agreed that efforts to develop methods to integrate management advice across multiple hypotheses on stock-mixing should continue through the development and application of stock assessment models that explicitly model spatial structure and mixing and are fitted to tagging data and stock ID data (e.g., Porch *et al.* 2001; Anon. 2002; SCRS/2008/097). It was agreed that scientists from both the eastern and western stock assessments should collaborate in developing and exploring the use of these models for stock assessment, management strategy evaluation and the evaluation of the potential future data requirements for future stock assessment and management approaches that more explicitly account for stock mixing.

General discussion on the integration of management advice across multiple hypotheses

It has long been recognized that an important source of uncertainty in the assessments of eastern and western Atlantic bluefin tuna has been over how to model future recruitment and determine stock rebuilding reference points such as B_{MSY} (e.g., McAllister *et al.* 2001; SCRS/2008/101). The stock-recruit models considered for the stock of interest underpin these choices. For the eastern stock, SCRS/2008/101 demonstrates the marked influence of alternative “realistic” models for recruitment on projection results. In the western assessment, the recruitment estimates prior to the early 1980s were the highest and estimates since then have been on average relatively low. In assessments up to 2002, stock projections from two alternative stock-recruit models had been reported in management advice. One model fitted a Beverton-Holt function to the full time series of stock-recruit data (i.e., starting in 1970) and provided a relatively high B_{MSY} reference point. The alternative model presumed that a “regime-shift” had occurred circa the late 1970s which has since resulted in low recruitment and that future recruitment could be most accurately represented using a “hockey stick” or “two-line” stock-recruit model that was fitted to the stock-recruit data since 1976. This model has provided much lower B_{MSY} reference points and stock status estimates much closer to B_{MSY}, and suggested for the same TAC policies, more rapid stock-rebuilding than the “high recruitment” model.

It was emphasized that for the western stock (and also the eastern stock), there still remains high scientific uncertainty over the various alternative recruitment hypotheses and associated biological reference points. Yet for the western stock in recent years, i.e., since 2002, the high uncertainty concerning recruitment hypotheses has not been conveyed in the provision of management advice. Despite the equivocal nature of the data and interpretations of them, the regime-shift (or “low recruitment”) hypothesis has since been emphasized in management advice. It is understood that the decision to emphasize the regime shift hypothesis was made by the Commissioners but that the failure to communicate the uncertainty concerning recruitment was the responsibility of the scientists. The group therefore recommended that management advice provided in this and future stock assessments for both east and western stock components should continue to explicitly account for and convey the management implications of the uncertainty over the alternative recruitment hypotheses. Thus, for the western stock, it was agreed that stock status and projection results computed from both the high recruitment and regime-shift (or “low”) recruitment hypotheses should continue to be reported and conveyed in the provision of management advice. Similarly, for the eastern stock, projection results from different recruitment hypotheses should also continue to be conveyed in the management advice provided.

In order to quantify and communicate uncertainty concerning alternative recruitment hypotheses in the provision of management advice, it was suggested that scientists collectively assign to the alternative hypotheses probability weightings for them and communicate these probabilities in the provision of management advice. The probabilities should reflect a consensus of the overall scientific credibility of each alternative hypothesis given all available evidence and scientific judgment concerning the evidence. Should the alternative hypotheses remain equally credible, equal probabilities should be assigned to the alternative hypotheses. When evidence is judged to support some hypotheses more strongly than others, the probability weightings should reflect this. Guidance should also be provided on how to interpret the probability weightings (e.g., see Kass and Raftery 1995).

It was noted that the computation of probabilities for alternative models based on how well they fit the data has received considerable attention in the fisheries scientific and statistical literature, but that the computation of such probabilities has remained technically difficult to achieve (e.g., Kass and Raftery 1995; Butterworth *et al.* 1996; Patterson 1999; Parma 2001; McAllister and Kirchner 2002; Hill *et al.* 2007). Due to current software configurations in ICCAT’s catalogued assessment software, such computations cannot easily be achieved using the stock assessment models currently applied for the eastern and western stock components. Some suggested that AICC values calculated for the alternative models could be transformed into probabilities and it was agreed that methodologies concerning this issue this warranted further exploration.

In some recent assessments, bootstrapping had been carried out with different recruitment models included in a single bootstrap run and the Monte Carlo results from the different recruitment models summarized into single statistics (e.g., probability of stock rebuilding to B_{MSY} and median values of By/SSB). It was agreed that this approach appropriately accounts for uncertainty in recruitment hypotheses and parameter values under each hypothesis for computing the probability of various management outcomes of interest. However, it was recommended that diagnostics should be checked prior to computing means and median results from such model averaging type analyses. If distributions for quantities of interest (e.g., projections of SSB) from the different models do not overlap or only scarcely overlap, medians or means from model averaging computations may have very low or no credibility and may lead to advice that is inconsistent with the alternative recruitment hypotheses. In such instances, it may be appropriate to compute and present median or mean results from the different recruitment hypotheses separately and present these together with probability weightings for each of the alternative hypotheses (e.g., McAllister and Kirchner 2002).

7.6 Other methods

SCRS/2008/089 presented three different strategies for modeling the terminal-year fishing mortality rates (F_{term}) in virtual population analyses of western bluefin tuna: retrospective patterns and consequences for projections. The method for modeling F_{term} in past western Atlantic bluefin tuna assessments was recently identified as a possible reason for the observed tendency of previous assessments to under-estimate the most recent SSB but over-predict projected future SSB (see for example SCRS/2008/013). The paper evaluated the F_{term} method that had been applied in previous assessments (e.g., for the 2002 assessment, $F_{2001,1}$ =0.318, $F_{2001,2}$ =0.318 $F_{2001,3}$, $F_{2001,4} = F_{2001,5}$, $F_{2001,6} = F_{2001,7}$ and $F_{2001,8} = F_{2001,9}$) a method that estimated F_{term} for all ages up to age 9 with no constraints, and a method that estimated F_{term} for all ages up to age 9 "subject to a penalty that constrains the amount of annual change in relative vulnerability of each age class". In the third method (called below the "constraint" method), the vulnerabilities for ages 1-9 were linked over three years with a standard deviation (SD) of 0.5.

It was found that the "constraint" method provided in all evaluations similar or better performance than the status quo and no-constraints methods. In the 2006 retrospective analysis that was performed, the estimated ratios of F_{term} for adjacent age classes were found to be quite different than assumed. For example the assumed ratio of 0.318 for F_1/F_2 was found to be lower and past estimates of F_3/F_2 were found to be higher than the assumed value of 1. It was found that "the current status quo method creates erratic retrospective patterns and may have led to overly optimistic projections of SSB" and that this method and the no vulnerability constraint method "erratically overestimate age 1 recruitment in the most recent years, including years prior to the last 3". In contrast, "the method of constraining changes in vulnerabilities appears to mute erratic retrospective patterns in abundance at age and result in projections of SSB that are less prone to initial leaps."

The Group questioned why an SD of 0.5 was selected. It was replied that previous experience had found that setting the SD too small (below 0.1) can sometimes force the VPA to settle on solutions that provide a poor fit to the indices owing to the need to simultaneously match the catch at age exactly. Values of the SD on the order of 0.5 generally were sufficient to damp the erratic behavior in the estimates of F for recent years while having little impact on the ability of the model to fit to the indices. The group accepted a proposal to replace the status quo F_{term} method for the west and east VPA stock assessments with the constraint method that has the SD in vulnerability set at 0.5.

8. Stock status results

8.1 Stock status – East

ADAPT VPA runs were made as explained in Section 7.1. The report file for the VPA runs including the whole data series (Runs 13 and 14) is included as **Appendix 9**. This appendix includes complete description of the model results corresponding to these two runs, including the matrix of estimated fishing mortality rates, abundance at age, stock biomass, recruitment, fits to indices, estimated index selectivities, F-ratios and Terminal Fs-at-age.

Diagnostics

Overall, the VPA fits to the available data for eastern Atlantic bluefin continue to be poor, as they were in previous assessments. The fits to different indices showed residual trends in all cases, especially for the trap and longline indices **(Figure 15)**.

Figures 17, 18, 19 and **20** summarize the abundance and fishing mortality estimates for Runs 6, 7, 13 and 14, respectively, resulting from a retrospective pattern analysis. Some bias in the estimates is indicated for F1-5 and F_{8+}, which was believed to be driven by the change in selectivity pattern towards larger fish that occurred in the latest years.

Summary VPA results

The results suggest that since 2000 there has been a rapid increase in fishing mortality especially for large (ages 8+) fish and a rapid decline in spawning stock biomass. Inclusion of the 1955-1969 data allowed estimating biomass and fishing mortality trajectories for this historical period that was not considered in earlier assessments. The 8+ fishing mortality pattern for this historical period showed a U-shape, the initial decline corresponding to the decline of the Norwegian purse seine fishery in the 1950s and 1960s, and the latter increase to the development of purse seine fisheries in the 1990s and 2000s. Under Runs 6 and 13 (based on reported catch), the spawning stock biomass over the last five years of the time series was only 38.33% and 37.79% of the one in the first five years of the time series (1970-1974 and 1955-1959, respectively). The scenarios that considered underreporting showed similar SSB reductions (40.44% and 39.50% for runs 7 and 14, respectively) although the SSB decline after the year 2000 was relatively steeper than scenarios with unadjusted catch.

The average (geometric mean) fishing mortality pattern for 2003-2006 estimated with the four model runs is shown in **Figure 21**. The scenarios with adjusted catch to 50,000 t since 1998 showed somewhat higher fishing mortality on average and slightly higher selectivity on ages 5 and older. The Group decided to consider both selectivity patterns for projections.

Year-class curve analyses

Using a year-class curve analysis on the Norwegian CPUE, document SCRS/2008/093 presented the first estimates of mortality rates of Atlantic bluefin tuna that migrated north from the mid-1950s to the late 1970s. The results indicated that bluefin tuna would have experienced a total mortality rate (Z) of 0.2 to 0.4 yr-1 (i.e. F at around 0.3 yr-1) during the late 1950s, 0.2 yr-1 during the 1960s and 0.1 yr-1afterwards (assuming M=0.1 yr-1). This F trend is consistent with VPA findings from the historical period (**Figures 19 and 20**), although absolute values are slightly higher. The fishing mortality rates experienced by bluefin tuna in the North Sea and Norwegian Sea during the period 1956-1979 were thus significant (so that local overfishing may have occurred, especially during the 1950s). However, these estimates are lower than F estimated by year-class curve analysis in more recent years (i.e. 1992-2004 based on trap data, Fromentin *et al.* 2007).

The Group updated additional year class curve analyses using the Japanese longline CPUE data. Results are shown in **Table 10 and Figure 22**. Because the year-class estimates of mortality in **Table 10** are calculated within cohorts, they are not directly comparable to mortality time series estimated with VPA. However, they do provide estimates of average total mortality that successive cohorts experienced. The F 9-14 trend in **Figure 21** shows a continuous increase from around 0.2 to around 0.4 for cohorts exploited in the 1984-2005 period. The trend for F 8-14 is similar but absolute values were slightly lower and the increasing trend disappeared approximately after the year 2000. These trends are consistent with the increasing F8+ trends observed in the VPA during that period of time, although the VPA estimates show higher rates of increase in F8+ for that period.

Conclusions about state of the stock

There are considerable data limitations for the assessment of the stock. These include poor temporal and spatial coverage for detailed size and catch-effort statistics for many fisheries, especially in the Mediterranean. Substantial under-reporting of total catches is also evident. Unless substantial improvements are made in the catch and effort statistics, there is little scientific need to perform a stock assessment every two years because many results are based on equilibrium assumptions and because BFT is a long lived species. This explains why our diagnosis and advice is very similar to that of 2006.

The 2008 assessment results indicate that the spawning stock biomass (SSB) continues to decline while fishing mortality is increasing rapidly, especially for large bluefin.

The decline in SSB is evident from the results of an age-structured model (VPA) that used both reported and adjusted (for underreporting) catch and CPUE information, which estimates that recent (2003-2007) SSB is less than 40% of the highest estimated levels (at the start of the time series 1970-1974 or 1955-1958, depending on the analysis). The decline in SSB appears to be more pronounced during the more recent years, especially under the scenarios with adjusted catches, although model estimates for recent years should be judged with caution due to imprecision.

The increase in mortality estimated with the age-structured model for large bluefin is consistent with a shift in targeting towards larger individuals destined for farming.

The Group conducted equilibrium projections so as to determine the stock status relative to MSY and other benchmarks. Projections were made under the assumption that future selectivity will be similar to the one in 2003-2006, scaled to a fishing mortality equal to the geometric mean of the 2005-2006 as estimated by the VPA and that future recruitment levels will be equal to the mean recruitment observed in the 1990-2003 period. Given the uncertainty of the VPA estimates from which assumptions for the projections are taken, estimates of stock status with respect to MSY benchmarks can be considered highly uncertain but it is nonetheless apparent that recent F is too high and recent SSB too low to be consistent with the Convention objectives.

Benchmarks were computed assuming the fishing mortalities estimated under scenarios 13 (reported catch) and 14 (adjusted catch). In both cases, current fishing mortality was estimated to be more than three times F_{MAX}, more than four times F30%SPR, and around 7 times $F_{0.1}$. Spawning stock biomass in equilibrium was estimated to be far below desired levels (**Table 11**, **Figure 23 and Figure 24**). Depending on different assumed levels of resource productivity current F is most likely at least 3 times that which would result in MSY and SSB is most likely less than 20% of the level needed to sustainably support MSY. Even in our most optimistic evaluation, assuming recruitment will not decrease if SSB continues to decline, substantial overfishing is occurring and spawning biomass is well below levels needed to sustain MSY (**Figure 25**).

8.2 Stock status – West

This Section summarizes the results from VPA analyses explained in Section 7.2. The report files output by the VPA-2BOX software for the base VPA model and one of the sensitivity runs (Case 9) are included as **Appendix 9**. These reports contain a complete description of the VPA results, including the matrix of estimated fishing mortality rates, abundance at age, stock biomass, recruitment, fits to indices, estimated index selectivities, F-ratios and Terminal Fs-at-age.

Diagnostics

Table 12 provides a summary of the AIC, AIC_C, BIC information criteria, log likelihoods, number of parameters and the number of data points for the various VPA model runs. The information, however, is not comparable unless the data inputs (and constraints) are identical. Therefore, only the base model and cases 6 and 8 can be compared.

Fits to the CPUE series for the base model are summarized in **Figure 26-28**. The fits to the indices were nearly identical for the continuity and base VPA runs **(Figure 26.)**. In fact, the model fits were virtually unchanged for all model runs except Case 7, and are therefore not shown in detail. The Case 7 fits are compared to the base model in **Figure 27**. The fits were not improved by estimating yearly variation in index selectivity (Powers and Restrepo, 1999) and allowing catchability to vary with a random walk (Case 7). Moreover, the annual selectivity estimates for all of the indices varied erratically with no apparent trend. Thus, there was deemed to be no advantage to using this approach and the model was not considered further. The fits to the indices that were used only in sensitivity runs (Cases 2-5) are shown in **Figure 28**.

Histograms of the bootstrap estimates of 2007 stock status from the VPA base and Case 9 (remove Canadian GSL index) model runs were constructed to examine the bias and normality of the distribution. In each case, there is no evidence of a strong bias in the results (**Figure 29**).

A retrospective analysis was conducted by sequentially removing inputs of catch and abundance indices in annual increments from the 2008 base case model, back to 2003. **Figure 30** shows the trends of spawning biomass and age 1 recruits for the base case. The estimated recruitment is not sensitive to the retrospective removal of data except for the most recent two years, which are uncertain and have generally been disregarded in past assessments. The overall magnitude of SSB decreases as more years of data are added suggesting that SSB tends to be over-estimated, however the recent downward trends also become less appreciable. These results are similar to what was apparent in earlier assessments (SCRS/1994/124). The retrospective results also indicate possible underestimation of fishing mortality for ages 9 and 10+ (**Figure 31**) and, conversely, overestimation of the abundance of ages 9 and 10 (**Figure 32)**. For other ages, the retrospective patterns are less evident (and much reduced relative to the 2006 assessment and 2008 continuity run).

Comparison of 2006 and 2008 VPA base model results

The base-case assessment is consistent with previous analyses in that spawning stock biomass (SSB) declined steadily between the early 1970s and 1992. Since then, SSB has fluctuated between 18% and 27% of the 1975 level (**Figure 33**). The stock has experienced different levels of fishing mortality (F) over time, depending on the size of fish targeted by various fleets (**Figure 34**). Fishing mortality on spawners (ages 8 and older) declined markedly between 2002 and 2007. Estimates of recruitment were very high for the early 1970s, but varied without trend since 1977.

The results from the 2008 base VPA model are compared to the 2006 base model (Anon. 2007) and corresponding 2008 continuity run in **Figure 34**. The trends in average fishing mortality by age group, spawning stock biomass (SSB), recruitment (Age 1) and the annual F-ratio (F10+/F9) are very similar.

Sensitivity Runs

Comparisons between the 2008 base and sensitivity runs are summarized in **Figure 35**. The SSB trends are very similar between all model runs, particularly when the series are expressed relative to the maximum value (i.e., scaled to a maximum of 1.0). The recruitment estimates are also nearly identical for all model runs. F-ratio outputs, from fixed assumptions or estimation procedures, are also summarized in **Figure 35.** Between 1974 and 1982, the estimated F-ratio varies substantially between models (1.0 to 2.5). Between 1983 and 2007, the model estimates are more similar (0.9 to 1.5).

The influence of the various indices of abundance on the base case model results was examined by removing one index at a time, running the VPA with the same model specifications, and computing the following quantities: SSB in 1970 and 2007, $F_{current}$ (the apical value of the vector of geometric mean F values for 2004-2006), and F_{max} (the multiplier of the geometric mean selectivity that maximizes yield-per-recruit). The results are given in **Table 13**. In terms of spawning biomass depletion (SSB_{2007}/SSB_{1970}), removing either the Canadian Gulf of St. Lawrence index or the early Japanese longline index in the Gulf of Mexico results in more pessimistic results (depletions of 0.10, compared to 0.18 in the base case). In terms of current F compared to F_{MAX}, removing the Canadian Gulf of St. Lawrence index also results in more pessimistic (higher relative F) results. On the other side of the spectrum, removing the fishery-independent larval index results in lower estimates of depletion (0.35) and relative F (0.83).

Of the quantities examined, the value of initial SSB is very sensitive to the exclusion of various indices. The range between the highest and lowest SSB_{1970} estimates is more than two-fold. On the other hand, the estimate of current SSB is less sensitive to the choice of index (**Table 13**).

Stocks status

A key factor in determining stock status is the estimation of the MSY-related benchmarks against which the current condition of the stock will be measured. These benchmarks depend to a large extent on the relationship between spawning biomass and recruitment. This year, the Group reexamined the two alternative spawner-recruit hypotheses explored in several prior assessments: two-line (hockey stick) and Beverton and Holt formulation. The two-line model assumes recruitment increase linearly with SSB from zero with no spawners to a maximum value (R_{MAX}) when SSB reaches a certain threshold. Here the SSB threshold (hinge) was set at the average SSB during 1989-1994 (a period of generally low estimated SSB), and R_{MAX} was calculated as the geometric mean recruitment during 1976-2004. The Beverton and Holt function was fit to the SSB and recruitment estimates corresponding to the period 1970-2004. The two curves are shown in **Figure 36**.

Stock status was determined under the two-line and Beverton-Holt scenarios for the base model from 1970 to current **(Figure 38)**. The results under the two-line (low recruitment) scenario suggest that the stock has been below convention objectives since the mid 1970s and that fishing mortality rates have been above convention objectives throughout the time series (note however the ‘current’ fishing mortality rate represented by the square in the graph is actually the 2004-2006 geometric mean and does not include 2007 when the 2100 t quota went into effect). The results under the Beverton-Holt (high recruitment) scenario are even more pessimistic, suggesting the convention objectives for SSB and fishing mortality rate have not been meant since 1970.

The estimated status of the stock in 2007 is summarized for the two recruitment levels in **Figures 37 and Figure 38. Figure 38** shows the results for the base case and case 9 (the VPA model that removes the Canadian GSL index where catch rates have increased rapidly in recent years and it was hypothesized that such an increase could be due to primarily changes in availability/catchability). With the two-line model, recent F is 30% to 50% higher than the MSY level and SSB is about half of the MSY level. Estimates of stock status are more pessimistic with the Beverton and Holt model ($F/F_{MSY} > 2$, $B/B_{MSY} < 0.2$). The estimated median trajectories of stock status since 1970 are shown in **Figure 37** for the two-line and Beverton and Holt models.

One important factor in the recent decline of fishing mortality on large bluefin (**Figure 34**) is that the TAC has not been taken during this time period, due primarily to a shortfall by the U.S. fisheries that target large bluefin. Two plausible explanations for the shortfall were put forward previously by the SCRS: (1) that availability of fish to the United States fishery has been abnormally low, and/or (2) the overall size of the population in the

Western Atlantic declined substantially from the level of recent years. While there is no overwhelming evidence to favor either explanation over the other, the base case assessment implicitly favors the notion of regional changes in availability (in the sense that the indices used to tune the model, and therefore the model estimates, do not indicate a recent decline). Nevertheless, there remains substantial uncertainty on this issue and more research needs to be done.

The conclusions of this assessment do not capture the full degree of uncertainty in the assessments and projections. An important factor contributing to uncertainty is mixing between fish of eastern and western origin. Limited analyses were conducted of the two stocks with mixing (see below). Depending on the types of data used (conventional tagging or samples of stock origin in the catches) and modeling assumptions made, the estimates of stock status varied considerably. These analyses are preliminary and more research needs to be done before mixing models can be used operationally for management advice. Another important source of uncertainty is recruitment, both in terms of recent levels (which estimated with low precision in the assessment), and potential future levels (the "low" vs "high" recruitment hypotheses which affect management benchmarks). Finally, the growth curve assumed in the analyses may be revised based on new information that is being collected. If the curve changes substantially, it may impact the assessment results as well as management benchmarks.

8.3 Stock status – variants considering mixing

Five variations of the overlap VPA were run using the western base case and eastern adjusted-catch case. Two runs estimated mixing using the proportion data (otolith microconstituents); one specifying the fixed F-ratios for the eastern case (see Section 7.1) and one estimating them. Three runs estimated mixing using the conventional tagging data; two specifying the fixed F-ratios indicated (the full model and a reduced model that estimates fewer reporting rates and other tagging-related parameters) and one that estimates the eastern F-ratios (using the reduced tagging model). The resulting estimates of mixing are summarized in **Table 14** and the estimates of recruitment, spawning biomass, and recent fishing mortality rates are summarized in **Figures 39-41**.

The estimates of the fraction of the eastern-origin population that sojourns in the west (eastern overlap) depended strongly on the type of data used. Fitting to the tagging data suggested the overlap was very low for ages 1-3 and on the order of two or three percent for older ages, whilst fitting to the proportion data suggested overlap rates of 2-3 percent for ages 1-3, 5.5 percent for ages 4-7, and 0.01-.04 percent for ages 8-10. The estimated overlap of western-origin fish into the eastern management zone was even more sensitive. Fitting to the tagging data produced estimates on the order of 10 percent for ages 1-3, 50 percent for ages 4-7 and 30 percent for ages 8-10. Fitting to the proportion data on the other hand produced estimates of very low overlap for every age class (except ages 8-10 when the eastern F-ratio parameters were estimated).

The abundance trends and absolute estimates for both the east and the west are sensitive to the use of the tagging and proportion data. When the proportion data were used and the F-ratios were fixed for the east, the estimates of spawning biomass for the east were similar to the no-mixing result. On the other hand, the estimates of spawning biomass were much higher when the F-ratios were estimated. The estimates of eastern SSB with the tagging data were similar to the no-mixing case except more optimistic in recent years (whether or not the F-ratio was estimated). The western estimates of SSB and recruitment fell into two groups; the estimates with the proportion data were very similar to the base case whereas the estimates with the tagging data were much higher in magnitude (although similar in trend).

In summary, the proportion (otolith microconstituent) and conventional tagging data lead to very different perceptions of the degree of overlap of each population. However, it should be kept in mind that both data sets are incomplete in the sense that they do not represent random samples of the overall population. Accordingly, the Group believes that the analyses of mixing have not yet reached the stage where they are reliable enough to be used as the basis for the advice called for in the Commission's rebuilding plans for the eastern and western Atlantic bluefin tuna. However, progress is being made in terms the information that is available about mixing and models that are flexible enough to utilize diverse types of data (conventional tagging, electronic tagging, otolith micro-chemistry and genetics). The modeling results considered by the Group this year confirm its previous conclusion that the state of the population in the western Atlantic is sensitive to mixing, and that the fishery in the eastern Atlantic potentially has an important impact on the western Atlantic. While the results are only preliminary, this year's modeling also gives the impression that the population in the eastern Atlantic may be more sensitive to mixing than previously thought. This new impression about mixing and the eastern Atlantic requires further investigation.

9. Evaluation of fishing capacity relative to the ICCAT Convention objectives

The current stock assessment indicates that there is overcapacity for both eastern and western bluefin tuna, because current levels of fishing mortality exceed F_{MSY}. The sections below analyze the available information on the sizes of the fleets targeting these two stocks.

9.1 East bluefin tuna stock

9.1.1 Fishing capacity

The Commission's Working Group on Capacity met in July 2007 and decided to focus on eastern Atlantic and Mediterranean bluefin (BFT-E) as the primary stock of concern, and asked for more refined quantitative estimates of capacity for the stock. Information presented below represents an updated view of fishing capacity for BFT-E held by the participants of the 2008 stock assessment session.

The fishing capacity table of the various fleets involved in the eastern bluefin fishery was updated during the meeting. The information used came from the ICCAT list of bluefin vessels and the scientists present at the meeting, on the basis of their knowledge of the fisheries, who provided additional information about bluefin tuna fleets of their own countries. The resulting estimates of vessel numbers were discussed by the group and adjusted when needed. They were finally grouped by main gears, by size categories and by main areas for the purse seiners (PS), longline (LL) and other fishing gears targeting bluefin tuna in the Mediterranean.

The comparison between the present table and that prepared during the 2006 assessment shows an important increase in the number of PS vessels targeting bluefin tuna in the Mediterranean between 2005 and 2007 due to newly developed fisheries or reflagged vessels. The present estimation of large and medium size purse seiners in the Mediterranean Sea alone is double that estimated for 2004-2005 (**Table 15**). In 2004 and 2005, the purse seine fleet was estimated as comprised of 41 large and 103 medium vessels, while for the 2007 fishing season the estimates grew to 83 large and 205 medium purse seiners. However the estimated number of small/multispecies purse seiners involved in the BFT fishery in the Mediterranean Sea has considerably decreased. In the case of the longliners in the Mediterranean Sea, a decrease in the estimated number of vessels is observed for all the size categories, with the estimated current fleet of 43 large LL vessels (compared to 56 in 2004-2005).

The Group further evaluated active capacity in the East Atlantic (which has not been done in 2006) which was dominated in 2007 (in number of units) by longliners, trawlers and baitboats (**Table 16**.). The joined active capacity in the Mediterranean Sea and East Atlantic is depicted in **Figure 42** (upper panel).

Estimates of catch-per-unit fishing category (CPU) were revised according to the new size categories used and then raised to get an estimate of the total catch in the Mediterranean and in the East Atlantic by the overall fleet (**Tables 15 and 16**). The mean CPU by gear type and vessel size over all areas during the recent period was used to construct this estimate. As CPU may vary between fleets, the Group decided to also calculate lower values to give a range by presuming that older PS vessels have a probable annual catch half of new PS vessels of the same size. Those assumptions lead to an estimated 2007 catch of about 47,800 t. for the Mediterranean alone and about 61,100 t for both the Mediterranean and East Atlantic and bluefin tuna stock. These values are much larger than the reported Task I, but fit much better with the collective expert opinion of the various national scientists attending the meeting (see also **Figure 42**, lower panel).

If the same premises are applied to the *total potential* fleet operating in the stock area (*i.e.* vessels that are not currently targeting BFT but that could shift from other large pelagics species to BFT), the estimated *potential catch* in the Mediterranean would be about 56,000 t in the Mediterranean and about 17,000 t in the East Atlantic, resulting in an estimated *total potential* catch for the entire East stock of about 73,000 t (**Table 17 and 18**).

The values obtained are considered as the best estimates available among the scientists at the meeting. If further and new information, such as VMS data, would be provided to the SCRS, more precise estimates might be obtained in the future.

In view of the assessment of stock status, this level of *active* capacity, leading to estimates of 2007 catch level on the order of 60,000 t, is at least 3 times the level needed to fish at a level consistent with the Convention objective. Estimates of *potential* capacity lead to even higher estimates of potential catch and would require much larger reductions in fleet size to achieve the Convention objective, if capacity control were the primary management measure of choice.

9.1.2. Farming capacity

As regards farming capacity for bluefin tuna in the Mediterranean, according to the ICCAT record of farming facilities (July 2008), it has grown to about 64,000 t, which would represent approximately 51,000-57,000 t round weight of (large) fish at time of capture (**Figure 43)**. This estimated farming capacity is as much as twice the 2008 TAC agreed by the Commission [Rec. 06-05] and represents a capacity excess of more than 32,000 t above the predicted short-term catch level consistent with the effort level implied by the Convention objective. As indicated above, the estimates of fleet size indicate there is sufficient active fishing capacity to fully supply the farms to their indicated limits.

In summary, information available reinforces our belief that catches of bluefin tuna from the eastern Atlantic and Mediterranean have been seriously under-reported in recent years. An estimate made by the Working Group in 2006 based on the number of vessels operating in the Mediterranean Sea and their respective catch rates, indicates that the volume of catch taken in recent years likely significantly exceeded TAC levels and probably was close to 43,000 t in the Mediterranean during the early 2000s. Our careful evaluation in 2008 using the information from the ICCAT list of bluefin vessels and the knowledge of the national scientists present at the meeting, led to a 2007 probable catch of 47,800 t for the Mediterranean and about 61,100 t for the eastern Atlantic and Mediterranean bluefin stock. Our belief in significant underreporting is further supported by examination of the information reported through various market data sources (see Section 5.3) and which all leads us to conclude that the exports to the Japanese and US markets largely exceed the reported catches. This apparent lack of compliance with the TAC and underreporting of the catch will undermine conservation of the stock.

9.2 West

The status of the WBFT stock indicated that overcapacity of the western fleet might be one of the contributing factors to the overfished condition of this stock. Reductions in the capacity of this fleet might be required to comply with the ICCAT Convention objectives of reducing fishing mortality rate F below F_{MSY} and increase stock biomass B to levels above B_{MSY}. To support the efforts of the SCRS Methods Working Group aimed at estimating fishing capacity for all tuna fleets in the Convention Area, the Group reviewed the available information needed to estimate capacity, catch rates per vessel type, and total catch in the WBFT fishery. Two documents were presented to the group with information on fleet size/characteristics.

Document SCRS/2008/087 provided a characterization of the U.S. tuna fleets. The number of fishing permits issued for catching Atlantic tunas was used as an estimate of fleet size. The U.S. Atlantic tuna fishery does not have a specific permit for BFT. In the case of the recreational fishery, there are two categories of permits: Angling and Charter/Headboat. The permit for the recreational sector is a Highly Migratory Species permit that allows the landing of all Atlantic tunas (including BFT), sharks, swordfish and billfish. The commercial sector has five permit categories: General (all hand gear), Harpoon, Trap, Longline, and Purse Seine. All permits (recreational and commercial) are 'open access' except for the Longline and Purse Seine categories which are of 'limited access'. The total number of permits that were valid during 2007 was 46,068 of which 40,088 were recreational permits. Of the 5,980 commercial permits the majority corresponded to the General category (5,652 permits), followed by longline (275 permits), Harpoon (37 permits), Trap (11 permits) and Purse Seine (5 permits). Information on length (LOA) of commercial and recreational vessels showed that the majority of the U.S. vessels are relatively small in size with the highest proportion of them in the '<20 m' category. Because during 2007 the U.S. tuna fisheries were managed on a fishing year cycle (June-May) instead of a calendar year cycle (January-December), the expiration of permits and the issue of new permits followed the fishing year cycle. Therefore, not all the 46,068 permits described above were valid at the same time during 2007. Due to reporting requirements and data confidentiality issues it was not possible to estimate the proportion of permits that were active for most of the fleets. It was possible, however, to do it for the longline fleet (44% active). The proportion of vessels with tuna permits that landed BFT was very low. The document described the problems to estimate BFT fleet capacity for the U.S. due to several factors such as, for example, the difficulty to identify vessels that target BFT, the incidental catches by the longline fleet in the Gulf of Mexico, the unknown proportion of active vessels compared to the number of valid permits.

Document SCRS/2008/083 provided some information on the Canadian fleet size. The document indicated that the number of license holders eligible to land bluefin tuna was 776 from 1999-2003, and increased to 777 in 2004 and has remained constant since then. The number of vessels active in the fishery has varied from year to year. In the Gulf of St. Lawrence, the dominant gear type was rod and reel, and the tended line component has become less significant. The highest number of active vessels in this area was observed in 2004 with over 350 vessels. The number of active vessels in 2007 was about 250. In the southwest Nova Scotia fishery, rod and reel is also dominant followed by the tended line fishery. The highest number of vessels in this fishery was observed in the late 1990s. The number of active vessels in 2007 was on the order of 150 vessels.

The Group was unable to estimate catch rates per vessel similar to those prepared for the eastern Atlantic and Mediterranean BFT fisheries (see Section 9.1). The main reasons that precluded the Group from performing this task were that, unlike in the EBFT fishery, ICCAT does not have a complete list of BFT vessels operating in the western fishery or information on the BFT catch of individual vessels. Therefore, information as basic as the number of vessels directly participating in the WBFT fishery was not available. It was clear to the Group that without more detailed information the process of estimating catch rates per vessel type and total catch would produce meaningless results.

10. Projections

10.1 Projections – East

Document SCRS/2008/101 relates to projections for the East stock was presented at the 2008 working group. The aim of this study is to investigate the implications of different stock-recruitment assumptions when examining the potential of the *Recommendation by ICCAT to Establish a Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean* [Rec. 06-05]. To do so, some Beverton and Holt relationships displaying contrasting steepness of 0.99, 0.90, 0.75 and 0.50 were applied within a simulation model. In addition to these four stock-recruitment scenarios, parental effects and stochastic variations were also considered. The main conclusion is that our ability to evaluate the consequences of [Rec. 06-05] (as any set of management measures) relies on our capacity to predict future recruitment levels in an accurate way. Assuming a Beverton and Holt relationship with different steepness, with or without parental effects and with or without stochastic variations led to contrasting outputs, i.e. from a significant rebuilding of the simulated population within 15 years to the crash of this same simulated population. This outcome is somewhat problematic, as we are unable to properly estimate the stock-recruitment relationship for the East Atlantic and Mediterranean bluefin tuna stock. Consequently, it is crucial to clearly state recruitment assumptions when an advice is given and to consider a significant range of contrasting and plausible stock-recruitment relationships.

Besides this, a Management Strategy Evaluation (MSE) for Atlantic bluefin tuna using the FLR open source software framework (Fisheries Library for R, http://www.flr-project.org, Kell *et al.* 2007) was presented to the Group. The three main elements of a MSE are the:

i) Operating Model (OM), that represents alternative plausible hypotheses about stock and fishery dynamics, allowing integration of a higher level of complexity and knowledge than is generally used within stock assessment models;

ii) the Management Procedure (MP) or management strategy which is the combination of the available pseudo-data, the stock assessment used to derive estimates of stock status and the management model or Harvest Control Rule (HCR) that generates the management outcomes, such as a target fishing mortality rate or Total Allowable Catch; and

iii) Observation Error Model (OEM) that describes how simulated fisheries data, or pseudo-data, are sampled from the Operating Model.

This MSE has been applied to BFT in a preliminary exercise to illustrative the types of evaluations that can be conducting. Several important points are clearly evident these are:

- A TAC management strategy based upon reducing fishing mortality to $F_{0.1}$, a proxy for F_{MSY}, alone will not recover the stocks to the B_{MSY} level within a generation time
- Additional measures such as a reducing fishing on immature fish will help in the recover stocks but again the stocks will not recover to the B_{MSY} level with a high probability within a generation time
- Recovery will be enhanced if recruitment is not affected by low SSBs; however, at current low SSB levels estimated recruitment has been low.
- Even with recent misreporting of 50% the conclusions are not changed.

The results are consistent with the SCRS conclusions that the only scenarios which have potential to address the declines and initiate recovery are those which (in combination) close the Mediterranean to fishing during spawning season and decrease mortality on small fish through fully enforced increases in minimum size.

Based on these two documents and following discussions, the Group agreed on conducting non-equilibrium projections using the FLR open source software framework while considering different recruitment scenario and catch levels to reflect various sources of uncertainties (see **Table 19**). Four management strategies were evaluated corresponding to (i) perfect implementation [Rec. 06-05]; (ii) as i but with a 20% implementation error; (iii) as i) but with a fishing mortality equal to $F_{0.1}$ from 2009 onwards; (iv) as i) but with a fishing mortality equal to F_{max} from 2009 onwards (**Table 20**). These were evaluated by running stock projections for alternative plausible hypotheses about historical stock status and stock dynamics. The simulations conducted by the group did not use an operating model and management procedure with feedback. Instead the population was projected ignoring the stock assessment, monitoring and implementation feedback processes.

The framework for these projections were agreed by the Group, but due to the time required for their implementation, it was decided to complete the work needed in time for Species Group discussions in September 2008, and to append a complete description of the methods and results to the detailed report of the assessment after further review in September. Projections conducted in September are included as **Appendix 12**.

In view of the information available at the meeting, the Committee's previous evaluation of the current regulatory scheme thus remains unaltered. Unless the Plan is adjusted to impose greater control over the fisheries by improving compliance and to further reduce fishing mortality rates (especially on larger fish), it will most likely lead to further reduction in spawning stock biomass with an increasing risk of fisheries and stock collapse. As the selectivity pattern and the fishing mortality rates are similar as those of the 2006 stock assessment, the Committee further stresses that the main conclusions from the "Report of the 2006 Atlantic BluefinTuna Stock Assessment Session" (Anon. 2007) still hold, i.e. only the management scenarios which have potential to address the declines and initiate recovery are those which (in combination) close the Mediterranean to fishing during spawning season and decrease mortality on small fish through minimum size of 20 or 30 kg.

10.2 Projections – West

Specifications

The projections for the western stock (Base Case and Case 9) were based on the bootstrap replicates of the fishing mortality-at-age and numbers-at-age matrices produced by the VPA-2BOX software. The current rebuilding plan has been designed implicitly on a low recruitment scenario that assumes the future recruitment will never exceed the values observed since 1976 (when spawning biomass is estimated to have been depleted). The short-term projections conducted in 2006 made a similar assumption on the basis that it would take several years for spawning biomass to increase sufficiently to have an appreciable impact on recruitment. However, in several past assessments an alternative recruitment scenario was examined for longer-term projections that allowed the level of recruitment to increase as a Beverton and Holt function of spawning biomass. The Group agreed that it had no strong evidence to favor one scenario over the other and noted that they provide reasonable (but not extreme) lower and upper bounds on rebuilding potential.

The Group agreed that projections and benchmarks should be computed for the Beverton and Holt (high) and two-line scenarios (low) to account for the uncertainty regarding the true form of the stock-recruitment relationship, consistent with the approach used during the 2002 assessment (see **Figure 36**). The 2-line stock-recruitment relationship involves a linear increase in recruitment from the origin to a "pivot" level of spawning stock size above which recruitment is independent of spawning stock size. The "pivot" spawning stock size is defined as the mean spawning stock size over 1989-94 (the period that includes the lowest estimates of spawning biomass). The constant level of recruitment is defined as the geometric mean recruitment over the years 1976-2004, a period over which recruitment was relatively constant. The Group agreed to set the extent of recruitment variability, σ_R, for each bootstrap replicate equal to the maximum likelihood estimate (~0.39).

The Beverton-Holt stock-recruitment relationship was fitted to the estimates of spawning stock size and recruitment for the 1970-2003 year-classes[2] by means of maximum likelihood (lognormal error). The Group agreed to set the extent of recruitment variability, σ_R, for each bootstrap replicate equal to the maximum

[2] Common convention has been to define "recruitment" as the number of age 1 fish and "year-class strength" as the number of age 0 fish. The "recruitment" for year *y* is therefore the same cohort as the year-class for year *y*-1.

likelihood estimate (~0.39). The fits of the stock-recruitment relationships for the Base and Case 9 assessments show evidence of significant auto-correlation in recent years (see **Appendix 10**). Therefore, future recruitment was allowed to deviate from its expectation as a first-order multiplicative (lognormal) autocorrelated process Generally the lognormal structure is preferred because it does not admit negative recruitments and because it allows the variance in recruitment to increase with its expectation. The autocorrelation parameter (ρ) was estimated to be equal to 0.52 for the VPA base case and 0.35 for the Case 9 (Remove CAN GSL Index).

The recruitment values from the VPA for 2005-2007 were replaced with values generated from the estimated stock-recruitment relationship underlying the projection (for both low and high recruitment scenarios). Numbers- and fishing mortality-at-age for ages 1-3 at the start of 2005 were therefore re-calculated by projecting these generated recruitments forward under the known catches-at-age. Partial recruitment (which combines the effects of gear selectivity and availability of fish by age) was calculated from the normalized (re-scaled) geometric mean values of fishing mortality-at-age for the years 2004-2006.

The projected catch for 2008 was assumed to be equal to the 2008 TAC of 2,100 t. For years beyond 2008, projections were continued using various levels of constant catch with the restriction that the fully-selected *F* was constrained not to exceed 2 yr^{-1}.

Medium-term (12-year) projections were conducted to cover the time of the rebuilding plan. Projected spawning stock size was expressed relative to the spawning stock size associated with *MSY* (i.e., B_{MSY}) for the appropriate recruitment scenario and the 1975 SSB. B_{MSY} was used as a reference level for rebuilding because it is the target of the current Rebuilding Program. The 1975 SSB was used as a reference level for this because it has been assumed as the rebuilding target in several previous assessments, where it had been suggested as a proxy for B_{MSY}.

Results

Projections of SSB from the base VPA and case 9 were made through 2019 under constant catches of 0, 500, 1,000, 1,500, 2,100, 2,300, 2,500, 2,700 or 3,000 t (**Figure 44**). The associated benchmarks for the base case and case 9 are given in **Tables 21** and **22,** respectively.

The Group noted that the recruitment expected when spawning biomass reached B_{MSY} was much lower with the two-line scenario (70,000) than with the Beverton-Holt scenario (160,000), with a correspondingly lower estimates of MSY and B_{MSY}. On the other hand, that the two-line (low) recruitment scenario actually predicts slightly higher levels of recruitment than the Beverton-Holt (high) scenario early in the projections when spawning stock sizes are low (between 5,000 and 8,500 t). For this reason, the early projections with the two-line model tend to increase slightly more rapidly than those with the high recruitment scenario (**Figure 45**). Nevertheless, the projections with the low recruitment scenario are more optimistic primarily because the rebuilding target (B_{MSY}) is presumed to be so much lower than with the high recruitment scenario.

The results with the low recruitment scenario (**Figure 44**) are similar to those from the 2006 assessment (Anon. 2007). A total catch of 2,100 t is predicted to have at least a 50% chance of achieving the convention objectives of preventing overfishing and rebuilding the stock to MSY levels by 2019, the target rebuilding time. The outlook under the high recruitment scenario (**Figure 44**) is more pessimistic since the rebuilding target would be higher; a total catch of less than 1.500 t is predicted to stop overfishing within the next few years by 2011-2012, but the stock would not be expected to rebuild by 2019 even with no fishing.

Table 23 summarizes the chance that various constant catch policies will allow rebuilding under the high and low recruitment scenarios for the base-case model as well as for an alternative model that does not use the optimistic Gulf of St. Lawrence index. **Table 24** similarly summarizes the chance that various constant catch policies will end overfishing. The base model with the low recruitment scenario suggests that catch levels of 2400 t will have about a 50% chance of rebuilding the stock by 2019 and catches of 2,000 t or lower will have greater than a 75% chance of rebuilding. The levels of catch that lead to rebuilding with the alternative model (remove GSL index) are lower; 1800 t will have about a 50% chance and 1,500 t will have a 75% chance. If the high recruitment scenario is correct, then the western stock will not rebuild by 2019 even with no catch, although catches of 1,500 t or less are expected to end overfishing and initiate rebuilding.

Subsequent to the June assessment meeting, the Group agreed that it would be useful to present the projection results in the form of surface plots that would allows inferences about the future status of the stock to be made for any TAC or probability levels. It was also agreed that it would be useful to present the results for the high and low recruitment scenarios combined to better reflect the Groups contention that there is no strong evidence to support one recruitment hypothesis over the other. These plots are included in **Appendix 11**.

The Group noted that considerable uncertainties remain for the outlook of the western stock, particularly with regards to mixing and the effectiveness of management measures on the eastern stock.

11. Recommendations

11.1 Research and statistics – East

It is imperative that CPCs provide accurate Task I and Task II data to the SCRS if they want to have improved and more precise stock status diagnoses and advice. Continuing failure to meet obligations results in very high uncertainty in the scientific advice and may lead to a catastrophic failure of the management systems envisaged to rebuild the stock to the Convention objectives, depending on how the Commission chooses to react to this high uncertainty.

11.1.1 Recommendations fisheries independent indices and information on purse seine fleets

The 80% to 85% of yields are currently made by the purse seine fishery in the Mediterranean Sea. However, little information is available on these fisheries and the Task I data of these fisheries are likely to be strongly underreported since a decade ago. To conduct more precise and reliable assessment, it is necessary to obtain information about the catch composition, effort (e.g. days-at-sea, days of active fishing, etc.), the spatial distribution (e.g. VMS) and the technological equipments of the PS fisheries operating in the Mediterranean Sea, so that an accurate CPUE index might be computed.

In addition to this information, the group also stresses the strong need for fisheries-independent indices (especially in the Mediterranean Sea), as this is currently available for many stocks assessed by ICES or GFCM. European and Mediterranean scientists have recently conducted over several years and with success aerial surveys or larval surveys. These surveys have been stopped and the group recommends that such monitoring be more strongly supported and restated.

Large-scale, well planned conventional tagging experiments cross-Atlantic and Mediterranean are needed to significantly improve the status of BFT resource.

11.1.2 Recommendation for data mining

Data mining made by individual scientists has allowed the SCRS and ICCAT Secretariat to reconstruct total catch and size composition of bluefin in the northeast Atlantic and Mediterranean Sea back to 1955. There is, however, still highly valuable historical information on past BFT fisheries that are not used by the SCRS because they are not directly accessible nor validated. The BFT Working Group thus recommends that data mining continues, so that future stock assessment could include past major BFT fisheries and thus be performed on a wider period, such as 1920 to the 2000s.

11.1.3 Observation recommendations for tuna farming and holding operations

Holding tuna in fattening farms introduces additional uncertainties to estimates of total catch, catch-at-age and catch by area. These quantities are essential to properly conduct stock assessments. The conversion of total catch into catch-at-age requires that there be size or size-at-age samples at time of capture. For farmed fish, fish-size data are currently only available at time of sale. In addition, because fish grow in farms, apparent fish age based on size conversions are biased higher. Therefore, reliable fish-growth measures in farms are still needed. These can be achieved by conducting regular size-sampling in each farm; tracking size and weight changes from entry to departure; and by conducting mark-recapture studies on fish inside the farms to better estimate growth. In order to properly determine total numbers, observers need to record number of fish transferred and collect data on deaths occurring in pens and during the transfer process. Observers also need to collect otolith and genetic samples from harvested fish. Finally original set locations of each purse seine used to transfer fish should be recorded to determine original catch areas. To resolve these issues, the Group recommends that additional data be collected by observers now having farm access.

11.2 Research and statistics – West

- Otolith microconstituent data can be very useful to determine stock origin with relatively high accuracy, and thus could be a key factor to improve our ability to conduct mixing analyses. The available samples have been collected primarily in recent years and from fisheries off North America. It is essential that representative samples be collected from all major fisheries, in all areas[3]. Added value would be obtained if genetic samples were also collected from the same fish, which could potentially result in more accurate and less expensive tests for stock origin. In terms of the mixing analyses, it is also important to identify existing collections of otoliths collected in historical time periods (1970s, 1980s) in order to understand how the stock origin proportions in the catch may have changed.

- Recent studies based on direct age readings of otoliths suggest that the growth curve assumed for western bluefin may be biased particularly for old (greater than 12-13) fish. The group recommends that more direct age reading samples be collected, from both old fish and young (ages 1-4) fish and that the resulting growth curve be considered by SCRS. In addition, Archived otoliths from the 1970s should be examined in order to determine if growth patterns may have changed. Contingent on the results of this investigation, a regular program of fishery sampling should be considered by national scientists, to allow the SCRS to better characterize the age structure of the catch.

- It is recommended that the historical catch and effort for the West Atlantic data from the Japanese longline fleet be analyzed by main areas and groups of years that show a consistent effort distribution, rather than considering only catches of bluefin reports. The main areas of interest are the Gulf of Mexico, the waters off Brazil and the Florida-Bahamas areas from 1960 through the 1980s.

- It took an inordinate amount of time during this assessment meeting to prepare the basic inputs to the assessment, such as catch-at-age. The use of time during the assessment needs to be more efficient and this can only be achieved through better preparation before the meeting. The Secretariat needs sufficient resources to prepare available data files (table of substitutions, catch-at-size, catch-at-age, tagging) at least two weeks before the meeting and National Scientists need to devote sufficient resources to review those files before the start of the meeting --and request any necessary modifications, if applicable--. Note that this issue should be addressed to the Sub-Committee on Statistics and revisited in the SCRS Plenaries and we should consider the use of modern web conferencing techniques.

- Research should continue to assess the significance of differences in life history parameters (maturity, fecundity, growth) between eastern and western bluefin tuna.

- The Group recommended that alternate assessment approaches, such as CATCHEM (Porch *et al.*, 2001), MULTIFAN-CL or MAST that allow for errors in the catch at age, be further developed for more extensive use at meetings in the near future. This has broad implications (not just for assessment results) in the way data are reported by national scientists and retained by ICCAT and this should be addressed (e.g., the actual size frequency observations used to estimate the catch at size for the various fleets). It is recommended that this work be advanced during 2009 in an inter-sessional meeting.

11.3 Management – East, including advice on the odds of achieving the current Rebuilding Plan objectives without further adjustment

The available information indicates that the current fishing mortality rate (under the current overall fishing pattern) may be more than three times the level which would permit the stock to stabilize at the MSY level. Previously SCRS advised that although [Rec. 06-05] is seen as a step in the right direction, it is unlikely to fully fulfill the objective of the plan to rebuild to the MSY level in 15 years with 50% probability. Although projections of the current assessment have not yet been fully implemented, the outcome of the status evaluation is very similar to that previously conducted which indicated the need for additional management measures if the

[3] The Group identified the following, *inter alia*: Japanese longline fisheries in the Atlantic and Mediterranean; Moroccan and Spanish trap fisheries in the Atlantic; Tunisian trap fisheries in the Mediterranean; Spanish baitboat fisheries in the Cantabrian; purse seine fisheries throughout the Mediterranean. It was recommended that industry and trade association groups be contacted by National Scientists for supporting these efforts. Past meetings of the SCRS have also identified the importance of obtaining samples in the ventral North Atlantic.

Recovery Plan objectives are to be met. In order to reverse SSB decline and to initiate rebuilding with a degree of confidence, additional reductions in fishing mortality and catch need to be implemented.

SCRS has evaluated a number of alternative management scenarios which might be used to achieve the recovery of this stock with a higher probability. All these scenarios involve a time-area closure including partial or full closure during the spawning season as well as much lower catches (TAC including all sources of fishing mortality) during the next few years (~15,000 t). The long-term gain resulting from these actions could lead to catches of 50,000 t or more with substantial increases in spawning biomass. For a long lived species such as bluefin tuna, it will take some time (> 10 years) to realize the benefit.

Clearly, an overall reduction in fishing effort and mortality is needed to reverse current trends. Current fishing capacity largely exceeds the current TAC and has even increased over the last two years. Therefore, management actions are also needed to mitigate the impacts of overcapacity as well as to eliminate illegal fishing. Deferring effective management measures will likely result in even more stringent measures being necessary in the future.

11.4 Management – West, including advice on the odds of achieving the current Rebuilding Plan objectives without further adjustment

In 1998, the Commission initiated a 20-year rebuilding plan designed to achieve B_{MSY} with 50% probability. The current assessment indicates that the stock is not rebuilding as rapidly as was projected under the plan initially. The 2007 SSB is estimated to be 7% below the level of the Plan's first year.

Based on a strict interpretation of the base case projections and the *Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program* [Rec. 06-06], the Commission is faced with a choice between TAC levels from 2,400 t to zero depending on its willingness to base management on the more risky low recruitment scenario. However, in light of the uncertainty about recruitment and other uncertainties not taken into account in the projections, the Group strongly advises against an increase in TAC. Instead, the Committee recommends that the Commission adopt more conservative catch levels that will result in a higher probability (75% chance) that B_{MSY} is achieved by the beginning of 2019. Under the more optimistic "low recruitment" scenario, this target could be achieved with a TAC of 2,000 t. However, if the assessment and estimates of future yield are positively biased or if there is implementation error (both of which have occurred in the past), the TAC should be lower. For instance, based on the assessment results without the Gulf of St. Lawrence CPUE index, the TAC would need to be reduced to 1,500 t in order to achieve B_{MSY} by 2019 with 75% probability.

Under the more pessimistic "high recruitment" scenario, B_{MSY} is very high and not achievable within the rebuilding time frame. However, some TAC levels that are projected to rebuild the stock under the optimistic scenario are also projected to end overfishing under the more pessimistic scenario. For instance, a TAC of 1,500 t is expected to end overfishing with 75% probability by 2015 under the high recruitment scenario.

As noted previously by the Committee, both the productivity of western Atlantic bluefin and western Atlantic bluefin fisheries are linked to the eastern Atlantic and Mediterranean stock. Therefore, management actions taken in the eastern Atlantic and Mediterranean are likely to impact the recovery in the western Atlantic, because even small rates of mixing from East to West can have significant effects on the West due to the fact that eastern plus Mediterranean resource is much larger than that of the West.

12. Other matters

12.1 Analyses of length frequencies and increases in weight in Mediterranean bluefin tuna farms

Harvest data from Mediterranean bluefin tuna farms were provided by Contracting Parties to the Secretariat. This data sometimes included various combinations of total weight harvested, histograms of harvested weights or histograms of harvested lengths. Only data with both harvested lengths and either total weight harvested or histograms of harvested weight could be used in this analysis. If it is deemed that growth and length frequency information is useful for future analyses it will be necessary to collect harvested lengths as well as the harvested weight, either by weight class and number or overall total.

The objectives of this analysis were to examine whether the length frequencies of fish harvested from the tuna pens matches the French purse seine catch at size for the same years and to determine whether the farm data could be used to calculate the percent increase in growth of fish during their tenure in the pens.

Results of the first objective (**Figure 46**) indicate that, in early years, the purse seine catch at size did not match harvested lengths from the farms. However, in more recent years, they appear to converge, particularly for Spain in 2007. It should be noted that purse seine catch usually occurs in May and June and that farms usually harvest in December and January so that sizes from the purse seine could be advanced by 6 months to match the farm sizes. However, this assumption is contrary to the assumption made to address the second objective of this analysis and, to date, remains untested.

To address the second objective we had to make several assumptions to address data limitation:

- We assumed that the length at harvest was the same as the length at capture, or that the tuna did not grow in length.
- Since there was no unique identifier for an individual farm harvest, we constructed a unique identifier based upon the flag, year, reported total catch, reported weight of sample and reported number of fish. We assumed that this unique identifier represents a farm harvest.
- Unique harvests for which no length frequency data and total catch (either in histogram or summed form) were removed from the analyses as we could not obtain initial weights.

This set of assumptions and data limitations provided 66 unique harvest sets (**Tables 25 and 26**). Unfortunately, it is difficult to cross reference these harvests with any other ancillary information and it is difficult to determine how long the fish were in the pens. It is likely that fish were captured and harvested at different times and these times are not always available. We assumed that all fish were placed in the pen and removed at the same time. Operating under these assumptions we used the ICCAT length-weight regression for Mediterranean bluefin tuna ($RWT = 1.9607 \cdot 10^{-5} (FL)^{3.0092}$, Arena), we obtained a putative weight at capture and then determined the percent increase in this value versus the harvest total weight (% increase= harvest weight- initial weight)/initial weight.

Of the 66 unique harvests, 34 showed positive growth and 32 indicated negative growth (**Tables 25 and 26**). For various reasons, listed in the table notes, we excluded 38 harvest sets that had either negative or anomalous growth or came from a flag for which similar harvests experienced anomalous growth. This resulted in keeping only all harvests from Turkey in 2004-2006 and most harvests from Spain. **Figures 47 and 48** show the length at harvest, implied weight at capture the actual weight distribution at harvest (when given) for the selected farms. A ‘weighted’ mean calculated as the % increase between the overall sum of the initial weights and the overall sum of the final weights was 14.5%.

Analysis of these putative increases in growth must be interpreted with caution. The method of estimating growth rate is likely to be a lower estimate as any increase in length will result in an underestimation of the difference between harvested and captured weight. This could explain the large numbers of landed weights that are less than 10% lower than the estimated initial weights. Furthermore, the anomalous estimates of growth must be explored in more detail before more conclusions can be made. In conclusion it appears that an initial estimate of growth rate in the pens may be around 14% but that this estimate appears to be highly variable and may be affected by many factors.

13. Adoption of the report and closure

The report was adopted by correspondence.

The Chairman thanked participants for their hard work.

The meeting was adjourned.

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Table 1. Estimated catch (landings and discards) of BFT.

Stock	*Flag*	*GearGrp*	***1990***	***1991***	***1992***	***1993***	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2007****
*ATE	Cape Verde	BB																			
	China P.R.	LL									85	103	80	68	39	19	41	24			88
	Chinese Taipei	LL				6	20	8	61	226	350	222	144	304	158			10	4		
	EC.Denmark	UN	0	0		37		0	0		1										0
	EC.España	BB	1314	997	769	3281	1694	2386	4595	2940	2017	1217	1729	2168	2410	1239	1735	2012	1065		1187
		GN																			0
		HL								162	28	33	126	61	63	109	87	11	4		5
		LL	32	32							5	8	3	4	0	1	4	3	18		21
		SU																			0
		TP	1911	1040	1271	1244	1136	941	1207	2723	1525	2005	1416	1240	1548	750	862	880	820		914
		TR	300	204	277	553	305	492	373	376	226	94	192	151	68	39	112	195	125		139
		UN			2		2					3	8	9							0
	EC.France	BB	367	448	372	164	66	181	310	134	282	270	91	105	150	130	47		50		56
		GN	42	47	74	497	21	144	253	3	72	71	57	68	6						0
		LL			7												2		95		106
		PS															223		153		170
		TR				2															0
		TW	101	70	441	436	224	400		57	259	247	394	456	599	518	26		731		815
		UN					25			75							263	818	189		210
	EC.Germany	TW																			0
		UN																			0
	EC.Greece	TR																			0
	EC.Ireland	GN									3	1	0	1							0
		LL								14	2	1									0
		TR											2								0
		TW									16	50	20	6	15	3	1	1	2		3
	EC.Poland	UN																			0
	EC.Portugal	BB	12		0	2	219	34	80	447	252	5	2	2	7	1	8	6	0		0
		HL	1																		0
		LL		99	4	4	8		97	246	18	404	398	383	160	33	1	63	71	29	79
		PS					0									0			1		1
		SU	14	18	34	19	12	0			8	0	1	3	3						0

		TP						1	15	19	45	2	40	15	17	27	18	9	25		27
		TW							7												0
		UN					0														0
	EC.Sweden	UN		1																	0
	EC.United Kingdom	GN						1	0	0		0									0
		LL								0		10									0
		TW									1	2	0			0			0		0
	EC Total	All	4094	2955	3251	6202	3712	4580	6937	7197	4758	4423	4479	4673	5046	2851	3390	3999	3349		3733
	Faroe Islands	LL									67	104	118								
	Guinée Conakry	UN					330														
	Iceland	LL									1	27			1						
		TW									1										
	Japan	BB																			
		LL	1464	2981	3350	2484	2075	3971	3341	2905	3195	2690	2895	2425	2536	2695	2015	2598	1896	1612	1612
	Korea Rep.	LL					4	205	92	203			6	1					1		10
	Libya	LL			312				576	477	511	450							47		48
		PS											487								
	Maroc	GN	31	3	6	4	13	10	13		34	30	28	17	11						0
		LL														2	8	16	273	1	338
		PS	54	46	462	24	213	458	323	828	692	709	660	150	884	490	855	871	179		221
		SU																			0
		TP	323	482	94	387	494	210	699	1240	1615	852	1540	2330	1670	1305	1098	1518	1744	2417	2157
		UN																			
	NEI (ETRO)	UN	74	4																	
	NEI (Flag related)	LL		85	144	223	68	189	71	208	66										
	Norway	LL																			
		PS										5									
	Panama	LL					1	19	550	255		1									
		PS										12									
	Seychelles	LL													2						
	Sierra Leone	LL											93	118							
	U.S.A.	PS																			
ATE Total			6040	6556	7619	9367	6930	9650	12663	13539	11376	9628	10528	10086	10347	7362	7407	9036	7493	4059	11941
ATW	Argentina	LL																			

	TW										0									
	UN	2																		
Brasil	LL	1				0	0				13		0							
Canada	GN												0							
	HP				33	34	43	32	55	36	38	18	20	13	10	7	14	20	17	17
	LL	4	6	9	25	5	4	22	12	32	31	47	20	53	28	43	36	48	58	58
	PS																			
	RR	28	32	30	88	71	195	155	245	303	348	433	402	508	407	421	497	629	389	389
	TL	404	447	403	284	203	262	298	138	172	125	81	79	39	42	49	44	35	23	23
	TP	2		1	29	79	72	90	59	68	44	16	16	28	84	32	8	3	4	4
	UN																			
Chinese Taipei	LL								2											
Cuba	LL													74	11	19	27	19		
EC.Poland	UN																			
EC.United Kingdom	GN													0						
FR.St Pierre et Miquelon	LL													3	1	10	5			
	UN										1									
Japan	LL	550	688	512	581	427	387	436	330	691	365	492	506	575	57	470	378	376	277	277
Korea Rep.	LL																1	52		
Mexico	LL					4			2	8	14	29	10	12	22	9	10	14	7	7
	UN																			
NEI (ETRO)	LL	24	23	17																
NEI (Flag related)	LL							2			429	270	49							
Norway	LL																			
Panama	LL																	0	0	0
Sta. Lucia	HL	14	14	14	2	43	9													
	UN							3												
Trinidad and Tobago	LL																			
U.S.A.	GN			0		0	1	4					0							
	HL	210	341	218	224	228	66	33	17	29	15	3	9	4		1	2	0		
	HP	129	129	105	88	68	77	96	98	133	116	184	102	55	88	41	32	30	23	23
	LL	275	305	347	177	185	211	235	191	156	222	242	130	224	299	275	211	205	164	164
	PS	384	237	300	295	301	249	245	250	249	248	275	196	208	265	32	178	4	28	28
	RR	752	696	324	540	462	844	840	931	777	760	683	1244	1523	991	716	425	376	634	634

		TP																			
		TW																			
		UN	1	2	1	1	2	1	3	2	1	0	0	0							
	UK.Bermuda	LL											1								
		UN							1	2	2	1		1	1	0					
	Uruguay	LL		1	0	1	0	2							1	0					
ATW Total			2780	2921	2282	2368	2113	2423	2495	2334	2657	2772	2775	2785	3319	2306	2125	1869	1811	1624	1623
MED	Algerie	GN									200	158	214	312	287		186	165	75		108
		HL									180	208	159	163	129		39	27	21		30
		LL											700	109	186		167	712	88		127
		PS									900	1056	778	917	922		753	623	850		1228
		TL									93	174	88								0
		TP									399	367	290	366	41		5	3	4		6
		UN	782	800	1104	1097	1560	156	156	157	175	179	101	145	145	1586	58				0
	China P.R.	LL					97	137	93	49											
	Chinese Taipei	LL				328	709	494	411	278	106	27	169	329	508	445	51	267	5		
	Croatia	HL								6	1	39									
		LL								11	16	10		9	1					5	5
		PS		1418	1076	1058	1410	1220	1360	1088	889	921	930	890	975	1137	827	1017	1022	815	815
		SP												4	1	2					
	EC.Cyprus	HL				4															0
		LL	10	10	10	10	10	10	10	10	21	31	61	85	91	79	11	149	110		123
		PS															94				0
	EC.España	BB	25	148	158	48		206	5	4	11	4			1	9	17	5			0
		GN																			0
		HL	296	10	4	200	93	726	206	69	76	21	67	98	48	9	9	2			0
		LL	59	51	28	40	178	368	369	871	253	418	493	644	436	583	529	484	668		745
		PS	635	807	1366	1431	1725	2896	1657	1172	1573	1504	1676	1453	1686	1886	1778	2242	2013		2244
		SP									18	8	11	11	10	10	10	20	8		9
		SU	247	126	250	146	336		76	30	55	35	38	28	11	9	9				0
		TP	470	24	16	6		1	1	1	5	1	0	1	0	0	1	0			0
		TR					13	15			9	8			12						0
		UN	90	226	343	147	396	395	274	58		4	488		11	7	1	5			0
	EC.France	GN																			0

	PS	4663	4570	7346	6965	11803	9494	8547	7701	6800	5907	6780	6119	5810	5549	6339	8328	7438		8291
	SP	50	50	30	30	40	50	44	34	22	3	14	48	22	10	2	0			0
	UN						60	580	500	300	246				300	130	309	226		252
EC.Greece	HL	124	98	348	339	766	915	784	1127	279	233	597	341	394	245	73		6		7
	LL	37	37	67	68	88	57	58	58	3	10	15	12	36	152	209	162	48		54
	PS	40	40	32	32	32	32	32	32	4	5	10	8	8	25	107	156	200		223
	UN																			0
EC.Italy	BB										0	0								0
	GN	55	203	188	209	72	109	57	150		10	13	26							0
	HL	547	128	106	161	324	351	122	186	5	0	3	1	21	0					0
	HP	7	6	5	2	2	4	10	20		5	5	2				1			0
	LL	79	102	78	135	1018	2103	2100	1620	292	515	287	260	395	475	302	310	286		319
	PS	2651	2652	3846	4162	4654	3613	7060	7068	3334	1859	2801	3256	3246	3849	3752	3961	4006		4466
	RR	50	50	50	50	100	150			4	10	0	2		0	0				0
	SP	442	352	368	410	480	491	360	350	5	415	383	401	600	500	500	500	277		309
	TP	279	263	364	199	182	241	297	154	419	308	353	427	364	145	119	69	125		140
	UN		27			50					156	0	4	2	3	13		0		0
EC.Malta	LL	81	105	80	251	572	587	399	393	407	447	376	219	240	255	264	321	263		294
	PS																25			0
	UN																			0
EC.Portugal	LL		278	320	183	428	446	274	37	54	76	61	64		2		0	11		12
EC Total	All	10937	10363	15403	15228	23362	23320	23322	21645	13950	12240	14531	13507	13444	14102	14268	17050	15686		17486
Israel	UN							14												
Japan	LL	172	85	123	793	536	813	765	185	361	381	136	152	390	316	638	265	556	466	466
Korea Rep.	LL					684	458	591	410	66								26		266
	PS															700	1145			
Libya	LL	173	164	60	67	802	865	80	448	409	450	1002	1867	331	170	393	318	140		143
	PS	129	177	300	568	470	495	598	32	230	195	16		200	512	872	730	1140		1167
	TP	26	29	65		150	180	134	72	181	100	44	74	107	71	34	42			0
	UN																			0
Maroc	GN	31	13	4	6	16	92	30	17	18	6	6	9	14	20					0
	HL					373	816	541	455	634	600	650	195	407	570	597	80	187	19	231
	LL																		107	
	PS														170	222	12	3	515	4

	SU																			0
	TP	1118	912	201	73	703	127	15	63	35	30	39	307							0
NEI (combined)	UN					773	211		101	1030	1995	109	571	508	610	709				
NEI (ETRO)	LL	341	1750	1349																
NEI (Flag related)	HL									64	42									
	LL					427	639	171	1066	761	98	17								
NEI-2	PS	19	49	49																
Panama	LL	74	287	484	467	1499	1498	2850	236											
Serbia & Montenegro	PS						2	4												
	UN											4								
Tunisie	HL	43	50	45	43	81	57	92	113	48	43	37	58	15	46	109	4	3	4	4
	PS	114	1073	975	1997	2523	1617	2147	1992	1662	2263	2134	2432	2510	740	2266	3245	2542	2191	2191
	TP	249	243	175	92	169	223	154	95	35	46	13	3	3	5	1				0
Turkey	PS	2059	2459	2817	3084	3466	4219	4616	5093	5899	1200	1070	2100	2300	3300	1075	990	806	918	918
	TP																			
	UN						1													
Yugoslavia Fed.	PS	940																		
MED Total		17207	19872	24230	24901	39810	37640	38144	33612	28342	22828	23238	24519	23424	23801	23970	26697	23154	5040	25197

* 2007 catches for some fleets (shaded) not reported to the Secretariat were estimated from the 2007 Compliance Tables.

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Table 2. Live weights (in tonnes) of farmed bluefin tuna estimated using a gain of 14.5% and 25% in weight.

Year	*Average weight gain in farms of 25%*	*Average weight gain in farms 14.5%*
2004	27,148	28,695
2005	29,974	31,599
2006	32,467	34,198
2007	29,091	31,134

Table 3. Catch-at-age for the western Atlantic stock (Areas 1 + 2).

YEAR	*AGE*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10+*
1960	485	588	652	2174	1269	1882	1132	1237	581	1167
1961	1279	1547	2130	6879	2513	2741	2360	1463	697	1278
1962	7252	14202	16316	69103	11003	1895	3781	4516	1996	2422
1963	33777	47982	47077	48206	35193	11997	5901	19685	12083	9357
1964	20855	32325	40284	26733	40776	11997	7292	43799	25329	9921
1965	70461	97740	30795	7610	18529	7196	7934	30600	16714	12139
1966	178396	74301	10351	136	116	662	1140	3648	6776	18730
1967	16018	100687	32743	9537	652	1122	795	3357	7253	8075
1968	5038	38310	16591	1004	1024	2220	297	1971	5355	3789
1969	10777	30235	28068	4637	2385	340	280	409	1596	5387
1970	61909	102549	126581	21101	3629	897	173	162	513	3656
1971	61511	150254	38184	45991	663	1646	2112	1351	1134	5980
1972	45326	97755	33545	3730	3856	118	568	574	261	5481
1973	4971	71796	29419	6964	2126	1450	951	1541	559	4535
1974	55834	19960	21028	6508	3164	681	913	914	1083	12401
1975	43341	146792	8323	11959	803	523	313	671	1650	9468
1976	5301	19357	71719	2911	2901	344	206	1168	558	14098
1977	1270	22341	9683	32004	4860	3629	957	513	1109	13568
1978	5103	10813	19800	6294	10482	4031	654	472	341	11996
1979	2745	10552	16287	14915	3447	3493	2611	598	557	12315
1980	3160	16182	11066	8879	2865	2981	5531	3453	1061	12240
1981	6046	9549	16496	5241	6019	3717	2882	3210	2763	10658
1982	3528	3729	1655	499	343	753	478	518	896	3114
1983	3600	2438	3243	891	880	918	1414	1287	957	5253
1984	868	7501	1845	2069	2068	1668	592	757	1087	4630
1985	568	5523	12308	2813	4329	4019	1024	612	696	5622
1986	563	5938	7129	3429	1115	1716	924	517	458	5226
1987	1534	13328	9162	5731	4378	2548	1725	1281	1063	3452
1988	4925	9282	12004	4123	3829	4267	2259	1438	1304	4005
1989	835	12925	1851	4243	1740	2184	2707	1840	1351	4772
1990	2400	4245	18073	2420	2567	1854	1727	2386	1543	4128
1991	3364	14542	10893	3470	1709	2293	2403	1967	1892	4136
1992	464	6015	2171	1383	1632	1207	2150	1880	1392	4583
1993	346	1134	5287	3494	2063	2050	1743	2500	1543	3084
1994	2015	691	1611	2619	2738	1743	2121	2363	1497	3030
1995	1088	1206	3685	4123	4394	2530	781	1598	1794	3523
1996	414	9473	1986	5754	2514	1720	2802	911	1360	4016
1997	219	994	6591	1320	1772	1639	2386	2276	1043	4130
1998	260	920	4013	3186	1162	1131	1921	3303	2625	4060

1999	73	589	2274	2038	1717	953	2158	2147	2699	5641
2000	98	278	1074	1854	4634	2825	1826	1760	1563	5045
2001	1398	323	2891	4424	1295	1984	2712	1089	1763	5770
2002	476	5807	4257	6259	3813	1035	3774	2953	1763	5691
2003	165	2748	5085	4013	2001	792	1731	2794	1392	3686
2004	306	3133	7084	3520	3088	2794	2063	1298	1215	2872
2005	369	5093	2863	2432	1470	891	1202	1126	1343	3695
2006	120	599	1380	2781	2228	1982	1429	1974	1453	3754
2007	65	253	8590	7335	2693	1582	806	700	614	2195

Table 4. Weights-at-age from slicing, west Atlantic.

	Weight-at-Age (kg)														
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**
1960	3.4	8.6	24.7	39.9	57.2	84.6	114.3	146.2	168.9	208.9	231.6	280.4	318.2	339.8	413.6
1961	3.4	8.6	24.8	39.8	55.1	85.2	113.5	146.3	173.7	214.9	239.1	276.8	309.3	356.3	-
1962	3.4	9.2	24.5	35.9	52.6	80.9	117.2	149.1	176.8	226.5	242.2	284.7	310.6		-
1963	3.7	10.0	19.5	38.7	58.4	78.3	116.8	138.0	162.4	209.5	231.1	282.4	309.8	343.4	-
1964	3.3	9.1	20.1	41.3	58.4	76.3	110.3	134.1	159.3	204.7	232.5	286.8	316.8	345.2	-
1965	3.4	9.0	19.1	43.4	56.7	82.0	109.6	133.8	159.5	200.8	227.6	286.2	319.9	345.0	375.4
1966	3.5	8.6	17.6	37.8	69.5	76.0	110.7	136.0	161.5	198.7	244.4	290.4	321.6	355.8	385.6
1967	5.0	10.0	20.5	38.0	53.0	75.5	108.2	138.3	160.7	194.6	236.2	283.1	307.8	356.7	389.5
1968	3.5	10.2	19.5	38.6	54.6	75.6	93.2	142.8	162.9	193.4	250.3	286.9	319.4	360.6	380.0
1969	3.9	8.5	22.0	38.0	56.2	76.9	104.6	144.7	168.3	202.3	244.7	282.9	321.3	371.3	411.9
1970	3.2	8.4	17.0	37.3	56.3	79.8	112.8	148.3	172.0	208.0	245.5	279.8	318.6	355.7	424.1
1971	3.5	8.4	21.2	32.0	60.3	82.0	108.5	135.1	169.2	208.6	248.2	283.2	322.1	355.3	411.9
1972	4.4	9.7	19.3	40.7	57.6	84.8	114.8	137.5	171.9	214.3	247.5	284.4	328.6	361.1	406.1
1973	3.7	8.9	20.9	39.9	62.4	77.5	119.5	142.7	172.9	217.6	250.5	292.5	329.6	366.2	407.4
1974	3.6	10.0	17.2	36.8	57.1	82.9	102.5	138.5	169.2	203.0	248.1	278.8	315.1	350.2	371.3
1975	3.9	8.7	23.8	34.2	58.4	78.5	114.8	141.3	164.8	198.3	238.7	273.4	313.7	347.6	401.2
1976	3.9	10.3	18.9	34.1	51.9	81.1	119.4	152.2	171.8	201.8	231.8	266.1	303.9	347.6	402.2
1977	4.4	10.3	20.8	35.3	52.4	74.8	97.8	136.5	165.3	196.2	236.2	265.8	302.9	339.7	396.2
1978	5.0	10.7	21.7	35.5	54.4	73.6	107.0	145.3	183.0	203.8	235.4	267.1	302.1	339.0	406.7
1979	5.3	11.2	21.9	39.2	50.8	78.7	105.8	141.1	179.2	205.6	234.1	268.6	304.0	345.1	406.9
1980	5.0	12.2	21.4	35.7	53.3	84.6	114.4	140.6	186.7	225.2	249.2	276.3	309.7	348.3	405.3
1981	5.6	11.0	21.5	34.7	52.3	77.6	107.2	141.1	174.2	209.1	235.1	270.6	302.9	344.6	426.8
1982	4.0	10.8	21.3	34.3	59.6	82.0	115.2	150.1	181.6	216.4	246.7	284.5	333.1	367.5	450.1
1983	3.9	10.1	20.0	37.9	59.0	84.4	116.2	148.8	184.7	222.5	256.3	288.4	335.1	375.2	434.8
1984	4.7	11.2	23.6	39.4	60.0	85.9	116.4	148.2	182.9	216.3	258.2	294.6	335.8	379.3	462.7
1985	3.7	10.2	17.3	33.3	49.0	70.9	98.4	131.3	170.2	207.6	241.5	276.0	311.9	352.5	432.4
1986	4.2	9.9	20.2	41.2	57.0	84.8	116.2	148.5	178.6	216.3	252.1	287.6	326.9	355.8	431.9
1987	4.3	9.7	22.7	40.0	58.3	76.1	109.4	137.8	168.8	210.1	251.9	293.6	329.9	364.6	436.2
1988	3.9	11.4	21.1	38.0	56.8	80.8	107.9	140.3	178.1	213.4	249.7	292.0	324.4	361.0	452.7
1989	4.0	11.0	22.1	39.4	55.3	83.3	113.6	141.6	177.5	211.6	250.3	287.9	326.5	368.7	449.9
1990	4.5	11.4	19.0	38.8	55.2	77.8	111.4	146.5	179.2	215.3	250.8	290.0	326.8	357.0	436.1
1991	5.1	13.1	20.1	41.4	61.6	85.3	115.9	151.5	181.1	212.0	252.3	290.4	326.1	367.7	425.2
1992	5.7	12.6	19.1	39.1	60.0	82.3	112.5	141.2	179.1	213.6	248.1	287.3	323.2	360.0	430.6
1993	4.5	11.2	24.9	38.4	56.8	82.0	109.7	143.0	174.0	211.2	246.8	287.8	325.8	373.1	449.0
1994	4.8	11.7	23.5	34.9	52.2	74.5	111.4	137.7	176.4	209.6	245.8	280.7	318.7	364.1	430.8
1995	4.5	13.4	22.9	39.9	62.7	85.5	111.7	147.7	175.5	211.9	246.7	288.0	330.8	373.7	441.2
1996	3.8	11.1	23.7	38.2	55.1	85.0	113.6	145.9	184.5	217.8	254.2	297.8	333.9	375.0	436.0
1997	4.8	12.3	20.6	40.9	60.1	84.3	113.0	142.7	176.9	218.7	253.4	289.0	330.5	369.8	439.0
1998	4.4	11.3	21.7	34.5	62.8	83.5	119.9	148.6	176.2	215.8	251.5	290.7	323.3	361.4	431.9
1999	4.8	11.1	23.2	40.0	60.5	87.1	115.0	145.3	179.8	212.4	249.1	286.1	321.4	364.8	430.7
2000	4.8	11.9	19.7	36.8	56.3	83.9	112.4	147.7	183.7	220.5	257.4	300.4	339.1	378.9	448.0
2001	4.7	11.8	23.3	36.0	62.0	89.2	116.4	154.2	189.0	226.1	261.2	302.2	337.3	369.1	429.6
2002	5.9	10.7	20.1	38.2	55.2	83.6	116.2	145.6	181.4	220.1	259.1	297.4	332.5	372.6	447.8
2003	4.8	11.2	22.2	37.3	60.4	81.1	118.6	145.8	177.6	221.0	259.4	300.6	333.1	359.8	415.9
2004	5.6	11.2	22.1	38.5	53.5	76.5	111.6	143.0	177.4	212.1	247.0	288.9	329.9	356.3	417.1
2005	3.8	9.6	20.5	31.9	52.5	75.6	106.0	140.2	181.1	212.4	249.5	291.0	328.9	363.4	417.3
2006	4.6	11.7	17.7	37.4	54.6	72.9	107.2	136.0	173.6	211.6	253.8	280.1	322.3	360.9	419.8
2007	4.6	11.8	23.6	32.7	55.8	78.3	113.5	144.9	183.0	219.4	258.8	294.1	343.4	373.1	442.5

Table 5. Catch-at-age for Area 3 (Japan longline only).

YEAR	*AGE*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10+*
1970	0	0	0	0	0	0	5	9	6	4
1971	0	0	1	0	1	6	19	25	40	51
1972	0	0	0	0	0	4	3	10	7	13
1973	0	0	0	0	0	0	0	0	0	63
1974	0	0	1	1	1	1	0	0	0	3
1975	0	0	0	2	1	1	1	1	4	40
1976	0	0	0	0	0	0	0	0	0	1
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	1	1	2	0	0	2	15
1979	0	0	0	0	2	6	10	9	2	0
1980	0	0	4	2	7	16	24	28	38	77
1981	0	0	0	0	1	2	11	12	10	25
1982	0	0	0	0	0	0	34	10	5	97
1983	0	0	0	0	0	1	1	1	1	2
1984	0	0	0	1	3	8	14	30	20	11
1985	0	0	0	2	23	20	14	8	23	169
1986	0	1	2	5	20	17	22	25	47	108
1987	0	0	0	1	3	14	18	15	14	43
1988	0	0	0	1	3	12	26	25	21	58
1989	0	0	2	27	47	170	277	182	157	298
1990	0	2	15	41	186	439	619	900	696	648
1991	4	85	129	433	340	961	1206	2055	1962	2397
1992	0	10	230	846	1551	706	1859	2136	2291	6106
1993	0	10	95	926	2014	1969	1125	896	1300	3807
1994	4	1	12	55	266	577	1222	888	514	1341
1995	0	8	29	202	349	884	427	567	294	956
1996	0	0	49	268	340	886	1797	1854	1204	2047
1997	0	0	2	23	68	248	426	700	351	504
1998	0	0	7	8	25	126	172	297	311	393
1999	0	16	17	155	239	251	407	349	317	293
2000	0	3	34	294	737	1265	1381	2271	1368	1804
2001	0	0	0	79	211	3578	4052	2684	684	790
2002	0	0	1	2	1	2	30	393	403	262
2003	0	3	26	103	249	357	332	345	396	608
2004	0	10	90	132	312	184	535	757	218	555
2005	0	6	145	242	271	605	1041	1563	1920	1853
2006	0	55	0	287	326	386	737	1302	755	1769
2007	0	50	19	110	642	793	705	1335	1363	1812

Table East 6. East Atlantic BFT Abundance Indices. Standardized CPUE scaled to its mean and associated CVs for the Spanish baitboat fishery in the Bay of Biscay.

Series age	**Spain TRAP 6+**	**CV**	**Morocco TRAP**	**CV**	**MO+SP TRAP 6+**	**CV**	**JPN LL 4+**	**CV**	**JPN LL 4+**	**CV**
indexing	**Whole Season**		**Whole season**		**Whole Season**		**Mid-year**		**Mid-Year**	
area	**Number**		**Number**		**Number**		**Number**		**Number**	
method	**East Atlantic**		**East Atlantic**		**East Atlantic**		**Area 5 and Med**		**Med**	
time of year	**Neg. Binom. (log) no RE**		**Neg. Binom. (log) no RE**		**Neg. Binom. (log) no RE**		**Delta-logn Lognormal RE**		**Delta-logn Lognormal RE**	
source	**SCRS/2008/ 099**		**SCRS/2008/ 098**		**Working Group**		**SCRS/2008/ 103**		**Working Group**	
1975	-	-					1.26	0.14	1.42	0.42
1976	-	-					1.42	0.12	1.26	0.36
1977	-	-					2.35	0.14	2.03	0.71
1978	-	-					1.01	0.15	0.66	0.34
1979	-	-					1.79	0.13	1.24	0.64
1980	-	-					1.14	0.16	1.18	0.44
1981	1.15	30.43			1.10	62.79	1.11	0.17	1.23	0.50
1982	1.51	17.54			1.42	36.24	2.18	0.13	2.49	0.79
1983	1.60	17.54			1.51	36.24	1.40	0.13	1.29	0.40
1984	1.77	17.53			1.67	36.23	1.07	0.12	1.10	0.30
1985	1.20	17.55			1.13	36.24	1.15	0.15	1.29	0.38
1986	0.42	15.55	1.17	66.70	0.53	29.16	0.88	0.13	0.73	0.24
1987	0.56	15.52	0.89	66.73	0.58	29.15	1.43	0.13	0.98	0.33
1988	1.29	15.48	2.23	66.65	1.37	29.13	0.89	0.13	0.71	0.22
1989	0.69	15.51	0.73	48.47	0.72	27.09	0.69	0.16	0.60	0.25
1990	1.42	15.48	0.25	33.27	0.74	23.33	0.94	0.13	0.90	0.43
1991	0.75	15.51	1.24	33.14	1.00	23.32	0.81	0.13	0.95	0.37
1992	0.69	15.51	0.20	36.34	0.44	24.34	0.69	0.14	0.54	0.19
1993	0.65	15.51	0.26	33.26	0.43	23.35	0.69	0.14	0.70	0.25
1994	0.61	15.52	0.34	36.25	0.48	24.34	0.73	0.15	0.64	0.23
1995	0.44	15.54	0.19	36.36	0.31	24.36	0.90	0.15	0.93	0.31
1996	0.68	15.51	0.42	36.20	0.56	24.33	0.31	0.23	0.33	0.17
1997	1.82	15.47	0.78	36.15	1.30	24.30	0.33	0.22	0.37	0.18
1998	1.25	15.48	1.44	36.12	1.37	24.30	0.45	0.17	0.69	0.29
1999	2.21	15.47	0.93	36.14	1.54	24.30	0.40	0.23	0.66	0.33
2000	1.00	15.49	1.29	33.14	1.21	23.32	0.46	0.21	0.92	0.40
2001	0.80	15.50	3.11	33.12	2.11	23.31	0.60	0.17	0.88	0.35
2002	1.13	15.49	1.85	33.13	1.48	23.31	1.28	0.14	1.73	0.66
2003	0.50	17.60	1.09	33.14	0.83	24.38	1.06	0.13	1.11	0.39
2004	0.50	15.53	0.45	33.20	0.47	23.34	0.50	0.19	0.59	0.25
2005	0.59	15.52	1.25	33.14	0.94	23.32	0.55	0.15	0.70	0.25
2006	0.79	15.50	0.90	33.15	0.87	23.32	1.53	0.17	1.16	0.60
2007	0.97	15.49			0.91	31.99				

Table East 6. Continued. East Atlantic BFT abundance indices. Standardized CPUE scaled to its mean and associated CVs for Spanish and Moroccan traps as well as the Japanese longline fishery.

Series age	**SP BB 1**	**CV**	**SP BB 2**	**CV**	**SP BB 3**	**CV**	**SP BB 4**	**CV**	**SP BB 5+**	**CV**
indexing	**Number**		**Number**		**Number**		**Number**		**Number**	
area	**East Atlantic**		**East Atlantic**		**East Atlantic**		**East Atlantic**		**East Atlantic**	
method	**Delta lognormal**		**Delta lognormal**		**Delta lognormal**		**Delta lognormal**		**Delta lognormal**	
time of year	**Mid-year**		**Mid-year**		**Mid-year**		**Mid-year**		**Mid-year**	
source	**SCRS/2008/100**		**SCRS/2008/100**		**SCRS/2008/100**		**SCRS/2008/100**		**SCRS/2008/100**	
1975	0.35	30.17	1.23	30.15	0.88	30.50	1.10	33.57	0.07	38.48
1976	0.02	36.52	0.84	36.06	1.14	36.00	0.58	36.87	0.46	54.81
1977	0.03	34.49	1.24	30.78	1.82	30.77	1.23	30.78	0.19	43.28
1978	0.41	31.16	0.43	31.07	0.27	32.29	1.31	37.10	1.51	47.25
1979	0.00	125.25	0.20	37.92	1.30	38.09	5.09	37.85	3.22	37.81
1980	0.22	43.15	0.40	41.80	0.49	41.79	0.93	43.32	3.99	49.92
1981	0.90	36.74	0.55	36.70	0.10	36.71	0.08	51.91	0.09	76.07
1982	0.20	34.20	0.74	33.88	0.77	34.39	0.65	35.40	0.64	53.52
1983	1.67	31.54	0.68	31.53	0.26	34.20	0.11	44.45	0.03	102.42
1984	0.05	34.96	2.79	34.82	2.28	34.81	1.11	34.86	0.00	42.35
1985	0.17	33.13	2.20	31.14	2.00	30.92	0.09	42.26	0.05	70.88
1986	0.55	32.61	0.50	32.35	0.44	32.33	0.53	35.14	0.40	50.29
1987	0.29	31.46	2.41	31.25	0.20	36.73	0.37	42.09	0.57	49.16
1988	6.89	34.40	0.30	32.27	0.13	37.80	0.08	42.39	0.27	63.18
1989	3.45	30.01	2.80	29.48	0.15	31.76	0.05	50.39	0.07	63.01
1990	0.94	33.50	0.62	31.78	0.74	33.17	0.37	35.20	0.24	54.49
1991	0.98	32.68	0.98	31.77	0.43	32.48	0.39	45.09	0.10	49.62
1992	0.28	36.88	1.46	32.93	0.22	33.36	0.18	61.31	0.09	65.55
1993	0.14	36.53	2.48	33.93	3.36	33.83	3.58	36.08	0.85	45.44
1994	0.06	36.47	0.20	29.69	0.81	29.64	0.65	29.87	0.03	36.41
1995	1.52	29.45	1.12	28.86	1.14	29.17	0.10	33.35	0.03	68.62
1996	4.76	31.76	0.96	31.04	2.34	32.65	3.42	37.23	1.38	41.49
1997	2.13	32.11	0.73	30.38	3.56	29.79	0.96	30.06	0.53	38.89
1998	1.24	50.56	0.37	31.55	0.91	31.64	3.50	33.81	0.67	38.01
1999	0.16	70.30	0.02	46.98	0.24	38.14	1.79	40.55	9.68	41.85
2000	1.01	37.10	0.26	33.29	0.63	41.61	1.26	41.45	2.49	45.65
2001	0.09	38.80	1.93	37.79	1.16	40.44	0.61	46.17	0.50	57.48
2002	0.01	34.85	2.07	33.42	2.78	35.25	0.21	46.09	0.12	64.25
2003	0.03	81.05	0.48	49.42	0.23	53.58	0.57	45.88	0.87	59.88
2004	1.30	47.72	0.50	33.25	0.19	43.95	0.25	39.63	1.07	42.09
2005	2.03	31.57	0.77	30.57	1.16	34.77	0.22	38.87	0.63	47.59
2006	0.14	40.63	0.60	38.23	0.22	37.49	0.15	41.53	0.55	47.31
2007	-		0.13	38.11	0.66	36.65	1.49	36.75	1.57	39.24

Table 7. Description of available indices of abundance for the 2008 western bluefin tuna assessment. Note that the use of the models for the various VPA runs (continuity, base, extended boundary) is summarized in **Table 8**.

	CAN GLS	CAN SWNS	US RR<145
Age Min	**13+**	**7**	**1**
Age Max	**13+**	**10**	**5**
Catch Unit	**Numbers**	**Numbers**	**Numbers**
Effort Unit	**Hour**	**Hour**	**Offset = log(Hours Fished)**
Method	**Delta-Lognormal**	**Delta-Lognormal**	**Delta-Poisson**
Months Covered	**Aug 1 - Oct 31**	**Aug 1 - Oct 31**	**June-Sept**
Area Covered	**Canada - Gulf of St. Lawrence**	**Canada - SW Nova Scotia**	**NE UNITED STATES**

	CAN GLS		CAN SWNS		US RR<145	
YEAR	INDEX	CV	INDEX	CV	INDEX	CV
1970	-	-	-	-	-	-
1971	-	-	-	-	-	-
1972	-	-	-	-	-	-
1973	-	-	-	-	-	-
1974	-	-	-	-	-	-
1975	-	-	-	-	-	-
1976	-	-	-	-	-	-
1977	-	-	-	-	-	-
1978	-	-	-	-	-	-
1979	-	-	-	-	-	-
1980	-	-	-	-	0.799	0.430
1981	1.834	0.423	-	-	0.399	0.520
1982	1.741	0.437	-	-	2.102	0.330
1983	2.660	0.410	-	-	1.114	0.260
1984	1.501	0.424	-	-	0.000	0.000
1985	0.567	0.511	-	-	0.630	0.640
1986	0.727	0.544	-	-	0.778	0.430
1987	0.425	0.772	-	-	1.219	0.400
1988	0.803	0.589	2.100	0.500	0.988	0.380
1989	0.806	0.629	3.470	0.430	0.988	0.430
1990	0.458	0.583	2.170	0.430	0.904	0.340
1991	0.804	0.620	1.280	0.520	1.261	0.350
1992	0.872	0.543	1.300	0.390	0.820	0.420
1993	0.970	0.407	0.350	0.540	-	-
1994	0.332	0.487	1.220	0.390	-	-
1995	1.176	0.359	0.850	0.380	-	-
1996	0.402	0.378	0.360	0.490	-	-
1997	0.398	0.386	0.250	0.550	-	-
1998	0.753	0.371	0.370	0.480	-	-
1999	1.078	0.366	0.910	0.480	-	-
2000	0.914	0.370	0.170	0.610	-	-
2001	1.016	0.386	0.620	0.420	-	-
2002	0.911	0.423	0.410	0.600	-	-
2003	1.277	0.406	1.110	0.390	-	-
2004	2.271	0.416	0.490	0.490	-	-
2005	2.023	0.378	0.590	0.510	-	-
2006	2.034	0.378	1.020	0.380	-	-
2007	2.934	0.362	0.980	0.380	-	-

Table 7. Continued.

US RR66-114	US RR115-144	US RR145-177	US RR>195
2	4	6	8
3	5	7	10
Numbers	Numbers	Numbers	Numbers
Offset = log(Hours Fished)	Offset = log(Hours Fished)	Offset = log(Hours Fished)	Offset = log(Hours Fished)
Delta-Poisson	Delta-Poisson	Delta-Poisson	Delta-Poisson
June-Sept	June-Sept	June-Sept	June-Sept
NE UNITED STATES	NE UNITED STATES	NE UNITED STATES	NE UNITED STATES

US RR66-114		US RR115-144		US RR145-177		US RR>195	
INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	2.805	0.100
-	-	-	-	-	-	1.246	0.188
-	-	-	-	-	-	0.857	0.300
-	-	-	-	-	-	0.503	1.097
-	-	-	-	-	-	0.529	0.476
-	-	-	-	-	-	0.941	0.364
-	-	-	-	-	-	0.763	0.364
-	-	-	-	-	-	0.626	0.335
-	-	-	-	-	-	0.820	0.284
-	-	-	-	-	-	0.910	0.276
1.157	0.331	1.800	0.563	0.311	3.743	-	-
0.220	1.157	0.418	1.131	0.378	3.118	-	-
0.757	0.351	0.353	0.897	1.334	1.779	-	-
1.554	0.263	0.627	0.686	0.697	2.717	-	-
2.348	0.219	0.231	1.297	0.461	3.046	-	-
1.394	0.261	0.878	0.499	0.362	3.455	-	-
0.994	0.390	0.788	0.658	1.071	2.060	-	-
0.886	0.611	1.824	0.677	0.961	2.064	-	-
0.388	0.524	1.688	0.470	3.424	2.573	-	-
0.870	0.372	2.440	0.498	-	-	-	-
0.399	0.385	0.452	0.546	-	-	-	-
1.572	0.231	0.497	0.628	-	-	-	-
1.400	0.240	0.568	0.598	-	-	-	-
0.529	0.445	1.141	0.449	-	-	-	-
0.532	0.320	1.295	0.388	-	-	-	-

Table 7. Continued.

US RR>195 COMB	US RR>177	JLL AREA 2 (WEST)	JLL AREA 3 (31+32)
8	7	2	5
10	10	9	10
Numbers	Numbers	Numbers	Numbers
Offset = log(Hours Fished)	Offset = log(Hours Fished)		
Delta-Poisson	Delta-Poisson	Delta-lognormal	Delta-lognormal
June-Sept	June-Sept	Nov-Feb	Nov-Feb
NE UNITED STATES	NE UNITED STATES		

US RR>195 COMB		US RR>177		JLL AREA 2 (WEST)		JLL AREA 3 (31+32)	
INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	0.696	0.437	-	-
-	-	-	-	2.263	0.255	-	-
-	-	-	-	1.091	0.316	-	-
-	-	-	-	0.842	0.305	-	-
-	-	-	-	1.346	0.275	-	-
-	-	-	-	1.920	0.208	-	-
-	-	-	-	0.600	0.299	-	-
2.544	0.248	-	-	0.286	0.365	-	-
0.961	0.426	-	-	0.932	0.264	-	-
0.736	0.559	-	-	1.180	0.260	-	-
0.433	1.300	-	-	0.128	0.476	-	-
0.617	0.590	-	-	0.535	0.305	-	-
0.796	0.596	-	-	0.981	0.276	-	-
0.583	0.599	-	-	0.833	0.258	-	-
0.482	0.638	-	-	0.609	0.291	0.343	0.854
0.612	0.573	-	-	0.783	0.280	0.249	0.586
0.741	0.495	-	-	1.140	0.245	0.448	0.424
0.525	0.786	0.829	0.799	1.051	0.280	0.875	0.265
0.659	0.669	0.916	0.735	1.367	0.252	0.596	0.289
1.104	0.437	1.313	0.553	0.769	0.308	0.788	0.260
1.543	0.461	2.275	0.484	1.940	0.210	0.673	0.355
1.405	0.572	0.987	1.002	1.244	0.261	2.601	0.188
1.347	0.424	1.333	0.617	0.762	0.265	1.547	0.207
1.458	0.464	1.466	0.650	0.635	0.323	0.632	0.323
0.888	0.553	0.690	0.866	0.718	0.277	0.935	0.259
1.564	0.526	1.469	0.661	0.471	0.383	1.353	0.176
-	-	1.898	0.482	0.654	0.291	1.214	0.206
-	-	0.400	1.441	0.545	0.373	1.025	0.207
-	-	0.469	1.222	0.989	0.320	0.765	0.349
-	-	0.399	1.407	1.159	0.196	1.064	0.182
-	-	0.316	2.208	1.509	0.216	1.153	0.209
-	-	0.241	2.558	-	-	-	-

Table 7. Continued.

JLL AREA 17+18	JLL GOM	LARVAL ZERO INFLATED	US PLL GOM 1 - 6	US PLL GOM 1 - 6 Split
	10+	8	10+	10+
	10+	10	10+	10+
Numbers	Numbers	Index of Spawning Biomass	Numbers	Numbers
		CPUE = Larvae/100m^2	1000 Hooks	1000 Hooks
Delta-lognormal	Delta-lognormal	Delta-lognormal Zero inflated	Delta-lognormal	Delta-Lgn with Repeated Measures
Jan-Feb	Nov-Feb	Apr 20 - May 31	Jan 1 - May 31	Jan 1 - May 31
		Gulf of Mexico	Gulf of Mexico and US Florida East Coast	Gulf of Mexico and US Florida East Coast

JLL AREA 17+18		JLL GOM		LARVAL ZERO INFLATED		US PLL GOM 1 - 6		US PLL GOM 1 - 6 Split	
INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	0.968	0.266	-	-	-	-	-	-
-	-	0.534	0.205	-	-	-	-	-	-
2.123	0.593	0.666	0.207	-	-	-	-	-	-
1.989	0.382	0.913	0.216	2.504	0.476	-	-	-	-
1.307	0.411	0.876	0.225	4.869	0.234	-	-	-	-
1.115	0.371	1.287	0.283	-	-	-	-	-	-
1.446	0.337	1.158	0.265	-	-	-	-	-	-
1.743	0.309	0.553	0.239	0.735	0.433	-	-	-	-
1.000	0.392	-	-	1.356	0.292	-	-	-	-
0.547	0.438	-	-	1.202	0.354	-	-	-	-
1.201	0.338	-	-	0.367	0.556	-	-	-	-
0.705	0.412	-	-	-	-	-	-	-	-
0.714	0.491	-	-	0.404	0.434	-	-	-	-
0.636	0.411	-	-	0.346	0.476	2.840	0.280	2.510	0.340
1.032	0.360	-	-	1.084	0.317	1.500	0.320	1.210	0.400
1.202	0.343	-	-	0.765	0.368	2.480	0.290	2.040	0.350
1.524	0.345	-	-	0.332	0.337	1.660	0.320	1.290	0.400
1.228	0.386	-	-	0.388	0.590	2.200	0.310	1.880	0.370
2.039	0.333	-	-	0.527	0.360	0.910	0.340	0.770	0.430
0.989	0.372	-	-	0.498	0.670	0.560	0.410	0.490	0.520
2.338	0.337	-	-	0.487	0.352	0.430	0.450	0.380	0.590
1.308	0.368	-	-	0.348	0.558	0.330	0.500	0.290	0.660
1.583	0.394	-	-	0.966	0.516	0.260	0.530	0.240	0.700
0.466	0.517	-	-	0.408	0.412	0.550	0.400	0.510	0.510
1.112	0.374	-	-	0.117	0.553	0.400	0.480	0.380	0.610
0.458	0.701	-	-	0.512	0.531	0.780	0.350	1.090	0.270
0.662	0.393	-	-	0.344	0.545	0.800	0.370	1.040	0.270
0.916	0.859	-	-	0.387	0.383	0.580	0.410	0.840	0.290
0.750	0.526	-	-	0.304	0.660	0.590	0.420	0.870	0.290
0.103	2.541	-	-	0.737	0.410	0.740	0.370	1.150	0.250
0.651	0.686	-	-	0.541	0.681	1.090	0.330	1.220	0.240
1.376	0.326	-	-	0.230	0.327	0.720	0.380	1.000	0.250
1.609	0.390	-	-	0.605	0.358	0.540	0.450	0.710	0.300
-	-	-	-	0.355	0.405	1.060	0.360	1.090	0.240

Table 7. Continued.

	TAGGING	JLL Florida Historic	JLL Brazil Historic
Age Min	**1**	**2**	**2**
Age Max	**3**	**10**	**10**
Catch Unit	**Numbers**	**Numbers**	**Numbers**
Effort Unit	**-**	**-**	**-**
Method	**-**	**Delta lognormal**	**Delta lognormal**
Months Covered	**Mid-year**	**Nov-Feb**	**Nov-Feb**
Area Covered	**Gulf of Maine**	**Florida Eastern US**	**Brazil**

	TAGGING		JLL Florida Historic		JLL Brazil Historic	
YEAR	INDEX	CV	INDEX	CV	INDEX	CV
1960	-	-	-	-	0.580	0.314
1961	-	-	-	-	0.700	0.239
1962	-	-	-	-	2.406	0.140
1963	-	-	-	-	4.566	0.075
1964	-	-	6.084	0.094	2.119	0.083
1965	-	-	9.762	0.125	0.244	0.150
1966	-	-	7.375	0.141	0.111	0.356
1967	-	-	1.954	0.462	0.064	0.581
1968	-	-	2.481	0.584	0.108	0.511
1969	-	-	0.825	1.045	0.023	2.208
1970	1065132	0.200	0.050	4.670	0.014	2.082
1971	1001624	0.200	1.264	0.463	-	-
1972	431955	0.200	-	-	-	-
1973	183616	0.200	-	-	-	-
1974	341589	0.200	-	-	-	-
1975	554596	0.200	-	-	-	-
1976	253265	0.200	-	-	-	-
1977	257385	0.200	-	-	-	-
1978	121110	0.200	-	-	-	-
1979	98815	0.200	-	-	-	-
1980	192541	0.200	-	-	-	-
1981	337995	0.242	-	-	-	-
1982	-	-	-	-	-	-
1983	-	-	-	-	-	-
1984	-	-	-	-	-	-
1985	-	-	-	-	-	-
1986	-	-	-	-	-	-
1987	-	-	-	-	-	-
1988	-	-	-	-	-	-
1989	-	-	-	-	-	-
1990	-	-	-	-	-	-

Table 8. Model parameters used in western Atlantic VPA models.

Terminal F:

Continuity Case:

Age	Lower Bound	Best Est. (Numbers)	Upper Bound	Est. Method	SD
1	0	0.318 * F @ Age2	3	Fixed	NA
2	0.01	44560	5000000	Est. Frequentist	NA
3	0	1.0 * F @ Age2	3	Fixed	NA
4	0.01	21027	1000000	Est. Frequentist	NA
5	0	1.0 * F @ Age4	3	Fixed	NA
6	0.01	19833	1000000	Est. Frequentist	NA
7	0	1.0 * F @ Age6	3	Fixed	NA
8	0.01	10637	100000	Est. Frequentist	NA
9	0	1.0 * F @ Age8	3	Fixed	NA

All other runs:

Age	Lower Bound	Best Est. (Numbers)	Upper Bound	Est. Method	SD
1	0	9869	5000000	Est. Frequentist	NA
2	0	31233	5000000	Est. Frequentist	NA
3	0	70437	5000000	Est. Frequentist	NA
4	0	17391	5000000	Est. Frequentist	NA
5	0	14446	1000000	Est. Frequentist	NA
6	0	27115	1000000	Est. Frequentist	NA
7	0	22619	1000000	Est. Frequentist	NA
8	0	6716	100000	Est. Frequentist	NA
9	0	23940	100000	Est. Frequentist	NA

F-Ratio:

Continuity, Base and Sensitivity Cases 2, 3, 5, 7 and 9.:

YEAR	Best Estimate Ratio F_{10+}/F_9	Estimation Method	SD
1970-1973	1	Fixed	0
1974-1981	0.509	Estimated as Frequentist Parameter	NA
1982-2007	1.14	Estimated as random deviation from Prior	0.25

Case 4:

YEAR	Best Estimate Ratio F_{10+}/F_9	Estimation Method	SD
1960-1969	1	Fixed	NA
1970-1981	1	Estimated as random deviation from Prior	0.25
1982-2007	1.14	Estimated as random deviation from Prior	0.25

Case 6:

YEAR	Best Estimate Ratio F_{10+}/F_9	Estimation Method	SD
1970-1973	1	Fixed	NA
1974-1981	0.509	Estimated as Frequentist Parameter	NA
1982-1989	1.14	Estimated as random deviation from Prior	0.25
1990-2007	1.14	Estimated using a random walk from a parameter estimate obtained using a deviation from a prior	0.25

Case 9:

YEAR	Best Estimate Ratio F_{10+}/F_9	Estimation Method	SD
1970-1973	1	Fixed	NA
1974-1981	0.509	Estimated as Frequentist Parameter	NA
1982-2001	1.14	Estimated as random deviation from Prior	0.25
2002-2007	1.14	Estimated as Frequentist Parameter	NA

Table 9. Key to indices used for the WBFT continuity run, base-case, and sensitivity runs (Cases 2-9).

Index/Run	*Cont*	*Base*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
CAN GSL ADJ	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
CAN SWNS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
US RR<145	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
US RR66-114	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
US RR115-144	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
US RR145-177										
US RR>195	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
US RR>195 COMB										
US RR>177	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
JLL AREA 2 (WEST)	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
JLL AREA 3 (31+32)				Yes						
JLL AREAS 17+18			Yes							
LARVAL ZERO INFLATED	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GOMPLL 1-6	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
GOMPLL 1-6 Early						Yes				
GOMPLL 1-6 Late						Yes				
JLL GOM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TAGGING	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
JLL Florida Historic					Yes					
JLL Brazil Historic					Yes					

Table 10. Estimates of average total mortality for spawning BFT in the eastern Atlantic and Mediterranean from year-class curve analyses based on Japanese longline cpue data. Fishing mortality values are obtained assuming M=0.1 for those ages.

Age range 8-14 *Fishing years*	*Cohorts*	*Z*	*F*	*p-values*	*Age range 9-14* *Fishing years*	*Cohorts*	*Z*	*F*	*p-values*
1984-1989	1975	0.2632	0.1632	0.0311	1984-1989	1975	0.330	0.230	0.043
1985-1990	1976	0.2710	0.1710	0.0329	1985-1990	1976	0.291	0.191	0.089
1986-1991	1977	0.2822	0.1822	0.0635	1986-1991	1977	0.391	0.291	0.052
1987-1992	1978	0.1937	0.0937	0.0827	1987-1992	1978	0.328	0.228	0.007
1988-1993	1979	0.2764	0.1764	0.0016	1988-1993	1979	0.281	0.181	0.011
1989-1994	1980	0.2600	0.1600	0.0122	1989-1994	1980	0.307	0.207	0.025
1990-1995	1981	0.2598	0.1598	0.0110	1990-1995	1981	0.349	0.249	0.004
1991-1996	1982	0.3613	0.2613	0.0095	1991-1996	1982	0.409	0.309	0.026
1992-1997	1983	0.4010	0.3010	0.0093	1992-1997	1983	0.500	0.400	0.011
1993-1998	1984	0.3028	0.2028	0.0184	1993-1998	1984	0.354	0.254	0.039
1994-1999	1985	0.4034	0.3034	0.0208	1994-1999	1985	0.574	0.474	0.005
1995-2000	1986	0.3999	0.2999	0.0050	1995-2000	1986	0.427	0.327	0.021
1996-2001	1987	0.3371	0.2371	0.0083	1996-2001	1987	0.370	0.270	0.028
1997-2002	1988	0.3264	0.2264	0.0551	1997-2002	1988	0.458	0.358	0.038
1998-2003	1989	0.2939	0.1939	0.0502	1998-2003	1989	0.353	0.253	0.085
1999-2004	1990	0.2977	0.1977	0.0650	1999-2004	1990	0.385	0.285	0.079
2000-2005	1991	0.5291	0.4291	0.0284	2000-2005	1991	0.672	0.572	0.036
2001-2006	1992	0.3302	0.2302	0.0375	2001-2006	1992	0.454	0.354	0.026

Table 11. Eastern Atlantic and Mediterranean recent stock status indicators across the catch at age matricies used in the analysis.

	Adjusted CAA	*Unadjusted CAA*
$F/F_{0.1}$	7.05	6.78
$F/F_{30\%SPR}$	4.41	4.04
F/F_{MAX}	3.34	3.08
$F/F_{20\%SPR}$	2.66	2.36
$SSB/SSB_{0.1}$	0.11	0.12
$SSB/SSB_{30\%}$	0.15	0.17
SSB/SSB_{MAX}	0.18	0.20
$SSB/SSB_{20\%}$	0.22	0.25

Table 12. Summary statistics and diagnostic output for VPA runs. Only models with the same inputs are directly comparable (Cont, Base, Cases 6 and 8). AIC, AICc and BIC criteria cannot be computed accurately when the number of parameters exceeds the number of data point (Case 7).

	CONT	*BASE **	*CASE 2*	*CASE 3*	*CASE 4*	*CASE 5*	*CASE 6 **	*CASE 7*	*CASE 8 **	*CASE 9*
Total objective function	-6.9	7.5	10.5	-6.1	69.6	5.2	-36.0	390.98	6.1	9.3
(with constants)	292.1	306.5	283.1	305.3	376.4	305.1	263.0	-91.98	305.2	288.5
Number of parameters	19	24	21	25	26	25	42	320	25	23
Number of data points	214	214	172	231	233	214	214	214	214	187
AIC :	622.3	660.9	608.1	660.5	804.9	660.2	610.0	NA	660.3	623.1
AICc:	626.2	667.3	614.3	666.9	811.7	667.1	631.1	NA	667.2	629.9
BIC :	686.2	741.7	674.2	746.6	894.6	744.3	751.3	NA	744.4	697.4
Chi-square discrepancy	190.8	191.0	148.3	202.6	270.7	185.6	180.5	232.79	185.6	159.4
Loglikelihoods	5.6	5.8	2.4	11.1	-51.6	7.9	8.7	407.7	6.8	4.9
effort data	5.6	5.8	2.4	11.1	-51.6	7.9	8.7	-7.3	6.8	4.9
Log-posteriors	1.3	1.4	1.4	1.3	-4.3	1.4	40.6	-0.6	0.9	1.4
catchability	0.0	0.0	0.0	0.0	0.0	0.0	0.0	415.0	0.0	0.0
f-ratio	1.3	1.4	1.4	1.3	-4.3	1.4	40.6	-0.6	0.9	1.4
Constraints	0.0	-14.6	-14.3	-6.2	-13.7	-14.5	-13.3	-16.1	-13.9	-15.5
terminal F	0.0	-14.6	-14.3	-6.2	-13.7	-14.5	-13.3	-16.1	-13.9	-15.5
Comments		*					*	**	*	

* Only models with the same inputs and constraints are directly comparable (Base, Cases 6 and 8).
** For Case 7, the number of model parameters is higher than the number of data points because the catchability coefficients are estimated as a random walk (the variance was very low, so the effective number of parameters is less than the number of data points, nevertheless the AIC criteria would not apply).

Table 13. Sensitivity of the Base Case assessment for western bluefin tuna to the exclusion of various indices of abundance. The table shows the values of various estimates when one index is removed from the analysis.

Index Out	SSB_{1970}	SSB_{2007}	*S07/S70*	F_{max}	F_{2007}	$F_{2007}/Fmax$
None(base)	49642	8733	0.18	0.19	0.17	0.89
CanGSL	68774	7117	0.10	0.19	0.19	1.01
CanSWNS	50991	9459	0.19	0.19	0.16	0.85
JLLArea2	42860	8197	0.19	0.19	0.19	0.97
JLLGoM	86672	8600	0.10	0.20	0.18	0.91
Larval	28221	9864	0.35	0.19	0.16	0.83
Tagging	47963	8648	0.18	0.20	0.18	0.90
USLLGoM	54505	9865	0.18	0.19	0.15	0.82
USRR<145	48293	8700	0.18	0.20	0.18	0.90
USRR>177	41620	9412	0.23	0.22	0.19	0.86
USRR>195	47900	8579	0.18	0.20	0.18	0.91
USRR115-144	49685	8292	0.17	0.19	0.18	0.94
USRR66-114	46478	8517	0.18	0.20	0.18	0.91

Table 14. Estimated percent overlap rates for the five scenarios. The East and West overlap rates refer to the percentage of the eastern-origin population that moves west and the percentage of the western-origin population that moves east, respectively.

Model	*Stock*	*Age 1-3*	*Age 4-7*	*Age 8-10+*
Tag-full	East	0.31	3.54	1.73
Tag-reduced	East	0	2.90	2.10
Tag-reduced-Fratio	East	0	2.69	2.04
Proportion	East	3.4	5.5	0.04
Proportion-F-ratio	East	2.42	5.5	0.01
Tag-full	West	4.33	37.78	23.20
Tag-reduced	West	10.5	57.89	32.20
Tag-reduced-Fratio	West	10.55	56.20	30.10
Proportion	West	<0.01	<0.01	<0.01
Proportion-F-ratio	West	<0.01	<0.01	20.50

Table 15. Estimates of the total number of vessels fishing bluefin tuna in the Mediterranean Sea during 2007 (*i.e.* active capacity), probable catch (yield) estimated from catch per vessel per year (catch rates or CPU). Calculations are based on ICCAT vessels list and/or information from national scientists and are expressed in t/year.

Mediterranean 2007			*Active fleet*
Vessel category	*Nb Vessels*	*Catch rates*	*Estimated yields*
PS large (>= 40 m)	83	150 - 300	17550
PS medium (> 24 m & < 40 m)	205	75 - 150	22050
PS small (<= 24 m)	63	20 - 40	2040
LL large (>= 40 m)	43	50	2150
LL medium (> 24 m & < 40 m)	9	20	180
LL small (<= 24 m)	221	10	2210
Handline	127	3	381
Trawler	25	2	50
Trap	10	40	400
Other artisanal	220	4	880
Total Mediterranean	1006		47891
Mediterranean PS			41640
Mediterranean LL			4540
Mediterranean OTH			1711

Table 16. Estimates of the total number of vessels fishing bluefin tuna in the eastern Atlantic during 2007(*i.e.* active capacity), probable catch (yield) estimated from catch per vessel per year (catch rates or CPU). Calculations are based on ICCAT vessels list and/or information from national scientists and are expressed in t/year.

East Atlantic 2007			*Active fleet*
Vessel category	*Nb Vessels*	*Catch_rates*	*Estimated yields*
PS medium (> 24 m & < 40 m)	30	50	1500
PS small (<= 24 m)	4	25	100
LL large (>= 40 m)	55	50	2750
LL medium (> 24 m & < 40 m)	29	20	580
LL small (<= 24 m)	13	10	130
Baitboat > 24 m	39	40	1560
Baitboat <= 24 m	42	15	630
Handline	12	5	60
Trawler	98	15	1470
Trap	18	245	4410
Other artisanal	20	3	60
Total East-Atlantic	330		13250
East-Atlantic PS			1600
East-Atlantic LL			3460
East-Atlantic OTH			8190

Table 17. Estimates of bluefin tuna vessels that are currently fishing BFT or could target BFT in the Mediterranean Sea during 2007 (*i.e.* potential capacity), potential catch (yield) estimated from catch per vessel per year (catch rates or CPU). Calculations are based on ICCAT vessels list and/or information from national scientists and are expressed in t/year.

Mediterranean 2007	*Potential fleet*		*Potential catch*
Vessel category	*Nb Vessels*	*Catch rates*	*Estimated yields*
PS large (>= 40 m)	83	150 - 300	17550
PS medium (> 24 m & < 40 m)	205	75 - 150	22050
PS small (<= 24 m)	71	20 - 40	2360
LL large (>= 40 m)	56	50	2800
LL medium (> 24 m & < 40 m)	17	20	340
LL small (<= 24 m)	731	10	7310
Handline	312	3	936
Trawler	25	2	50
Trap	10	40	400
Other artisanal	562	4	2248
Total Mediterranean	2072		56044
Mediterranean PS			41960
Mediterranean LL			10450
Mediterranean OTH			3634

Table 18. Estimations of bluefin tuna vessels that are currently fishing BFT or could target BFT in the east Atlantic during 2007 (i.e. potential capacity), potential catch (yield) estimated from catch per vessel per year (catch rates or CPU). Calculations are based on ICCAT vessels list and/or information from national scientists and are expressed in t/year.

East Atlantic 2007	*Potential fleet*		*Potential catch*
Vessel category	*Nb Vessels*	*Catch_rates*	*estimated yields*
PS medium (> 24 m & < 40 m)	30	50	1500
PS small (<= 24 m)	4	25	100
LL large (>= 40 m)	55	50	2750
LL medium (> 24 m & < 40 m)	29	20	580
LL small (<= 24 m)	288	10	2880
Baitboat > 24 m	63	40	2520
Baitboat <= 24 m	42	15	630
Handline	12	5	60
Trawler	98	15	1470
Trap	18	245	4410
Other artisanal	20	3	60
Total East-Atlantic	629		16960
East-Atlantic PS			1600
East-Atlantic LL			6210
East-Atlantic OTH			9150

Table 19. Summary table of the different projection scenarios that have performed using FLR framework.

Scenario	*VPA*	*Steepness*	*Mean Recruitment*	*Selectivity*
1	Reported	0.5	medium	Rec. [06-05]
2	adjusted	0.5	medium	Rec. [06-05]
3	Reported	0.75	medium	Rec. [06-05]
4	adjusted	0.75	medium	Rec. [06-05]
5	Reported	0.99	medium	Rec. [06-05]
6	adjusted	0.99	medium	Rec. [06-05]
7	Reported	0.5	high	Rec. [06-05]
8	adjusted	0.5	high	Rec. [06-05]
9	Reported	0.75	high	Rec. [06-05]
10	adjusted	0.75	high	Rec. [06-05]
11	Reported	0.99	high	Rec. [06-05]
12	adjusted	0.99	high	Rec. [06-05]
13	Reported	0.5	medium	Rec. [06-05] 20%
14	adjusted	0.5	medium	Rec. [06-05] 20%
15	Reported	0.75	medium	Rec. [06-05] 20%
16	adjusted	0.75	medium	Rec. [06-05] 20%
17	Reported	0.99	medium	Rec. [06-05] 20%
18	adjusted	0.99	medium	Rec. [06-05]20%
19	Reported	0.5	high	Rec. [06-05] 20%
20	adjusted	0.5	high	Rec. [06-05]20%
21	Reported	0.75	high	Rec. [06-05] 20%
22	adjusted	0.75	high	Rec. [06-05] 20%
23	Reported	0.99	high	Rec. [06-05] 20%

24	adjusted	0.99	high	Rec. [06-05] 20%
25	Reported	0.5	medium	Rec. [06-05]& F0.1
26	adjusted	0.5	medium	Rec. [06-05]& F0.1
27	Reported	0.75	medium	Rec. [06-05] & F0.1
28	adjusted	0.75	medium	Rec. [06-05] & F0.1
29	Reported	0.99	medium	Rec. [06-05] & F0.1
30	adjusted	0.99	medium	Rec. [06-05] & F0.1
31	Reported	0.5	high	Rec. [06-05] & F0.1
32	adjusted	0.5	high	Rec. [06-05]& F0.1
33	Reported	0.75	high	Rec. [06-05] & F0.1
34	adjusted	0.75	high	Rec. [06-05] & F0.1
35	Reported	0.99	high	Rec. [06-05] & F0.1
36	adjusted	0.99	high	Rec. [06-05] & F0.1
37	Reported	0.5	medium	Rec. [06-05] & Fmax
38	adjusted	0.5	medium	Rec. [06-05] & Fmax
39	Reported	0.75	medium	Rec. [06-05] & Fmax
40	adjusted	0.75	medium	Rec. [06-05] & Fmax
41	Reported	0.99	medium	Rec. [06-05] & Fmax
42	adjusted	0.99	medium	Rec. [06-05] & Fmax
43	Reported	0.5	high	Rec. [06-05] & Fmax
44	adjusted	0.5	high	Rec. [06-05] & Fmax
45	Reported	0.75	high	Rec. [06-05] & Fmax
46	adjusted	0.75	high	Rec. [06-05] & Fmax
47	Reported	0.99	high	Rec. [06-05] & Fmax
48	adjusted	0.99	high	Rec. [06-05] & Fmax

Table 20. F-multiplers being applied to current F-selectivity vector according to Rec. [06-05] to either perfect implementation and a 20% implementation error.

	Full implementation	20% error implementation
Age 1	0	0.200
Age 2	0.315	0.468
Age 3	0.199	0.325
Age 4	0.320	0.436
Age 5	0.944	0.994
Age 6	0.973	0.997
Age 7	0.989	0.999
Age 8	0.899	0.997
Age 9	0.963	0.996
Age 10	0.912	0.998

Table 21. Table of benchmarks and reference points for the base VPA model under the low and high recruitment scenarios.

	BASE - 2 Line (low recruitment scenario)			BASE - B&H (high recruitment scenario)		
MEASURE	LOWER CI	MEDIAN	UPPER CI	LOWER CI	MEDIAN	UPPER CI
F at MSY	0.13	0.15	0.17	0.07	0.09	0.10
MSY	2680.3	2851.9	3031.9	4886.5	6201.1	9142.2
Y/R at MSY	39.6	41.3	43.2	36.5	38.7	40.9
S/R at MSY	215.3	220.2	223.9	354.2	377.7	408.6
SPR AT MSY	0.20	0.20	0.21	0.33	0.35	0.38
SSB AT MSY	14549	15148	15783	44626	59921	100045
F at max. Y/R	0.13	0.15	0.17	0.13	0.15	0.17
Y/R maximum	39.6	41.3	43.2	39.6	41.3	43.1
S/R at Fmax	215.3	220.2	223.9	215.5	220.3	224.2
SPR at Fmax	0.20	0.20	0.21	0.20	0.20	0.21
SSB at Fmax	14549	15148	15783	22914	27669	38546
F 0.1	0.08	0.08	0.09	0.08	0.08	0.09
Y/R at F0.1	37.0	38.4	39.9	37.0	38.4	39.9
S/R at F0.1	383.1	389.9	396.6	383.4	389.9	396.4
SPR at F0.1	0.36	0.36	0.37	0.36	0.36	0.37
SSB at F0.1	25699	26854	28062	49507	62527	93849
F 20% SPR	0.14	0.15	0.17	0.14	0.15	0.17
Y/R at F20	39.6	41.3	43.2	39.6	41.3	43.1
S/R at F20	216.6	217.3	218.0	216.6	217.3	218.0
SSB at F20	14328	14955	15677	22621	27276	37657
F 30% SPR	0.09	0.10	0.12	0.09	0.10	0.12
Y/R at F30	38.4	40.1	41.8	38.4	40.1	41.8
S/R at F30	324.5	325.6	326.9	324.4	325.6	326.8
SSB at F30	21462	22407	23498	39583	49426	72637
F 40% SPR	0.07	0.07	0.08	0.07	0.07	0.08
Y/R at F40	35.4	36.9	38.5	35.4	36.9	38.4
S/R at F40	432.3	434.2	435.8	432.2	434.0	435.9
SSB at F40	28612	29884	31252	56144	71433	109621
SSB 2007	6743	8506	10983	6743	8506	10983
SSB 2007 / SSB MSY	0.46	0.57	0.70	0.08	0.14	0.21
F Current	0.15	0.19	0.24	0.15	0.19	0.24
F Current / FMSY	1.04	1.27	1.53	1.74	2.18	2.64

Table 22. Table of benchmarks and reference points for the case 9 VPA model under the low and high recruitment scenarios.

	CASE 9 - 2 Line (low recruitment scenario)			CASE 9 - B&H (high recruitment scenario)		
MEASURE	LOWER CI	MEDIAN	UPPER CI	LOWER CI	MEDIAN	UPPER CI
F at MSY	0.13	0.15	0.17	0.07	0.09	0.10
MSY	2582.8	2755.2	2916.5	4739.4	5698.2	9209.7
Y/R at MSY	39.7	41.4	43.0	36.3	38.6	40.6
S/R at MSY	213.5	218.6	222.6	359.7	383.6	414.6
SPR AT MSY	0.20	0.20	0.21	0.33	0.36	0.39
SSB AT MSY	13929	14464	15107	44302	56029	97929
F at max. Y/R	0.13	0.15	0.17	0.13	0.15	0.17
Y/R maximum	39.7	41.4	43.0	39.7	41.4	43.0
S/R at Fmax	213.5	218.6	222.6	214.5	219.1	222.9
SPR at Fmax	0.20	0.20	0.21	0.20	0.20	0.21
SSB at Fmax	13929	14464	15107	20832	25046	38358
F 0.1	0.08	0.09	0.09	0.08	0.09	0.09
Y/R at F0.1	37.1	38.5	39.8	37.0	38.5	39.8
S/R at F0.1	381.6	388.7	395.5	382.3	388.7	395.6
SPR at F0.1	0.35	0.36	0.37	0.36	0.36	0.37
SSB at F0.1	24644	25809	26922	47675	57398	91576
F 20% SPR	0.13	0.15	0.17	0.14	0.15	0.17
Y/R at F20	39.7	41.4	43.0	39.7	41.4	43.0
S/R at F20	216.6	217.3	218.0	216.6	217.4	218.0
SSB at F20	13887	14409	15057	21002	24586	37605
F 30% SPR	0.09	0.10	0.11	0.09	0.10	0.11
Y/R at F30	38.5	40.2	41.7	38.5	40.2	41.7
S/R at F30	324.5	325.6	326.8	324.4	325.5	326.8
SSB at F30	20750	21620	22556	38043	45144	71777
F 40% SPR	0.07	0.07	0.08	0.07	0.07	0.08
Y/R at F40	35.5	37.0	38.3	35.4	37.0	38.3
S/R at F40	432.2	434.0	435.9	432.3	434.0	435.9
SSB at F40	27733	28769	30114	54831	65762	106657
SSB 2007	5233	6675	8511	5189	6672	8423
SSB 2007 / SSB MSY	0.38	0.46	0.57	0.06	0.12	0.17
F Current	0.18	0.22	0.28	0.18	0.22	0.28
F Current / FMSY	1.24	1.48	1.77	2.12	2.58	3.12

Table 23. Estimated chance of recovery under the high and low recruitment scenarios and two alternative assessment models (green=Yes, with year of recovery shown, red=No).

50% Probability				
Projected Catch Level (mt)	Base Case		Removing GSL (Case 9)	
	Low	High	Low	High
0	2012	No	2013	No
500	2012	No	2013	No
1000	2013	No	2014	No
1500	2014	No	2016	No
1600	2014	No	2017	No
1700	2015	No	2017	No
1800	2015	No	2018	No
1900	2015	No	2019	No
2000	2016	No	No	No
2100	2017	No	No	No
2200	2017	No	No	No
2300	2018	No	No	No
2400	2019	No	No	No
2500	No	No	No	No
2600	No	No	No	No
2700	No	No	No	No
3000	No	No	No	No
5000	No	No	No	No

75% Probability				
Projected Catch Level (mt)	Base Case		Removing GSL (Case 9)	
	Low	High	Low	High
0	2013	No	2013	No
500	2013	No	2014	No
1000	2014	No	2016	No
1500	2015	No	2019	No
1600	2016	No	No	No
1700	2016	No	No	No
1800	2017	No	No	No
1900	2018	No	No	No
2000	2019	No	No	No
2100	No	No	No	No
2200	No	No	No	No
2300	No	No	No	No
2400	No	No	No	No
2500	No	No	No	No
2600	No	No	No	No
2700	No	No	No	No
3000	No	No	No	No
5000	No	No	No	No

Table 24. Estimated chance of ending overfishing under the high and low recruitment scenarios and two alternative assessment models. Entries are year overfishing ends or "no" if overfishing has less than the given probability of success by 2019.

50% Probability				
Projected Catch Level (mt)	Base Case		Removing GSL (Case 9)	
	Low	High	Low	High
0	2009	2009	2009	2009
500	2009	2009	2009	2009
1000	2009	2009	2009	2011
1500	2009	2009	2009	2017
1600	2009	2010	2010	2018
1700	2009	2011	2011	No
1800	2009	2012	2012	No
1900	2009	2013	2013	No
2000	2010	2014	2015	No
2100	2011	2015	2016	No
2200	2012	2016	2019	No
2300	2014	2017	No	No
2400	2015	2018	No	No
2500	2017	No	No	No
2600	No	No	No	No
2700	No	No	No	No
3000	No	No	No	No
5000	No	No	No	No
75% Probability				
Projected Catch Level (mt)	Base Case		Removing GSL (Case 9)	
	Low	High	Low	High
0	2009	2009	2009	2009
500	2009	2009	2009	2009
1000	2009	2010	2009	2013
1500	2009	2015	2011	No
1600	2009	2016	2012	No
1700	2009	2018	2014	No
1800	2011	2019	2015	No
1900	2012	No	2018	No
2000	2013	No	No	No
2100	2014	No	No	No
2200	2016	No	No	No
2300	2019	No	No	No
2400	No	No	No	No
2500	No	No	No	No
2600	No	No	No	No
2700	No	No	No	No
3000	No	No	No	No
5000	No	No	No	No

Table 25. Table of percent increase in weight for the harvests that showed positive growth. Increase in weight was determined from the difference between the assumed weights at capture based on measured lengths at harvest and the ICCAT length-weight conversion for Mediterranean BFT from the reported weights of the sample or reported total catch, when provided.

UniqueID, based on the combination of flag, Year, Reported total catch, reported weight of sample and reported number of fish	*1. Reported weight of sample (kg)*	*2. Reported total catch (kg)*	*3. Weight from sum of reported lengths using L-W regression (Kg)*	*% increase (1-3)/3 or (2-3)/3*	*Number of fish*	*Note*
Turkey 2005 NA 129434 1384	129,434	NA	115,392	12.2%	1384	A
Turkey 2005 NA 34780 350	34,780	NA	24,229	43.5%	350	A
Turkey 2005 NA 4439 48	4,439	NA	3,071	44.5%	48	A
Turkey 2005 NA 46064 587	46,064	NA	41,420	11.2%	587	A
Turkey 2005 NA 77088 1028	77,088	NA	69,524	10.9%	1028	A
Turkey 2006 NA 33513 629	33,513	NA	30,612	9.5%	629	A
Turkey 2006 NA 90038 1282	90,038	NA	81,662	10.3%	1282	A
EC.España 2005 1122 NA NA	NA	1,122	1,077	4.2%	5	B
EC.España 2005 1169 NA NA	NA	1,169	802	45.8%	6	B
EC.España 2005 534 NA NA	NA	534	439	21.6%	3	B
EC.España 2005 572 NA NA	NA	572	371	54.3%	3	B
EC.España 2006 1482 NA NA	NA	1,482	1,145	29.4%	17	B
EC.España 2006 1656 NA NA	NA	1,656	1,406	17.8%	32	B
EC.España 2006 1691 NA NA	NA	1,691	1,155	46.5%	21	B
EC.España 2006 2135 NA NA	NA	2,135	1,739	22.7%	22	B
EC.España 2006 2283 NA NA	NA	2,283	1,568	45.6%	16	B
EC.España 2006 2963 NA NA	NA	2,963	2,538	16.8%	46	B
EC.España 2006 3268 NA NA	NA	3,268	2,860	14.3%	13	B
EC.España 2006 3715 NA NA	NA	3,715	3,244	14.5%	20	B
EC.España 2006 4123 NA NA	NA	4,123	3,484	18.3%	35	B
EC.España 2006 4551 NA NA	NA	4,551	3,932	15.7%	18	B
EC.España 2006 4566 NA NA	NA	4,566	3,732	22.3%	35	B
EC.España 2006 5284 NA NA	NA	5,284	3,597	46.9%	20	B
EC.España 2006 5664 NA NA	NA	5,664	4,871	16.3%	20	B
EC.España 2006 679 NA NA	NA	679	603	12.6%	10	B
EC.España 2006 781 NA NA	NA	781	664	17.6%	12	B
EC.España 2006 7826 NA NA	NA	7,826	6,362	23.0%	36	B
Mean of percentages				24.0%		
Median of percentages				17.8%		
Overall percentage		471,420	411,500	14.56%		
Mean Turkey				20.3%		
Median Turkey				11.2%		
Mean Spain				25.3%		
Median Spain				19.9%		

Note A. This recent data from Turkey has both length and weight by size classes, as well as weight of the harvest.
Note B. The results appear legitimate but the harvests are very low, between 3 and 46 fish. It is disturbing that there are some decreases in weight for EC.España in Note C, Table 2, and one is for the largest Spanish trap harvest (26,068 kg).

Table 26. Table unique combinations of flag, year, reported total catch, reported weight of sample and reported number of fish that showed negative or strange growth.

UniqueID, based on the combination of flag, Year, Reported total catch, reported weight of sample and reported number of fish	*1. Reported weight of sample (kg)*	*2. Reported total catch (kg)*	*3. Weight from sum of reported lengths using L-W regression (Kg)*	*% increase (1-3)/3 or (2-3)/3*	*Number of fish*	*Note*
EC.Cyprus 2006 77399 NA NA	NA	77399	82381	-6.05%	403	C
EC.España 2005 1043 NA NA	NA	1043	1067	-2.27%	5	C
EC.España 2006 26068 NA NA	NA	26068	26516	-1.69%	150	C
EC.Greece 2005 13850 NA NA	NA	13850	14295	-3.11%	100	C
EC.Greece 2005 14795 NA NA	NA	14795	15520	-4.67%	143	C
EC.Greece 2005 15119 NA NA	NA	15119	16518	-8.47%	105	C
EC.Malta 2005 18733 NA NA	NA	18733	20010	-6.38%	59	C
EC.Malta 2005 22294 NA NA	NA	22294	23919	-6.80%	97	C
EC.Malta 2005 23140 NA NA	NA	23140	25211	-8.22%	91	C
EC.Malta 2005 25620 NA NA	NA	25620	26398	-2.95%	200	C
EC.Malta 2005 29362 NA NA	NA	29362	31261	-6.07%	96	C
EC.Malta 2005 30737 NA NA	NA	30737	31706	-3.06%	200	C
EC.Malta 2005 33070 NA NA	NA	33070	33650	-1.72%	200	C
EC.Malta 2005 39823 NA NA	NA	39823	44054	-9.61%	151	C
EC.Malta 2005 41117 NA NA	NA	41117	42441	-3.12%	130	C
EC.Malta 2005 41674 NA NA	NA	41674	44127	-5.56%	146	C
EC.Malta 2005 42757 NA NA	NA	42757	46386	-7.82%	203	C
EC.Malta 2005 43537 NA NA	NA	43537	44228	-1.56%	200	C
EC.Malta 2005 43820 NA NA	NA	43820	44814	-2.22%	200	C
EC.Malta 2005 56088 NA NA	NA	56088	59466	-5.68%	169	C
EC.Malta 2005 56325 NA NA	NA	56325	59501	-5.34%	193	C
EC.Malta 2005 8195 NA NA	NA	8195	9123	-10.17%	52	C
EC.Cyprus 2006 63313 NA NA	NA	63313	73371	-13.71%	280	D
EC.Greece 2005 12926 NA NA	NA	12926	15981	-19.11%	107	D
EC.Greece 2005 4785 NA NA	NA	4785	6134	-21.99%	63	D
EC.Italy 2004 35843 NA NA	NA	35843	46066	-22.19%	189	D
EC.Malta 2005 195 NA NA	NA	195	287	-32.02%	3	D
EC.Malta 2005 20068 NA NA	NA	20068	22705	-11.61%	105	D
EC.Malta 2005 27653 NA NA	NA	27653	31711	-12.80%	101	D
EC.Malta 2005 305 NA NA	NA	305	368	-17.23%	2	D
Turkey 2004 423383 NA NA	NA	423383	641157	-33.97%	7880	D
EC.Malta 2005 14194 NA NA	NA	14194	4313	229.09%	200	E
EC.Malta 2005 24791 NA NA	NA	24791	10789	129.79%	200	E
EC.Malta 2005 25474 NA NA	NA	25474	11908	113.92%	200	E
EC.Malta 2005 29820 NA NA	NA	29820	14405	107.01%	200	E
EC.Malta 2005 30525 NA NA	NA	30525	14630	108.64%	200	E
EC.Malta 2005 53104 NA NA	NA	53104	41374	28.35%	200	E
EC.Malta 2005 53655 NA NA	NA	53655	42419	26.49%	200	E

Note C. The reported total catch is lower than if we applied the L-W regression but is within 10%. This could be due to growth in length during tenure in the farms but without further information we cannot explain these differences.
Note D. The reported total catch is much lower than if we applied the L-W regression. We have no explanation for this.
Note E. Increase greater than 100%, for many samples from Malta. This requires further exploration.

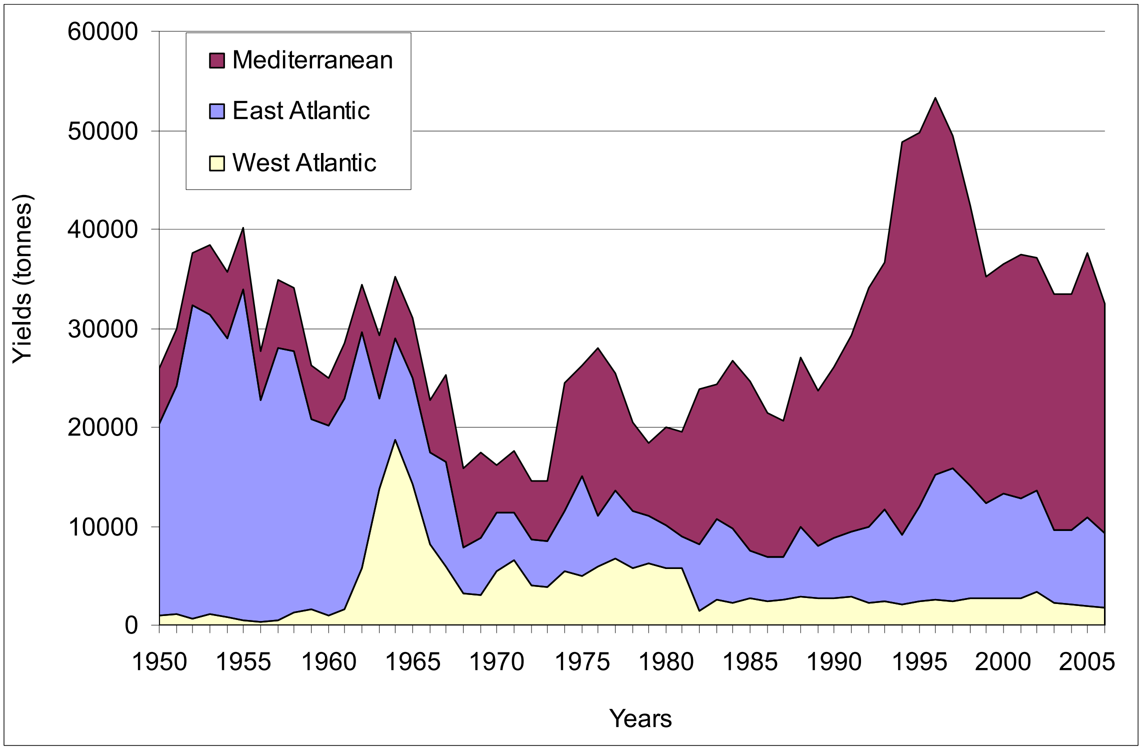


Figure 1. Bluefin reported catches by year and area.

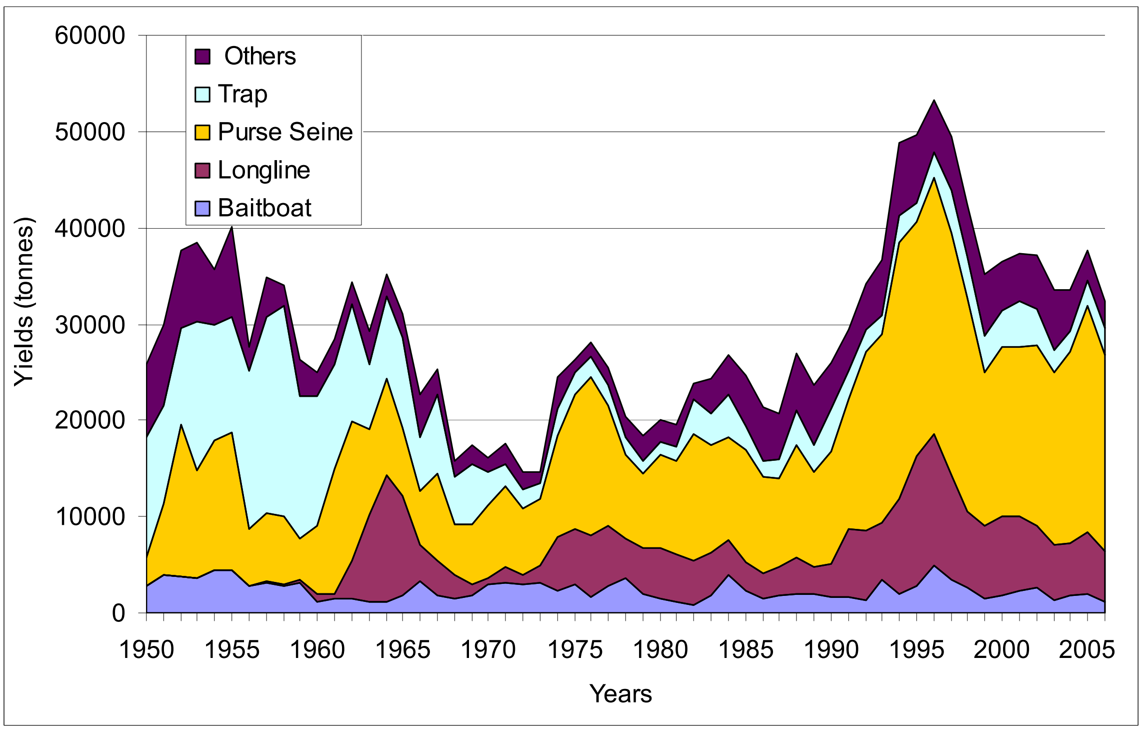
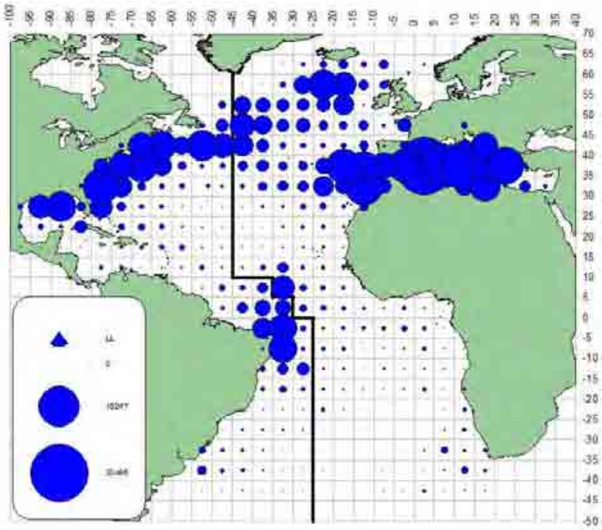
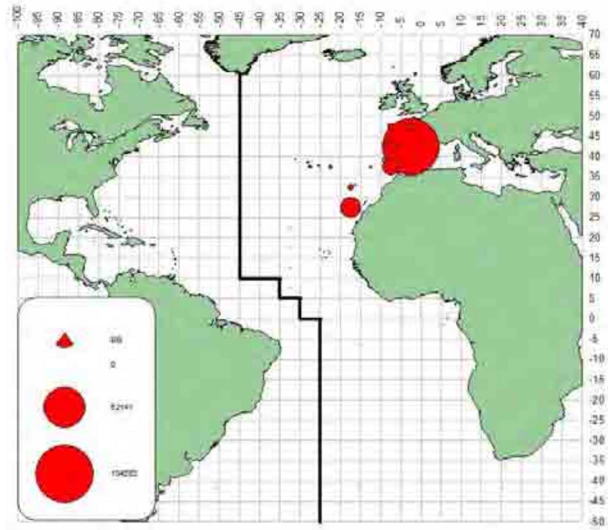


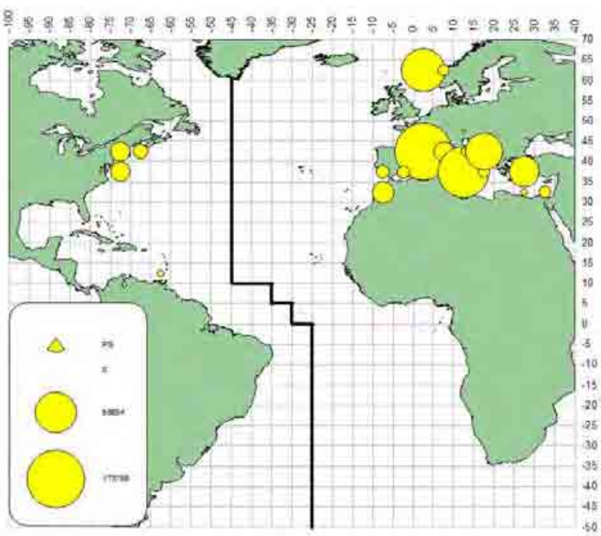
Figure 2. Bluefin reported annual catches by gear.



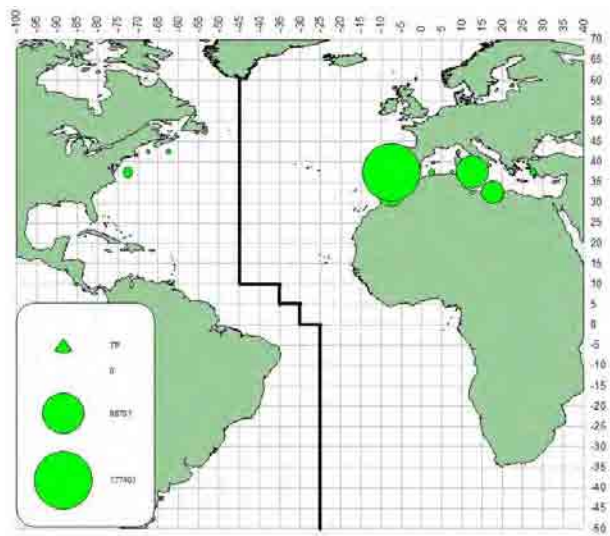
a. BFT (LL)



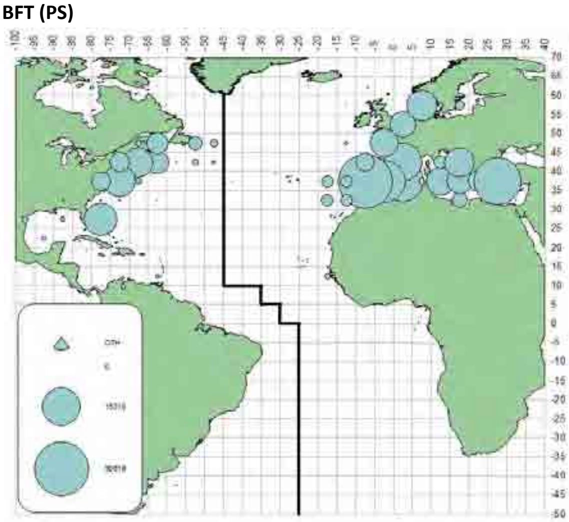
b. BFT (BB)



c. BFT (PS)

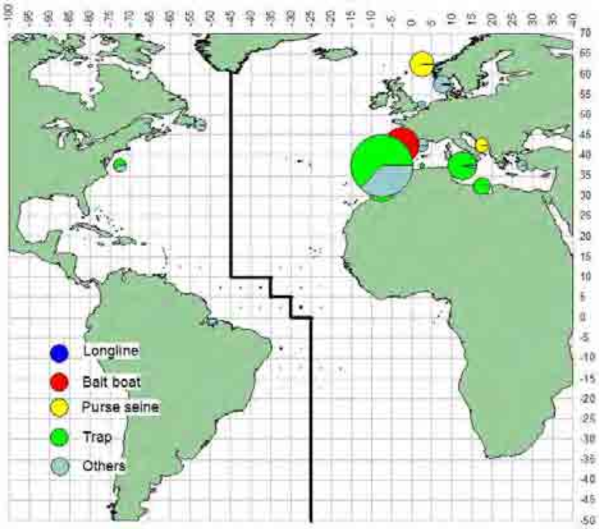


d. BFT (TRAP)

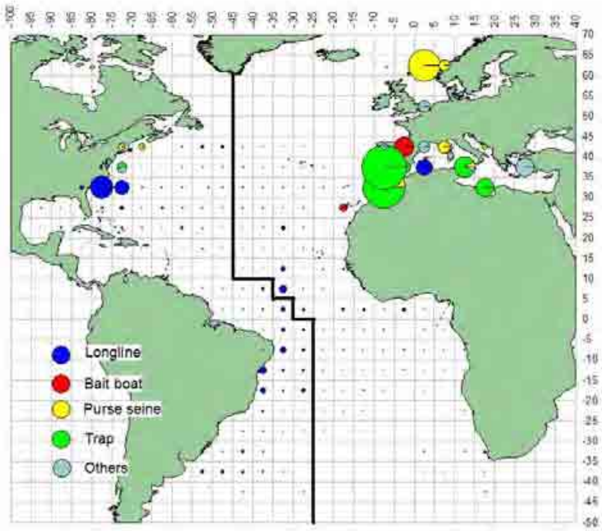


e. BFT (OT)

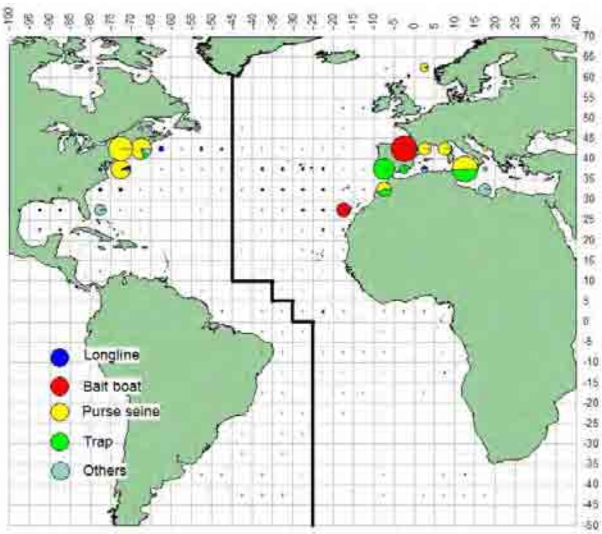
Figure 3. Geographical distribution of bluefin catches (BFT, *Thunnus thynnus*) 1950-2006.



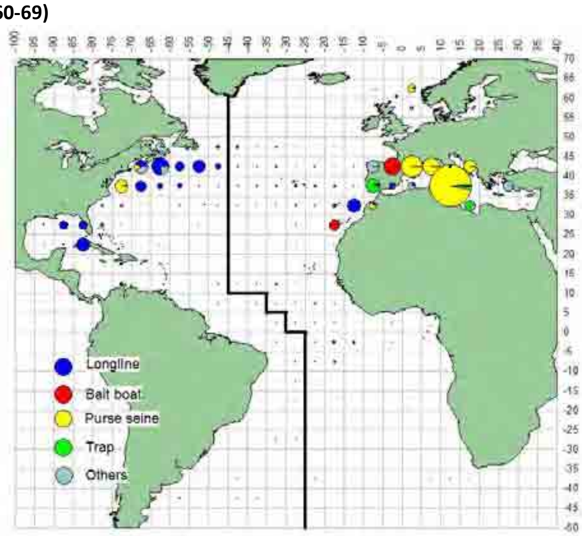
a. BFT(1950-59)



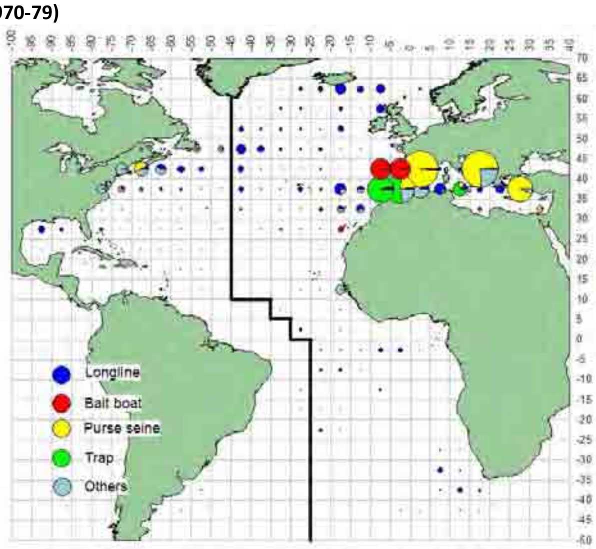
b. BFT(1960-69)



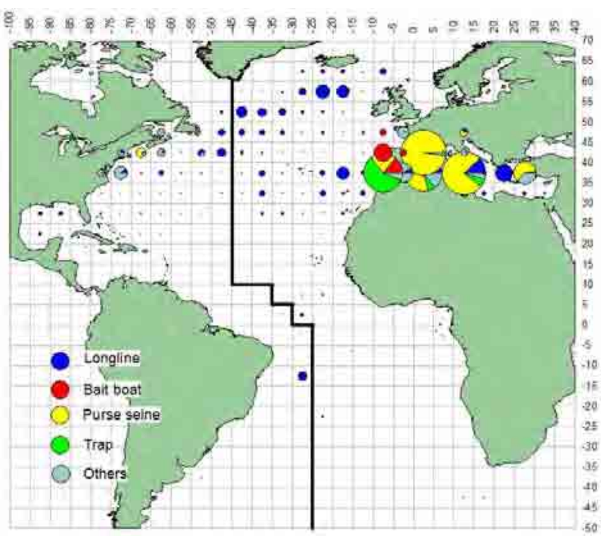
c. BFT(1970-79)



d. BFT(1980-89)



e. BFT (1990-99)



f. BFT (2000-2006)

Figures 4. Geographical distribution of BFT catch by major gears and decade.

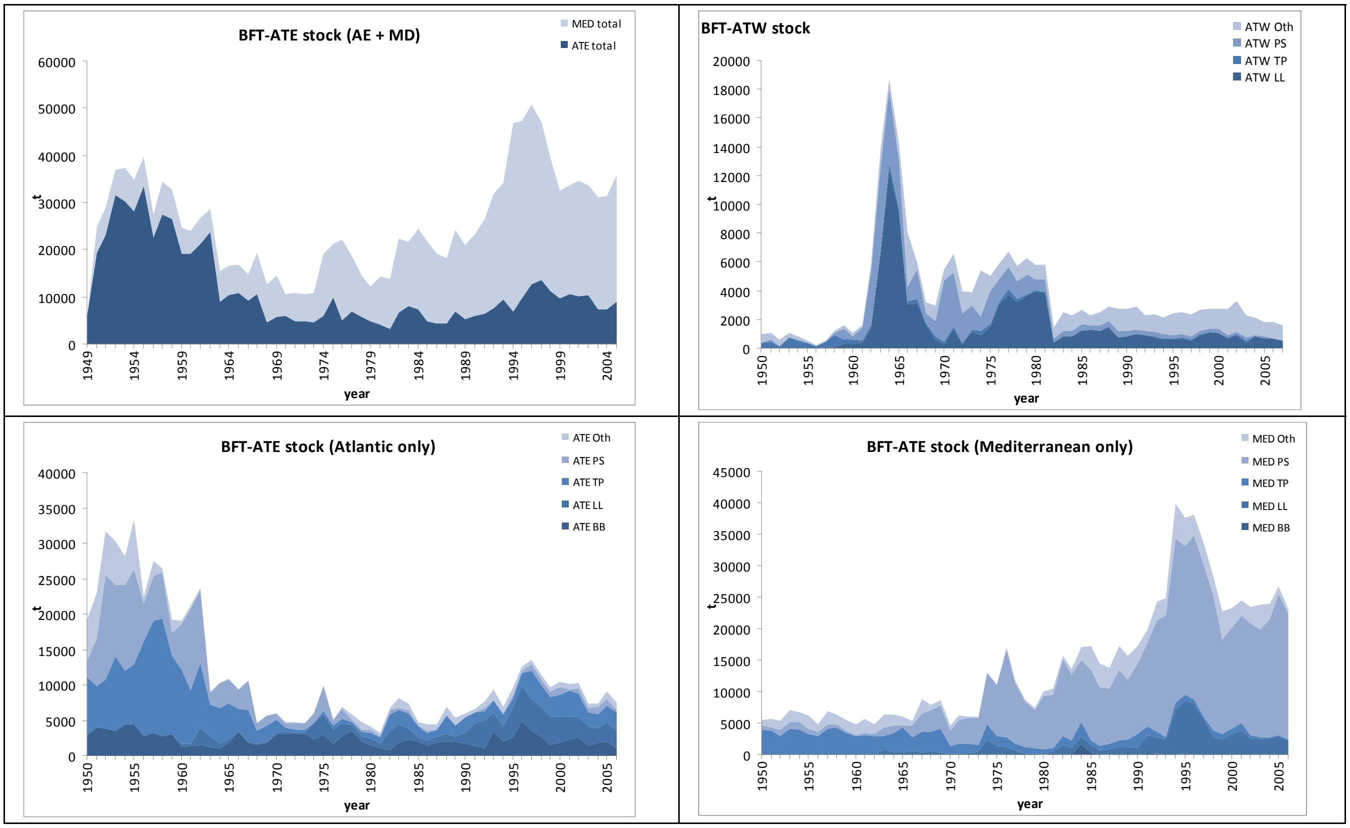


Figure 5. Bluefin reported annual catches by area and gear.

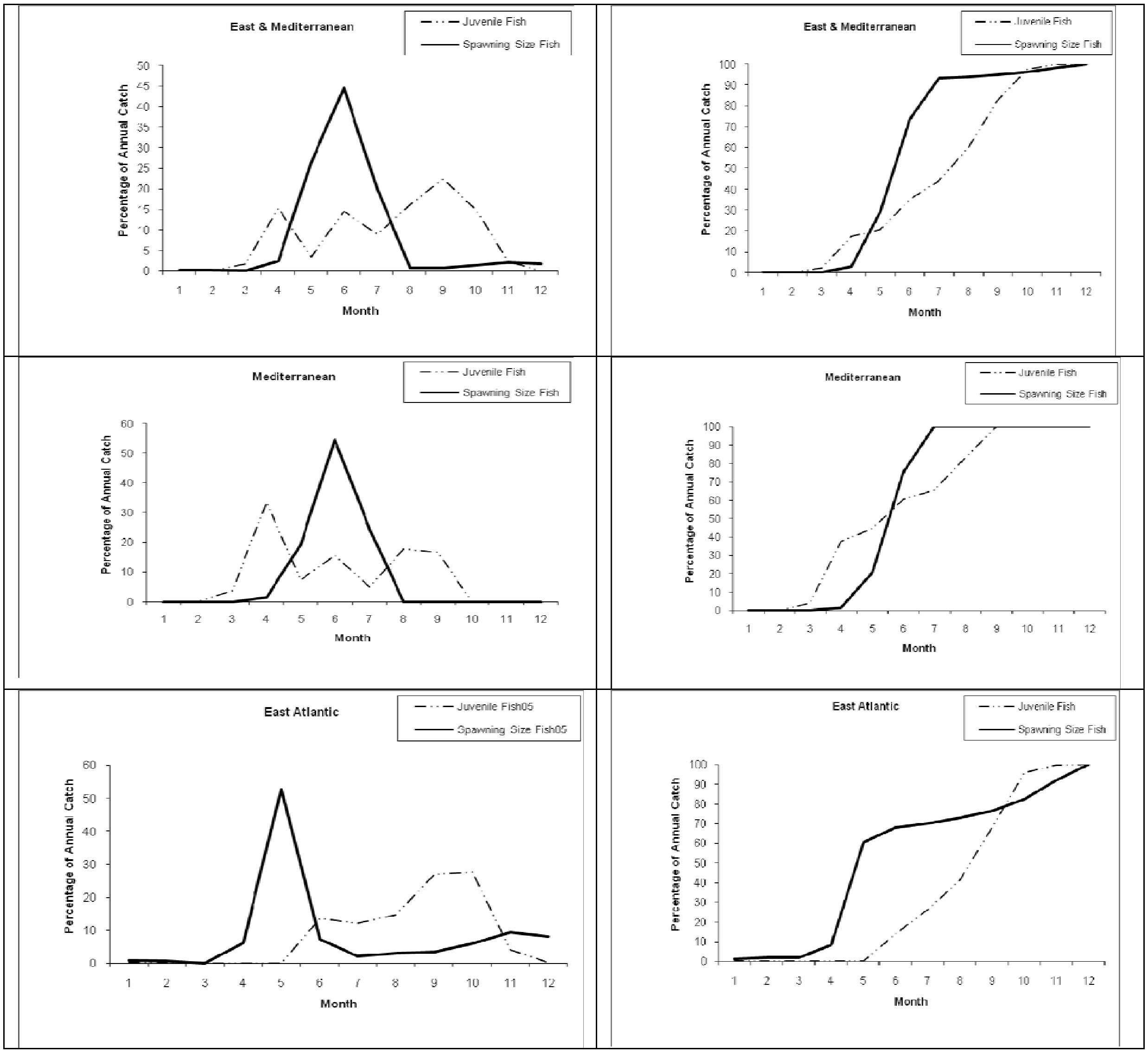


Figure 6. Estimated temporal pattern in monthly catches of spawning size (> 130 cm FL) and juvenile (< 130 cm FL) bluefin tuna in the east Atlantic and Mediterranean fisheries

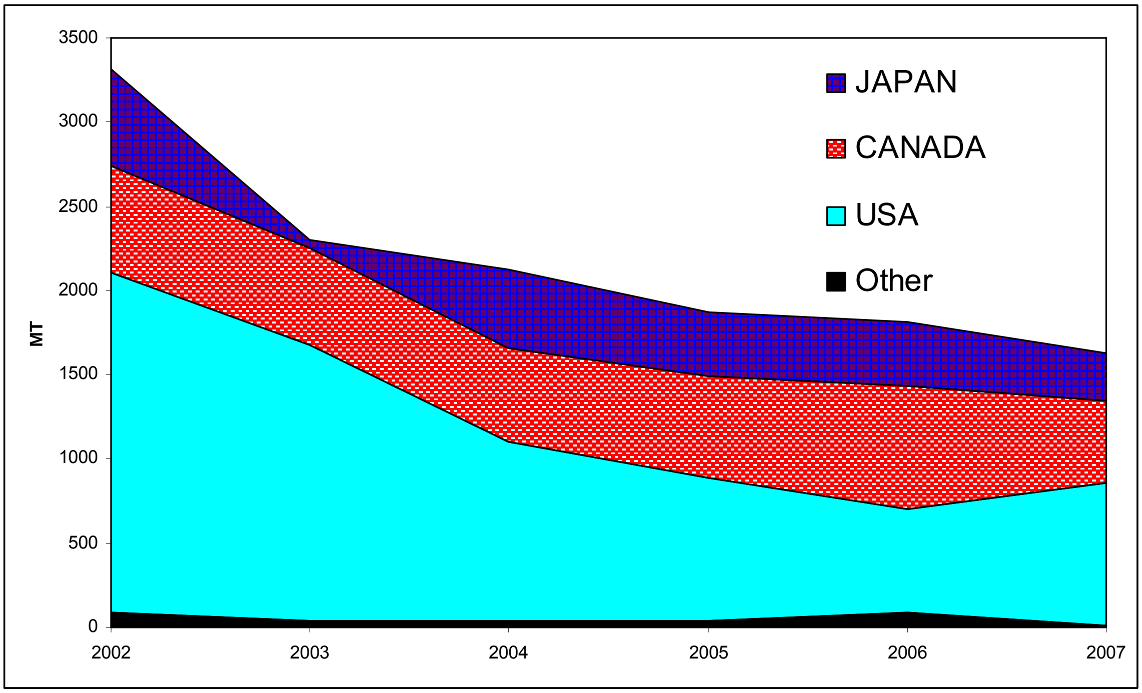


Figure 7. Recent trends in bluefin tuna catch (landings + discards) by flag.

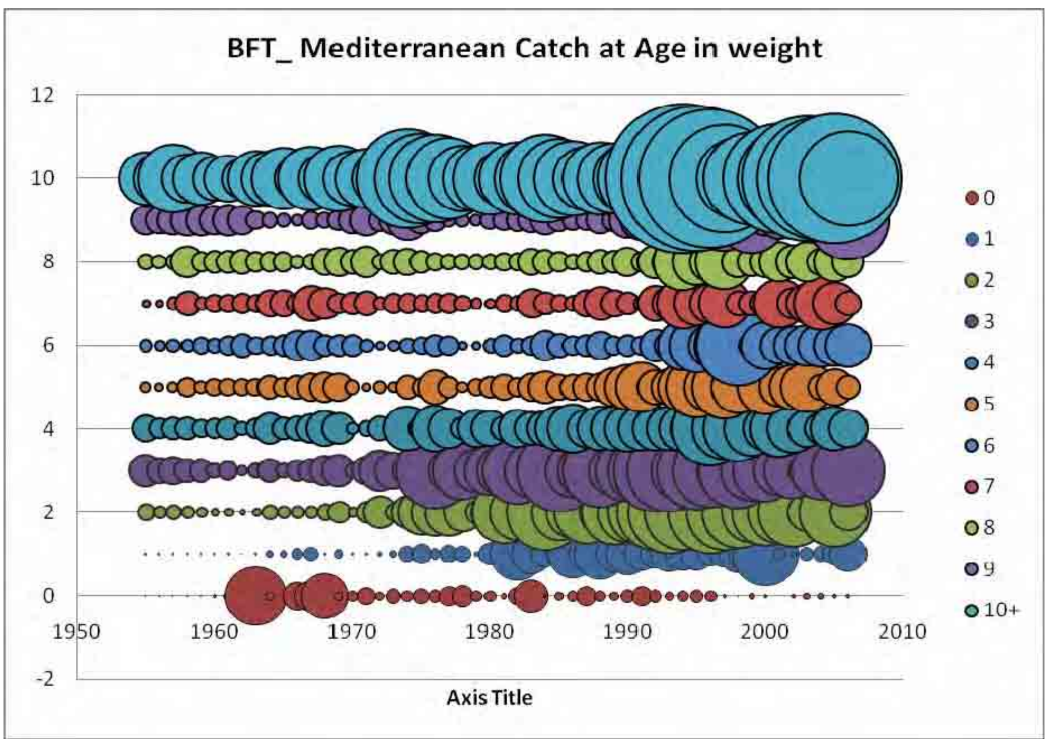


Figure 8. Catch at age, in weight, of the Mediterranean bluefin for period 1955-2006.

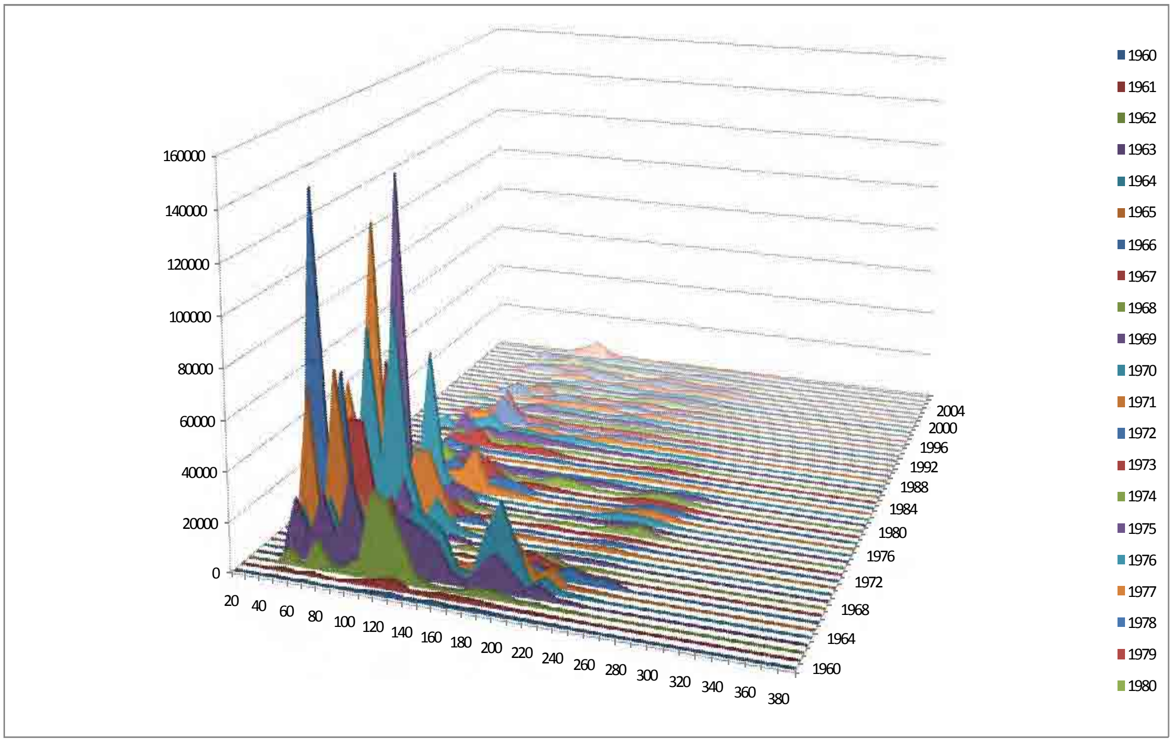


Figure 9. Frequency distribution of catch at size, by year, for western Atlantic bluefin tuna.

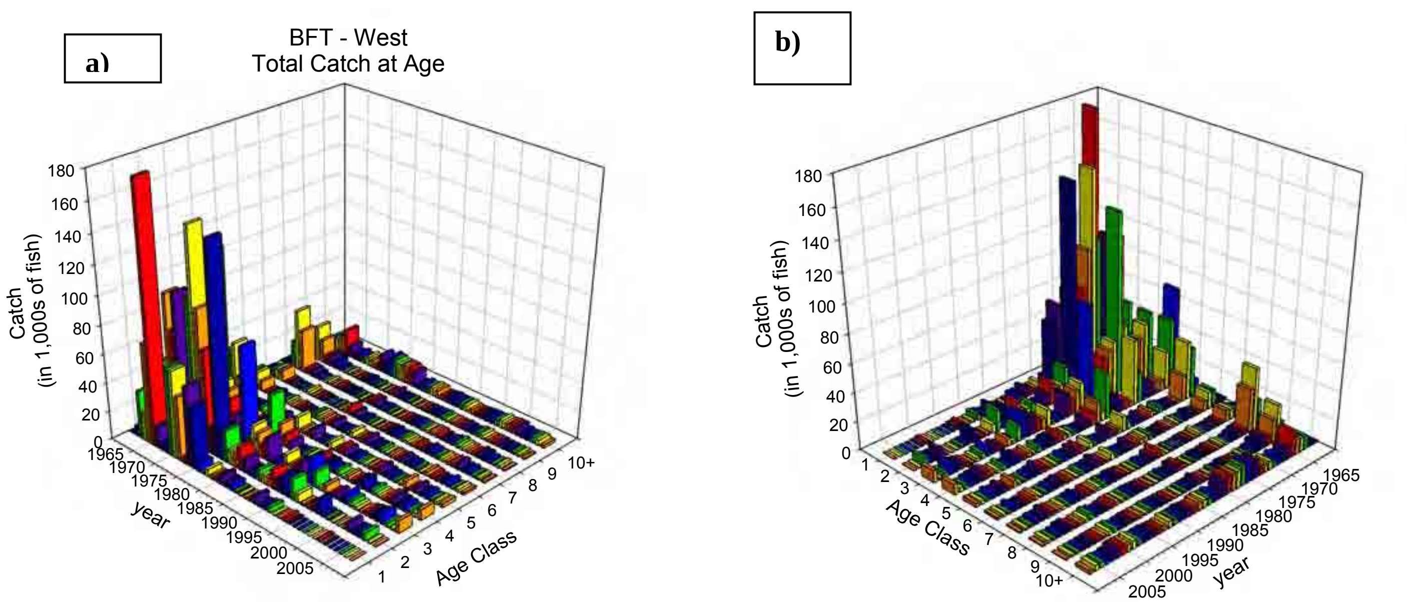


Figure 10. Frequency distribution of total catches at age 1960-2007, by year, for western Atlantic (areas 1 + 2) bluefin tuna (colors are consistent across age classes within a year). Graphs (a) and (b) represent the same graph seen from different angles to reveal bars which may be hidden behind larger bars.

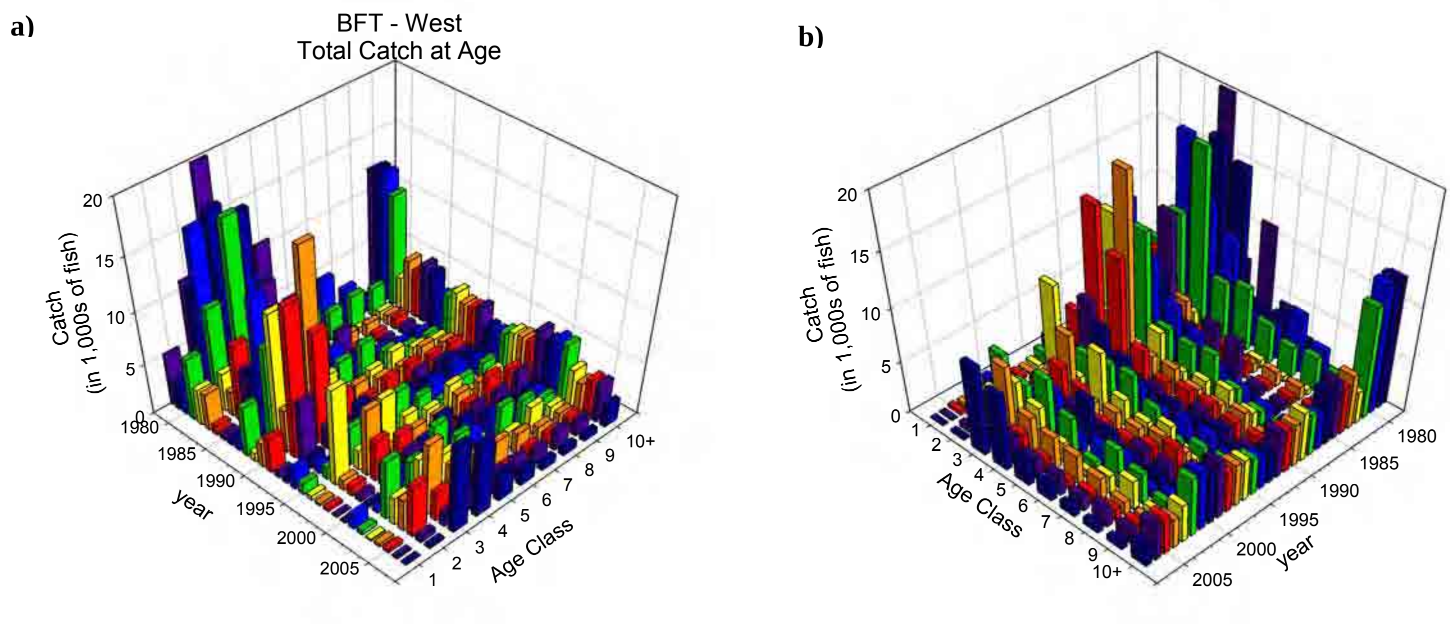


Figure 11. Frequency distribution of total catches at age during the most recent 30 years (1978-2007), by year, for western Atlantic (areas 1 + 2) bluefin tuna (colors are consistent across age classes within a year). Graphs (a) and (b) represent the same graph seen from different angles to reveal bars which may be hidden behind larger bars.

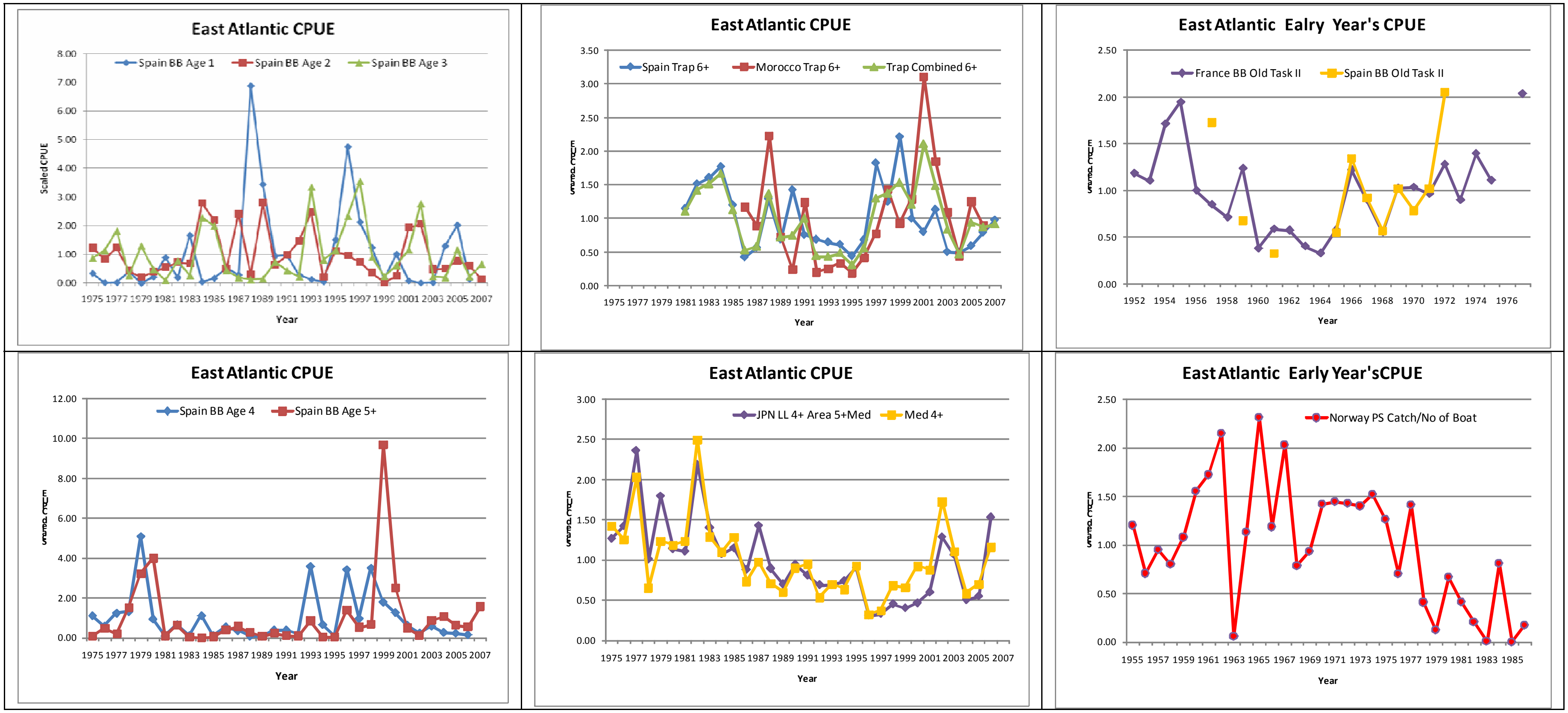


Figure East 12. East Atlantic BFT Abundance Indices considered by the Working Group. Standardized CPUE scaled to its mean

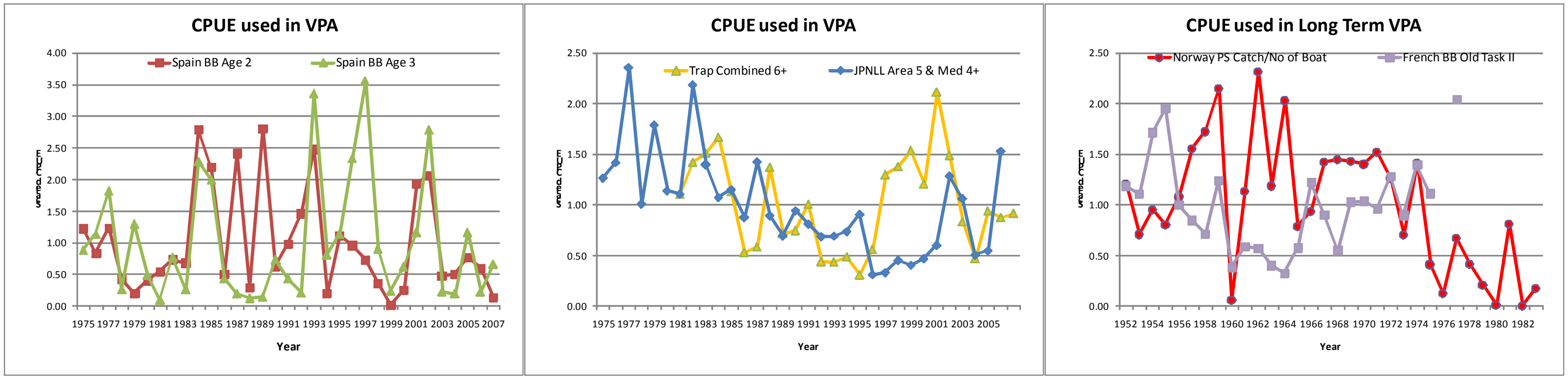


Figure East 13. East Atlantic BFT Abundance Indices used in VPA analysis. CPUE was scaled to its mean.

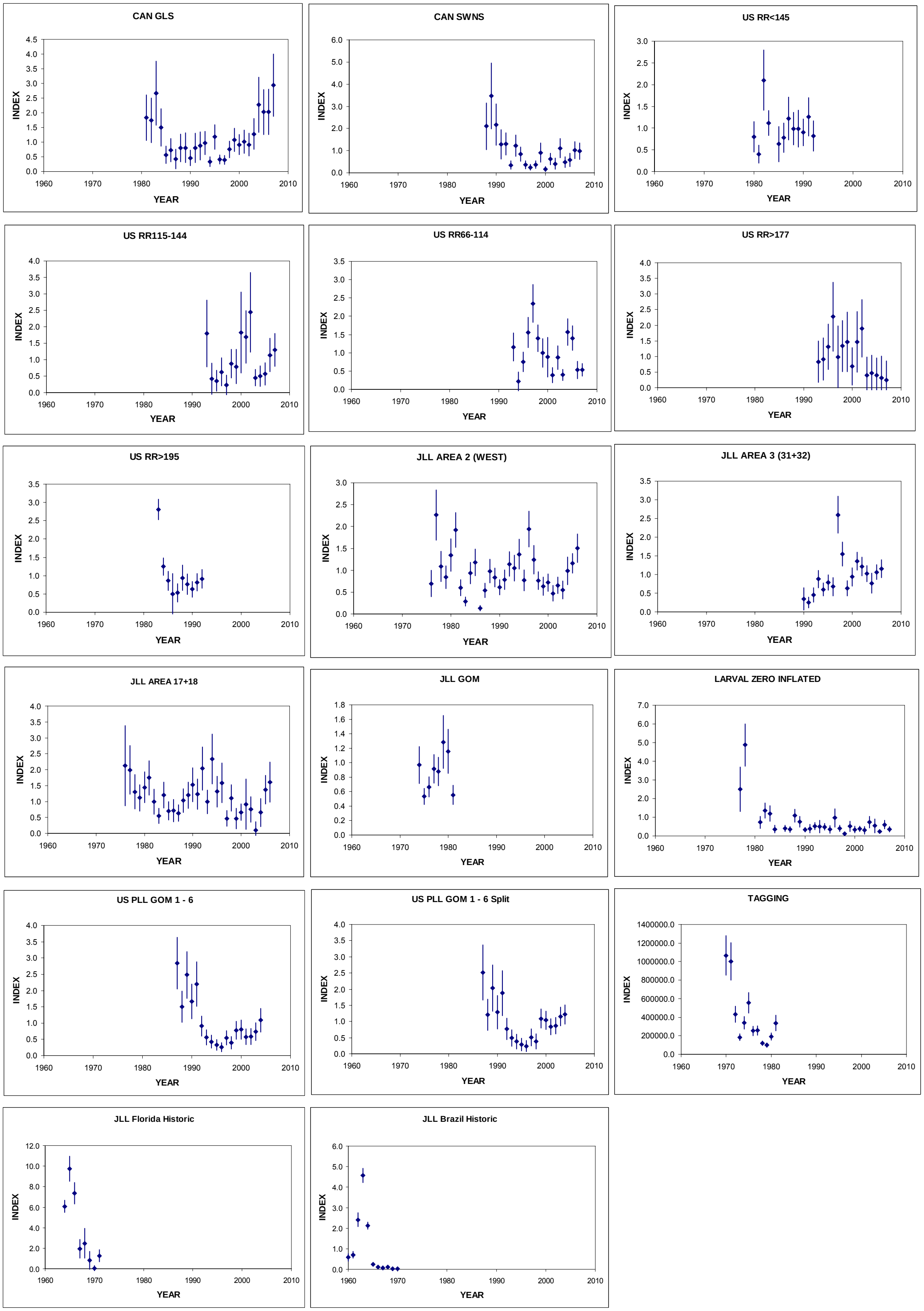


Figure 14. Comparison of standardized CPUE series for adult bluefin in the western Atlantic.

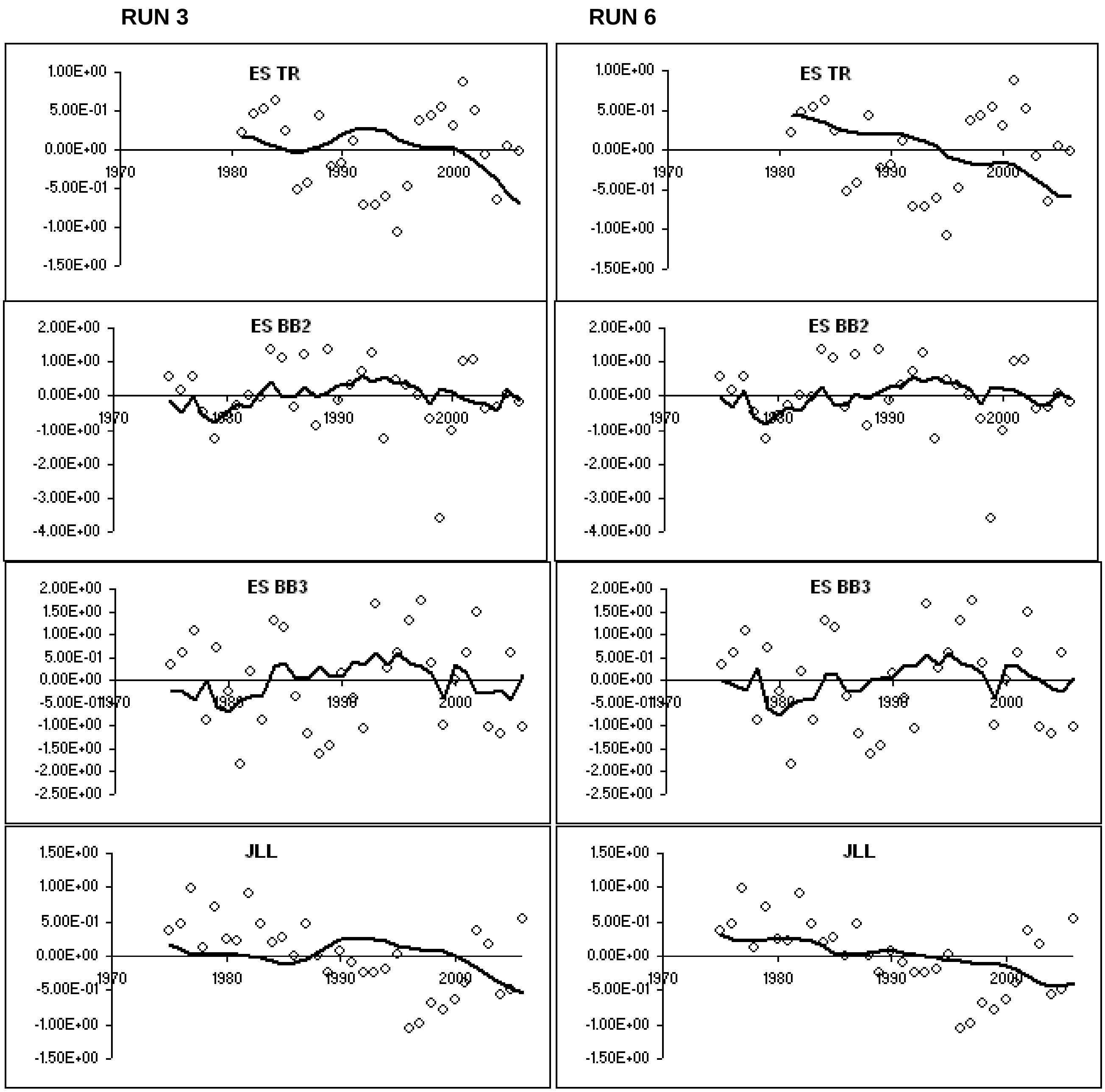


Figure 15. VPA fits to the available eastern bluefin CPUE indices in RUN 3 and RUN 6.

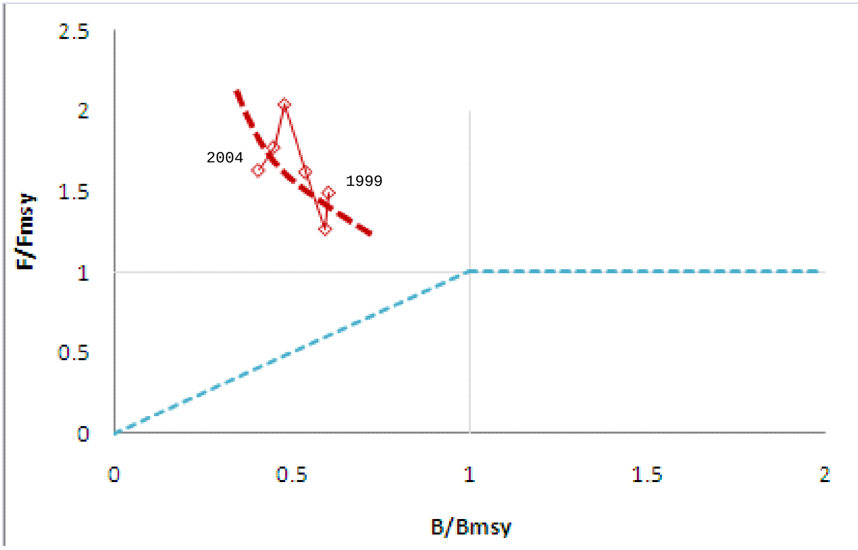


Figure 16. Recent trajectory of F and B relative to MSY proxy references showing a trend towards increasing F and declining B as estimated in 2006.

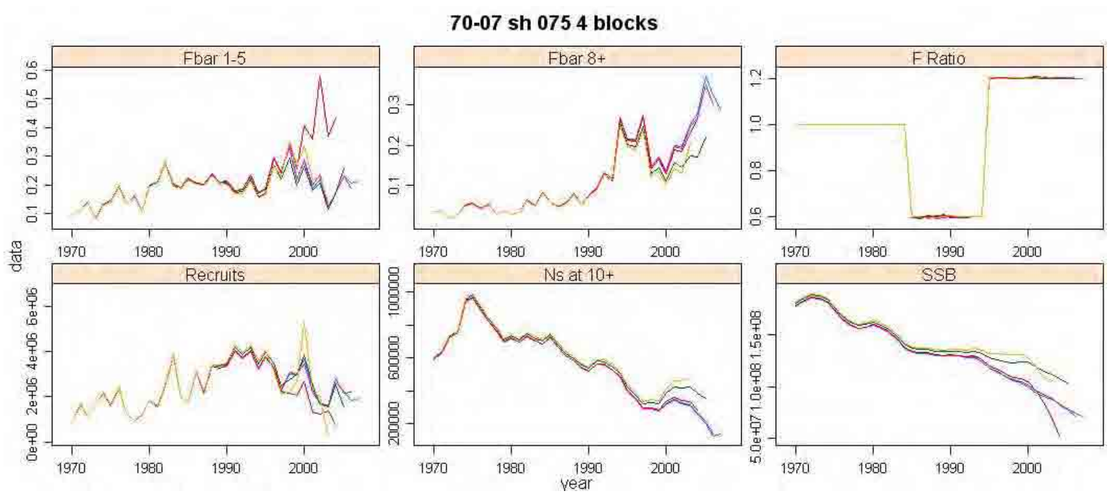


Figure 17. VPA results for Run 6.

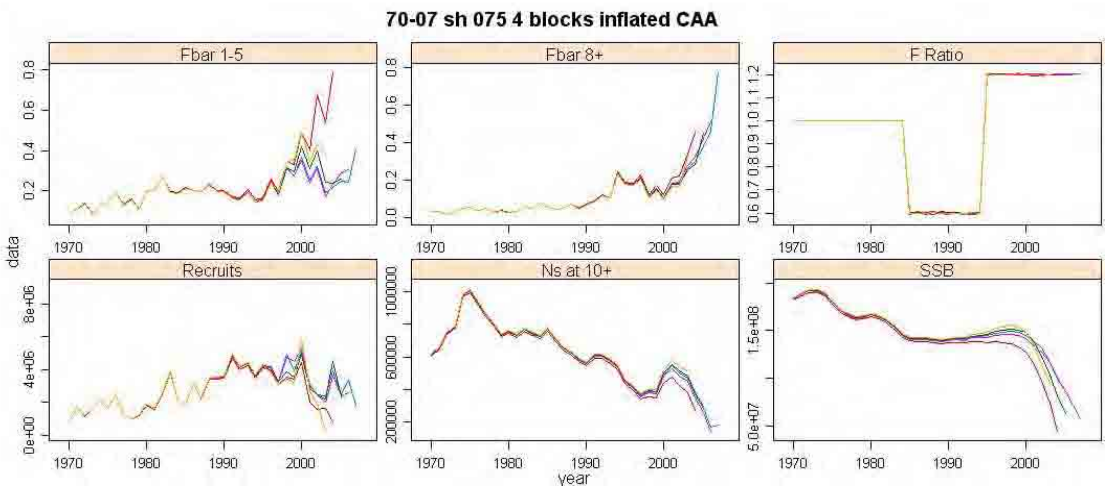


Figure 18. VPA results for Run 7.

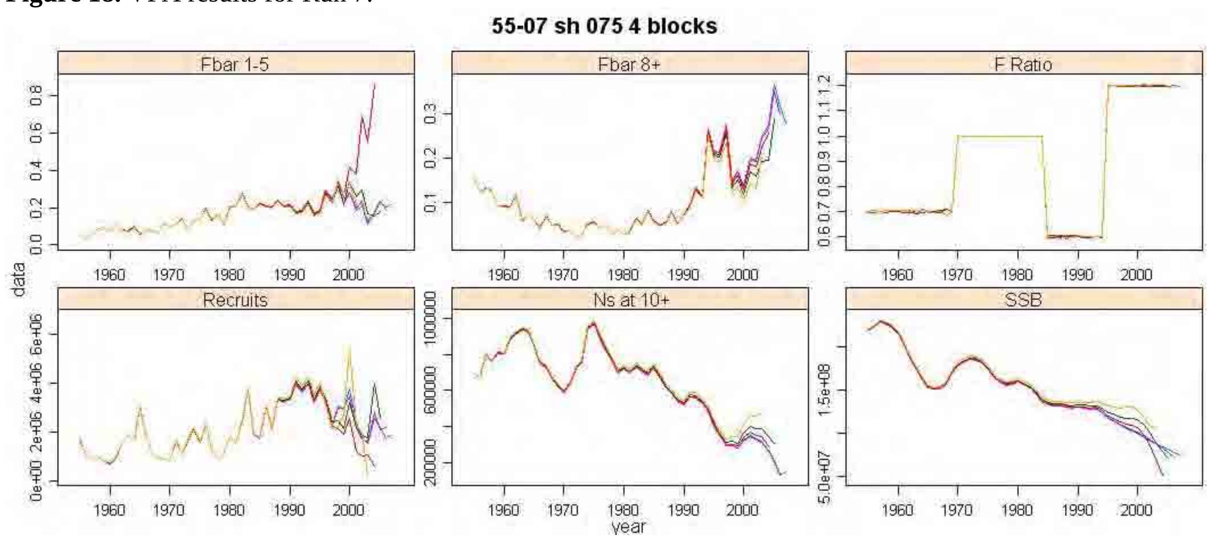


Figure 19. VPA results for Run 13.

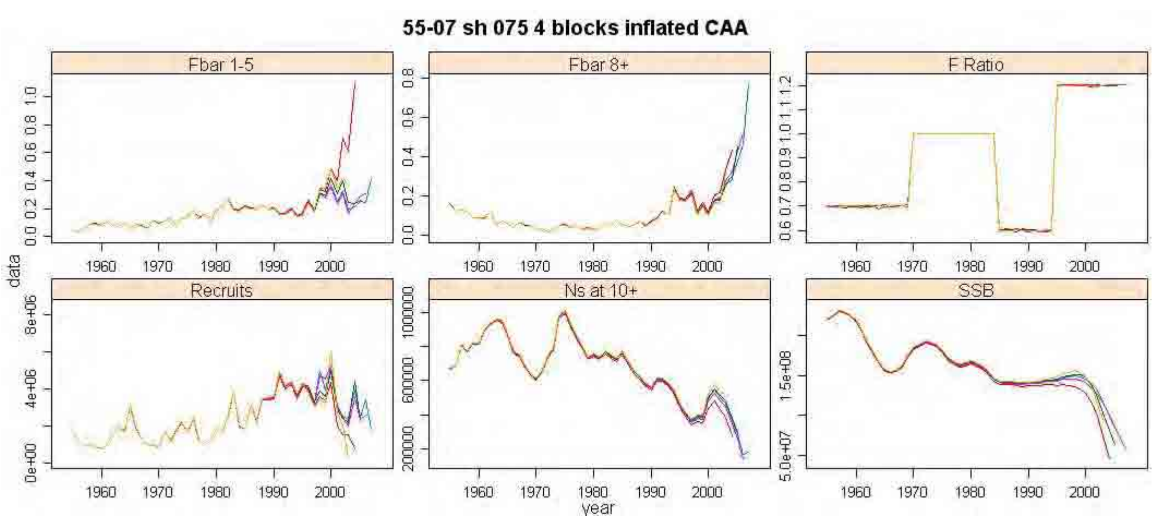


Figure 20. VPA results for Run 14.

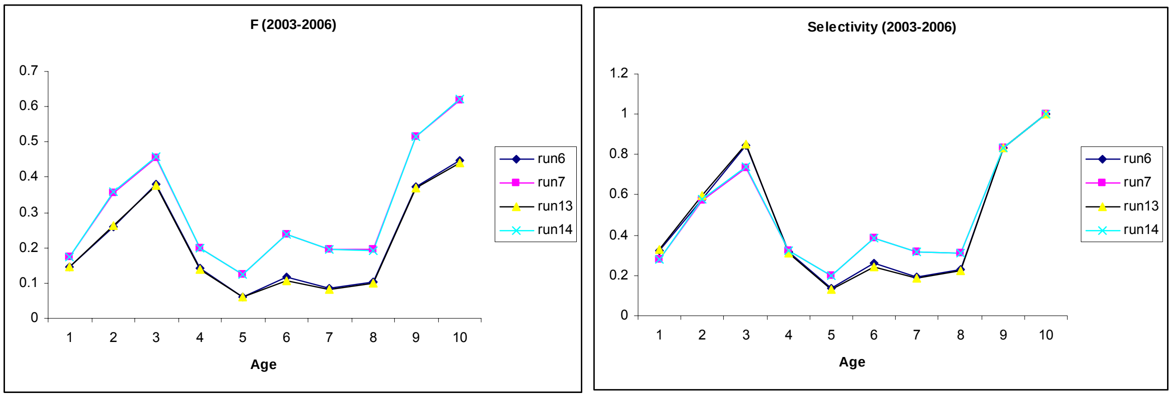


Figure 21. Geometric mean of F for the period 2003-2006 and corresponding selectivity vectors.

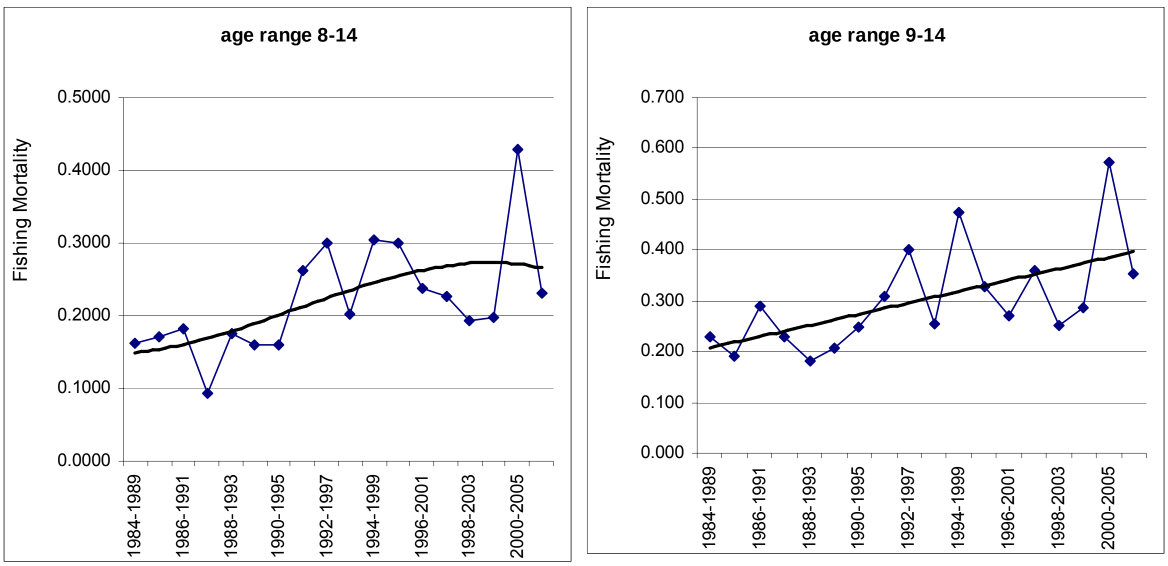


Figure 22. Estimates of fishing mortality (assuming M=0.1) for spawning BFT in the Eastern Atlantic and Mediterranean from year-class curve analyses based on Japanese longline cpue data. Estimates are average F values applied on different cohorts over 5 year periods (in the X axis).

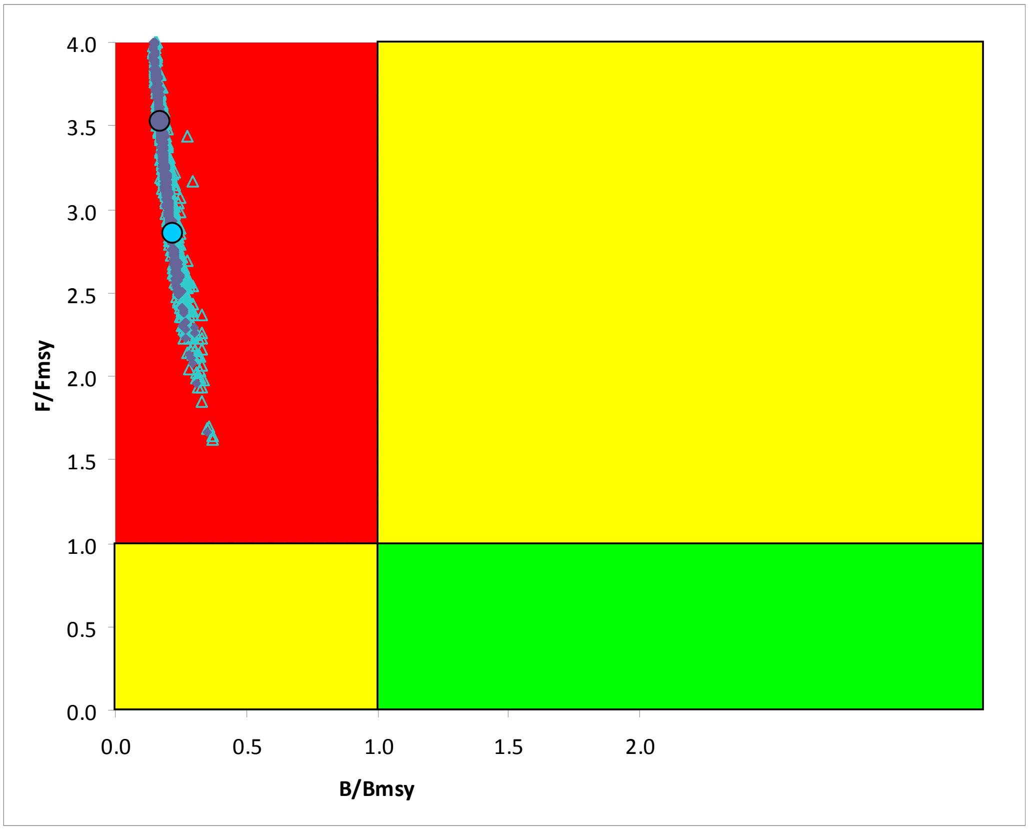


Figure 23. Phase plot of eastern Atlantic and Mediterranean recent stock status evaluations based upon two assumptions about recent catch at age.

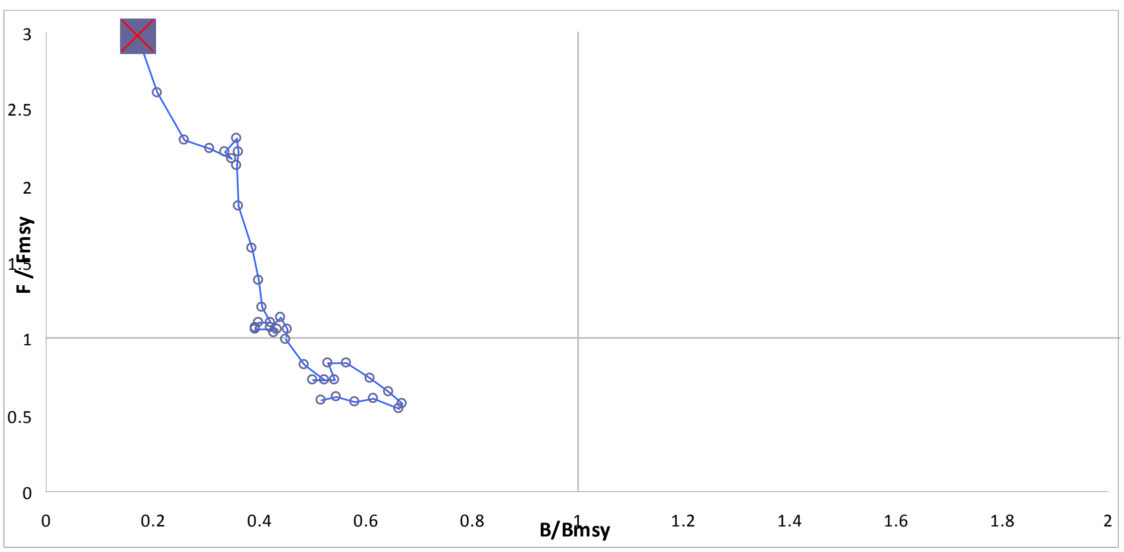
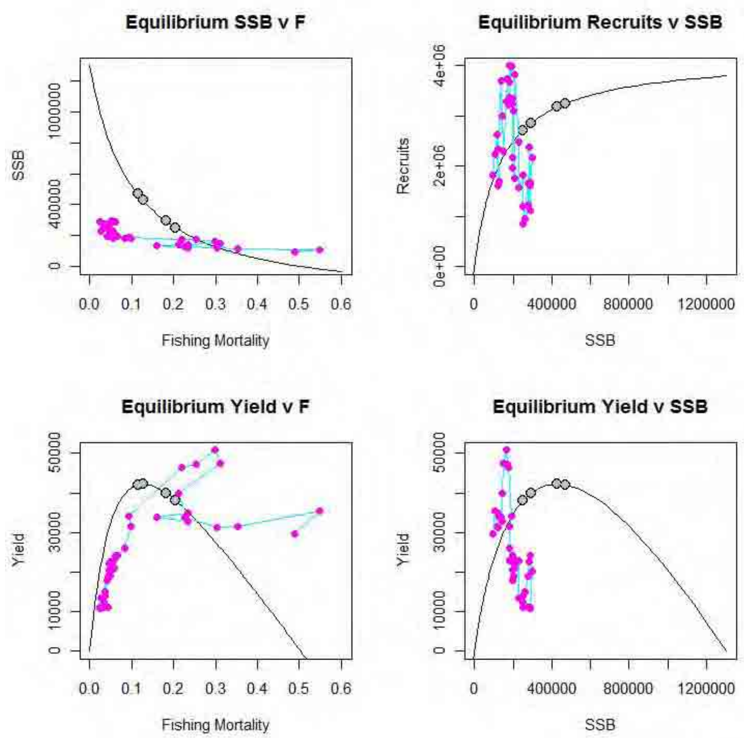
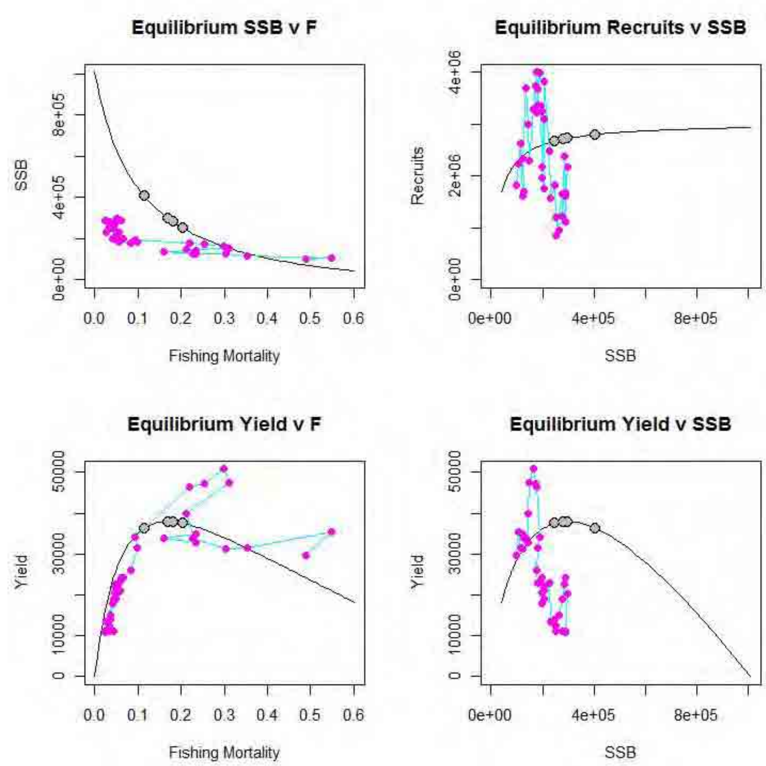


Figure 24. Snail track for East Atlantic and Mediterranean bluefin tuna. The X indicates 2006 status.

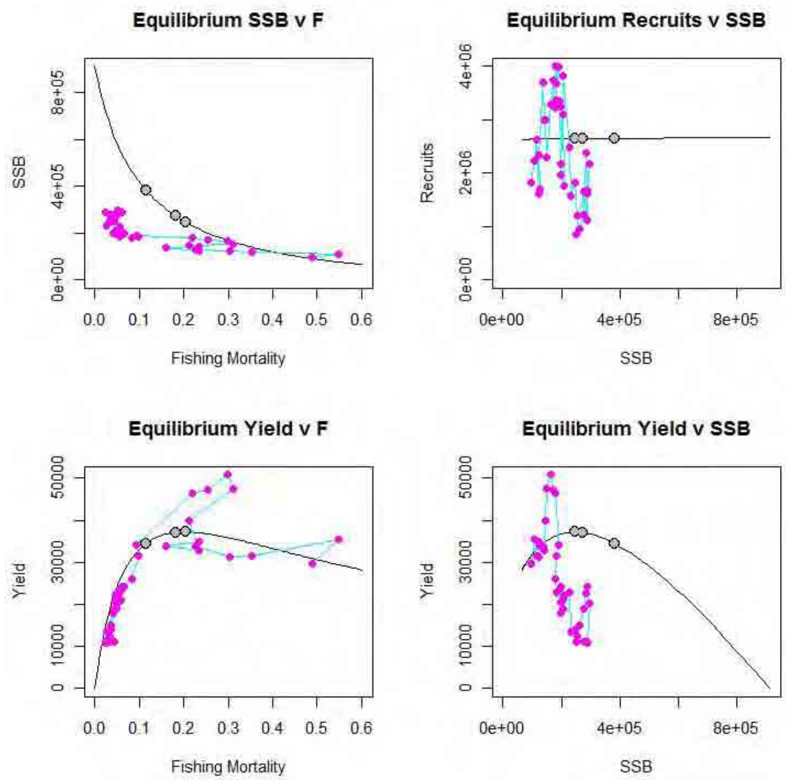
a) Reported catch, low recruitment (70s level), steepness = 0.5



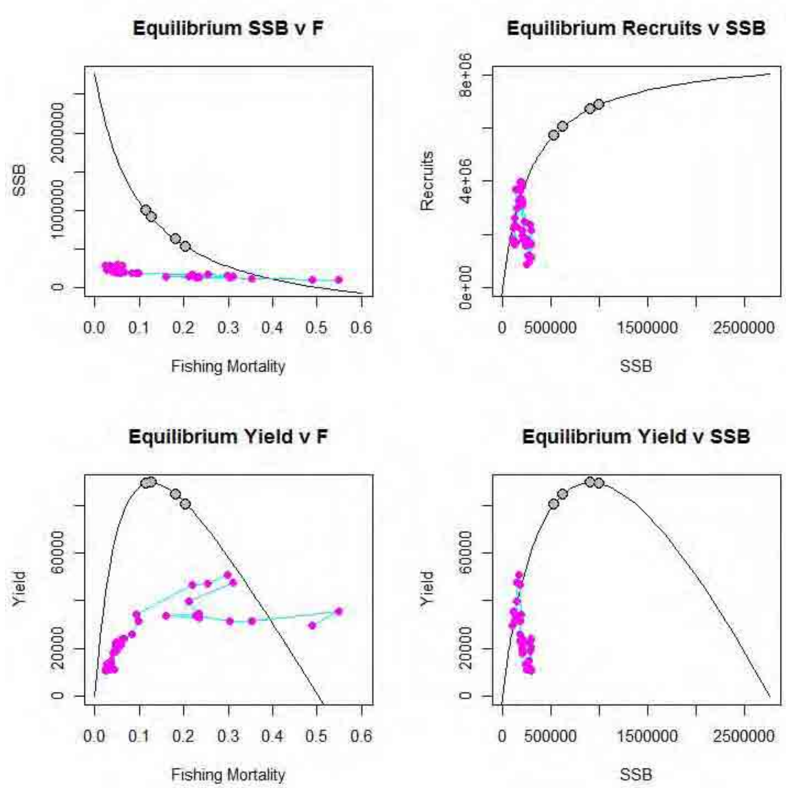
b) Reported catch, low recruitment (70s level), steepness = 0.75



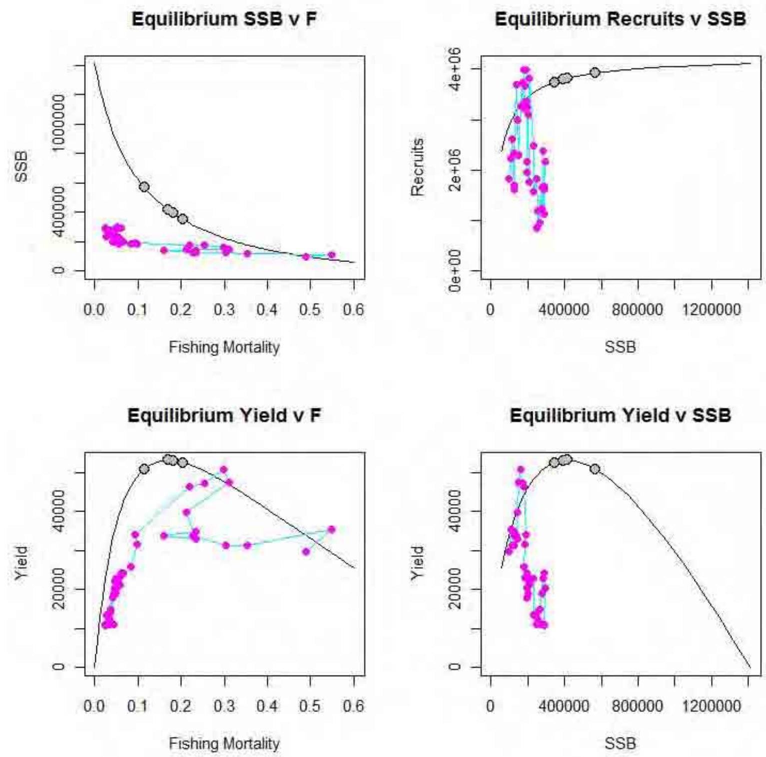
c) Reported catch, low recruitment (70s level), steepness = 0.99



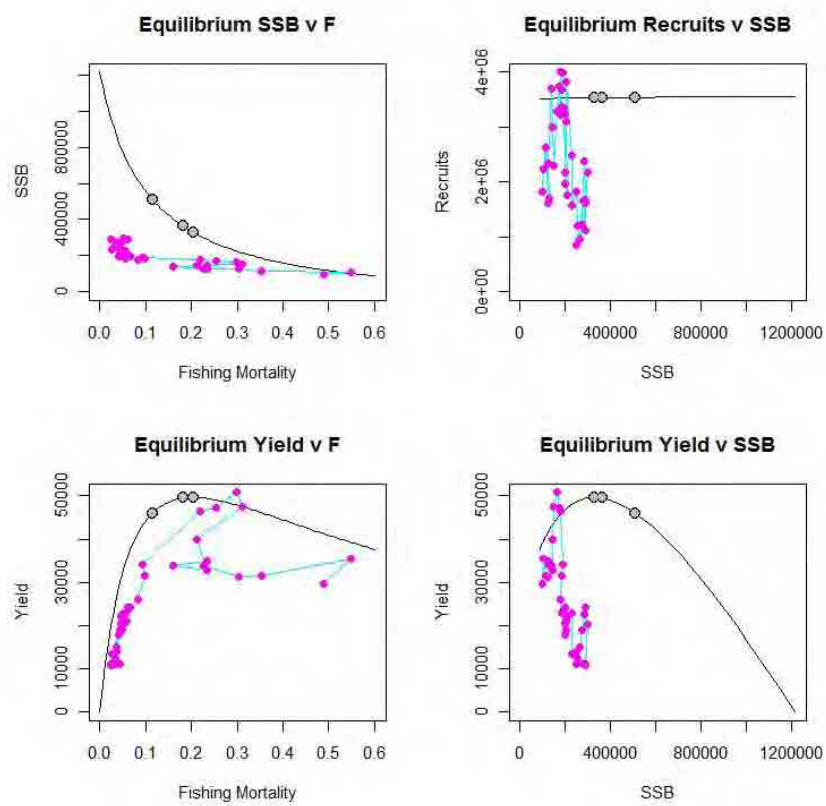
d) Reported catch, high recruitment (90s level), steepness = 0.5



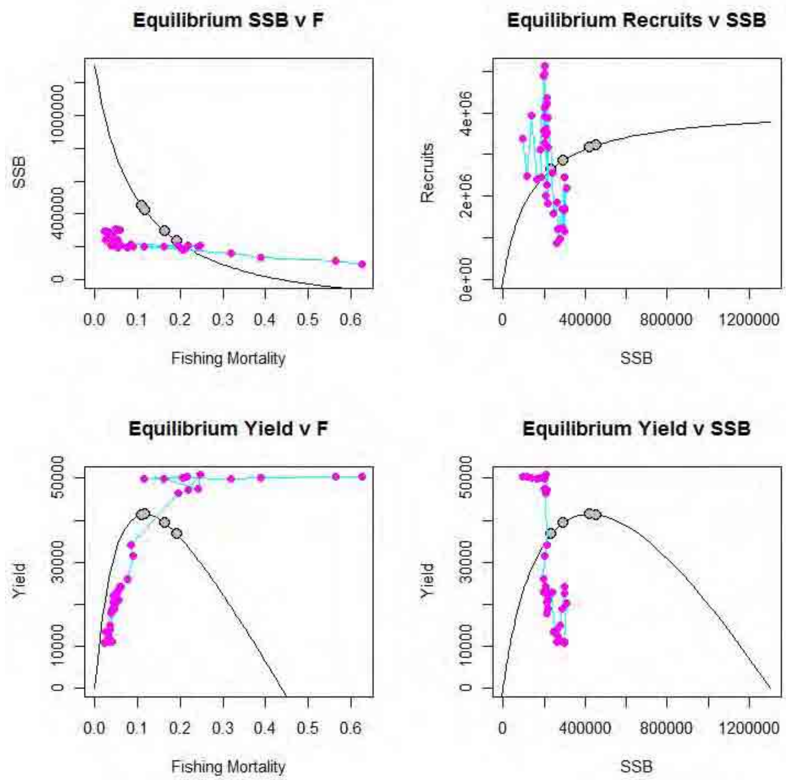
e) Reported catch, high recruitment (90s level), steepness = 0.75



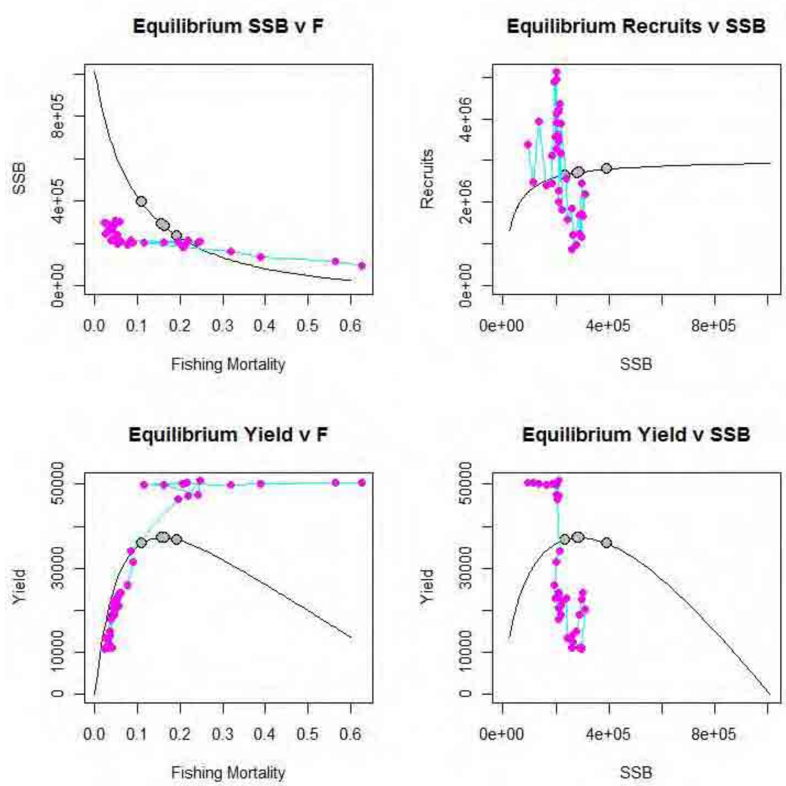
f) Reported catch, high recruitment (90s level), steepness = 0.99



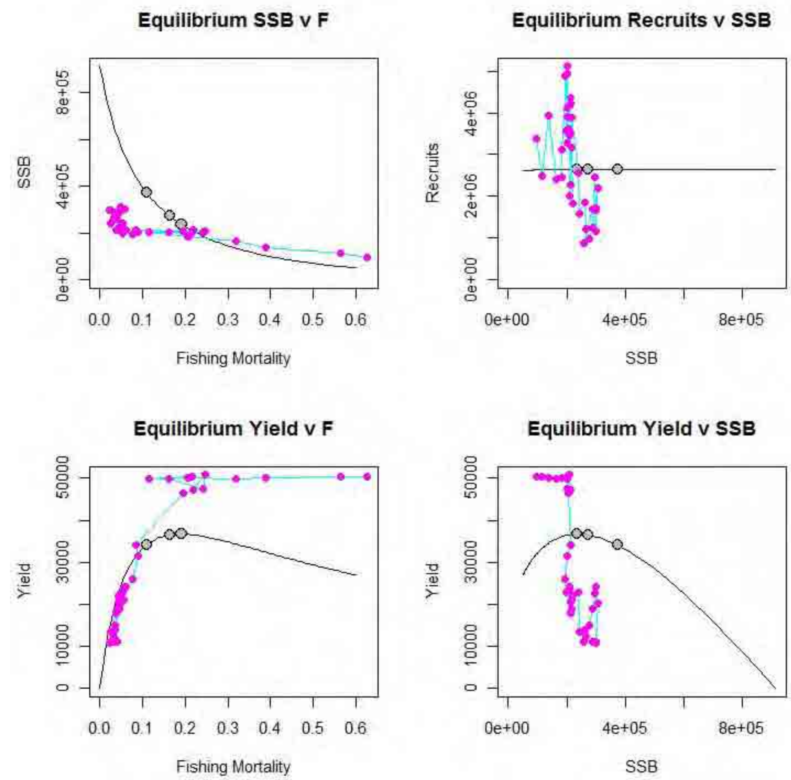
g) Adjusted catch, low recruitment (70s level), steepness = 0.5



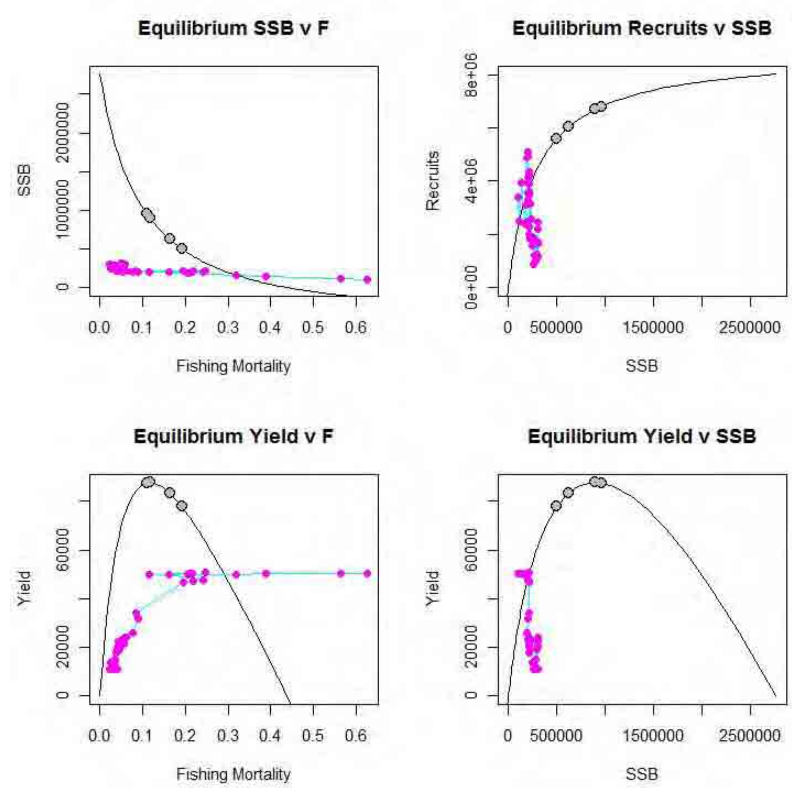
h) Adjusted catch, low recruitment (70s level), steepness = 0.75



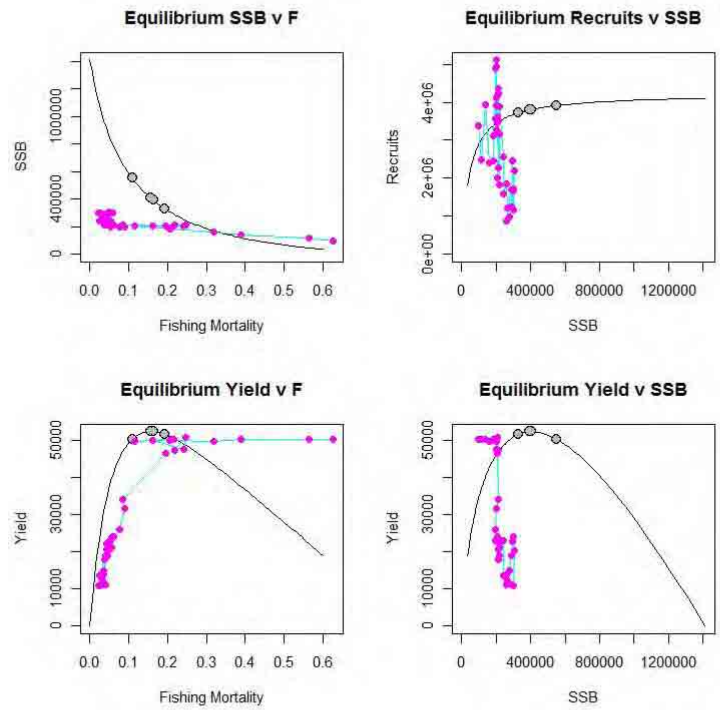
i) Adjusted catch, low recruitment (70s level), steepness = 0.99



j) Adjusted catch, high recruitment (90s level), steepness = 0.5



k) Adjusted catch, high recruitment (90s level), steepness = 0.75



l) Adjusted catch, high recruitment (90s level), steepness = 0.99

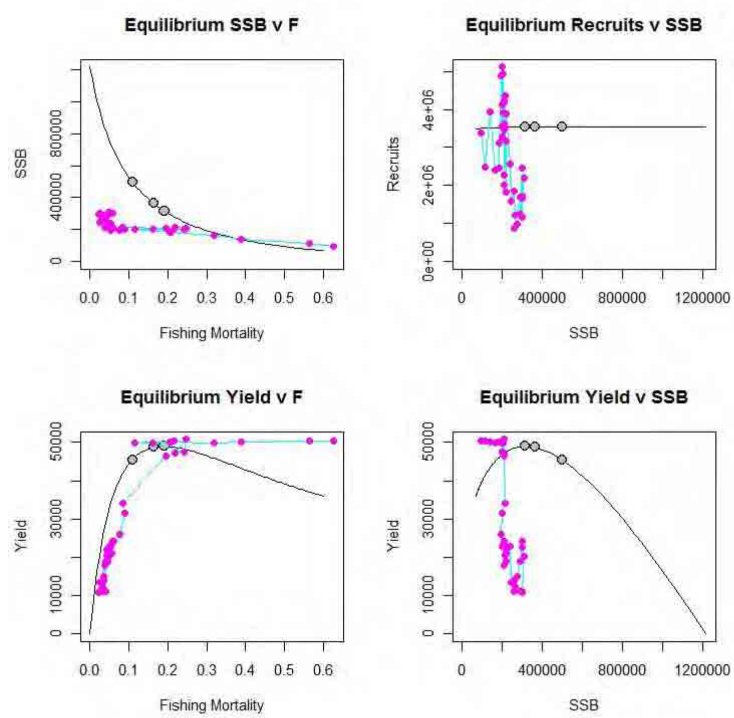


Figure 25. Results of projections made assuming high (mean 90s) and low (mean 70s) recruitment levels, different steepness values for the Beverton and Holt stock recruitment relationship (0.5, 0.75 or 0.99) and reported catch and adjusted catch.

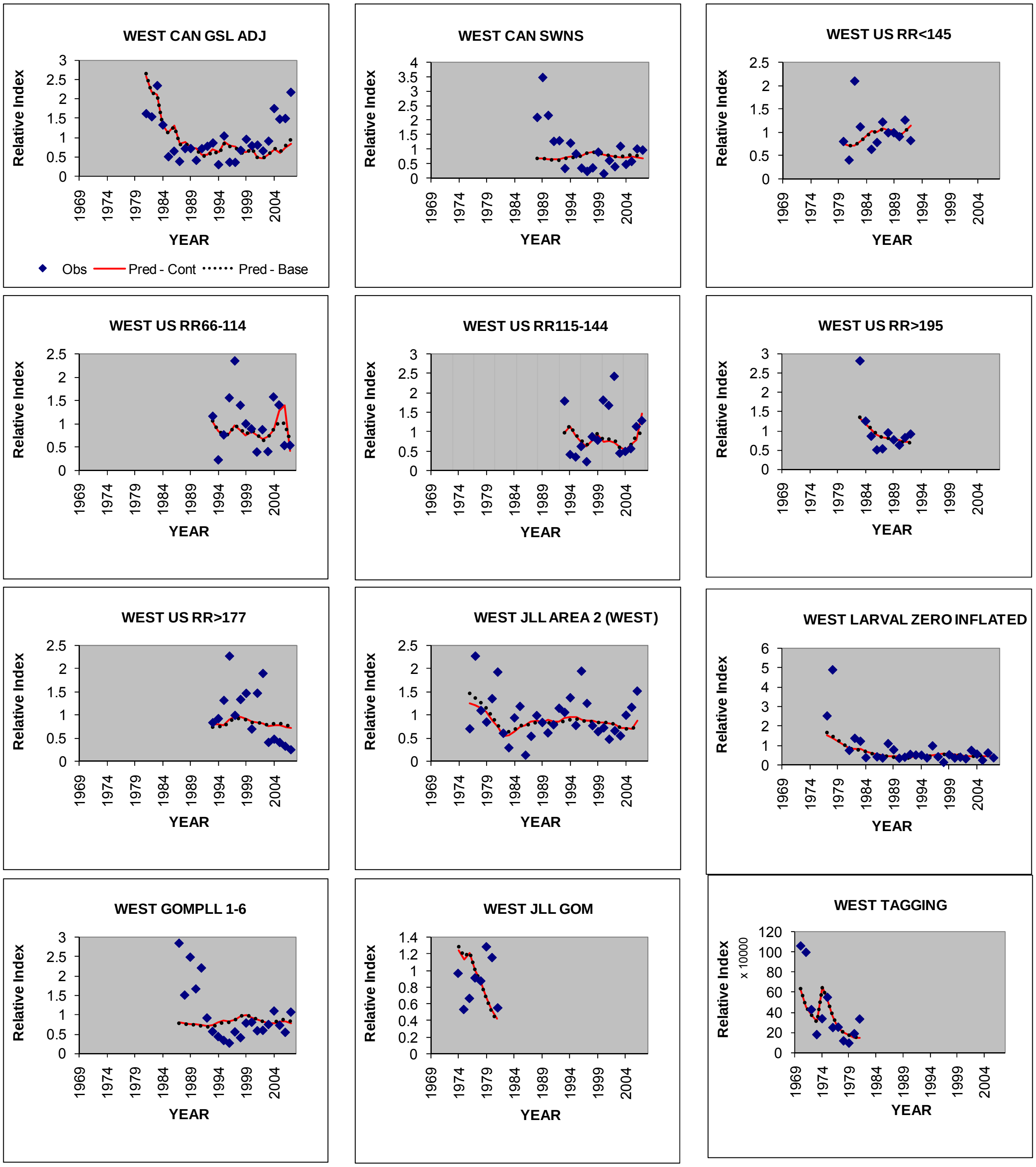


Figure 26. Fits to the CPUE indices for western Atlantic BFT continuity VPA (solid line) and base VPA(dashed line).

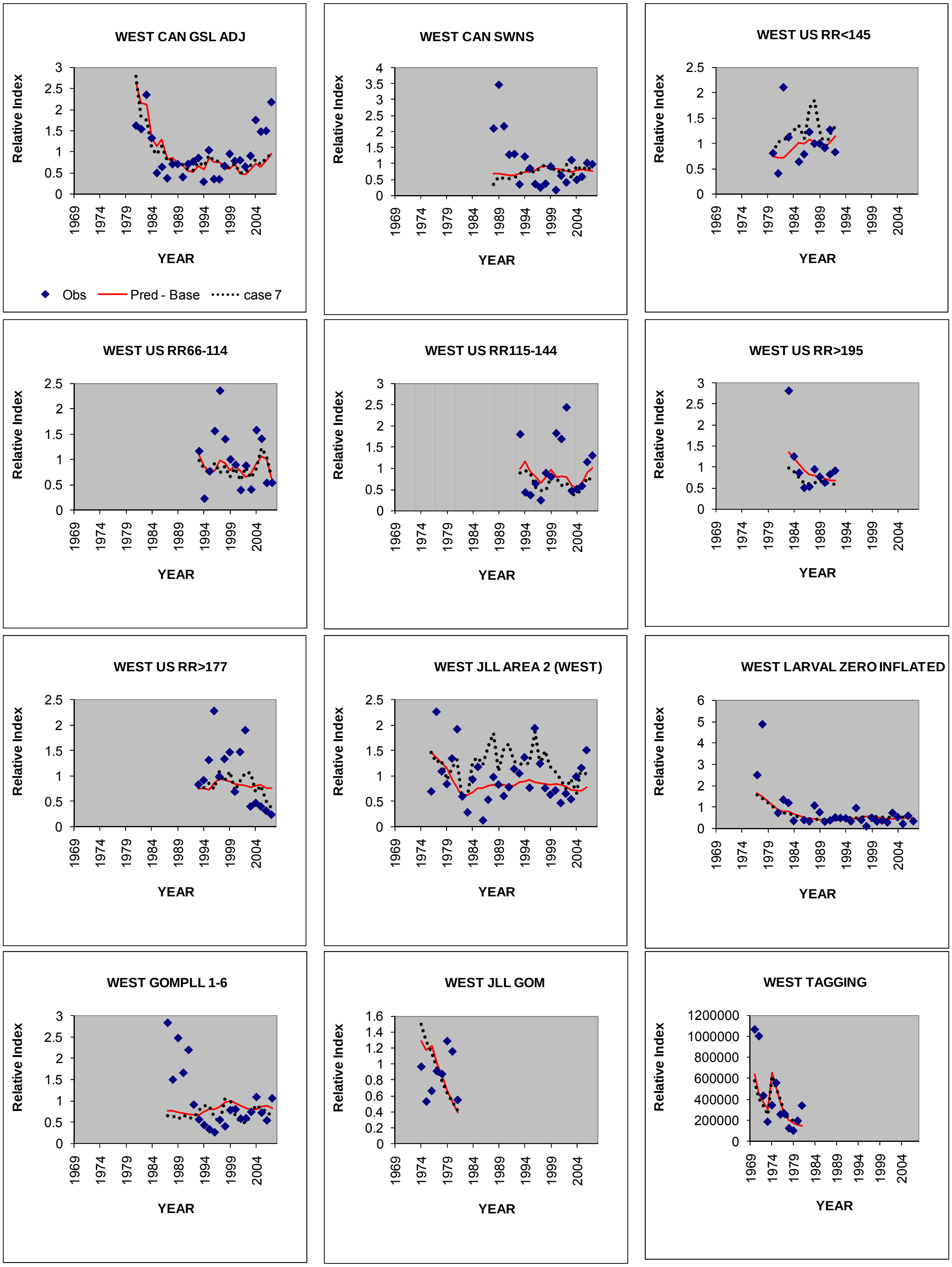


Figure 27. Fits to the CPUE indices for western Atlantic base VPA (solid line) and Case 7 (dashed line).

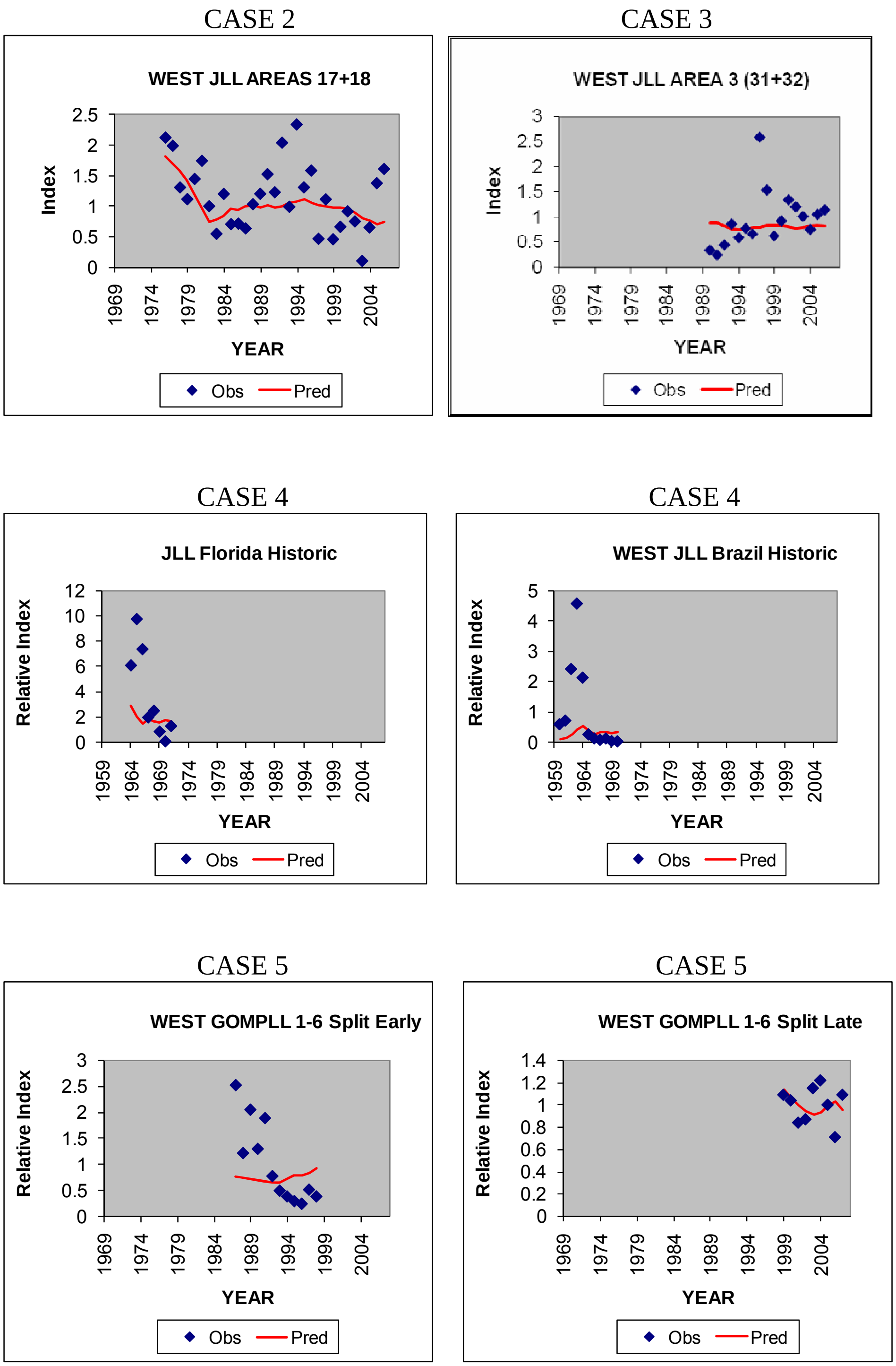


Figure 28. Fits to assorted CPUE indices for western Atlantic BFT used in sensitivity cases only.

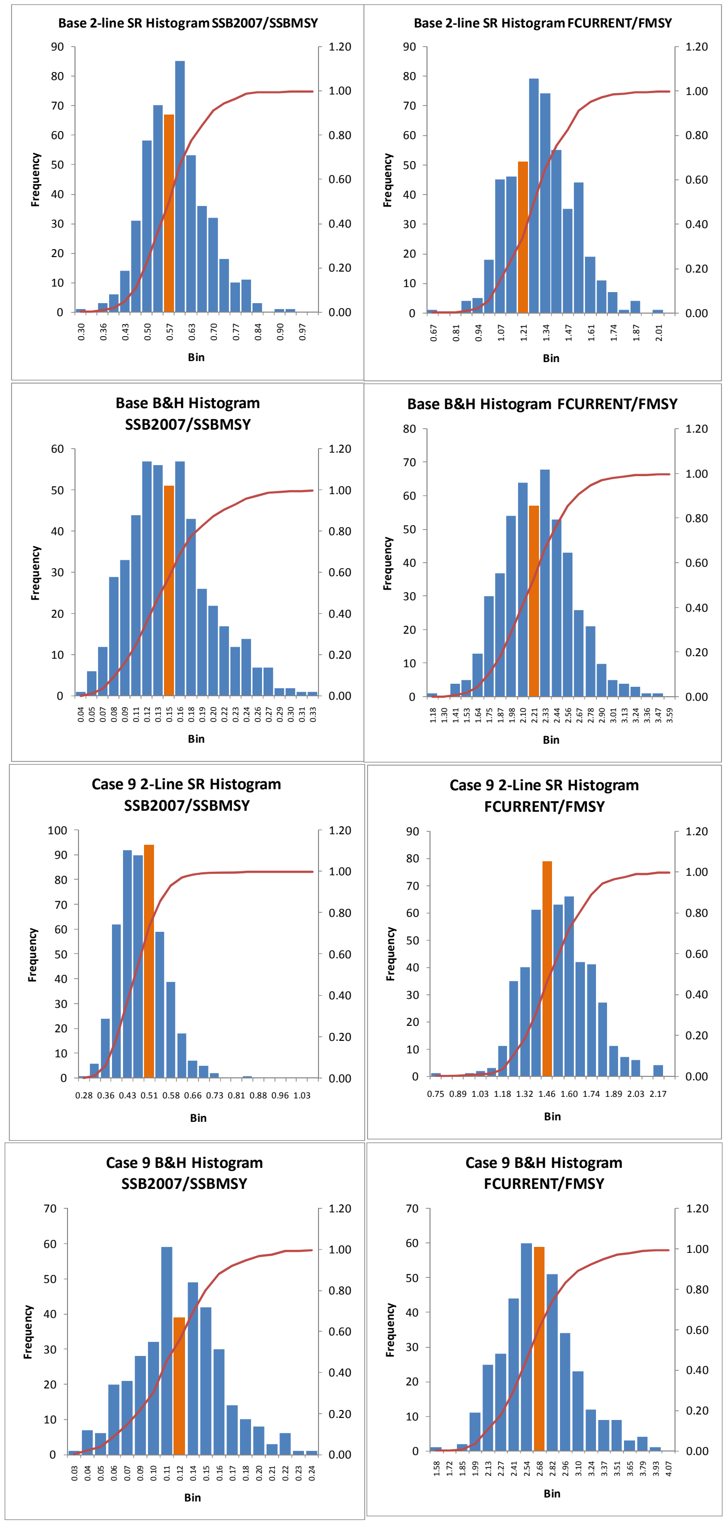


Figure 29. Histograms of bootstrap estimates of 2007 stock status. The red bar represents the values corresponding to the base-case deterministic estimate. The cumulative frequency is indicated with a solid red line.

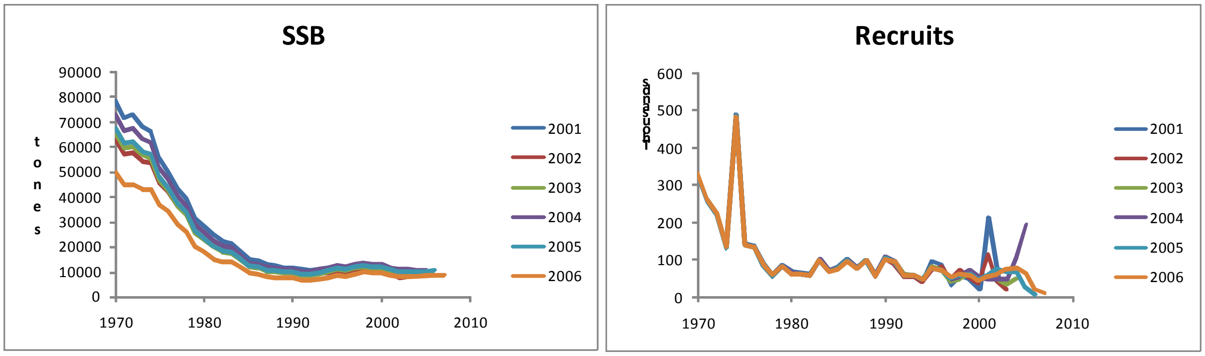


Figure 30. Retrospective trends of spawning biomass and recruits (age 1) from the West BFT base case. Each line represent the latest year included in the model fit.

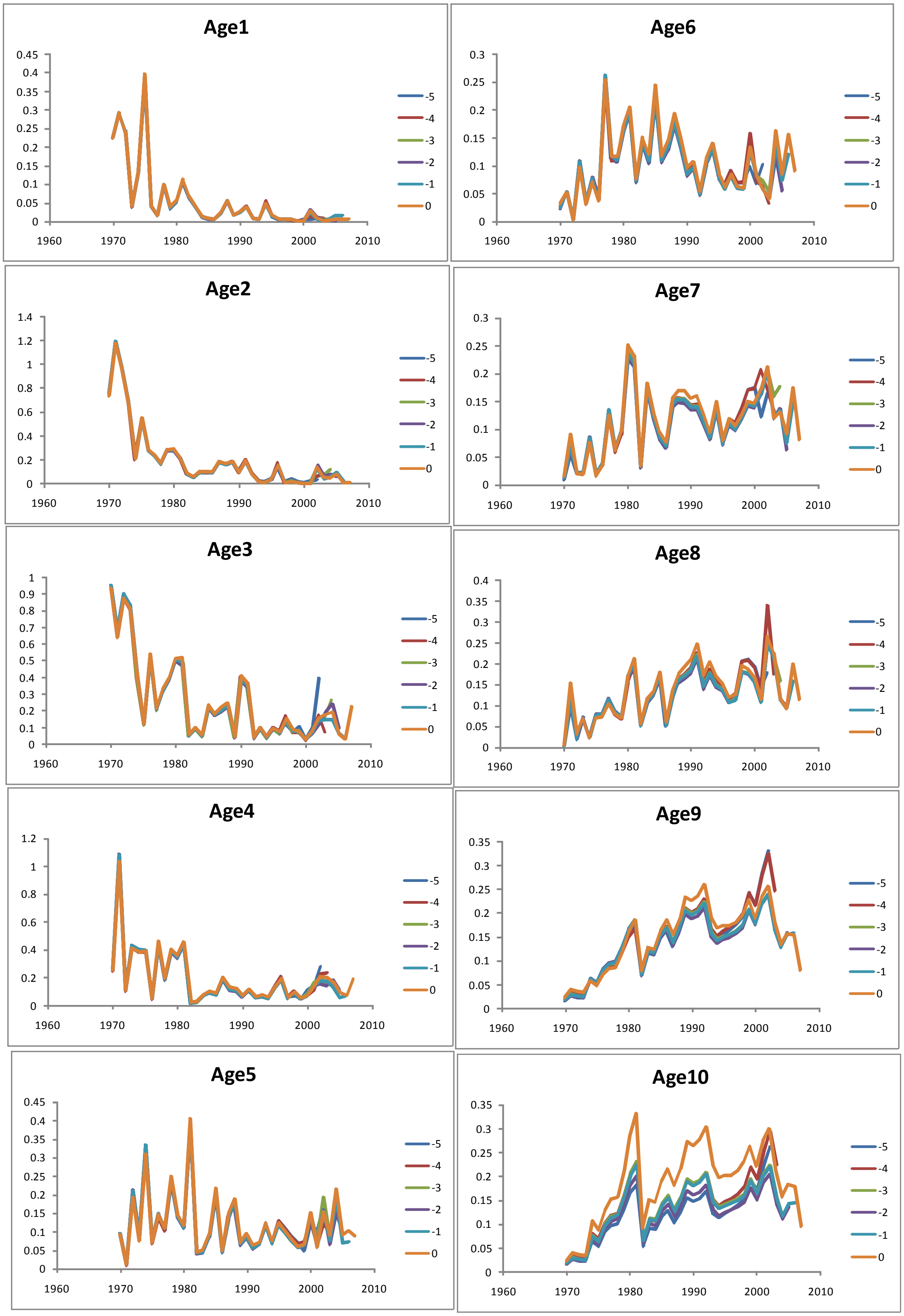


Figure 31. Retrospective patterns of fishing mortality by age (FAA) from the West BFT base case model. The legend indicates the number of years removed from the 2008 base run.

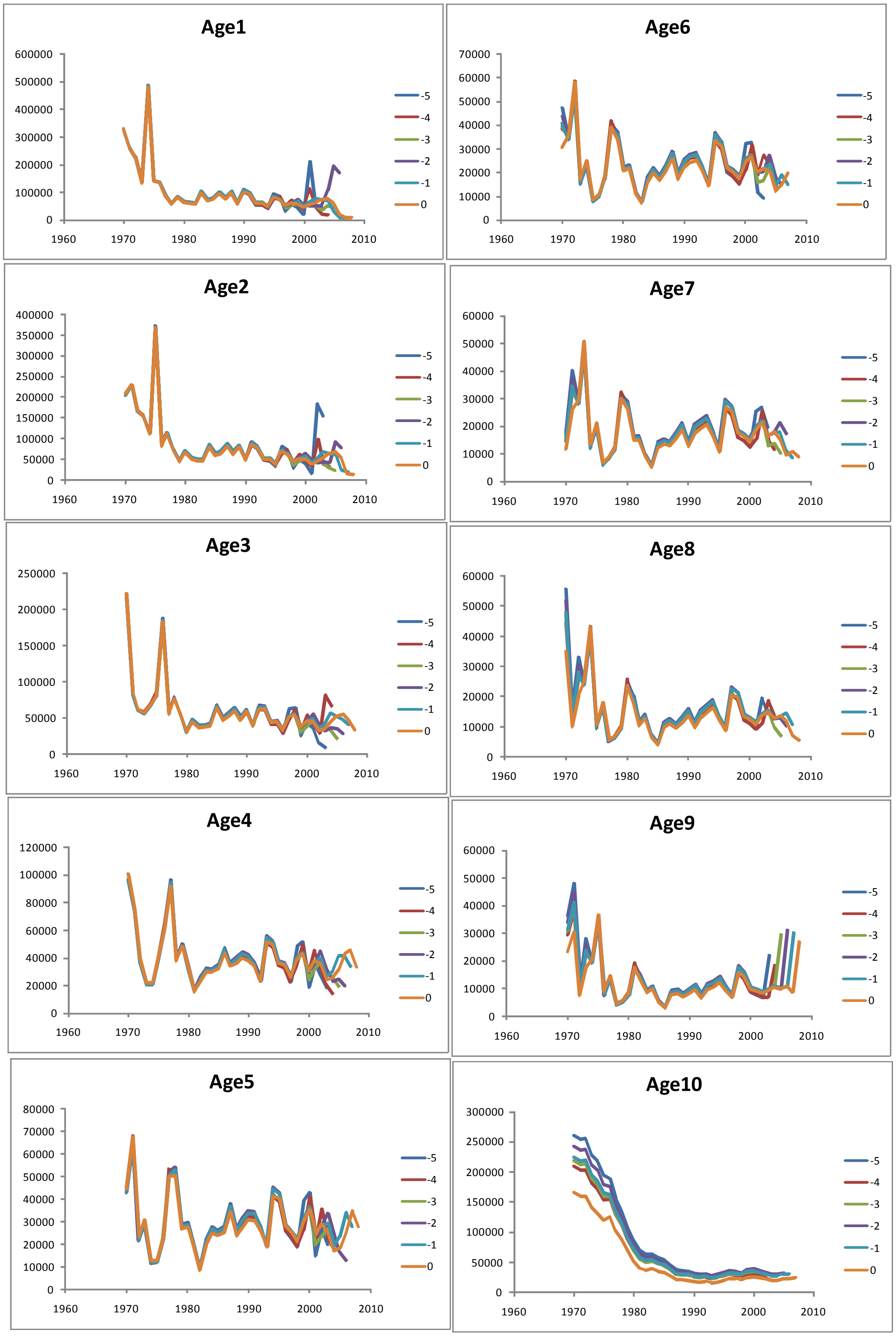


Figure 32. Retrospective patterns of numbers at age (NAA) from the West BFT base case model. The legend indicates the number of years removed from the 2008 base run.

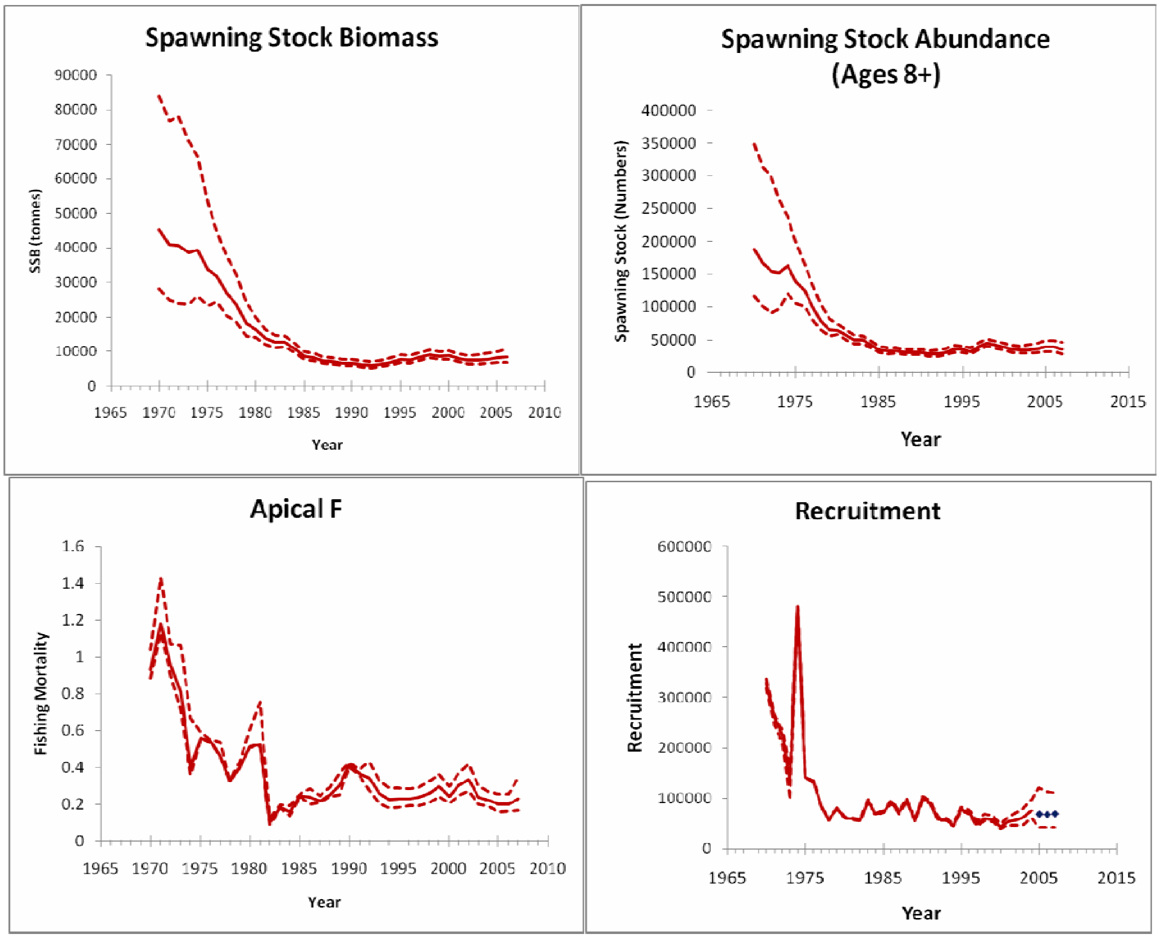


Figure 33. Annual median estimates of total biomass, yield, spawning stock biomass, abundance of spawners (Age 8+), apical fishing mortality and recruitment relationship. The 2005-2007 recruitment estimates were replaced by values from the two-line S-R relationship (blue diamonds). Dashed lines indicate the 80% confidence interval.

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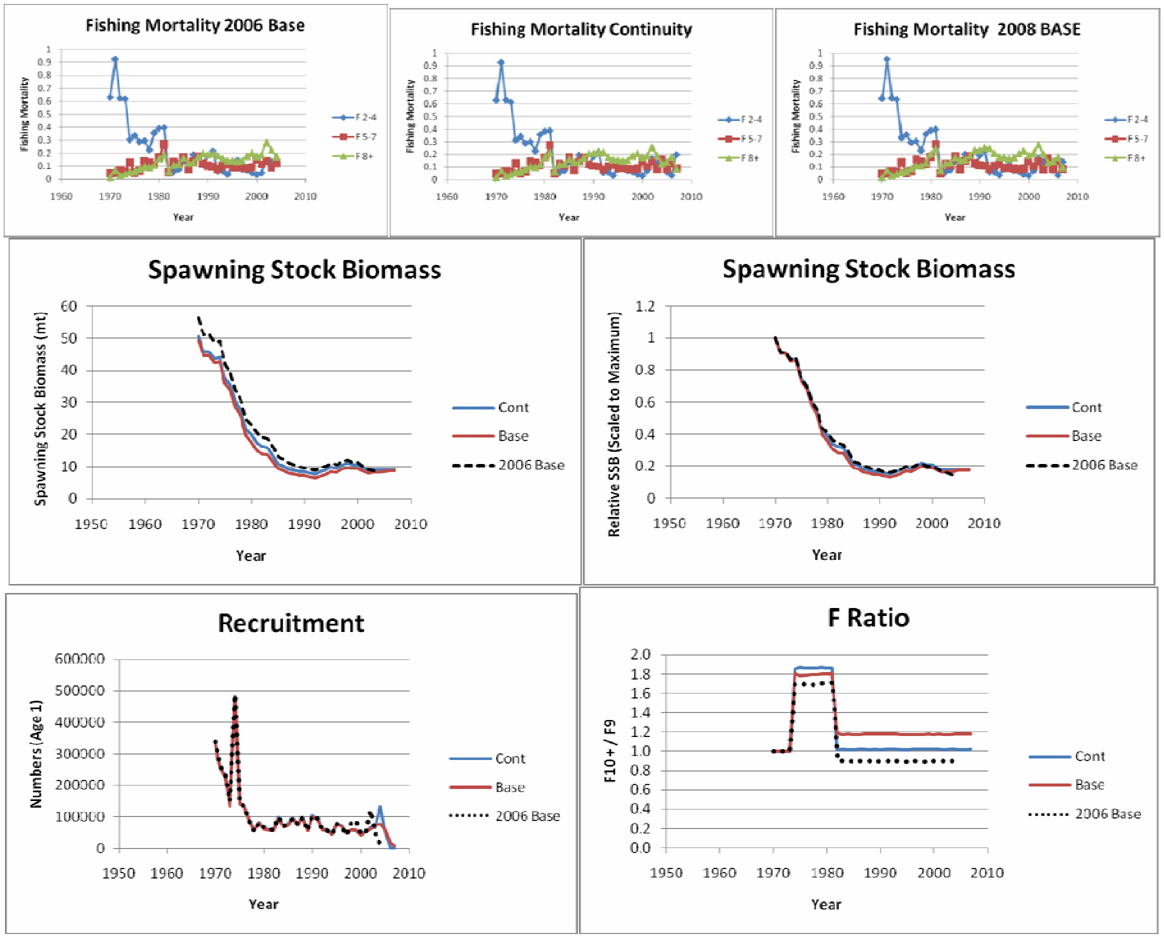


Figure 34. Annual estimates of average fishing mortality by age group, spawning stock biomass (SSB), recruitment and F-Ratio for the 2006 base and 2008 base and continuity VPA runs.

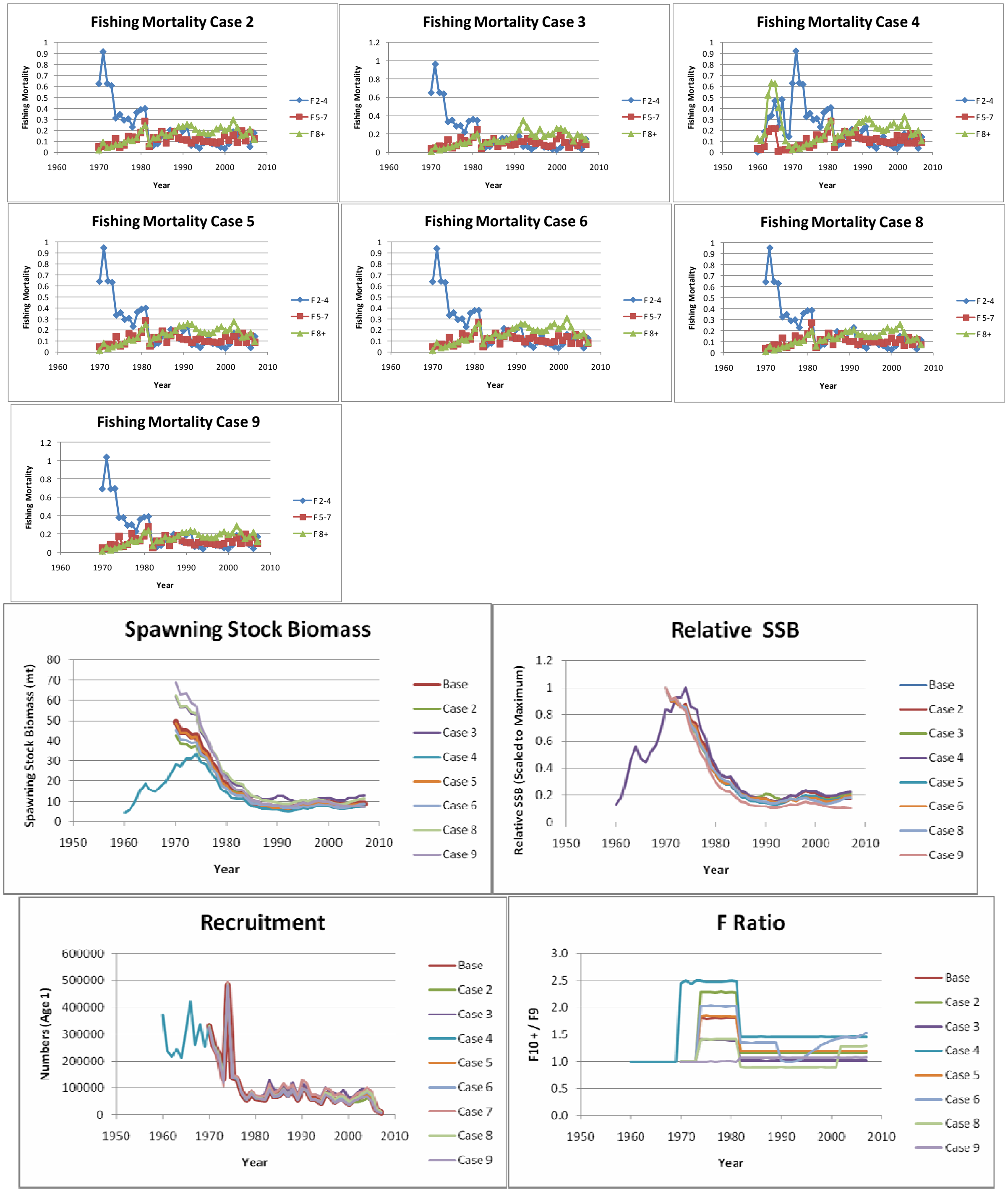


Figure 35. Annual estimates of spawning stock biomass (SSB), recruitment and F-Ratio for the VPA base and sensitivity runs.

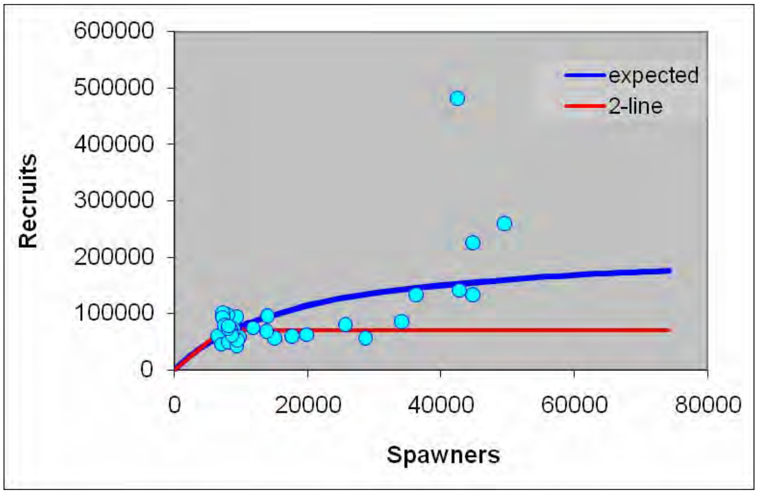
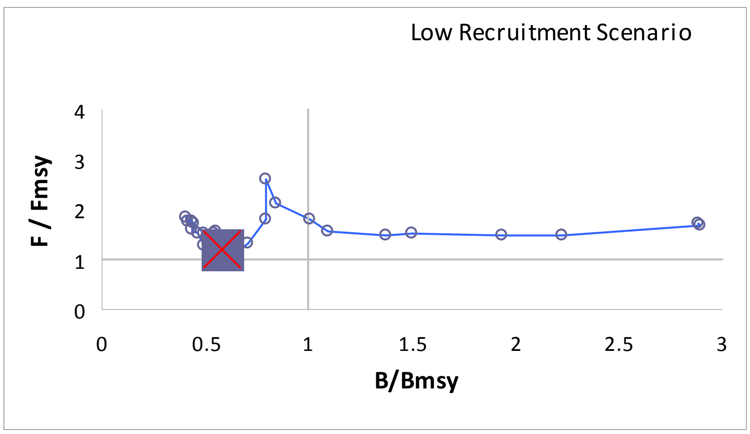


Figure 36. The spawner-recruit relationships fit to the 2008 VPA base model. The two-line and Beverton and Holt formulations were used to calculate management reference points and project the population dynamics through 2019.



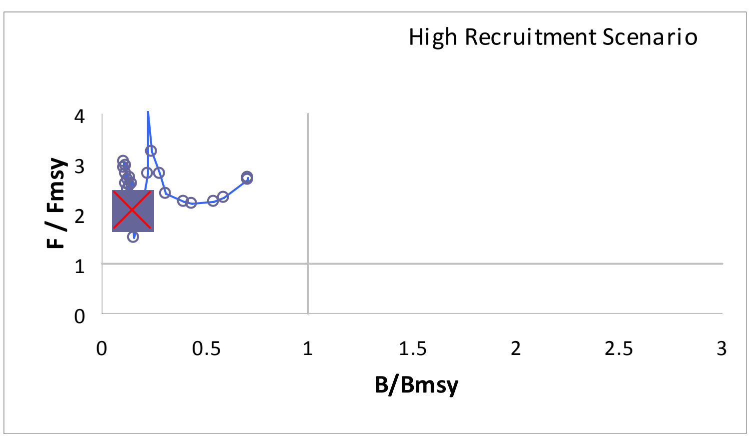


Figure 37. Trajectory of stock status estimated by the VPA base case. Two types of S-R relationships were examined, a two-line model (low recruitment) and the Beverton and Holt (high recruitment) option. F current is defined as the geometric mean fishing mortality during 2004-2006. The X is the current median status result. The calculation of MSY benchmarks was made annually so as to allow for interannual changes in selectivity.

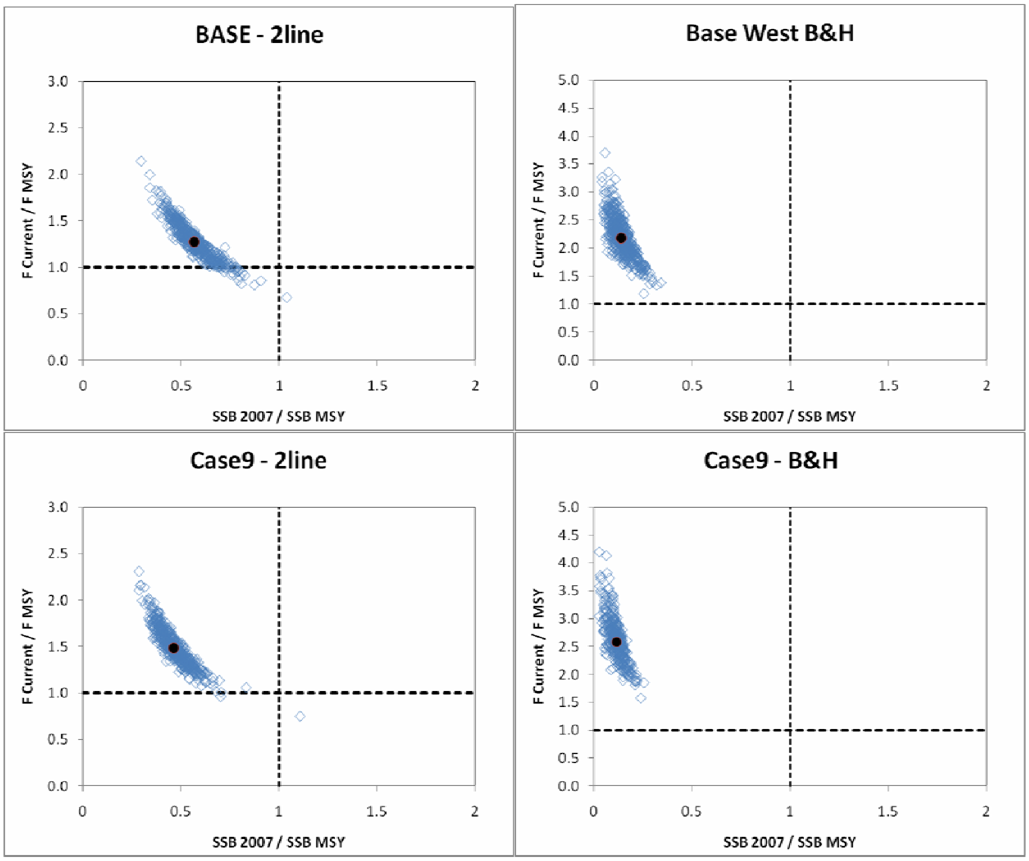


Figure 38. Stock status in 2007 estimated by the VPA base and Case 9 models (Case 9: remove Can GSL index). Two types of S-R relationships were examined, a two-line model (low recruitment) and the Beverton and Holt (high recruitment) option. F current is defined as the geometric mean fishing mortality during 2004-2006. The filled circle is the median result. The open circles are estimates of stock status from 500 bootstrap runs.

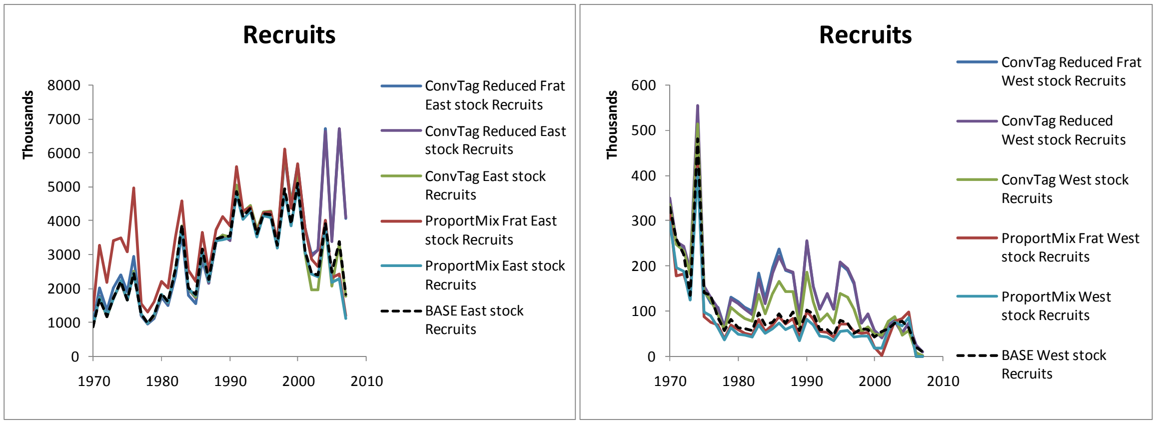


Figure 39. Recruitment (age 1) estimates for the eastern (left) and western (right) populations of bluefin tuna for the five scenarios compared to the corresponding base cases without mixing (dashed line).

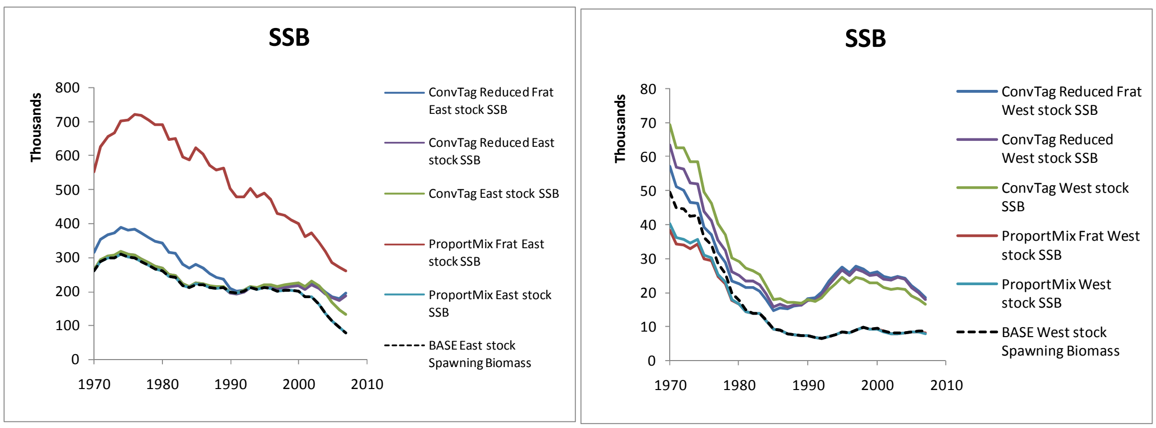


Figure 40. Spawning biomass estimates (tons) for the eastern (left) and western (right) populations of bluefin tuna for the five scenarios compared to the corresponding base cases without mixing (dashed line).

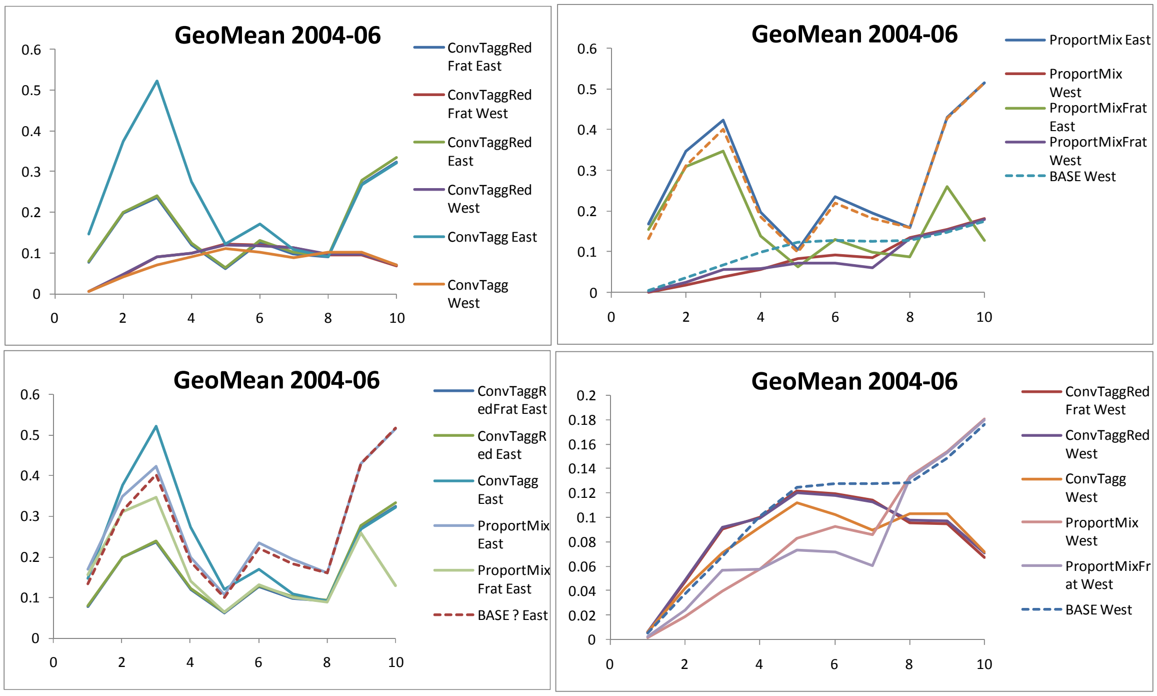
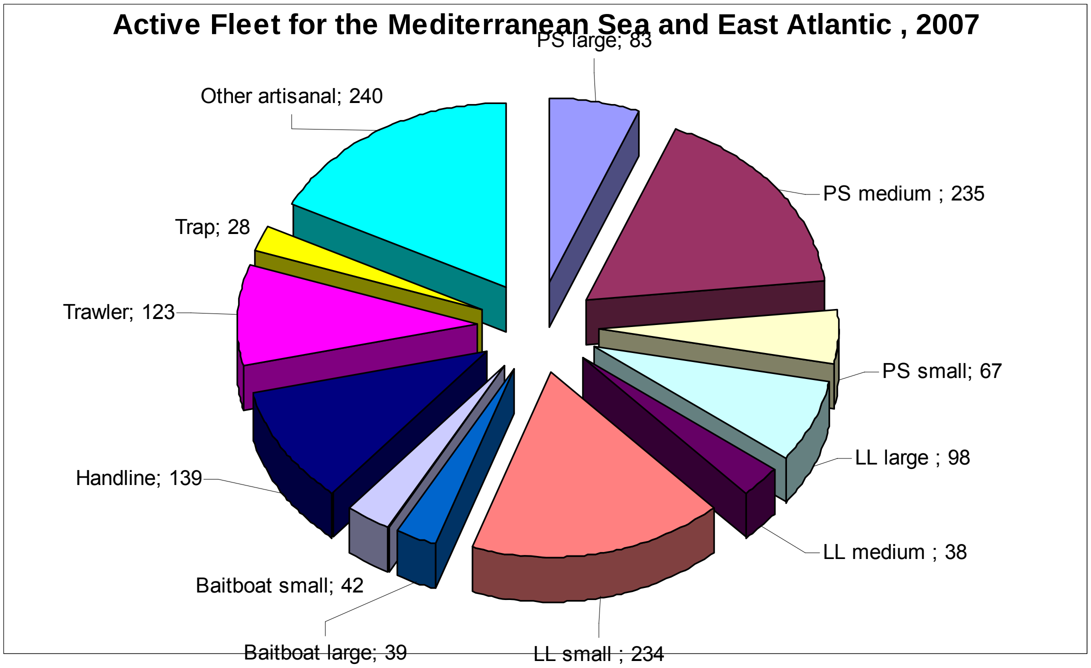


Figure 41. Recent fishing mortality rate estimates (geometric mean from 2004-2006) for the eastern (left) and western (right) populations of bluefin tuna for the five scenarios compared to the corresponding base cases without mixing (dashed line).



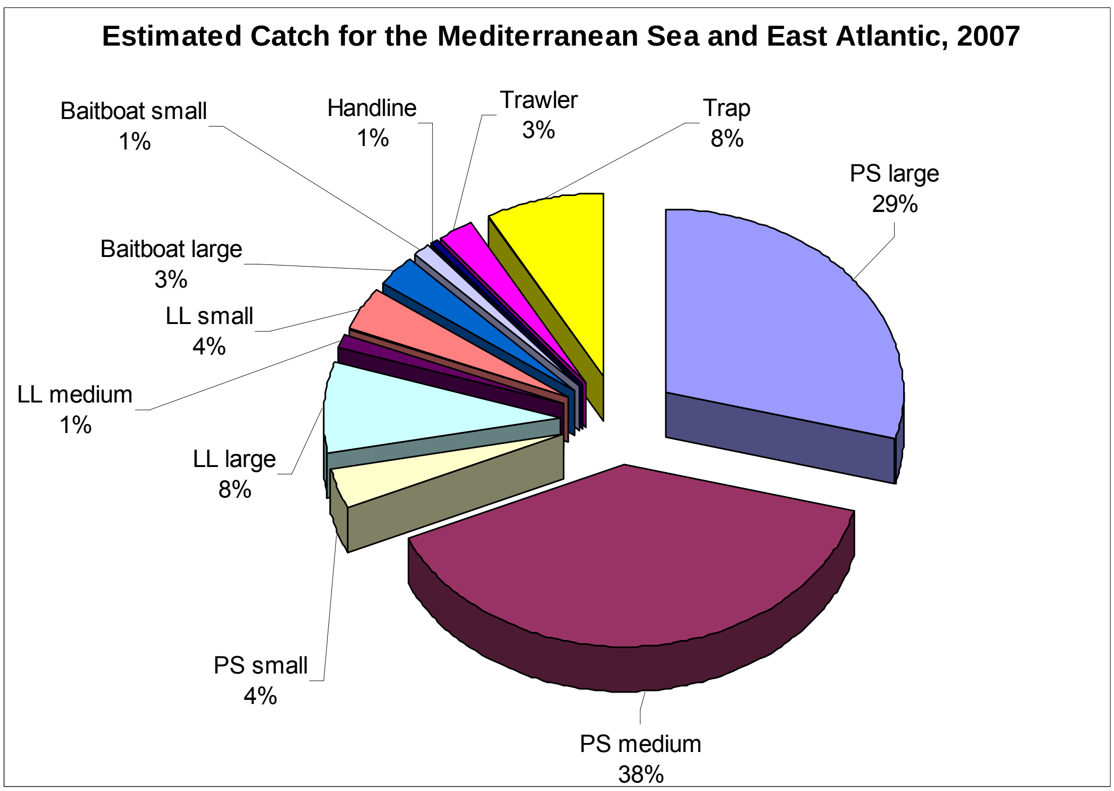
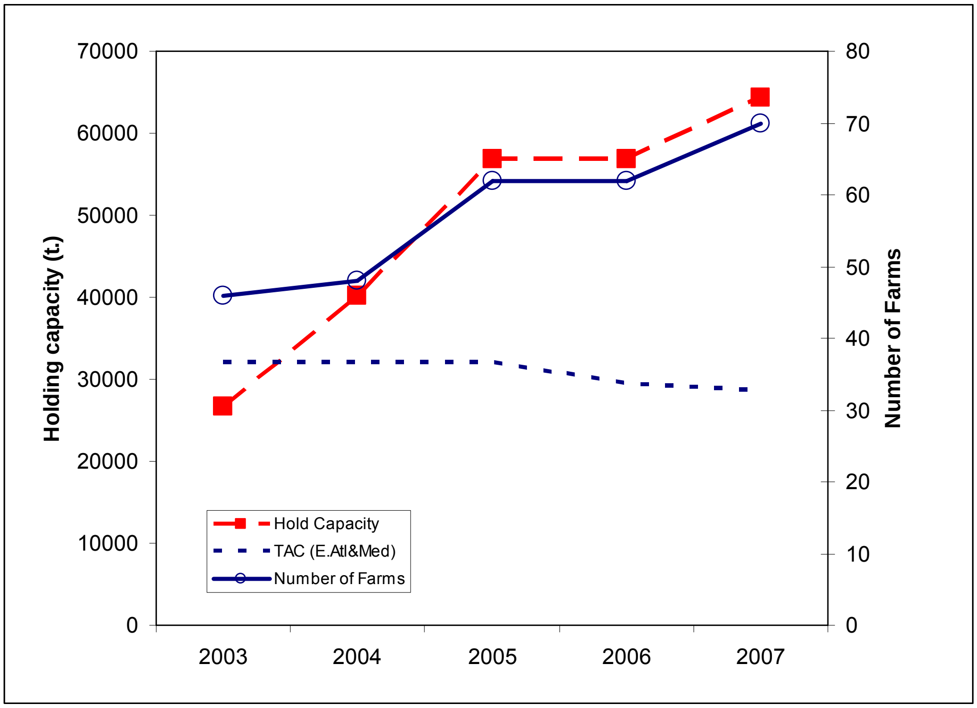


Figure 42. Estimated 2007 active fleet fishing for bluefin (upper) and the corresponding percentage contribution to an estimated overall catch of about 60,000 t in 2007 (lower) by fleet types for the Mediterranean Sea and East Atlantic.



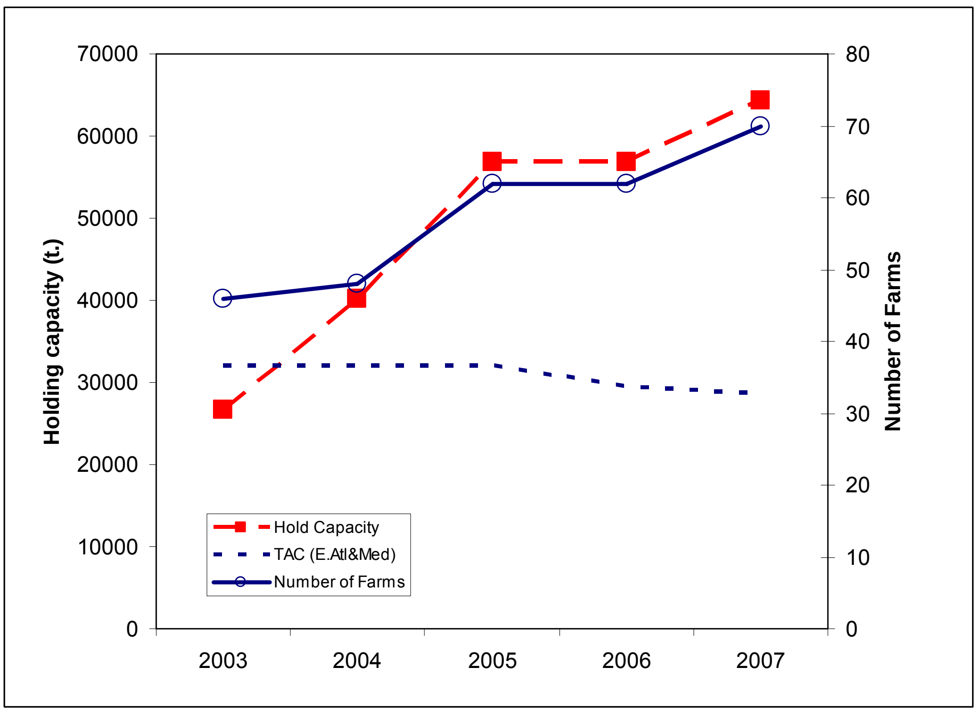
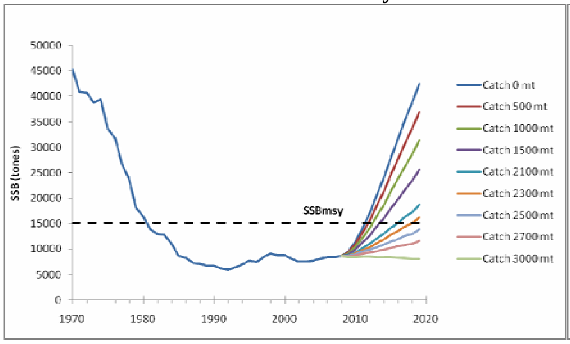
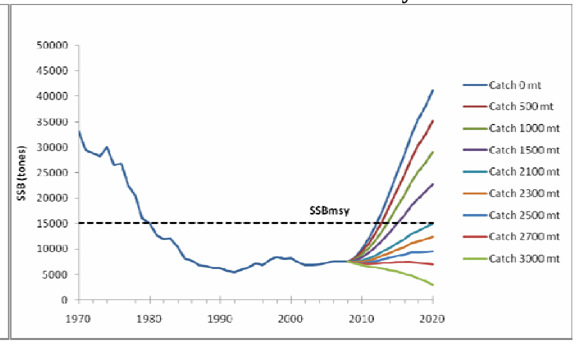


Figure 43. Estimated Mediterranean bluefin farm capacity and number of farms as reported by CPCs to the Secretariat. Agreed TACs for the time period are also indicated.

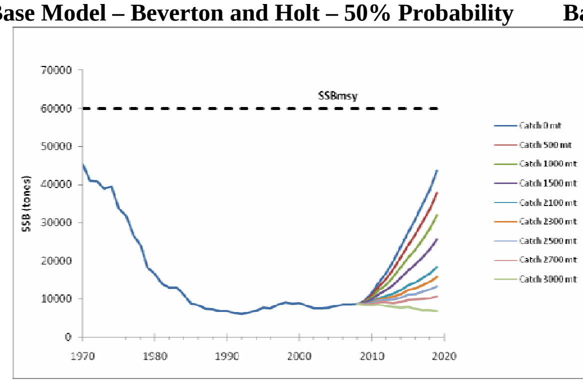
Base Model – Two-line – 50% Probability



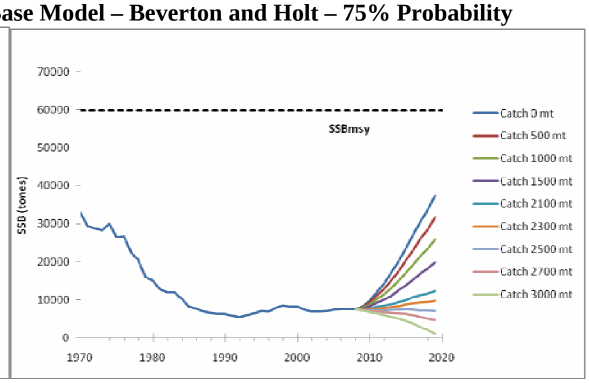
Base Model – Two-line – 75% Probability



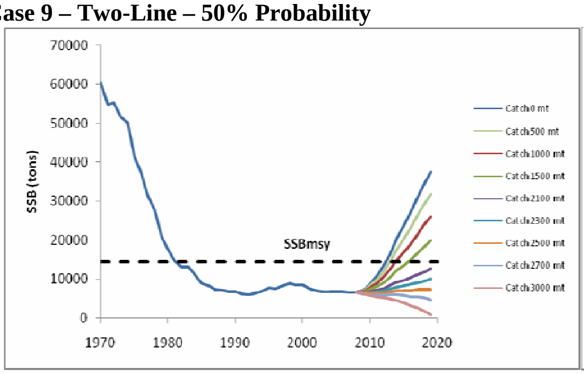
Base Model – Beverton and Holt – 50% Probability



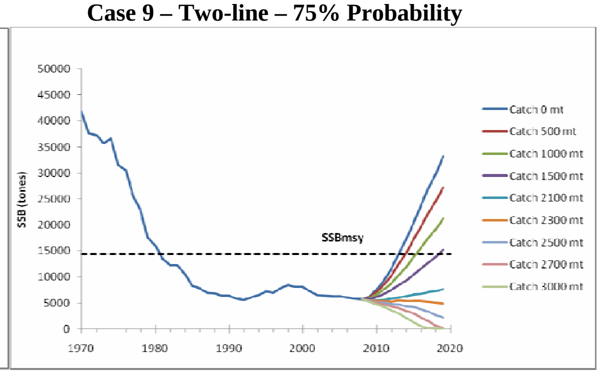
Base Model – Beverton and Holt – 75% Probability



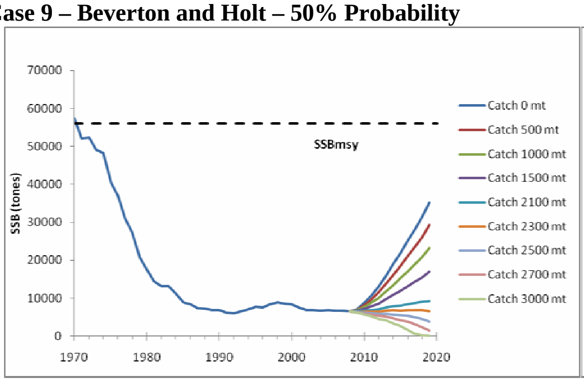
Case 9 – Two-Line – 50% Probability



Case 9 – Two-line – 75% Probability



Case 9 – Beverton and Holt – 50% Probability



Case 9 – Beverton and Holt – 75% Probability

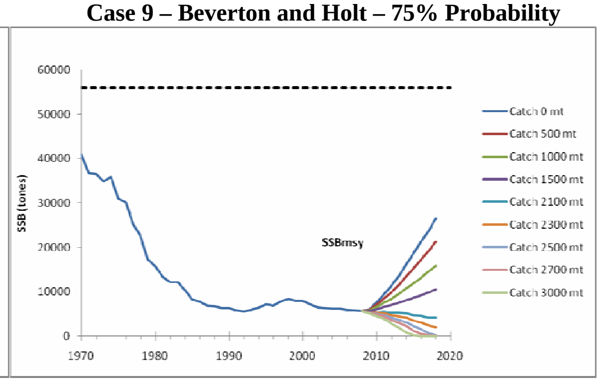


Figure 44. Projections of spawning stock biomass (SSB) from the Base and Case 9 (no GSL index) VPAs under various levels of constant catch. The labels "50% probability" and "75% probability" refer to the probability that the SSB will be greater than or equal to the values indicated by each line. Note that the lines corresponding to each catch level are arranged sequentially in the same order as the legends.

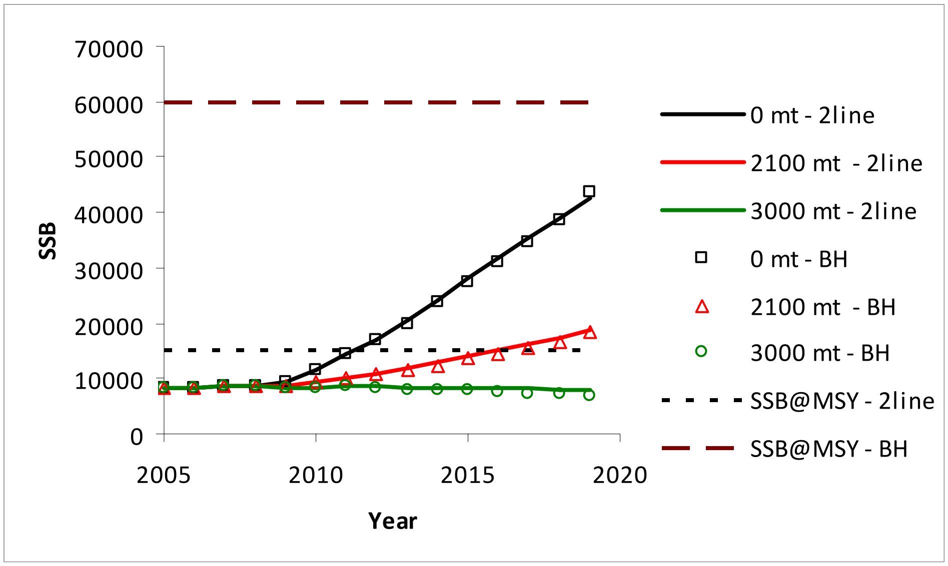


Figure 45. Median projections of spawning stock biomass (SSB) for the Base Case assessment under various levels of constant catch (left) and under various levels of constant fishing mortality rate (right). NOTE: Lines are arranged sequentially in the same order as the legends.

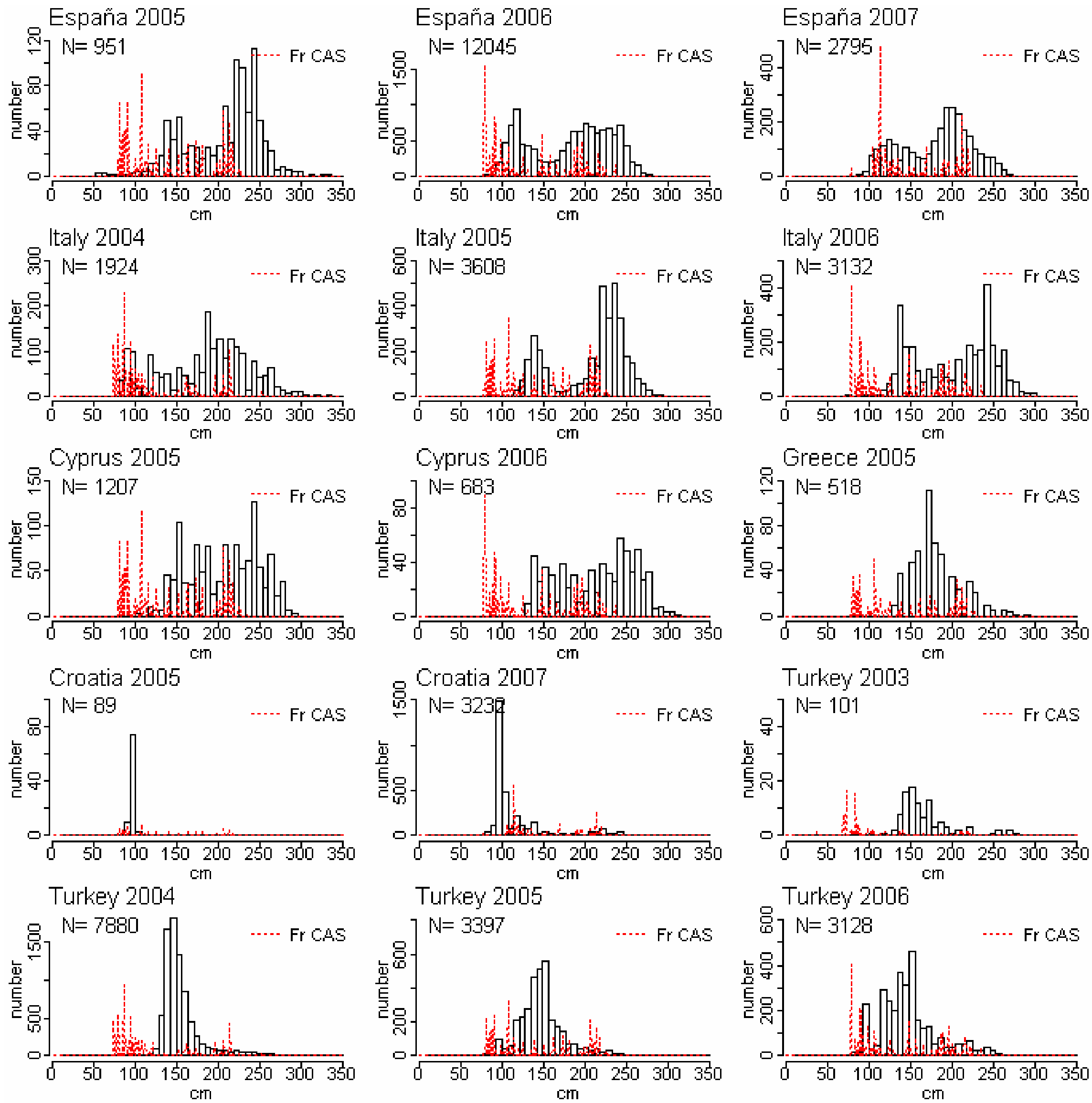


Figure 46. Histogram of fork lengths or weights of fish at time of harvest from Mediterranean BFT farms. French purse seine catch at size for the year of harvest plotted in red. (note that catch is usually taken in May-June, while the farm harvest is in December so there could be some growth in length over this time period).

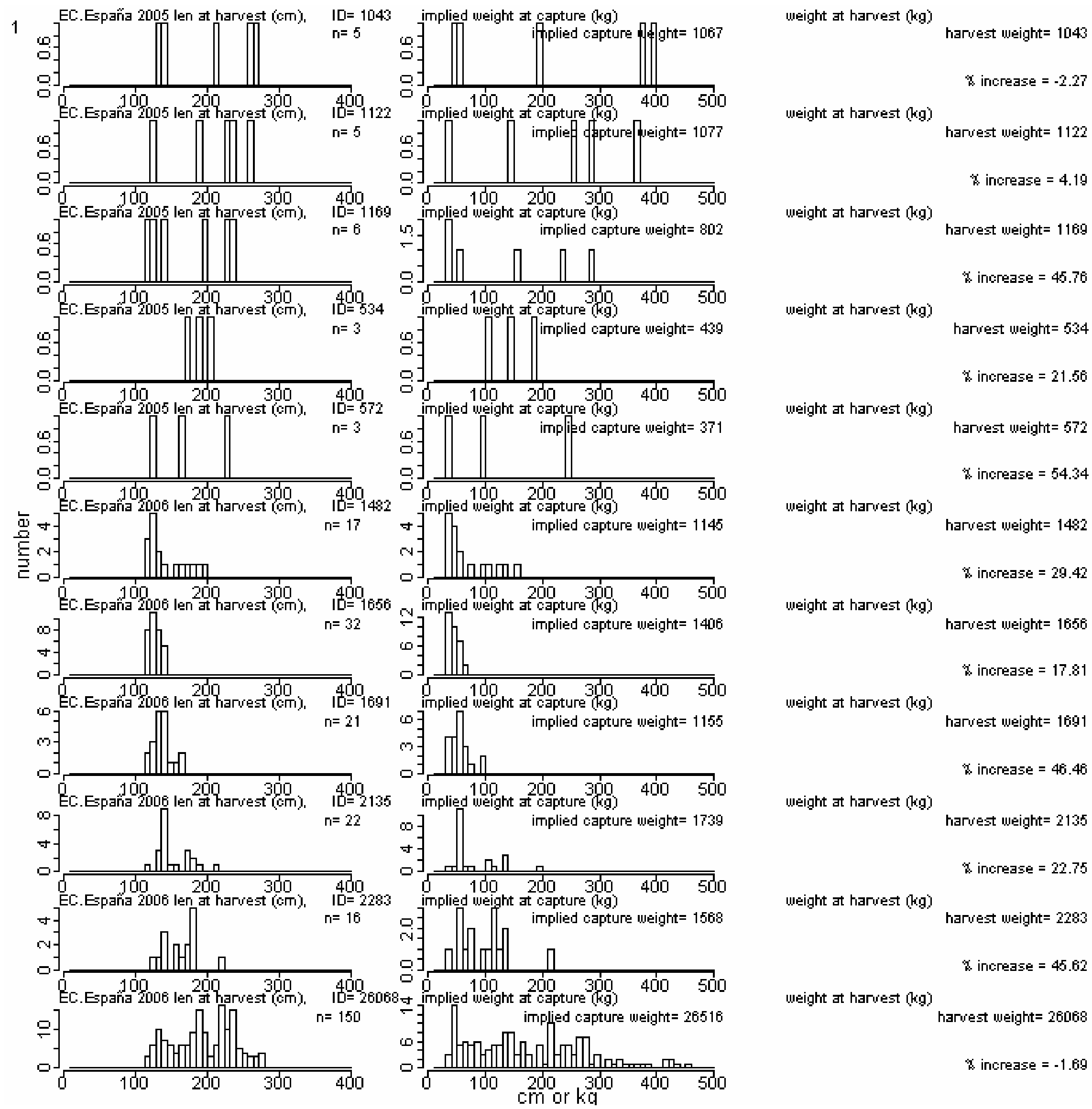


Figure 47. Histograms of length at harvest, implied weight at capture assuming that captured BFT follow the ICCAT length-weight conversion (Arena, unpub.) and the actual weights at harvest for the farms from Spain for which weight at harvest was provided.

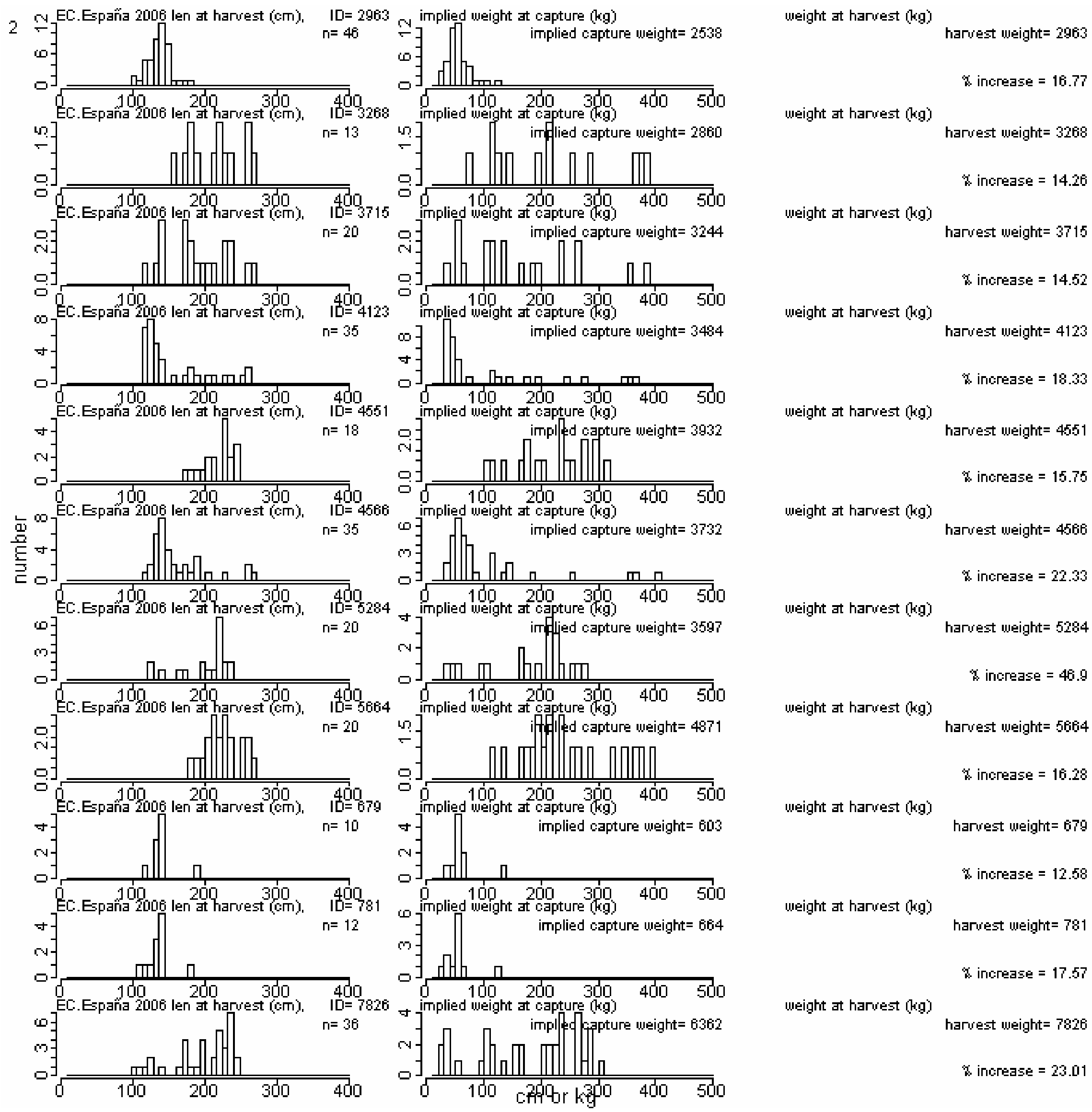


Figure 47 Continued.

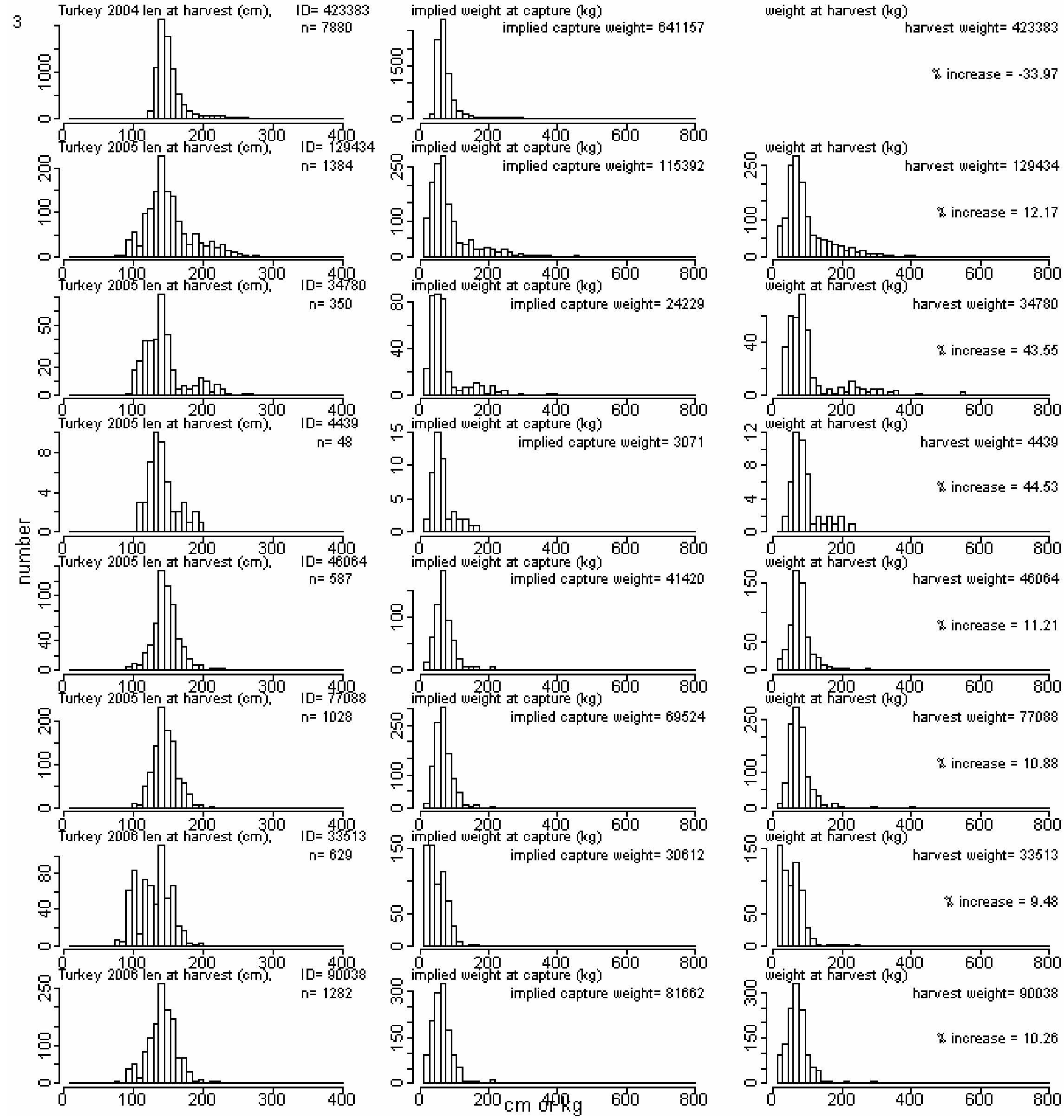


Figure 48. Histograms of length at harvest, implied weight at capture assuming that captured BFT follow the ICCAT length-weight conversion (Arena, unpub.) and the actual weights at harvest for the farms from Turkey for which weight at harvest was provided.

Appendix 1

Agenda

1. Opening, adoption of the Agenda and meeting arrangements.
2. Review of the Rebuilding Plans for Atlantic and Mediterranean bluefin tuna and previous SCRS advice
3. Consideration of the findings and recommendations of the World Symposium for the Study into the Stock Fluctuation of Northern Bluefin Tunas (*Thunnus thynnus* and *Thunnus orientalis*), including the historic periods
4. New biological information, including results from tagging, microconstituent analysis, growth and reproductive studies, and other studies pertinent to the assessment
5. Catch data, including size frequencies and fisheries trends
   - 5.1 Fishery trends – East
   - 5.2 Fishery trends – West
   - 5.3 Catch data – East
   - 5.4 Catch data – West
   - 5.5 Mixing variants
6. Relative abundance indices and other fishery indicators
   - 6.1 Relative abundance indices – East
   - 6.2 Relative abundance indices – West
7. Methods and other data relevant to the assessment
   - 7.1 Methods – East
   - 7.2 Methods – West
   - 7.3 Methods – Mixing variants
   - 7.4 Methods – Regulatory analyses
   - 7.5 Methods for integration of management advice across multiple hypotheses
   - 7.6 Other methods
8. Stock status results
   - 8.1 Stock status – East
   - 8.2 Stock status – West
   - 8.3 Stock status – variants considering mixing
9. Evaluation of fishing capacity relative to the ICCAT Convention objectives
   - 9.1 East
   - 9.2 West
10. Projections
    - 10.1 Projections – East
    - 10.2 Projections – West
11. Recommendations
    - 11.1 Research and statistics – East
    - 11.2 Research and statistics – West
    - 11.3 Management – East, including advice on the odds of achieving the current Rebuilding Plan objectives without further adjustment
    - 11.4 Management – West, including advice on the odds of achieving the current Rebuilding Plan objectives without further adjustment
12. Other matters
13. Adoption of the report and closure

Appendix 2

BLUEFIN TUNA WORKPLAN: YEAR 2008

1. Overview

The next bluefin tuna stock assessment (East and West) has been scheduled by the Commission for 2008. The Bluefin Tuna Species Group reiterates the fact that its general advice is unlikely to change significantly within two years time because of bluefin tuna long life span and the necessary delay to detect first effects of most recent regulations. The group thinks that a four-year period would be more appropriate between each comprehensive bluefin tuna stock assessment session. This will allow the Group more time for inter-sessional work, especially to investigate important or novel issues regarding data and models. If the requirement of a stock assessment in 2008 remains, this should be scheduled in late June/early July. Nine days are considered sufficient for the quantitative assessment work and report writing only if much of the data-preparatory work is carried out in advance of the meeting. In particular, it is essential that catch (being disaggregated by gear/main area[1]/month), catch-at-age and tagging data through 2006 be as final as a few months prior to the meeting to allow preparatory works and analyses.

2. Data submission

National scientists should submit any missing eastern Atlantic and Mediterranean statistics forthwith. Data for the eastern and western stock through 2006 should be submitted to the Secretariat by the end of March 2008, while data of 2007 should be submitted, at the latest, one week prior to the meeting, so that the Secretariat can incorporate the statistics into the database. *Action National Scientists*

Estimates of unreported landings for the eastern unit should be investigated prior to the meeting and completed during the assessment meeting. *Action National Scientists and Secretariat*

All National Scientists should provide catch, catch-at-size, tagging and CPUE data up to and including 2007 where available (East and West). 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 2007 and earlier. *Action National Scientists and Secretariat*

The SCRS has also recommended that efforts be made to extend the assessment time series into the past. National Scientists are asked to ensure that any available historical data (especially catch-at-size pre-1970) have been made available to the Secretariat. *Action National Scientists*

The SCRS also recommended that efforts be made to share novel biological information prior to the meeting, e.g. through a list server maintained by the secretariat. *Action National Scientists and Secretariat*

3. Catch summaries

The Secretariat should prepare summaries of the available catch data as well as catch-at-size data by the start of the meeting. Late submissions will not be included. *Action Secretariat*

4. Assessment

The stock assessment work should update the 2006 stock assessments. In the case of the West stock, mainline advice should be based on results from validated and documented software retained in the ICCAT catalog. These catalog entries need to be completed by April 2008. *Action National Scientists*

In the case of the East stock, it is still recommended that the Bluefin Tuna Species Group should investigate various assessment methods that may be robust to or that can take into account the large uncertainties in the total

[1]Main areas correspond to the 6 areas defined in Figure 3 of the ICCAT Bluefin Tuna Mixing Workshop (Anon. 2002).

catch and catch-at-size data. It is also expected that the Group will investigate more deeply the effects on stock status of the management measures that were adopted in November 2006 in Dubrovnik. *Action National Scientists*

Appendix 3

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Appendix 4

LIST OF DOCUMENTS

SCRS/2008/013	Proceedings of the joint CANADA-ICCAT 2008 Workshop on the Precautionary Approach for Western Bluefin Tuna *(Halifax, Nova Scotia, Canada, March 17 to 20, 2008)*. Gavaris S (Chairman), Hazin F, Neilson JN, Pallares P, Porch C, Restrepo VR, Scott G, Shelton P, Wang Y (editors).
SCRS/2008/083	Indices of stock status from the Canadian bluefin tuna fishery. Neilson, J., Smith, Ortiz and Lester.
SCRS/2008/084	Growth of Atlantic bluefin tuna: direct age estimates. Secor, D. H., R.L. Wingate, J.D. Neilson, J.R. Rooker, and S.E. Campana.
SCRS/2008/085	Standardized catch rates of bluefin tuna *(Thunnus thynnus)* from the U.S. pelagic longline vessels in the Gulf of Mexico 1987-2007. Diaz, G., and S. Cass-Calay.
SCRS/2008/086	Annual indices of bluefin tuna *(Thunnus thynnus)* spawning biomass in the Gulf of Mexico developed using delta-lognormal and multivariate models. Ingram, G.W. Jr., W. J. Richards, C. E. Porch, V. Restrepo, J. T. Lamkin, B. Muhling, J. LycDiaz, G.A., V. Restrepo, and B. McHalezkowski-Shultz, G. P. Scott and S. C. Turner.
SCRS/2008/087	Characterization of the U.S. commercial and recreational tuna fleets during 2007. Diaz, G.A., V. Restrepo and B. McHale.
SCRS/2008/088	Standardized catch rates of bluefin tuna, *Thunnus thynnus*, from the rod and reel/handline fishery off the northeast United States during 1980-2007. Brown, C.
SCRS/2008/089	Three different strategies for modeling the terminal-year fishing mortality rates in virtual population analyses of western bluefin tuna: Retrospective patterns and consequences for projections. Walter, J. and C. Porch.
SCRS/2008/091	Sensitivity of virtual population analyses of western Atlantic bluefin tuna to the use of an alternative growth curve for estimation of catch at age. Porch, C., V. Restrepo, J. Nielson and D. Secor.
SCRS/2008/092	Preliminary results from electronic Tagging of bluefin tuna *(Thunnus thynnus)* in the Gulf of St. Lawrence, Canada. Block, B.A., G. L. Lawson, A. M. Boustany, M. J.W. Stokesbury, M. Castleton, A. Spares, and J. D. Neilson.
SCRS/2008/093	A year-class curve analysis to estimate mortality of Atlantic bluefin tuna caught by the Norwegian fishery from 1956 to 1979. Fromentin, J.M. and V. Restrepo.
SCRS/2008/094	Evaluation of the performance and robustness of VPA-based stock assessment and MSY-based management strategy to process error: An Atlantic bluefin tuna case study. Fromentin, J.M. and L. Kell.
SCRS/2008/096	Preliminary estimation of the size composition of bluefin tuna (*thunnus thynnus*) caught by Moroccan Atlantic traps from biological scraps in 2006. Idrissi, M. and N. Abid.
SCRS/2008/097	A multi stock tag integrated age structured assessment of Atlantic bluefin tuna. Taylor, N., M. McAllister, B. Block and G. Lawson.
SCRS/2008/098	Updated standardized indices for bluefin tuna from the Moroccan trap fishery (1998-2006). Abid, N., M. Idrissi and J.M. Ortiz de Urbina.
SCRS/2008/099	Updated standardized indices for bluefin tuna from the Spanish trap fishery (1981-2007). Ortiz de Urbina, J.M., J.M. de la Sern and D. Macías.

SCRS/2008/100 Updated standardized CPUE of Atlantic bluefin tuna caught by the Spanish baitboat fishery in the Bay of Biscay (eastern Atlantic). Time series from 1975 to 2007. Rodriguez-Marin, E., M. Ortiz, C. Rodríguez-Cabello and S. Barreiro.

SCRS/2008/101 The key importance of the underlying stock-recruitment assumption when evaluating the potential of management regulations of Atlantic bluefin tuna. Fromentin, J.M.

SCRS/2008/102 Revised catch-at-size estimates of Atlantic bluefin tuna (eastern and western stocks: 1960-06). Palma, C & P.Kebe.

SCRS/2008/103 Standardized bluefin CPUE from the Japanese longline fishery in the Atlantic up to 2007. Ohshima, K., Y. Takeuchi and N. Miyabe.

SCRS/2008/104 Repartition demographique du thon rouge engraisse dans les fermes Tunisiennes pendant les campagnes 2005 à 2007. Hattour, A.

Appendix 5

Investigations of Growth Modeling Undertaken by the Group

As illustrated by SCRS/2008/084, estimates of age derived from bluefin tuna otoliths can provide useful information concerning age and growth. However, as the authors of SCRS/2008/084 (referred to as Secor *et al.* here) noted, there was a need to include a broader range of ages in their investigation. For example, the Secor *et al.* equation does not predict length at age well for the youngest ages (ages 1-3), whereas the Restrepo *et al.* model currently in use by the SCRS appears to provide better predictions **(Figure Appendix 5.1)**.

As noted previously, the Secor et al. curve was estimated using age-length data derived from otolith reading while the curve used by the SCRS was derived from length frequency data and tagging. Given the differences observed between the two growth curves, the Group decided to explore the results of combining different data sets and using different error assumptions to estimate growth curves. Because the complete data set used to estimate the current SCRS growth curve was not available, the Group utilized the data used by Restrepo et al. (Col. Vol. Sci. Pap. ICCAT (60)3:1014-1026) to estimate their growth curve. Although the L_∞ estimated by Restrepo *et al.* was lower than the value estimated by Turner and Restrepo (1994) (353.2 cm vs. 382.0 cm), the Group agreed that for comparison purposes the Restrepo et al. curve was a good approximation **(Table Appendix 5.1)**.

The data sets available were:

1. Length frequency data (ages 1-3) from modal analysis (Restrepo *et al.*).
2. Tagging data (Restrepo *et al.*).
3. Age-length data derived from otolith readings (Secor *et al.*).
4. Age-length data derived from using deposition of bomb radiocarbon to derive age (Neilson and Campana, Can. J. Fish. Aquat. Sci. (65) in press).

The curve derived using the Restrepo et al. data used the following likelihood functions (Kirkwood and Somers, 1984):

$$\Phi_1 = -\frac{n_1}{2}\ln(2\pi\sigma_1^2) - \frac{1}{2\sigma_1^2}\sum_{i=1}^{n_1}\left[\delta t_i + \frac{1}{K}\ln\left(1-\frac{\delta l_i}{L_\infty - R_i}\right)\right]^2$$

$$\Phi_2 = -\frac{n_2}{2}\ln(2\pi\sigma_2^2) - \frac{1}{2\sigma_2^2}\sum_{i=1}^{n_2}\left[t_i - t_0 + \frac{1}{K}\ln\left(1-\frac{l_i}{L_\infty}\right)\right]^2$$

where the subscripts 1 and 2 indicate the tagging data and age-length data derived from modal analysis, respectively. Note than in the Restrepo *et al.* formulations an observed length could not be greater than L_∞ and length was the predicted variable.

The following combinations of data/error assumptions were used to estimate growth curves (numbers 1, 2, 3, and 4 correspond to the data sets described above).

1) 1 + 2 + 3 using length as predicted var.

2) 1 + 2 + 3 using age as predicted var.

3) 3 + 4 using length as predicted var.

4) 1 + 3 + 4 using length as predicted var.

5) 1 + 2 + 3 + 4 using length as predicted var.

6) 1 + 2 + 3 + 4 using age as predicted var.

The difference between the last formulation (number 6) and the other 5 is that the likelihood functions included a model error term (σm, i) and a common σL∞ as follows (equations taken from Restrepo *et al.*):

$$\Phi_1 = -\sum_i \frac{\ln(2\pi(\sigma^2_{L_\infty}(1-e^{-K\delta t_t})^2 + \sigma^2_{m,1}))}{2} + \frac{(\delta l_1 - (L_\infty - R_i)(1-e^{-K\delta_{t_i}}))^2}{2(\sigma^2_{L\infty}(1-e^{-K\delta t_t})^2 + \sigma^2_{m,1})}$$

$$\Phi_2 = -\sum_i \frac{\ln(2\pi(\sigma^2_{L_\infty}(1-e^{-K(t_i-t_o)})^2 + \sigma^2_{m,2}))}{2} + \frac{(l_1 - L_\infty(1-e^{-K(t_i-t_o)}))^2}{2(\sigma^2_{L_\infty}(1-e^{-K(t_i-t_o)})^2 + \sigma^2_{m,2})}$$

Where $\sigma^2_{L_\infty}$ = variance of L_∞,

$\sigma^2_{L_m}$ = variance for model error

Table 4.1.1 summarizes the estimated growth parameters of the SCRS (Turner and Restrepo 1994), the Restrepo *et al.,* and Secor *et al.* growth curves and the 6 additional cases. The estimated six curves lay between the Restrepo et al., Secor *et al.* curves **(Figure Appendix 5.2)**. For simplification purposes, Figure APPENDIX 5.3 only shows the Restrepo et al. and Secor et al. growths curves together with the curve estimated using all data and assuming an error model for each data set and a common error for L_∞ (case 6).

Table X.1. Estimated growth parameters for the Secor *et al.* and Restrepo *et al.* growth curves and 6 combinations of data and error assumptions.

Parameters	SCRS	Secor *et al.* fit	Restrepo *et al.* fit	1. Combine R+S- Fit pred to obs length	2. Combine R+S - Fit pred to obs age	3. Combine S+Neilson and Campana	4. Combine R modal age 1-3+S+N	5. Combine all data, fit to length at age	6. All data with error on each model and one Linf
L(inf)	382	256.65	353.17	336.15	353.2	271.46	276.26	300.67	306.68
K	0.079	0.195	0.089	0.156	1.210	0.151	0.136	0.100	0.11
t0	-0.707	0.83	-0.71	0.22	2.21	0.00	-0.33	-0.85	-0.886

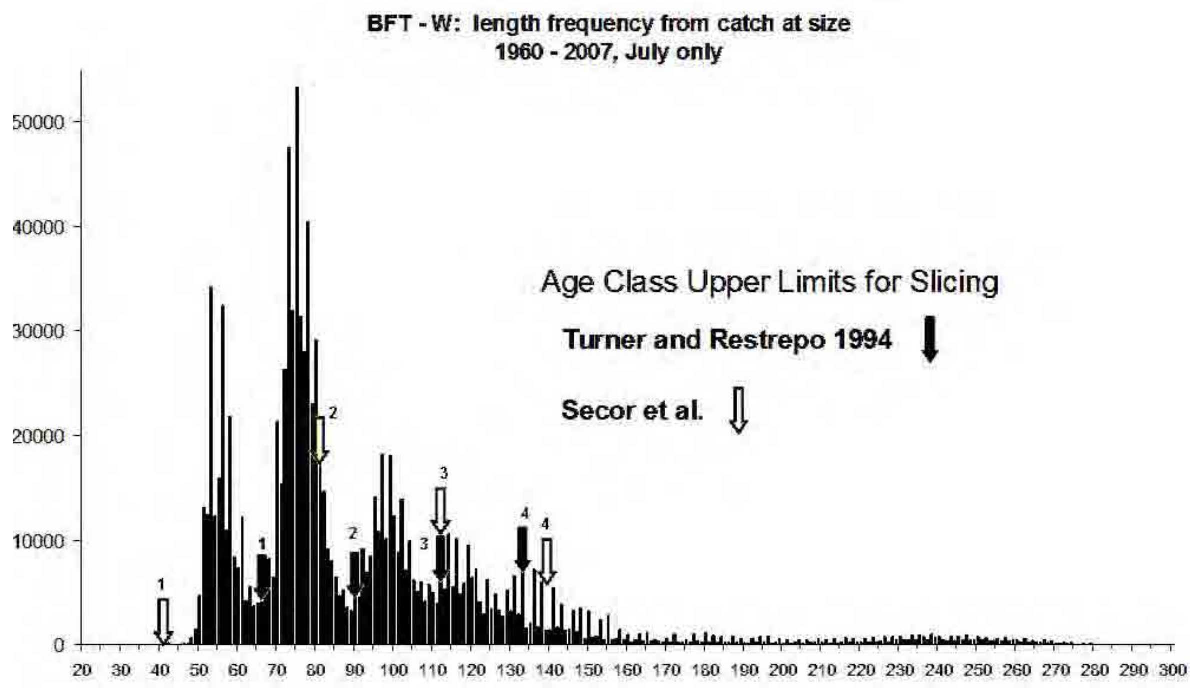

Figure Appendix 5.1 Upper limits for slicing of age groups using the Turner and Restrepo (1994) equation, compared with the Secor *et al.* growth equation for western origin – western capture bluefin tuna (SCRS/ 2008/084)

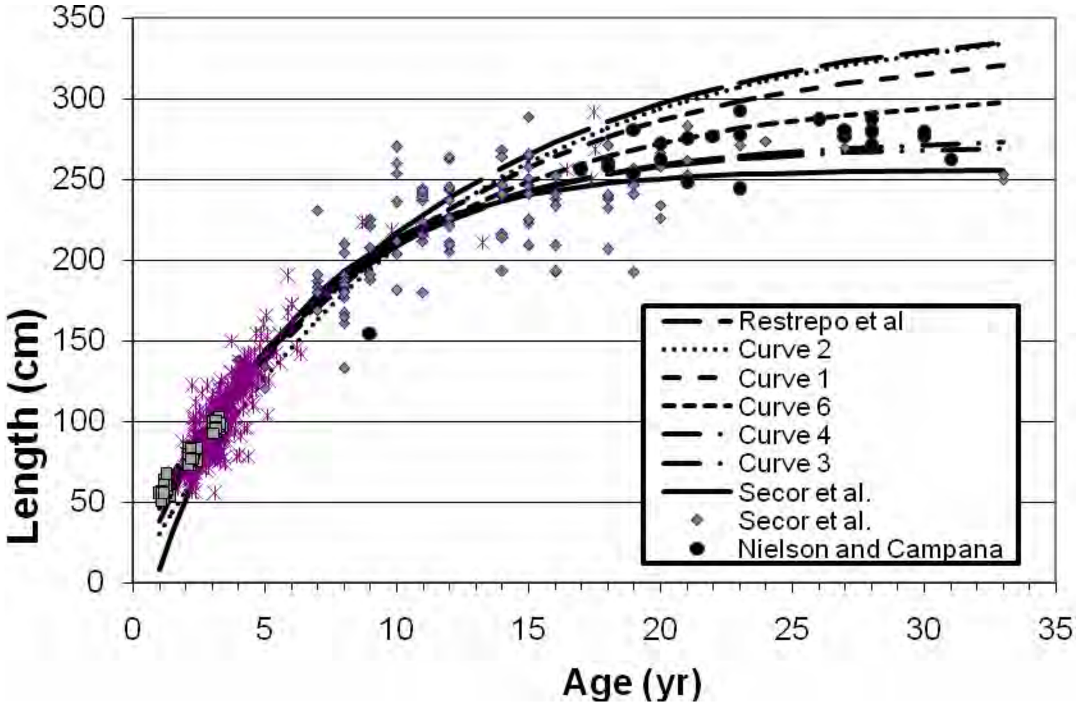

Figure Appendix 5.2 Age-length observations, modal analysis data, and estimated growth curves. The order of the curves in the legend follow the order of the curves in the graphs (i.e., the Restrepo *et al.* curve is the top curve in the graph and the Secor *et al.* is the bottom curve). Curve 1 was estimated using the tagging data (crosses), modal analysis data (gray squares) and the age-length data from Secor *et al.* (gray diamonds) and length as the predicted variable. Curve 2 used the same data and used age as the predicted variable. Curve 3 used only age-length data from Secor *et al.* (gray diamonds) and Neilson and Campana (black circles). Curve 4 used the modal data, and the age-length data from Secor et al. and Campana and Neilson and length as predicted variable. Curve 6 used all data and assumed individual model error for each data set and a common variance for L_∞.

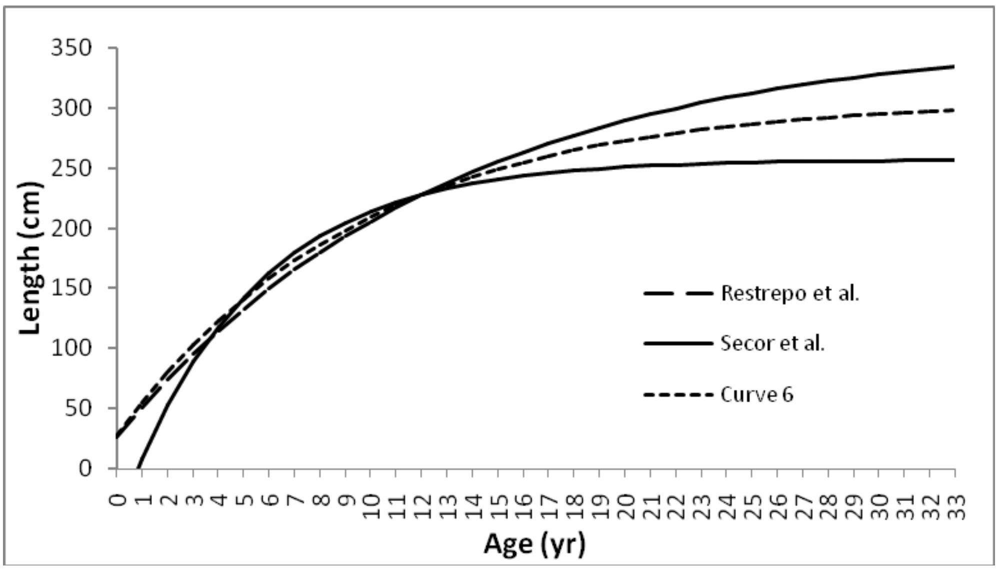

Figure Appendix 5.3 Estimated growth curves. Curve 6 used all data and assumed individual model error for each data set and a common variance for L_∞.

Appendix 6

Letter sent by scientists participating at the meeting to the Commission Chairperson

INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS
COMMISSION INTERNATIONALE POUR LA CONSERVATION DES THONIDES DE L'ATLANTIQUE
ICCAT CICTA CICAA
COMISIÓN INTERNACIONAL PARA LA CONSERVACIÓN DEL ATÚN ATLÁNTICO

Madrid – June 27, 2008

TO: Commission Chair
THROUGH: SCRS Chair
FROM: Scientists participating at the 2008 Bluefin Tuna Stock Assessment Session

SUBJECT: Concern about the paucity of reported data for 2007 for the eastern Atlantic and Mediterranean

We, the scientists participating at the bluefin assessment session are expected to conduct analyses, requested by the Commission, that the SCRS will use as the basis for advice to the Commission. Such work includes the evaluation of current stock status, as well as other tasks requested by the Commission. The 2006 Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean calls for the SCRS to "monitor and review the progress of the Plan and submit an assessment to the Commission for the first time in 2008, and each two years thereafter."

Now, upon completion of the fourth day (of 10 days) of the assessment meeting, we only have Task I (total catch) and Task II (catch/effort and size samples) from three of CPCs that have quotas in the eastern Atlantic and Mediterranean, which amount to less than 15% of the Total Allowable Catch. Note that the deadline of submission for the 2007 data was June 9, 2008 (i.e., two weeks prior to the meeting).

It takes considerable time to prepare, assimilate and validate data into the databases and then to analyze these data. Consequently, we will not be able to evaluate the status of the eastern stock as of 2007, nor will we be able to carry out the review of the progress of the plan which has been requested from us, even if we received these data today.

The SCRS planned, and the Commission endorsed this plan, to conduct these analyses three months before the Species Groups and Plenary sessions so that there would be sufficient time to review the results and prepare the advice requested by the Commission. We realize that the 2007 Task I and Task II data may become available between now and the SCRS plenary, and that therefore there will be pressure for us to meet once more during the Species Groups. This is unfortunate because most of us will also be expected to work on other ICCAT species at the same time and there will not be enough time at the September meeting to conduct a complete reassessment of the eastern stock.

It is also disappointing that such a large group of scientists and international experts meets during two weeks at considerable expense to their organizations and is unable to complete the work required because of a (chronic) lack of data being transmitted in time. This situation is even more incomprehensible given the high international concern about bluefin tuna stock status.

cc: Executive Secretary

Corazón de María, 8 – 28002 MADRID, Spain – Espagne – España – Tel: +34 91 416 5600 – Fax: +34 91 415 2612 – http://ww.iccat.int – info@icat.int

Appendix 7

Tuna Farming Sampling Coverage

Length distributions from ICCAT Secretariat SizeCaging_v3 were converted to RW (based on previous work by J. Walter. **Table 1**). For those samples originally submitted in weight, a 14.5 per cent discount was applied in order to account for the increase in weight during the fattening process.

Since there is not official information regarding the amount of fish in each farm, sampling coverage can not be estimated by flag. Assuming that TASK I figures for all purse seiners in the Mediterranean (Table 2) is a proxy for the caged fish in the Mediterranean farms, sampling coverage percentage is estimated as the ratio between total sampled weight in the farms by year and reported Task I catch for purse seines in the Mediterranean for the corresponding year.

Table 1. Farming samples (kg RW) by country and year (in brackets, sample size in number of fish).

	Croatia	*EC.Cyprus*	*EC.España*	*EC.Greece*	*EC.Italy*	*EC.Malta*	*Turkey*	*Total*
2003							10896.43 *(101)*	10.90
2004					305779.50 *(1924)*		1284419.00 *(15760)*	1590.20
2005	1638.03 *(89)*	244354.90 *(1207)*	193203.80 *(951)*	68446.94 *(518)*	747183.30 *(3608)*	1617281.00 *(7996)*	466352.86 *(6794)*	3338.46
2006		155751.80 *(683)*	1815113.60 *(12045)*		623070.40 *(3132)*		336003.08 *(5039)*	2929.94
2007	153309.43 *(3232)*		407758.40 *(2795)*			689364.10 *(4155)*	866634.52 *(6968)*	2117.07

Table 2. Reported catches (t RW) for purse seine (PS) in the Mediterranean by year.

	Task I Med. PS (t)
2003	17167
2004	18785
2005	22475
2006	20020
2007	Total catch not available

Table 3. Estimated sampling coverage (%) in tuna farms. Mediterranean Sea.

	Sampling rate (%)
2003	0.06
2004	8.47
2005	14.85
2006	14.64
2007	Not estimated

Remarks:

- Since there is not an official Task I figure for 2007, sampling coverage could not be estimated.
- Due to misreporting, figures in Table 3 could be overestimated.

Appendix 8

Analysis of Bluefin Conventional Tagging Data 2008

In preparation for the bluefin 2008 stock assessment an update of the conventional tagging data was provided by the Secretariat. After reviewing the data by national scientists, it was found several inconsistencies between the tagging files provided and a similar tagging files used in the 1998 assessment, particularly for the main tagging fleets (USA, EC-Spain and Canada) **(Table 1.tagging.section)**. These differences appeared in both tag releases and recaptures by year, and fleet. Further revision indicated that the tagging files changed between 2004 and 2005, particularly for the historical time series. The tagging files at the Secretariat were correct for 2004 forward with exception of the U.S. tagging records. Therefore it was proposed to use the 2004 Secretariat files (included tag release-recaptures up to 2003), and update this file with tag releases-recaptures from the United States provided by national scientist, and current tagging files for other contracting parties from the Secretariat 2008. EC-Spain scientist also provided tag releases and recaptures for 2004.

The resulting BFT tag release-recapture file was compared to the 1998 inputs, and revised by scientist from the main tagging fleets. There were some tag filtering during the assembling process; tags with no release or recapture date, tags put on ranched-farm fish, and tags without recapture date were excluded. **Table 2.tagging.section** summarizes the tag releases by fleet and quadrant by year of the compiled database. **Table 3.tagging.section** shows the overall number of releases and recaptures by year matrix. For the mix VPA analysis the conventional tagging information was restricted to releases recaptures with complete latitude longitude information, size (or estimated size from weight if size was not recorded), and date of release and recapture. The mix VPA used Tags releases from 1970 through 2007 and their respective recaptures.

Tag release-recapture cohorts (by year and BFT area of release) were aged using the slicing program with the corresponding growth function, Table 3.tagging.section summarizes the tag releases-recaptures inputs after fish were aged. About 80% of the tag release records were input in the MIX VPA run, as indicators of movement transfer rates by age and cohort between the east and west BFT areas.

Table Appendix 8.1 Comparison of tag release-recaptures matrix by year for the 2008 ICCAT tag database and the 1998 tagging database. Top, all fleets, and for main tagging fleet/countries USA, EC-Spain and Canada.

difference: ICCAT 2007 data -(ICCAT 1998 (Spain, Canada, others) + CGFTP for US)

																															difference relative to 1998		
rYear	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	total recaptures	not recaptured	total releases	total recaptures	not recaptured	total releases
1970	(60)	(86)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(145)	137	(8)	-71%	25%	-1%
1971	-	(50)	(19)	(5)	(2)	(1)	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(78)	(264)	(342)	-52%	-40%	-42%
1972	-	-	(5)	15	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	(18)	(6)	21%	-6%	-2%
1973	-	-	-	(5)	2	3	-	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(1)	(62)	(63)	-1%	-12%	-11%
1974	-	-	-	-	2	33	19	1	1	-	(1)	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	58	(3)	55	27%	0%	3%
1975	-	-	-	-	-	(4)	5	-	1	(1)	(1)	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(1)	(6)	(7)	-2%	-1%	-1%
1976	-	-	-	-	-	-	1	-	5	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	9	229	238	3%	11%	10%
1977	-	-	-	-	-	-	-	(17)	23	5	2	-	-	2	-	-	1	-	1	-	-	-	-	-	-	-	-	-	17	217	234	5%	12%	11%
1978	-	-	-	-	-	-	-	-	(2)	9	1	2	2	3	-	1	2	-	1	-	2	-	1	1	-	-	-	-	23	334	357	11%	20%	19%
1979	-	-	-	-	-	-	-	-	-	(4)	(10)	2	-	-	-	(1)	-	-	-	-	-	-	-	-	-	-	-	-	(13)	223	210	-19%	19%	17%
1980	-	-	-	-	-	-	-	-	-	-	(30)	(2)	(2)	(1)	1	(1)	-	-	-	-	-	-	-	-	-	-	-	1	(34)	226	192	-11%	7%	6%
1981	-	-	-	-	-	-	-	-	-	-	-	(4)	(6)	-	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	(11)	231	220	-8%	11%	10%
1982	-	-	-	-	-	-	-	-	-	-	-	-	(1)	(7)	(2)	1	(2)	-	-	-	-	1	-	-	-	-	-	-	(10)	48	38	-33%	8%	6%
1983	-	-	-	-	-	-	-	-	-	-	-	-	-	(1)	1	-	(1)	-	-	-	-	-	-	-	-	-	-	1	-	64	64	0%	8%	8%
1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(2)	-	(2)	-	-	-	-	-	-	1	-	-	-	-	(3)	329	326	-11%	53%	50%
1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(3)	(2)	-	-	-	-	-	-	-	-	-	-	-	(5)	58	53	-23%	11%	10%
1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(9)	-	(2)	-	1	-	-	-	-	-	-	(10)	76	66	-16%	9%	7%
1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	10	0%	16%	16%
1988	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(4)	(4)	-	-	-	-	-	-	-	-	(8)	66	58	-13%	6%	5%
1989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	1	-	5	34	39	63%	15%	17%
1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(4)	(1)	-	(1)	1	1	-	2	(2)	(8)	(10)	-2%	0%	0%
1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(2)	-	-	-	-	-	-	(2)	3	1	-2%	0%	0%
1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	1	4	66	70	10%	4%	5%
1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	371	372	4%	60%	57%
1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	51	1	1	-	53	1,099	1,152	72%	109%	107%
1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	4	30	42	165	207	76%	10%	12%

Table Appendix 8.2 Compiled bluefin tuna conventional tag releases by county/fleet ID and geographical quadrant.

No.Tags	CountryID															Count of strTags						
Year release	Canada	Cuba	France	Greece	Italy	Japan	Malta	Portugal	Spain	USA	Mexico	Unk	Ireland	Unk	Grand Total	rYear	NE	SE	SW	NW	Unk	Grand Total
1940										24					24	1940				17	7	24
1954										193					193	1954				193		193
1955										230					230	1955				230		230
1956										99					99	1956				99		99
1957										37					37	1957				37		37
1958										38					38	1958				38		38
1959										147					147	1959				147		147
1960										236					236	1960				236		236
1961										185					185	1961				185		185
1962										127					127	1962				127		127
1963	18									222					240	1963				240		240
1964	20									552					572	1964		2		570		572
1965	300									1806					2106	1965				2100	6	2106
1966	74									4131					4205	1966				4205		4205
1967	204									712					916	1967				916		916
1968	26									519					545	1968				545		545
1969	44									566					610	1969	19			590	1	610
1970	20									733					753	1970				753		753
1971	368									446					814	1971				814		814
1972	82									287					369	1972				369		369
1973	172									397					569	1973				569		569
1974	49									1746					1795	1974				1795		1795
1975	170									352					522	1975				522		522
1976	30								1	2428					2459	1976				2459		2459
1977	11								133	2138					2282	1977				2281	1	2282
1978	6	1							174	1697					1878	1978				1869	9	1878
1979									100	1127					1227	1979				1227		1227
1980	16								301	3088					3405	1980				3405		3405
1981	9		1						294	1845					2149	1981				2149		2149
1982	1								403	210					614	1982				614		614
1983			1						709	150				1	861	1983	4			857		861

1984									858	89					947
1985									412	131					543
1986									849	51					900
1987										64					64
1988									1163	98					1261
1989									133	113					246
1990	74		1						1521	427					2023
1991	95				16				2358	1111					3580
1992	55				1				473	1018					1547
1993					4				310	649					963
1994	8				573				1139	375					2095
1995			1		6				178	1704					1889
1996	3				1				14	3382					3400
1997					2				391	3450					3843
1998					1					1914					1915
1999						60				684		1			745
2000					1					699					700
2001						16				298					314
2002									1	8					9
2003									6	5					11
2004	1		3	41			1		475	1597	1		3	4	2126
2005	1		10	8	1				2141	264				11	2436
2006			21	9				8	105	122					265
2007										285					285
2008										9					9
Grand Total	1857	1	38	58	606	76	1	8	14642	45015	1	1	3	16	62323

1984				947		947
1985				543		543
1986	1			899		900
1987				64		64
1988				1261		1261
1989				246		246
1990	8			2015		2023
1991	112			3467	1	3580
1992	90			1457		1547
1993	5			958		963
1994	650			1443	2	2095
1995	8			1862	19	1889
1996	2			3386	12	3400
1997	16			3826	1	3843
1998	5			1902	8	1915
1999	60		1	682	2	745
2000				699	1	700
2001	19			295		314
2002				9		9
2003				11		11
2004	1724		30	372		2126
2005	263		30	2127	16	2436
2006	138	2	15	107	3	265
2007	271		14			285
2008	9					9
Grand Total	3404	4	90	58736	89	62323

Table Appendix 8.3 Summary of tag releases-recaptures by BFT area and age input into the MIX VPA runs 1970-2007.

Sum of total rec		*Area recovered*				*Sum of number tag released*		
Aarea rel	*Age rel*	*1*	*2*		*Grand Total*	*Area rel.*	*Age at release*	*Total*
1	1	242	8		250	1	1	13889
	2	34	3		37		2	2423
	3	5	0		5		3	489
	4	1	0		1		4	175
	5	0	0		0		5	41
	6	0	0		0		6	32
	7	0	0		0		7	28
	8	0	0		0		8	16
	9	0	0		0		9	20
	10	0	0		0		10	190
1 Total		282	11		293	**1 Total**		17303
2	1	24	633		657	2	1	5609
	2	19	768		787		2	7875
	3	16	121		137		3	2614
	4	6	24		30		4	714
	5	6	21		27		5	685
	6	5	29		34		6	1146
	7	5	66		71		7	1485
	8	5	46		51		8	993
	9	4	30		34		9	706
	10	7	121		128		10	2433
2 Total		97	1859		1956	**2 Total**		24260
				0	0			0
Total				0	0	**Total**		0
Grand Total		379	1870	0	2249	**Grand Total**		41563

Appendix 9

BFT Report File for VPA Runs

BFT _Eastern stock_Report file for the VPA runs 13 and 14.

RUN 13

****

VPA-2BOX

SUMMARY STATISTICS AND DIAGNOSTIC OUTPUT

****

BFT East 55-06 test
9:27, 2 July 2008

```
==============================================================================
Total objective function =        34.79
      (with constants)   =       189.17
Number of parameters (P) =           15
Number of data points (D)=          168
AIC : 2*objective+2P     =       408.35
AICc: 2*objective+2P(...)=       411.50
BIC : 2*objective+Plog(D)=       455.20
Chi-square discrepancy   =        83.28

Loglikelihoods (deviance)=       -38.69 (      168.09)
   effort data           =       -38.69 (      168.09)

Log-posteriors           =         0.00
   catchability          =         0.00
   f-ratio               =         0.00
   natural mortality     =         0.00
   mixing coeff.         =         0.00

Constraints              =         3.90
   terminal F            =         3.90
   stock-rec./sex ratio  =         0.00

Out of bounds penalty    =         0.00
==============================================================================
```

TABLE 1. FISHING MORTALITY RATE FOR EAST OF 45

	1	2	3	4	5	6	7	8	9	10
1955	0.008	0.052	0.104	0.047	0.066	0.084	0.143	0.100	0.225	0.157
1956	0.006	0.039	0.054	0.030	0.035	0.062	0.077	0.138	0.139	0.097
1957	0.009	0.075	0.099	0.044	0.043	0.091	0.178	0.131	0.157	0.110
1958	0.027	0.095	0.144	0.060	0.106	0.113	0.095	0.161	0.129	0.090
1959	0.012	0.089	0.228	0.092	0.044	0.040	0.041	0.047	0.137	0.096
1960	0.008	0.051	0.081	0.100	0.147	0.090	0.047	0.080	0.116	0.081
1961	0.010	0.095	0.146	0.105	0.241	0.196	0.048	0.048	0.129	0.091
1962	0.006	0.058	0.134	0.090	0.121	0.258	0.096	0.124	0.136	0.095
1963	0.004	0.036	0.103	0.109	0.115	0.095	0.108	0.067	0.065	0.045
1964	0.010	0.054	0.101	0.140	0.182	0.109	0.088	0.098	0.072	0.051
1965	0.006	0.055	0.069	0.063	0.080	0.113	0.101	0.046	0.085	0.059
1966	0.026	0.071	0.212	0.083	0.052	0.098	0.083	0.052	0.047	0.033
1967	0.076	0.073	0.093	0.106	0.041	0.050	0.137	0.062	0.086	0.060

1968	0.029	0.084	0.078	0.048	0.056	0.020	0.045	0.068	0.048	0.034
1969	0.061	0.262	0.197	0.065	0.022	0.026	0.015	0.039	0.067	0.047
1970	0.060	0.179	0.124	0.080	0.027	0.016	0.031	0.022	0.043	0.043
1971	0.003	0.227	0.180	0.082	0.069	0.016	0.013	0.042	0.033	0.033
1972	0.006	0.184	0.345	0.094	0.073	0.057	0.019	0.008	0.024	0.024
1973	0.006	0.154	0.144	0.084	0.033	0.039	0.063	0.037	0.025	0.025
1974	0.027	0.174	0.193	0.148	0.122	0.060	0.042	0.054	0.050	0.050
1975	0.068	0.364	0.148	0.095	0.045	0.106	0.054	0.047	0.061	0.061
1976	0.009	0.273	0.477	0.125	0.100	0.032	0.069	0.031	0.049	0.049
1977	0.072	0.242	0.180	0.159	0.024	0.035	0.026	0.064	0.048	0.048
1978	0.138	0.359	0.183	0.086	0.042	0.012	0.025	0.013	0.037	0.037
1979	0.017	0.107	0.288	0.095	0.038	0.024	0.017	0.051	0.034	0.034
1980	0.112	0.246	0.422	0.193	0.031	0.036	0.031	0.017	0.036	0.036
1981	0.077	0.444	0.342	0.106	0.091	0.022	0.032	0.048	0.027	0.027
1982	0.248	0.400	0.489	0.178	0.070	0.042	0.023	0.079	0.056	0.056
1983	0.248	0.206	0.333	0.137	0.083	0.062	0.121	0.035	0.059	0.059
1984	0.111	0.461	0.127	0.136	0.133	0.099	0.090	0.121	0.065	0.065
1985	0.094	0.417	0.411	0.120	0.073	0.070	0.038	0.057	0.077	0.046
1986	0.280	0.322	0.252	0.155	0.032	0.045	0.041	0.033	0.073	0.044
1987	0.146	0.402	0.301	0.122	0.048	0.030	0.086	0.063	0.067	0.040
1988	0.347	0.218	0.398	0.169	0.060	0.043	0.051	0.078	0.101	0.061
1989	0.194	0.379	0.175	0.156	0.145	0.033	0.052	0.036	0.077	0.046
1990	0.178	0.254	0.328	0.135	0.170	0.057	0.055	0.076	0.095	0.057
1991	0.080	0.302	0.234	0.142	0.144	0.047	0.050	0.061	0.140	0.084
1992	0.082	0.303	0.374	0.095	0.074	0.064	0.108	0.135	0.165	0.099
1993	0.093	0.515	0.368	0.142	0.065	0.069	0.076	0.100	0.157	0.094
1994	0.127	0.291	0.220	0.093	0.130	0.100	0.196	0.217	0.367	0.220
1995	0.161	0.233	0.292	0.127	0.125	0.185	0.104	0.179	0.211	0.254
1996	0.187	0.483	0.388	0.285	0.143	0.072	0.120	0.094	0.248	0.298
1997	0.184	0.382	0.254	0.234	0.179	0.174	0.108	0.254	0.260	0.312
1998	0.156	0.600	0.440	0.313	0.152	0.331	0.053	0.058	0.175	0.210
1999	0.130	0.215	0.363	0.258	0.135	0.064	0.066	0.085	0.195	0.234
2000	0.349	0.314	0.247	0.234	0.259	0.186	0.074	0.115	0.133	0.160
2001	0.008	0.388	0.177	0.179	0.178	0.149	0.246	0.170	0.195	0.234
2002	0.043	0.465	0.309	0.128	0.092	0.170	0.106	0.172	0.188	0.226
2003	0.025	0.237	0.115	0.079	0.121	0.093	0.274	0.196	0.251	0.302
2004	0.080	0.326	0.304	0.076	0.041	0.086	0.150	0.183	0.291	0.350
2005	0.197	0.382	0.305	0.193	0.078	0.077	0.089	0.102	0.453	0.543
2006	0.174	0.178	0.447	0.178	0.056	0.116	0.057	0.072	0.401	0.481
2007	0.164	0.219	0.490	0.136	0.068	0.178	0.061	0.074	0.349	0.418

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TABLE 2. ABUNDANCE AT THE BEGINNING OF THE YEAR [BY AREA] FOR EAST OF 45

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	1	2	3	4	5	6	7	8	9	10
1955	1712816.	1575283.	1221373.	1021769.	615394.	515277.	274724.	399963.	243764.	663721.
1956	1081682.	1040496.	1176936.	866283.	766890.	453241.	388007.	199920.	311360.	684967.
1957	837090.	658442.	786947.	876934.	661421.	582439.	348929.	301526.	149877.	801526.
1958	1006726.	508104.	480610.	560646.	660210.	498260.	435330.	245037.	227701.	762749.
1959	858493.	600365.	363437.	327253.	415365.	467194.	364391.	332271.	179584.	807197.

1960	738764.	519889.	432075.	227528.	234838.	312791.	367502.	293749.	272991.	802072.
1961	968713.	448894.	388788.	313344.	161994.	159418.	234100.	294352.	233392.	883511.
1962	1546138.	587412.	321244.	264233.	221925.	100141.	107314.	187296.	241504.	911167.
1963	1877340.	941820.	435834.	221092.	190013.	154673.	63314.	81847.	142408.	935811.
1964	1688720.	1145419.	714430.	309251.	155899.	133266.	115127.	47731.	65886.	927019.
1965	3035718.	1024113.	853815.	507832.	211387.	102236.	97794.	88473.	37261.	851454.
1966	1914027.	1849345.	762322.	626604.	375254.	153450.	74769.	74222.	72732.	756392.
1967	1132353.	1142056.	1355560.	485017.	453687.	280294.	113905.	57755.	60660.	723550.
1968	952632.	643022.	835287.	971263.	343035.	342668.	218346.	83408.	46723.	665786.
1969	914503.	566817.	465014.	607768.	727872.	255241.	274938.	175282.	67052.	621708.
1970	850272.	526927.	343084.	300375.	447976.	559922.	203675.	227337.	145135.	591923.
1971	1649638.	490758.	346676.	238388.	218123.	342914.	451206.	165731.	191349.	635956.
1972	1123825.	1007933.	307538.	227865.	172818.	160177.	276359.	373807.	136771.	719908.
1973	1666713.	684167.	659932.	171344.	163229.	126374.	123900.	227521.	319109.	753869.
1974	2161394.	1015062.	461269.	449714.	123977.	124190.	99549.	97677.	188677.	939990.
1975	1610861.	1289309.	671264.	299277.	305046.	86334.	95786.	80166.	79671.	967512.
1976	2375431.	922109.	704983.	455269.	214182.	229500.	63564.	76171.	65839.	889607.
1977	1221908.	1441672.	551959.	344178.	316189.	152426.	182061.	49822.	63549.	822121.
1978	958743.	696481.	890606.	362722.	230985.	242825.	120560.	148887.	40209.	762804.
1979	1190761.	511396.	382565.	583677.	261699.	174151.	196494.	98712.	126456.	699281.
1980	1820093.	717128.	361354.	225734.	417485.	198210.	139237.	162177.	80712.	719490.
1981	1560673.	996805.	441208.	186426.	146376.	318295.	156558.	113298.	137286.	696406.
1982	2481481.	885488.	502892.	246581.	131934.	105180.	255011.	127313.	92990.	731318.
1983	3806864.	1186378.	466949.	242698.	162282.	96781.	82543.	209252.	101250.	703203.
1984	1950635.	1820686.	759694.	263226.	166534.	117494.	74457.	61368.	173933.	684293.
1985	1762617.	1069405.	903641.	526518.	180697.	114657.	87156.	57134.	46804.	724040.
1986	3097453.	983142.	554126.	471044.	367458.	132079.	87567.	70431.	46464.	663591.
1987	2165222.	1434089.	560654.	338935.	317254.	279923.	103402.	70588.	58670.	612982.
1988	3348612.	1146355.	754534.	326388.	235973.	237946.	222325.	79640.	57063.	581395.
1989	3250205.	1449812.	724855.	398760.	216889.	174793.	186617.	177279.	63385.	540717.

1990	3361449.	1639636.	781021.	478614.	268283.	147570.	138478.	148672.	147138.	519017.
1991	3996324.	1723106.	1000403.	442544.	328984.	178087.	114136.	109987.	118556.	561587.
1992	3669586.	2260370.	1001931.	623065.	301936.	224189.	139083.	91165.	89054.	558167.
1993	3988467.	2070950.	1313795.	542136.	445609.	220646.	172121.	104784.	68580.	523990.
1994	3221540.	2226862.	973695.	715432.	369896.	328468.	168554.	133868.	81567.	483384.
1995	3735603.	1738584.	1309851.	614467.	512691.	255555.	243451.	116324.	92755.	400743.
1996	3276449.	1947413.	1083337.	769475.	425503.	355927.	173815.	184173.	83751.	347655.
1997	2292542.	1665456.	944819.	577912.	455189.	290018.	271202.	129403.	144349.	291137.
1998	3007903.	1168659.	893773.	576562.	359854.	299473.	199439.	204396.	86386.	291085.
1999	3003343.	1576546.	504504.	452606.	331666.	243053.	176140.	158764.	165937.	277413.
2000	3769605.	1616061.	999917.	276168.	275066.	228060.	186752.	138440.	125544.	319194.
2001	2425260.	1629615.	928324.	614515.	171928.	166972.	155084.	145545.	106160.	343202.
2002	1790886.	1473399.	869268.	611723.	403996.	113238.	117803.	101777.	105723.	322717.
2003	1573795.	1050867.	728332.	502004.	423441.	289938.	78220.	88920.	73787.	310301.
2004	2603448.	940126.	651904.	510626.	364731.	295223.	216238.	49915.	62916.	258341.
2005	2219122.	1472367.	533893.	378406.	372437.	275486.	221695.	156254.	35793.	206287.
2006	1796012.	1116760.	790262.	309505.	245404.	271083.	208771.	170280.	121435.	128515.
2007	1896656.	924149.	735216.	397520.	203827.	182476.	197581.	165478.	136350.	143646.
2008		985735.	583820.	354405.	273028.	149774.	125061.	156085.	132217.	170459.

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TABLE 3. CATCH OF EAST OF 45

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	1	2	3	4	5	6	7	8	9	10
1955	11390.	70400.	107008.	41704.	34906.	37542.	33620.	35532.	46230.	92065.
1956	5455.	35668.	55302.	22639.	23547.	24550.	26464.	23989.	38002.	60427.
1957	6091.	42266.	66121.	33498.	24920.	46045.	52455.	34392.	20523.	79533.
1958	21162.	41049.	57587.	29029.	59060.	48301.	36300.	33860.	25940.	62720.
1959	7804.	45504.	66262.	25576.	15776.	16623.	13275.	14031.	21575.	70071.
1960	4765.	22821.	30043.	19236.	28693.	24382.	15475.	20995.	28190.	59676.

1961	7810.	36085.	47151.	27817.	30990.	25774.	10084.	12790.	26672.	72883.
1962	6948.	29693.	35820.	20199.	22545.	20762.	9015.	20314.	28861.	78671.
1963	6053.	29894.	38039.	20408.	18355.	12761.	5931.	4925.	8392.	39445.
1964	13483.	53408.	61333.	36132.	23139.	12549.	8941.	4128.	4324.	43564.
1965	13434.	48963.	50961.	27408.	14527.	9909.	8615.	3689.	2841.	46567.
1966	39436.	112263.	130125.	44396.	16847.	13006.	5482.	3480.	3133.	23246.
1967	65608.	71404.	107636.	43596.	16077.	12342.	13370.	3226.	4680.	40047.
1968	21694.	46196.	55796.	40894.	16520.	6218.	8761.	5117.	2075.	21100.
1969	43107.	116782.	74227.	34077.	14296.	5870.	3784.	6187.	4111.	27275.
1970	38988.	76925.	35680.	20559.	10718.	7994.	5735.	4664.	5693.	23503.
1971	3451.	89131.	50860.	16647.	12908.	4866.	5421.	6342.	5904.	19863.
1972	5573.	150797.	80312.	18135.	10831.	8023.	4886.	2837.	3049.	16246.
1973	7760.	87196.	78670.	12234.	4762.	4339.	6926.	7721.	7439.	17790.
1974	44979.	144277.	72124.	55216.	12678.	6529.	3719.	4751.	8656.	43652.
1975	83784.	352023.	82482.	24048.	11829.	7896.	4634.	3412.	4453.	54737.
1976	17530.	197044.	240034.	47517.	18182.	6467.	3870.	2172.	2940.	40211.
1977	67420.	276479.	81061.	45073.	6668.	4692.	4314.	2886.	2775.	36339.
1978	98571.	188168.	132601.	26750.	8539.	2562.	2725.	1825.	1375.	26405.
1979	15969.	46352.	85483.	47165.	8652.	3706.	3029.	4589.	3957.	22150.
1980	153269.	139588.	111493.	35389.	11433.	6339.	3921.	2484.	2707.	24427.
1981	91415.	320655.	114344.	16664.	11282.	6186.	4494.	4886.	3452.	17726.
1982	435146.	261565.	174480.	35938.	7924.	3956.	5269.	8996.	4771.	37980.
1983	666701.	196951.	118425.	27630.	11504.	5298.	8674.	6661.	5419.	38096.
1984	162820.	602875.	80534.	29877.	18519.	10023.	5876.	6501.	10301.	41021.
1985	125240.	327181.	273233.	52924.	11390.	6990.	2989.	2928.	3280.	31283.
1986	604933.	241954.	110132.	60406.	10325.	5246.	3194.	2105.	3059.	26910.
1987	233816.	425593.	130343.	34716.	13139.	7595.	7836.	3987.	3555.	22852.
1988	787349.	200802.	221886.	45198.	12255.	9080.	10230.	5575.	5152.	32507.
1989	457215.	409309.	103864.	51463.	26117.	5129.	8733.	5880.	4406.	23170.
1990	436999.	328717.	195473.	53837.	37369.	7406.	6846.	10160.	12584.	27460.

1991	243243.	401951.	186083.	52343.	39217.	7448.	5083.	6060.	14583.	43095.
1992	229347.	527898.	280117.	50401.	19090.	12665.	13102.	10684.	12771.	50172.
1993	280529.	748302.	362086.	64111.	24966.	13407.	11619.	9313.	9357.	44739.
1994	304848.	502294.	171943.	56716.	40132.	28248.	27584.	24304.	23658.	91141.
1995	443085.	322791.	296580.	65551.	53670.	39327.	22102.	17701.	16646.	85602.
1996	444406.	669905.	312384.	170611.	50658.	22395.	18071.	15306.	17363.	85496.
1997	306585.	474121.	189317.	107583.	66457.	42198.	25467.	27049.	31140.	74424.
1998	345669.	474407.	285557.	138603.	45368.	76858.	9468.	10784.	13078.	52629.
1999	290411.	272684.	137391.	91981.	37212.	13568.	10307.	11994.	27671.	55147.
2000	889624.	389997.	195408.	51453.	56123.	35130.	12280.	14042.	14717.	44867.
2001	15983.	469972.	134430.	90059.	24959.	20978.	31158.	21135.	17743.	68377.
2002	59817.	491266.	206723.	65445.	31541.	16088.	10913.	14935.	17076.	62176.
2003	31032.	198423.	70574.	34139.	42903.	23442.	17278.	14728.	15451.	77057.
2004	158681.	233924.	152821.	33093.	12918.	22186.	27674.	7752.	14992.	72739.
2005	315743.	419027.	125614.	59295.	24776.	18596.	17314.	14102.	12307.	82644.
2006	228907.	162488.	255565.	44959.	11954.	27022.	10693.	11027.	37860.	46891.
2007	228907.	162488.	255565.	44959.	11954.	27022.	10693.	11027.	37860.	46891.

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TABLE 4. SPAWNING STOCK FECUNDITY AND RECRUITMENT OF EAST OF 45

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year	spawning biomass	recruits from VPA
1955	278890.	1712816.
1956	290065.	1081682.
1957	301128.	837090.
1958	305136.	1006726.
1959	290660.	858493.
1960	271944.	738764.
1961	266051.	968713.
1962	253527.	1546138.
1963	225337.	1877340.
1964	228995.	1688720.
1965	240704.	3035718.
1966	226754.	1914027.
1967	235291.	1132353.
1968	243630.	952632.
1969	262779.	914503.
1970	250412.	850272.
1971	278237.	1649638.

1972	287473.	1123825.
1973	288073.	1666713.
1974	297194.	2161394.
1975	288002.	1610861.
1976	285281.	2375431.
1977	275360.	1221908.
1978	263599.	958743.
1979	252886.	1190761.
1980	247884.	1820093.
1981	230570.	1560673.
1982	228289.	2481481.
1983	205248.	3806864.
1984	198062.	1950635.
1985	207407.	1762617.
1986	204504.	3097453.
1987	197572.	2165222.
1988	195088.	3348612.
1989	196746.	3250205.
1990	182163.	3361449.
1991	178785.	3996324.
1992	181860.	3669586.
1993	189909.	3988467.
1994	178053.	3221540.
1995	171927.	3735603.
1996	162863.	3276449.
1997	149042.	2292542.
1998	144084.	3007903.
1999	142302.	3003343.
2000	137926.	3769605.
2001	124530.	2425260.
2002	127796.	1790886.
2003	124894.	1573795.
2004	117992.	2603448.
2005	110082.	2219122.
2006	101002.	1796012.
2007	100046.	1896656.

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TABLE 5. FITS TO INDEX DATA FOR EAST OF 45

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5.1 ESP MAR Trap

Lognormal dist.
average numbers
Ages 6 - 10
log-likelihood = -0.15
deviance = 14.34
Chi-sq. discrepancy= 8.03

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1981	0.211	0.429	-0.218	0.763	0.457E-02	3248.936	4040.421	0.201
1982	0.464	0.416	0.047	0.763	0.457E-02	4181.572	3987.632	0.059
1983	0.528	0.383	0.145	0.763	0.457E-02	4457.914	3856.273	0.023
1984	0.626	0.346	0.280	0.763	0.457E-02	4919.679	3719.024	0.000
1985	0.234	0.287	-0.053	0.763	0.457E-02	3323.686	3506.103	0.108

1986	-0.527	0.224	-0.751	0.763	0.457E-02	1552.599	3291.742	0.530
1987	-0.429	0.205	-0.634	0.763	0.457E-02	1712.964	3229.876	0.461
1988	0.428	0.190	0.238	0.763	0.457E-02	4036.118	3180.860	0.003
1989	-0.219	0.184	-0.403	0.763	0.457E-02	2112.991	3161.338	0.317
1990	-0.182	0.195	-0.376	0.763	0.457E-02	2193.198	3194.995	0.300
1991	0.117	0.185	-0.068	0.763	0.457E-02	2956.781	3165.696	0.115
1992	-0.710	0.147	-0.857	0.763	0.457E-02	1293.345	3046.638	0.589
1993	-0.725	0.101	-0.827	0.763	0.457E-02	1273.456	2910.561	0.573
1994	-0.609	0.038	-0.648	0.763	0.457E-02	1430.110	2732.928	0.469
1995	-1.067	-0.073	-0.994	0.763	0.457E-02	905.197	2444.966	0.661
1996	-0.473	-0.128	-0.345	0.763	0.457E-02	1639.230	2313.743	0.280
1997	0.375	-0.176	0.551	0.763	0.457E-02	3827.381	2206.679	0.111
1998	0.433	-0.185	0.618	0.763	0.457E-02	4053.510	2185.158	0.188
1999	0.544	-0.164	0.708	0.763	0.457E-02	4531.091	2231.747	0.338
2000	0.303	-0.144	0.447	0.763	0.457E-02	3559.320	2276.336	0.036
2001	0.863	-0.189	1.052	0.763	0.457E-02	6234.335	2178.103	1.639
2002	0.510	-0.293	0.803	0.763	0.457E-02	4380.586	1961.929	0.565
2003	-0.072	-0.377	0.305	0.763	0.457E-02	2448.107	1804.944	0.000
2004	-0.649	-0.476	-0.173	0.763	0.457E-02	1374.174	1633.382	0.174
2005	0.048	-0.566	0.614	0.763	0.457E-02	2759.992	1493.550	0.183
2006	-0.022	-0.561	0.539	0.763	0.457E-02	2572.432	1500.911	0.100

Selectivities by age

Year	6	7	8	9	10
----	-----	-----	-----	-----	-----
1981	0.157	0.264	0.463	0.790	1.000
1982	0.157	0.264	0.463	0.790	1.000
1983	0.157	0.264	0.463	0.790	1.000
1984	0.157	0.264	0.463	0.790	1.000
1985	0.157	0.264	0.463	0.790	1.000
1986	0.157	0.264	0.463	0.790	1.000
1987	0.157	0.264	0.463	0.790	1.000
1988	0.157	0.264	0.463	0.790	1.000
1989	0.157	0.264	0.463	0.790	1.000
1990	0.157	0.264	0.463	0.790	1.000
1991	0.157	0.264	0.463	0.790	1.000
1992	0.157	0.264	0.463	0.790	1.000
1993	0.157	0.264	0.463	0.790	1.000
1994	0.157	0.264	0.463	0.790	1.000
1995	0.157	0.264	0.463	0.790	1.000
1996	0.157	0.264	0.463	0.790	1.000
1997	0.157	0.264	0.463	0.790	1.000
1998	0.157	0.264	0.463	0.790	1.000
1999	0.157	0.264	0.463	0.790	1.000
2000	0.157	0.264	0.463	0.790	1.000
2001	0.157	0.264	0.463	0.790	1.000
2002	0.157	0.264	0.463	0.790	1.000
2003	0.157	0.264	0.463	0.790	1.000
2004	0.157	0.264	0.463	0.790	1.000
2005	0.157	0.264	0.463	0.790	1.000
2006	0.157	0.264	0.463	0.790	1.000

5.2 ESP BB 1

Not used

5.3 ESP BB 2

Lognormal dist.
average numbers
Ages 2 - 2
log-likelihood = -17.44
deviance = 52.17
Chi-sq. discrepancy= 20.92

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1975	0.542	-0.019	0.561	0.763	0.126E-03	213.720	122.007	0.121
1976	0.163	-0.313	0.476	0.763	0.126E-03	146.320	90.917	0.052
1977	0.548	0.148	0.400	0.763	0.126E-03	215.130	144.215	0.017
1978	-0.504	-0.633	0.129	0.763	0.126E-03	75.110	66.043	0.029
1979	-1.277	-0.826	-0.452	0.763	0.126E-03	34.670	54.459	0.348
1980	-0.583	-0.552	-0.031	0.763	0.126E-03	69.410	71.602	0.096
1981	-0.270	-0.312	0.043	0.763	0.126E-03	94.950	90.996	0.061
1982	0.030	-0.411	0.441	0.763	0.126E-03	128.090	82.443	0.033
1983	-0.045	-0.030	-0.015	0.763	0.126E-03	118.830	120.660	0.088
1984	1.362	0.283	1.079	0.763	0.126E-03	485.620	165.007	1.818
1985	1.123	-0.230	1.353	0.763	0.126E-03	382.160	98.790	4.519
1986	-0.353	-0.271	-0.082	0.763	0.126E-03	87.360	94.818	0.123
1987	1.218	0.070	1.148	0.763	0.126E-03	420.300	133.385	2.319
1988	-0.876	-0.070	-0.805	0.763	0.126E-03	51.800	115.911	0.561
1989	1.368	0.092	1.276	0.763	0.126E-03	488.140	136.280	3.553
1990	-0.134	0.271	-0.405	0.763	0.126E-03	108.780	163.084	0.318
1991	0.319	0.299	0.020	0.763	0.126E-03	171.110	167.658	0.071
1992	0.717	0.570	0.147	0.763	0.126E-03	254.590	219.893	0.023
1993	1.246	0.388	0.858	0.763	0.126E-03	432.270	183.272	0.735
1994	-1.272	0.561	-1.833	0.763	0.126E-03	34.840	217.814	0.980
1995	0.449	0.340	0.109	0.763	0.126E-03	194.750	174.608	0.035
1996	0.298	0.340	-0.042	0.763	0.126E-03	167.510	174.732	0.102
1997	0.024	0.229	-0.204	0.763	0.126E-03	127.410	156.283	0.193
1998	-0.671	-0.221	-0.450	0.763	0.126E-03	63.560	99.658	0.346
1999	-3.608	0.250	-3.858	0.763	0.126E-03	3.370	159.633	1.225
2000	-1.030	0.229	-1.259	0.763	0.126E-03	44.400	156.375	0.785
2001	0.996	0.204	0.792	0.763	0.126E-03	336.760	152.506	0.534
2002	1.063	0.070	0.993	0.763	0.126E-03	359.870	133.295	1.308
2003	-0.402	-0.166	-0.236	0.763	0.126E-03	83.220	105.324	0.212
2004	-0.350	-0.318	-0.032	0.763	0.126E-03	87.650	90.498	0.097
2005	0.078	0.105	-0.027	0.763	0.126E-03	134.470	138.172	0.094
2006	-0.170	-0.078	-0.093	0.763	0.126E-03	104.880	115.050	0.129

Selectivities by age

Year	2
1975	1.000
1976	1.000
1977	1.000
1978	1.000
1979	1.000
1980	1.000
1981	1.000
1982	1.000
1983	1.000
1984	1.000
1985	1.000
1986	1.000
1987	1.000

1988	1.000
1989	1.000
1990	1.000
1991	1.000
1992	1.000
1993	1.000
1994	1.000
1995	1.000
1996	1.000
1997	1.000
1998	1.000
1999	1.000
2000	1.000
2001	1.000
2002	1.000
2003	1.000
2004	1.000
2005	1.000
2006	1.000

5.4 ESP BB 3

Lognormal dist.
average numbers
Ages 3 - 3
log-likelihood = -16.41
deviance = 50.10
Chi-sq. discrepancy= 35.28

Year	Observed	Residuals Predicted	Standard (Obs-pred)	Q Deviation	Untransfrmd Catchabil.	Untransfrmd Observed	Chi-square Predicted	Discrepancy
1975	0.332	-0.010	0.342	0.763	0.622E-04	48.740	34.617	0.003
1976	0.590	-0.110	0.700	0.763	0.622E-04	63.040	31.314	0.322
1977	1.057	-0.220	1.278	0.763	0.622E-04	100.630	28.049	3.571
1978	-0.868	0.257	-1.125	0.763	0.622E-04	14.670	45.201	0.725
1979	0.721	-0.636	1.358	0.763	0.622E-04	71.910	18.500	4.586
1980	-0.251	-0.754	0.503	0.763	0.622E-04	27.200	16.448	0.070
1981	-1.855	-0.518	-1.336	0.763	0.622E-04	5.470	20.816	0.816
1982	0.199	-0.453	0.652	0.763	0.622E-04	42.670	22.224	0.239
1983	-0.873	-0.458	-0.415	0.763	0.622E-04	14.600	22.116	0.325
1984	1.285	0.124	1.161	0.763	0.622E-04	126.380	39.577	2.429
1985	1.150	0.167	0.983	0.763	0.622E-04	110.430	41.321	1.256
1986	-0.363	-0.249	-0.113	0.763	0.622E-04	24.320	27.240	0.140
1987	-1.175	-0.260	-0.914	0.763	0.622E-04	10.800	26.946	0.620
1988	-1.612	-0.007	-1.606	0.763	0.622E-04	6.970	34.715	0.913
1989	-1.443	0.055	-1.497	0.763	0.622E-04	8.260	36.916	0.877
1990	0.152	0.059	0.093	0.763	0.622E-04	40.680	37.078	0.041
1991	-0.381	0.350	-0.731	0.763	0.622E-04	23.880	49.590	0.518
1992	-1.066	0.287	-1.353	0.763	0.622E-04	12.040	46.587	0.823
1993	1.672	0.561	1.110	0.763	0.622E-04	185.980	61.263	2.034
1994	0.251	0.329	-0.078	0.763	0.622E-04	44.930	48.560	0.120
1995	0.590	0.592	-0.003	0.763	0.622E-04	63.030	63.213	0.082
1996	1.308	0.359	0.949	0.763	0.622E-04	129.240	50.052	1.092
1997	1.728	0.283	1.445	0.763	0.622E-04	196.790	46.397	5.949
1998	0.360	0.143	0.217	0.763	0.622E-04	50.100	40.347	0.007
1999	-0.973	-0.394	-0.579	0.763	0.622E-04	13.210	23.581	0.427
2000	-0.009	0.343	-0.352	0.763	0.622E-04	34.650	49.263	0.285

2001	0.611	0.301	0.310	0.763	0.622E-04	64.420	47.234	0.000
2002	1.483	0.175	1.308	0.763	0.622E-04	153.960	41.626	3.933
2003	-1.010	0.087	-1.098	0.763	0.622E-04	12.730	38.149	0.712
2004	-1.183	-0.111	-1.072	0.763	0.622E-04	10.710	31.290	0.700
2005	0.610	-0.311	0.921	0.763	0.622E-04	64.340	25.610	0.973
2006	-1.039	0.017	-1.056	0.763	0.622E-04	12.370	35.568	0.693

Selectivities by age

Year	3
----	-----
1975	1.000
1976	1.000
1977	1.000
1978	1.000
1979	1.000
1980	1.000
1981	1.000
1982	1.000
1983	1.000
1984	1.000
1985	1.000
1986	1.000
1987	1.000
1988	1.000
1989	1.000
1990	1.000
1991	1.000
1992	1.000
1993	1.000
1994	1.000
1995	1.000
1996	1.000
1997	1.000
1998	1.000
1999	1.000
2000	1.000
2001	1.000
2002	1.000
2003	1.000
2004	1.000
2005	1.000
2006	1.000

5.5 ESP BB 4

Not used

5.6 ESP BB 5

Not used

5.7 JLL EastMed

Lognormal dist.
average numbers
Ages 4 - 10

log-likelihood = 3.20
deviance = 10.88
Chi-sq. discrepancy= 6.94

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1975	0.357	0.315	0.042	0.763	0.215E-05	1.956	1.876	0.062
1976	0.472	0.255	0.216	0.763	0.215E-05	2.194	1.767	0.007
1977	0.979	0.218	0.762	0.763	0.215E-05	3.647	1.702	0.456
1978	0.131	0.217	-0.086	0.763	0.215E-05	1.561	1.701	0.125
1979	0.705	0.250	0.455	0.763	0.215E-05	2.771	1.758	0.040
1980	0.253	0.246	0.007	0.763	0.215E-05	1.763	1.751	0.077
1981	0.223	0.263	-0.040	0.763	0.215E-05	1.712	1.781	0.100
1982	0.904	0.241	0.663	0.763	0.215E-05	3.382	1.742	0.257
1983	0.458	0.211	0.247	0.763	0.215E-05	2.165	1.691	0.002
1984	0.192	0.143	0.049	0.763	0.215E-05	1.660	1.581	0.059
1985	0.261	0.042	0.219	0.763	0.215E-05	1.778	1.429	0.006
1986	-0.010	0.017	-0.027	0.763	0.215E-05	1.356	1.393	0.094
1987	0.477	0.022	0.456	0.763	0.215E-05	2.207	1.400	0.040
1988	0.008	0.038	-0.030	0.763	0.215E-05	1.380	1.422	0.095
1989	-0.242	0.074	-0.316	0.763	0.215E-05	1.075	1.475	0.262
1990	0.064	0.099	-0.034	0.763	0.215E-05	1.460	1.511	0.098
1991	-0.088	0.055	-0.143	0.763	0.215E-05	1.254	1.447	0.157
1992	-0.252	0.017	-0.269	0.763	0.215E-05	1.064	1.393	0.233
1993	-0.248	0.002	-0.250	0.763	0.215E-05	1.069	1.372	0.221
1994	-0.186	-0.018	-0.168	0.763	0.215E-05	1.137	1.345	0.172
1995	0.022	-0.066	0.088	0.763	0.215E-05	1.400	1.281	0.043
1996	-1.054	-0.077	-0.978	0.763	0.215E-05	0.477	1.268	0.653
1997	-0.984	-0.094	-0.890	0.763	0.215E-05	0.512	1.246	0.607
1998	-0.677	-0.114	-0.563	0.763	0.215E-05	0.696	1.222	0.417
1999	-0.789	-0.104	-0.684	0.763	0.215E-05	0.622	1.234	0.491
2000	-0.643	-0.147	-0.496	0.763	0.215E-05	0.720	1.182	0.375
2001	-0.393	-0.208	-0.185	0.763	0.215E-05	0.924	1.112	0.181
2002	0.372	-0.299	0.671	0.763	0.215E-05	1.986	1.016	0.269
2003	0.182	-0.384	0.567	0.763	0.215E-05	1.643	0.932	0.127
2004	-0.562	-0.427	-0.135	0.763	0.215E-05	0.781	0.894	0.152
2005	-0.481	-0.419	-0.063	0.763	0.215E-05	0.846	0.901	0.112
2006	0.547	-0.368	0.915	0.763	0.215E-05	2.366	0.948	0.946

Selectivities by age

Year	4	5	6	7	8	9	10
1975	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1976	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1977	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1978	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1979	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1980	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1981	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1982	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1983	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1984	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1985	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1986	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1987	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1988	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1989	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1990	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1991	0.038	0.079	0.217	0.441	0.762	1.000	0.741

1992	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1993	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1994	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1995	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1996	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1997	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1998	0.038	0.079	0.217	0.441	0.762	1.000	0.741
1999	0.038	0.079	0.217	0.441	0.762	1.000	0.741
2000	0.038	0.079	0.217	0.441	0.762	1.000	0.741
2001	0.038	0.079	0.217	0.441	0.762	1.000	0.741
2002	0.038	0.079	0.217	0.441	0.762	1.000	0.741
2003	0.038	0.079	0.217	0.441	0.762	1.000	0.741
2004	0.038	0.079	0.217	0.441	0.762	1.000	0.741
2005	0.038	0.079	0.217	0.441	0.762	1.000	0.741
2006	0.038	0.079	0.217	0.441	0.762	1.000	0.741

5.8 MAR Trap

Not used

5.9 ESP Trap

Not used

5.10 FR BB

Lognormal dist.
average biomass
Ages 2 - 5
log-likelihood = 0.63
deviance = 9.55
Chi-sq. discrepancy= 5.52

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1955	0.879	0.758	0.121	0.763	0.138E-04	808.267	716.428	0.031
1956	0.212	0.653	-0.441	0.763	0.138E-04	415.143	645.318	0.341
1957	0.048	0.392	-0.344	0.763	0.138E-04	352.273	496.750	0.279
1958	-0.125	0.016	-0.141	0.763	0.138E-04	296.136	341.130	0.156
1959	0.426	-0.295	0.721	0.763	0.138E-04	514.177	249.993	0.364
1960	-0.754	-0.401	-0.353	0.763	0.138E-04	158.000	224.810	0.285
1961	-0.315	-0.465	0.150	0.763	0.138E-04	245.135	210.957	0.022
1962	-0.343	-0.473	0.130	0.763	0.138E-04	238.272	209.306	0.028
1963	-0.698	-0.247	-0.451	0.763	0.138E-04	167.077	262.291	0.347
1964	-0.907	0.049	-0.956	0.763	0.138E-04	135.593	352.633	0.642
1965	-0.340	0.233	-0.574	0.763	0.138E-04	238.846	423.938	0.424
1966	0.413	0.445	-0.032	0.763	0.138E-04	507.500	524.063	0.097
1967	0.108	0.577	-0.470	0.763	0.138E-04	373.913	598.087	0.359
1968	-0.381	0.399	-0.780	0.763	0.138E-04	229.412	500.466	0.546
1969	0.241	0.042	0.199	0.763	0.138E-04	427.200	350.081	0.010
1970	0.249	-0.338	0.587	0.763	0.138E-04	430.588	239.468	0.149
1971	0.175	-0.586	0.761	0.763	0.138E-04	400.000	186.811	0.455
1972	0.461	-0.404	0.865	0.763	0.138E-04	532.374	224.048	0.760
1973	0.104	-0.265	0.369	0.763	0.138E-04	372.414	257.570	0.008
1974	0.547	-0.092	0.638	0.763	0.138E-04	580.000	306.322	0.218

Selectivities by age

Year	2	3	4	5
1955	0.809	1.000	0.446	0.173
1956	0.809	1.000	0.446	0.173
1957	0.809	1.000	0.446	0.173
1958	0.809	1.000	0.446	0.173
1959	0.809	1.000	0.446	0.173
1960	0.809	1.000	0.446	0.173
1961	0.809	1.000	0.446	0.173
1962	0.809	1.000	0.446	0.173
1963	0.809	1.000	0.446	0.173
1964	0.809	1.000	0.446	0.173
1965	0.809	1.000	0.446	0.173
1966	0.809	1.000	0.446	0.173
1967	0.809	1.000	0.446	0.173
1968	0.809	1.000	0.446	0.173
1969	0.809	1.000	0.446	0.173
1970	0.809	1.000	0.446	0.173
1971	0.809	1.000	0.446	0.173
1972	0.809	1.000	0.446	0.173
1973	0.809	1.000	0.446	0.173
1974	0.809	1.000	0.446	0.173

5.11 NOR PS

Lognormal dist.
average biomass
Ages 10 - 10
log-likelihood = -8.51
deviance = 31.05
Chi-sq. discrepancy= 6.59

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1955	0.235	-0.418	0.653	0.763	0.169E-06	36.199	18.845	0.240
1956	-0.298	-0.323	0.025	0.763	0.169E-06	21.254	20.731	0.069
1957	-0.001	-0.155	0.154	0.763	0.169E-06	28.607	24.512	0.021
1958	-0.171	-0.130	-0.041	0.763	0.169E-06	24.126	25.130	0.101
1959	0.124	-0.131	0.255	0.763	0.169E-06	32.408	25.118	0.002
1960	0.492	-0.149	0.641	0.763	0.169E-06	46.831	24.661	0.222
1961	0.594	-0.018	0.611	0.763	0.169E-06	51.836	28.128	0.180
1962	0.815	0.044	0.771	0.763	0.169E-06	64.669	29.909	0.479
1963	-2.841	0.015	-2.856	0.763	0.169E-06	1.671	29.061	1.158
1964	0.171	0.098	0.073	0.763	0.169E-06	33.978	31.572	0.048
1965	0.889	0.142	0.747	0.763	0.169E-06	69.604	32.992	0.420
1966	0.221	-0.011	0.232	0.763	0.169E-06	35.705	28.302	0.004
1967	0.758	-0.022	0.779	0.763	0.169E-06	61.057	28.015	0.499
1968	-0.196	-0.086	-0.110	0.763	0.169E-06	23.532	26.255	0.138
1969	-0.020	-0.113	0.093	0.763	0.169E-06	28.056	25.576	0.041
1970	0.401	-0.292	0.693	0.763	0.169E-06	42.755	21.373	0.309
1971	0.419	-0.068	0.487	0.763	0.169E-06	43.519	26.751	0.059
1972	0.408	0.072	0.336	0.763	0.169E-06	43.047	30.764	0.003
1973	0.387	0.123	0.264	0.763	0.169E-06	42.148	32.377	0.001
1974	0.468	0.310	0.158	0.763	0.169E-06	45.719	39.028	0.020
1975	0.283	0.332	-0.049	0.763	0.169E-06	38.000	39.906	0.105

1976	-0.302	0.308	-0.610	0.763	0.169E-06	21.160	38.954	0.446
1977	0.394	0.241	0.152	0.763	0.169E-06	42.444	36.444	0.021
1978	-0.846	0.160	-1.007	0.763	0.169E-06	12.278	33.603	0.668
1979	-2.033	0.046	-2.079	0.763	0.169E-06	3.750	29.981	1.039
1980	-0.351	0.022	-0.374	0.763	0.169E-06	20.143	29.268	0.298

Selectivities by age

Year	10
1955	1.000
1956	1.000
1957	1.000
1958	1.000
1959	1.000
1960	1.000
1961	1.000
1962	1.000
1963	1.000
1964	1.000
1965	1.000
1966	1.000
1967	1.000
1968	1.000
1969	1.000
1970	1.000
1971	1.000
1972	1.000
1973	1.000
1974	1.000
1975	1.000
1976	1.000
1977	1.000
1978	1.000
1979	1.000
1980	1.000

==

TOTAL NUMBER OF FUNCTION EVALUATIONS = 2984

RUN 14

****

VPA-2BOX

SUMMARY STATISTICS AND DIAGNOSTIC OUTPUT

****

BFT East 55-06 test
9:27, 2 July 2008

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Total objective function = 41.85
(with constants) = 196.23
Number of parameters (P) = 15
Number of data points (D)= 168
AIC : 2*objective+2P = 422.46
AICc: 2*objective+2P(...)= 425.62
BIC : 2*objective+Plog(D)= 469.32
Chi-square discrepancy = 83.08

Loglikelihoods (deviance)= -44.59 (167.92)
effort data = -44.59 (167.92)

Log-posteriors = 0.00
catchability = 0.00
f-ratio = 0.00
natural mortality = 0.00
mixing coeff. = 0.00

Constraints = 2.74
terminal F = 2.74
stock-rec./sex ratio = 0.00

Out of bounds penalty = 0.00
==

TABLE 1. FISHING MORTALITY RATE FOR EAST OF 45

	1	2	3	4	5	6	7	8	9	10
1955	0.008	0.051	0.102	0.046	0.065	0.083	0.141	0.099	0.222	0.156
1956	0.006	0.039	0.053	0.029	0.035	0.061	0.076	0.136	0.137	0.096
1957	0.009	0.074	0.098	0.043	0.043	0.090	0.176	0.129	0.155	0.109
1958	0.027	0.094	0.143	0.059	0.104	0.111	0.094	0.158	0.127	0.089
1959	0.011	0.088	0.226	0.091	0.043	0.039	0.040	0.046	0.134	0.094
1960	0.008	0.050	0.080	0.099	0.145	0.088	0.046	0.079	0.114	0.080
1961	0.010	0.093	0.144	0.103	0.238	0.192	0.047	0.047	0.127	0.089
1962	0.006	0.058	0.131	0.088	0.119	0.254	0.094	0.121	0.133	0.093
1963	0.004	0.036	0.101	0.107	0.112	0.093	0.105	0.065	0.063	0.044
1964	0.010	0.052	0.099	0.138	0.178	0.107	0.086	0.095	0.071	0.049
1965	0.005	0.054	0.068	0.061	0.079	0.110	0.098	0.045	0.082	0.058
1966	0.026	0.069	0.207	0.080	0.050	0.096	0.081	0.050	0.046	0.032
1967	0.074	0.071	0.091	0.103	0.039	0.048	0.133	0.060	0.083	0.058
1968	0.029	0.082	0.076	0.047	0.054	0.020	0.043	0.066	0.047	0.033
1969	0.060	0.256	0.192	0.063	0.022	0.025	0.015	0.038	0.065	0.046
1970	0.059	0.174	0.121	0.078	0.026	0.015	0.030	0.022	0.041	0.041
1971	0.003	0.223	0.174	0.079	0.067	0.015	0.013	0.041	0.032	0.032
1972	0.006	0.178	0.337	0.090	0.071	0.055	0.019	0.008	0.023	0.023
1973	0.006	0.150	0.139	0.081	0.032	0.037	0.061	0.036	0.024	0.024
1974	0.026	0.168	0.187	0.143	0.118	0.057	0.040	0.052	0.048	0.048
1975	0.066	0.357	0.143	0.091	0.043	0.102	0.052	0.045	0.059	0.059
1976	0.009	0.265	0.463	0.119	0.096	0.030	0.066	0.030	0.047	0.047
1977	0.071	0.233	0.173	0.152	0.023	0.033	0.025	0.062	0.046	0.046
1978	0.135	0.351	0.175	0.083	0.041	0.011	0.024	0.013	0.035	0.035
1979	0.017	0.104	0.279	0.091	0.036	0.023	0.016	0.049	0.032	0.032
1980	0.110	0.239	0.407	0.186	0.030	0.034	0.030	0.016	0.035	0.035
1981	0.075	0.435	0.330	0.101	0.087	0.021	0.030	0.045	0.026	0.026
1982	0.239	0.389	0.472	0.170	0.066	0.040	0.022	0.075	0.053	0.053
1983	0.243	0.196	0.320	0.130	0.079	0.059	0.116	0.033	0.055	0.055
1984	0.108	0.447	0.120	0.129	0.126	0.093	0.085	0.114	0.061	0.061
1985	0.091	0.401	0.393	0.113	0.069	0.066	0.036	0.053	0.073	0.044
1986	0.274	0.310	0.238	0.146	0.030	0.042	0.038	0.031	0.068	0.041
1987	0.139	0.390	0.287	0.114	0.045	0.028	0.081	0.059	0.062	0.037
1988	0.334	0.206	0.379	0.159	0.056	0.040	0.048	0.073	0.094	0.056
1989	0.179	0.358	0.164	0.147	0.135	0.031	0.049	0.034	0.071	0.043
1990	0.168	0.229	0.303	0.125	0.158	0.053	0.051	0.071	0.088	0.053
1991	0.065	0.280	0.205	0.129	0.131	0.044	0.046	0.056	0.129	0.077
1992	0.073	0.237	0.337	0.082	0.066	0.058	0.099	0.123	0.151	0.090

1993	0.084	0.438	0.266	0.125	0.055	0.062	0.069	0.091	0.141	0.085
1994	0.113	0.259	0.176	0.063	0.112	0.083	0.172	0.192	0.326	0.196
1995	0.142	0.202	0.251	0.098	0.081	0.156	0.086	0.152	0.182	0.218
1996	0.144	0.405	0.322	0.235	0.107	0.045	0.098	0.076	0.205	0.246
1997	0.126	0.273	0.199	0.182	0.141	0.125	0.065	0.200	0.202	0.243
1998	0.122	0.527	0.403	0.328	0.168	0.364	0.043	0.038	0.136	0.163
1999	0.190	0.244	0.462	0.314	0.148	0.066	0.068	0.068	0.179	0.215
2000	0.510	0.509	0.278	0.263	0.281	0.223	0.075	0.107	0.097	0.116
2001	0.010	0.574	0.281	0.195	0.197	0.140	0.294	0.161	0.172	0.207
2002	0.038	0.636	0.571	0.256	0.099	0.195	0.094	0.171	0.172	0.206
2003	0.025	0.270	0.166	0.201	0.297	0.103	0.337	0.207	0.265	0.318
2004	0.072	0.337	0.443	0.119	0.101	0.240	0.166	0.187	0.324	0.389
2005	0.217	0.366	0.277	0.270	0.117	0.199	0.247	0.094	0.470	0.564
2006	0.153	0.253	0.534	0.203	0.086	0.225	0.149	0.233	0.522	0.627
2007	0.392	0.522	0.667	0.244	0.233	0.297	0.237	0.339	0.896	1.076

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TABLE 2. ABUNDANCE AT THE BEGINNING OF THE YEAR [BY AREA] FOR EAST OF 45

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	1	2	3	4	5	6	7	8	9	10
1955	1736848.	1597729.	1236915.	1034900.	621522.	520828.	277390.	404162.	246129.	670382.
1956	1093366.	1055216.	1194593.	878504.	777215.	458060.	392551.	202155.	314972.	693078.
1957	844063.	665599.	798525.	890820.	671035.	590558.	352874.	305339.	151800.	812052.
1958	1021211.	512375.	486237.	569751.	671129.	505824.	441977.	248347.	230983.	773955.
1959	870920.	609239.	366796.	331681.	422528.	475783.	370582.	337850.	182432.	820261.
1960	748982.	527506.	439053.	230166.	238320.	318427.	374530.	298946.	277793.	816424.
1961	983755.	455153.	394779.	318830.	164068.	162156.	238714.	300252.	237865.	900770.
1962	1580676.	596626.	326168.	268944.	226239.	101771.	109554.	191169.	246583.	930718.
1963	1925067.	962985.	443081.	224963.	193717.	158066.	64647.	83728.	145741.	957922.
1964	1724113.	1174655.	731079.	314951.	158944.	136179.	117904.	48849.	67504.	950029.
1965	3120179.	1045792.	876811.	520927.	215867.	104629.	100178.	90804.	38224.	873731.
1966	1965051.	1901099.	779375.	644692.	385554.	156975.	76728.	76223.	74739.	777406.
1967	1154908.	1173314.	1396261.	498420.	467916.	288396.	116790.	59400.	62382.	744350.
1968	972429.	656842.	859869.	1003274.	353577.	353861.	224979.	85830.	48138.	686096.
1969	934494.	578946.	475883.	627102.	753051.	263532.	284101.	180849.	69135.	641221.
1970	863567.	539173.	352611.	308919.	463182.	579728.	210460.	235030.	149926.	611463.
1971	1692900.	498903.	356301.	245880.	224843.	354873.	467423.	171427.	197969.	657958.

1972	1152386.	1034445.	313940.	235432.	178710.	165462.	286151.	387422.	141673.	745713.
1973	1717086.	701662.	680773.	176368.	169180.	131009.	128228.	235742.	330829.	781555.
1974	2196570.	1045918.	475026.	466101.	127929.	128871.	103343.	101311.	195752.	975237.
1975	1651172.	1310859.	695518.	310092.	317932.	89441.	99619.	83351.	82798.	1005483.
1976	2448968.	946796.	721893.	474340.	222688.	239636.	66108.	79388.	68580.	926641.
1977	1242764.	1486730.	571352.	357421.	331188.	159116.	190359.	51957.	66318.	857935.
1978	980476.	709253.	926013.	377967.	241398.	254625.	126037.	155853.	42047.	797670.
1979	1219496.	524696.	392586.	611513.	273691.	182341.	206156.	103310.	132452.	732435.
1980	1849152.	734729.	371813.	233605.	439376.	207643.	145942.	170288.	84669.	754767.
1981	1595021.	1014599.	455040.	194625.	152564.	335514.	164281.	118926.	144265.	731811.
1982	2564629.	906531.	516837.	257438.	138383.	110046.	269111.	133796.	97835.	769412.
1983	3877844.	1237200.	483452.	253617.	170817.	101854.	86526.	221086.	106829.	741946.
1984	2008307.	1864079.	799639.	276181.	175118.	124207.	78610.	64711.	184119.	724360.
1985	1811972.	1104721.	937632.	557931.	190884.	121409.	92652.	60620.	49681.	769230.
1986	3159758.	1013370.	581817.	497697.	392164.	140090.	93094.	75044.	49464.	707050.
1987	2262575.	1472144.	584384.	360691.	338211.	299358.	109960.	75228.	62640.	655006.
1988	3462646.	1205943.	784374.	345025.	253083.	254431.	238236.	85145.	61056.	622895.
1989	3512123.	1519342.	771692.	422163.	231542.	188251.	200114.	190634.	68123.	581748.
1990	3552554.	1799869.	835571.	515436.	286685.	159091.	149496.	160002.	158633.	560330.
1991	4873058.	1840042.	1126305.	485369.	357941.	192555.	123569.	119235.	128306.	609067.
1992	4126302.	2797355.	1093764.	722009.	335612.	246958.	150927.	99082.	97014.	609714.
1993	4369670.	2350672.	1735601.	614197.	523431.	247133.	190762.	114725.	75393.	577681.
1994	3605480.	2460324.	1192758.	1046587.	426560.	389679.	190237.	149515.	90122.	537965.
1995	4218166.	1973653.	1493221.	786658.	773153.	300113.	293560.	134518.	106216.	457645.
1996	4178050.	2242765.	1268077.	913512.	560922.	560775.	210278.	226231.	99405.	410988.
1997	3267734.	2217212.	1176247.	722873.	568343.	396511.	438908.	160007.	180545.	362214.
1998	4945338.	1765532.	1326891.	758422.	473790.	388440.	286597.	345162.	112711.	387282.
1999	3918775.	2681311.	819946.	697457.	429780.	315172.	221087.	230564.	286099.	384660.
2000	5120961.	1985414.	1653348.	406539.	400636.	291682.	241586.	173404.	185403.	491936.
2001	3123352.	1883395.	938464.	984623.	245856.	237957.	191049.	188142.	134038.	544769.

2002	2460795.	1893665.	834444.	557318.	637596.	158754.	169299.	119582.	137822.	500523.
2003	2402065.	1451898.	788509.	370775.	339247.	454271.	106977.	129374.	86757.	470952.
2004	3927801.	1435916.	871589.	525288.	238497.	198342.	335390.	64128.	90528.	368621.
2005	2475036.	2239034.	806188.	440059.	366987.	169607.	127775.	238420.	45769.	283724.
2006	3378944.	1220327.	1221176.	480662.	264303.	256787.	113788.	83826.	186818.	171299.
2007	1829416.	1776547.	745636.	563165.	308740.	190846.	167955.	82303.	57179.	180627.
2008		757512.	828936.	301031.	346938.	192389.	116071.	111230.	50464.	76331.

==

TABLE 3. CATCH OF EAST OF 45

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	1	2	3	4	5	6	7	8	9	10
1955	11390.	70400.	107008.	41704.	34906.	37542.	33620.	35532.	46230.	92065.
1956	5455.	35668.	55302.	22639.	23547.	24550.	26464.	23989.	38002.	60427.
1957	6091.	42266.	66121.	33498.	24920.	46045.	52455.	34392.	20523.	79533.
1958	21162.	41049.	57587.	29029.	59060.	48301.	36300.	33860.	25940.	62720.
1959	7804.	45504.	66262.	25576.	15776.	16623.	13275.	14031.	21575.	70071.
1960	4765.	22821.	30043.	19236.	28693.	24382.	15475.	20995.	28190.	59676.
1961	7810.	36085.	47151.	27817.	30990.	25774.	10084.	12790.	26672.	72883.
1962	6948.	29693.	35820.	20199.	22545.	20762.	9015.	20314.	28861.	78671.
1963	6053.	29894.	38039.	20408.	18355.	12761.	5931.	4925.	8392.	39445.
1964	13483.	53408.	61333.	36132.	23139.	12549.	8941.	4128.	4324.	43564.
1965	13434.	48963.	50961.	27408.	14527.	9909.	8615.	3689.	2841.	46567.
1966	39436.	112263.	130125.	44396.	16847.	13006.	5482.	3480.	3133.	23246.
1967	65608.	71404.	107636.	43596.	16077.	12342.	13370.	3226.	4680.	40047.
1968	21694.	46196.	55796.	40894.	16520.	6218.	8761.	5117.	2075.	21100.
1969	43107.	116782.	74227.	34077.	14296.	5870.	3784.	6187.	4111.	27275.
1970	38988.	76925.	35680.	20559.	10718.	7994.	5735.	4664.	5693.	23503.
1971	3451.	89131.	50860.	16647.	12908.	4866.	5421.	6342.	5904.	19863.
1972	5573.	150797.	80312.	18135.	10831.	8023.	4886.	2837.	3049.	16246.

1973	7760.	87196.	78670.	12234.	4762.	4339.	6926.	7721.	7439.	17790.
1974	44979.	144277.	72124.	55216.	12678.	6529.	3719.	4751.	8656.	43652.
1975	83784.	352023.	82482.	24048.	11829.	7896.	4634.	3412.	4453.	54737.
1976	17530.	197044.	240034.	47517.	18182.	6467.	3870.	2172.	2940.	40211.
1977	67420.	276479.	81061.	45073.	6668.	4692.	4314.	2886.	2775.	36339.
1978	98571.	188168.	132601.	26750.	8539.	2562.	2725.	1825.	1375.	26405.
1979	15969.	46352.	85483.	47165.	8652.	3706.	3029.	4589.	3957.	22150.
1980	153269.	139588.	111493.	35389.	11433.	6339.	3921.	2484.	2707.	24427.
1981	91415.	320655.	114344.	16664.	11282.	6186.	4494.	4886.	3452.	17726.
1982	435146.	261565.	174480.	35938.	7924.	3956.	5269.	8996.	4771.	37980.
1983	666701.	196951.	118425.	27630.	11504.	5298.	8674.	6661.	5419.	38096.
1984	162820.	602875.	80534.	29877.	18519.	10023.	5876.	6501.	10301.	41021.
1985	125240.	327181.	273233.	52924.	11390.	6990.	2989.	2928.	3280.	31283.
1986	604933.	241954.	110132.	60406.	10325.	5246.	3194.	2105.	3059.	26910.
1987	233816.	425593.	130343.	34716.	13139.	7595.	7836.	3987.	3555.	22852.
1988	787349.	200802.	221886.	45198.	12255.	9080.	10230.	5575.	5152.	32507.
1989	457215.	409309.	103864.	51463.	26117.	5129.	8733.	5880.	4406.	23170.
1990	436999.	328717.	195473.	53837.	37369.	7406.	6846.	10160.	12584.	27460.
1991	243243.	401951.	186083.	52343.	39217.	7448.	5083.	6060.	14583.	43095.
1992	229347.	527898.	280117.	50401.	19090.	12665.	13102.	10684.	12771.	50172.
1993	280529.	748302.	362086.	64111.	24966.	13407.	11619.	9313.	9357.	44739.
1994	304848.	502294.	171943.	56716.	40132.	28248.	27584.	24304.	23658.	91141.
1995	443085.	322791.	296580.	65551.	53670.	39327.	22102.	17701.	16646.	85602.
1996	444406.	669905.	312384.	170611.	50658.	22395.	18071.	15306.	17363.	85496.
1997	306585.	474121.	189317.	107583.	66457.	42198.	25467.	27049.	31140.	74424.
1998	451731.	649694.	394557.	189770.	65233.	107965.	10958.	11856.	13452.	55410.
1999	540099.	517710.	271985.	168325.	52591.	18235.	13333.	14086.	44138.	70849.
2000	1651573.	711627.	359074.	84005.	87737.	53068.	16037.	16434.	16114.	51446.
2001	25533.	739701.	205608.	155369.	39309.	28320.	44773.	26069.	19960.	96913.
2002	71927.	802414.	326482.	112638.	53543.	25543.	13947.	17481.	20485.	88878.

2003	46055.	307381.	107698.	60328.	77901.	40516.	28196.	22527.	19063.	122562.
2004	216436.	367903.	279989.	52360.	20386.	38471.	47244.	10194.	23660.	113503.
2005	385283.	614905.	174453.	93018.	36131.	27849.	25703.	19866.	16213.	116936.
2006	381072.	243431.	453977.	78709.	19316.	46985.	14476.	16199.	71825.	76296.
2007	476208.	649262.	326962.	109102.	57313.	44700.	32636.	22075.	32112.	114263.

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TABLE 4. SPAWNING STOCK FECUNDITY AND RECRUITMENT OF EAST OF 45

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year	spawning biomass	recruits from VPA
1955	281954.	1736848.
1956	293686.	1093366.
1957	305347.	844063.
1958	309932.	1021211.
1959	295669.	870920.
1960	276992.	748982.
1961	271430.	983755.
1962	259169.	1580676.
1963	230712.	1925067.
1964	234749.	1724113.
1965	247121.	3120179.
1966	233128.	1965051.
1967	242289.	1154908.
1968	251277.	972429.
1969	271379.	934494.
1970	258938.	863567.
1971	288022.	1692900.
1972	297867.	1152386.
1973	298750.	1717086.
1974	308609.	2196570.
1975	299682.	1651172.
1976	297488.	2448968.
1977	287708.	1242764.
1978	275893.	980476.
1979	265092.	1219496.
1980	260270.	1849152.
1981	242430.	1595021.
1982	240487.	2564629.
1983	216818.	3877844.
1984	209947.	2008307.
1985	220586.	1811972.
1986	218118.	3159758.
1987	211313.	2262575.
1988	209345.	3462646.
1989	211845.	3512123.
1990	196955.	3552554.
1991	194648.	4873058.
1992	200396.	4126302.
1993	212334.	4369670.
1994	206727.	3605480.
1995	211502.	4218166.

1996	209234.	4178050.
1997	201479.	3267734.
1998	202337.	4945338.
1999	202877.	3918775.
2000	200567.	5120961.
2001	183252.	3123352.
2002	184442.	2460795.
2003	163087.	2402065.
2004	136590.	3927801.
2005	113838.	2475036.
2006	94978.	3378944.
2007	78724.	1829416.

===

TABLE 5. FITS TO INDEX DATA FOR EAST OF 45
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5.1 ESP MAR Trap

Lognormal dist.
average numbers
Ages 6 - 10
log-likelihood = 0.91
deviance = 10.36
Chi-sq. discrepancy= 5.24

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1981	0.211	0.298	-0.086	0.791	0.368E-02	3248.936	3541.909	0.125
1982	0.464	0.287	0.177	0.791	0.368E-02	4181.572	3503.041	0.019
1983	0.528	0.254	0.274	0.791	0.368E-02	4457.914	3389.974	0.002
1984	0.626	0.213	0.413	0.791	0.368E-02	4919.679	3253.580	0.013
1985	0.234	0.150	0.084	0.791	0.368E-02	3323.686	3057.316	0.048
1986	-0.527	0.093	-0.620	0.791	0.368E-02	1552.599	2887.361	0.423
1987	-0.429	0.083	-0.512	0.791	0.368E-02	1712.964	2859.060	0.363
1988	0.428	0.081	0.348	0.791	0.368E-02	4036.118	2851.305	0.001
1989	-0.219	0.085	-0.304	0.791	0.368E-02	2112.991	2864.800	0.244
1990	-0.182	0.098	-0.279	0.791	0.368E-02	2193.198	2900.316	0.230
1991	0.117	0.087	0.030	0.791	0.368E-02	2956.781	2869.870	0.070
1992	-0.710	0.057	-0.766	0.791	0.368E-02	1293.345	2783.499	0.501
1993	-0.725	0.026	-0.751	0.791	0.368E-02	1273.456	2698.741	0.493
1994	-0.609	-0.007	-0.602	0.791	0.368E-02	1430.110	2611.502	0.413
1995	-1.067	-0.076	-0.991	0.791	0.368E-02	905.197	2437.907	0.610
1996	-0.473	-0.051	-0.422	0.791	0.368E-02	1639.230	2499.511	0.311
1997	0.375	-0.022	0.397	0.791	0.368E-02	3827.381	2572.335	0.009
1998	0.433	0.027	0.405	0.791	0.368E-02	4053.510	2702.987	0.011
1999	0.544	0.070	0.474	0.791	0.368E-02	4531.091	2820.305	0.035
2000	0.303	0.087	0.216	0.791	0.368E-02	3559.320	2868.026	0.010
2001	0.863	0.037	0.826	0.791	0.368E-02	6234.335	2730.150	0.516
2002	0.510	-0.079	0.590	0.791	0.368E-02	4380.586	2429.226	0.117
2003	-0.072	-0.171	0.099	0.791	0.368E-02	2448.107	2217.854	0.043
2004	-0.649	-0.348	-0.301	0.791	0.368E-02	1374.174	1856.262	0.242
2005	0.048	-0.552	0.600	0.791	0.368E-02	2759.992	1515.004	0.127
2006	-0.022	-0.726	0.704	0.791	0.368E-02	2572.432	1272.267	0.263

Selectivities by age
Year 6 7 8 9 10

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1981	0.179	0.326	0.550	0.849	1.000
1982	0.179	0.326	0.550	0.849	1.000
1983	0.179	0.326	0.550	0.849	1.000
1984	0.179	0.326	0.550	0.849	1.000
1985	0.179	0.326	0.550	0.849	1.000
1986	0.179	0.326	0.550	0.849	1.000
1987	0.179	0.326	0.550	0.849	1.000
1988	0.179	0.326	0.550	0.849	1.000
1989	0.179	0.326	0.550	0.849	1.000
1990	0.179	0.326	0.550	0.849	1.000
1991	0.179	0.326	0.550	0.849	1.000
1992	0.179	0.326	0.550	0.849	1.000
1993	0.179	0.326	0.550	0.849	1.000
1994	0.179	0.326	0.550	0.849	1.000
1995	0.179	0.326	0.550	0.849	1.000
1996	0.179	0.326	0.550	0.849	1.000
1997	0.179	0.326	0.550	0.849	1.000
1998	0.179	0.326	0.550	0.849	1.000
1999	0.179	0.326	0.550	0.849	1.000
2000	0.179	0.326	0.550	0.849	1.000
2001	0.179	0.326	0.550	0.849	1.000
2002	0.179	0.326	0.550	0.849	1.000
2003	0.179	0.326	0.550	0.849	1.000
2004	0.179	0.326	0.550	0.849	1.000
2005	0.179	0.326	0.550	0.849	1.000
2006	0.179	0.326	0.550	0.849	1.000

5.2 ESP BB 1

Not used

5.3 ESP BB 2

Lognormal dist.
average numbers
Ages 2 - 2
log-likelihood = -20.80
deviance = 56.60
Chi-sq. discrepancy= 22.58

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
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1975	0.542	-0.136	0.678	0.791	0.110E-03	213.720	108.513	0.223
1976	0.163	-0.420	0.583	0.791	0.110E-03	146.320	81.702	0.110
1977	0.548	0.046	0.502	0.791	0.110E-03	215.130	130.173	0.050
1978	-0.504	-0.748	0.244	0.791	0.110E-03	75.110	58.847	0.005
1979	-1.277	-0.936	-0.342	0.791	0.110E-03	34.670	48.788	0.265
1980	-0.583	-0.662	0.079	0.791	0.110E-03	69.410	64.163	0.050
1981	-0.270	-0.427	0.158	0.791	0.110E-03	94.950	81.110	0.024
1982	0.030	-0.519	0.549	0.791	0.110E-03	128.090	73.968	0.082
1983	-0.045	-0.121	0.075	0.791	0.110E-03	118.830	110.194	0.051
1984	1.362	0.175	1.187	0.791	0.110E-03	485.620	148.186	2.242
1985	1.123	-0.327	1.450	0.791	0.110E-03	382.160	89.636	5.157
1986	-0.353	-0.373	0.020	0.791	0.110E-03	87.360	85.655	0.074
1987	1.218	-0.035	1.253	0.791	0.110E-03	420.300	120.070	2.798

1988	-0.876	-0.151	-0.725	0.791	0.110E-03	51.800	106.914	0.479
1989	1.368	0.011	1.357	0.791	0.110E-03	488.140	125.695	3.893
1990	-0.134	0.239	-0.373	0.791	0.110E-03	108.780	157.930	0.283
1991	0.319	0.238	0.082	0.791	0.110E-03	171.110	157.692	0.049
1992	0.717	0.676	0.040	0.791	0.110E-03	254.590	244.490	0.065
1993	1.246	0.411	0.835	0.791	0.110E-03	432.270	187.593	0.540
1994	-1.272	0.538	-1.810	0.791	0.110E-03	34.840	212.867	0.891
1995	0.449	0.344	0.105	0.791	0.110E-03	194.750	175.304	0.040
1996	0.298	0.379	-0.081	0.791	0.110E-03	167.510	181.635	0.122
1997	0.024	0.427	-0.403	0.791	0.110E-03	127.410	190.602	0.300
1998	-0.671	0.086	-0.757	0.791	0.110E-03	63.560	135.510	0.496
1999	-3.608	0.631	-4.239	0.791	0.110E-03	3.370	233.682	1.126
2000	-1.030	0.211	-1.241	0.791	0.110E-03	44.400	153.566	0.715
2001	0.996	0.130	0.866	0.791	0.110E-03	336.760	141.626	0.628
2002	1.063	0.109	0.954	0.791	0.110E-03	359.870	138.645	0.928
2003	-0.402	0.005	-0.407	0.791	0.110E-03	83.220	124.990	0.303
2004	-0.350	-0.036	-0.313	0.791	0.110E-03	87.650	119.907	0.249
2005	0.078	0.395	-0.317	0.791	0.110E-03	134.470	184.543	0.251
2006	-0.170	-0.160	-0.010	0.791	0.110E-03	104.880	105.909	0.087

Selectivities by age

Year	2
1975	1.000
1976	1.000
1977	1.000
1978	1.000
1979	1.000
1980	1.000
1981	1.000
1982	1.000
1983	1.000
1984	1.000
1985	1.000
1986	1.000
1987	1.000
1988	1.000
1989	1.000
1990	1.000
1991	1.000
1992	1.000
1993	1.000
1994	1.000
1995	1.000
1996	1.000
1997	1.000
1998	1.000
1999	1.000
2000	1.000
2001	1.000
2002	1.000
2003	1.000
2004	1.000
2005	1.000
2006	1.000

5.4 ESP BB 3

Lognormal dist.
average numbers
Ages 3 - 3
log-likelihood = -16.95
deviance = 48.90
Chi-sq. discrepancy= 36.47

Year	Observed	Residuals Predicted	Standard (Obs-pred)	Q Deviation	Untransfrmd Catchabil.	Untransfrmd Observed	Chi-square Predicted	Discrepancy
1975	0.332	-0.107	0.440	0.791	0.543E-04	48.740	31.401	0.021
1976	0.590	-0.216	0.805	0.791	0.543E-04	63.040	28.173	0.466
1977	1.057	-0.318	1.375	0.791	0.543E-04	100.630	25.431	4.123
1978	-0.868	0.164	-1.032	0.791	0.543E-04	14.670	41.183	0.629
1979	0.721	-0.742	1.464	0.791	0.543E-04	71.910	16.641	5.365
1980	-0.251	-0.854	0.604	0.791	0.543E-04	27.200	14.874	0.131
1981	-1.855	-0.618	-1.237	0.791	0.543E-04	5.470	18.850	0.714
1982	0.199	-0.554	0.753	0.791	0.543E-04	42.670	20.091	0.352
1983	-0.873	-0.553	-0.320	0.791	0.543E-04	14.600	20.116	0.253
1984	1.285	0.043	1.242	0.791	0.543E-04	126.380	36.490	2.701
1985	1.150	0.077	1.074	0.791	0.543E-04	110.430	37.743	1.493
1986	-0.363	-0.330	-0.033	0.791	0.543E-04	24.320	25.130	0.098
1987	-1.175	-0.348	-0.827	0.791	0.543E-04	10.800	24.682	0.532
1988	-1.612	-0.096	-1.517	0.791	0.543E-04	6.970	31.771	0.810
1989	-1.443	-0.013	-1.430	0.791	0.543E-04	8.260	34.503	0.782
1990	0.152	0.002	0.149	0.791	0.543E-04	40.680	35.031	0.026
1991	-0.381	0.346	-0.727	0.791	0.543E-04	23.880	49.405	0.481
1992	-1.066	0.256	-1.322	0.791	0.543E-04	12.040	45.157	0.745
1993	1.672	0.750	0.921	0.791	0.543E-04	185.980	74.017	0.806
1994	0.251	0.417	-0.165	0.791	0.543E-04	44.930	53.015	0.166
1995	0.590	0.606	-0.017	0.791	0.543E-04	63.030	64.103	0.091
1996	1.308	0.411	0.897	0.791	0.543E-04	129.240	52.711	0.723
1997	1.728	0.392	1.336	0.791	0.543E-04	196.790	51.735	3.650
1998	0.360	0.420	-0.060	0.791	0.543E-04	50.100	53.179	0.111
1999	-0.973	-0.088	-0.885	0.791	0.543E-04	13.210	32.019	0.561
2000	-0.009	0.696	-0.705	0.791	0.543E-04	34.650	70.108	0.469
2001	0.611	0.128	0.483	0.791	0.543E-04	64.420	39.743	0.040
2002	1.483	-0.118	1.601	0.791	0.543E-04	153.960	31.060	7.922
2003	-1.010	0.007	-1.017	0.791	0.543E-04	12.730	35.211	0.622
2004	-1.183	-0.019	-1.164	0.791	0.543E-04	10.710	34.311	0.685
2005	0.610	-0.022	0.632	0.791	0.543E-04	64.340	34.203	0.162
2006	-1.039	0.279	-1.318	0.791	0.543E-04	12.370	46.195	0.743

Selectivities by age

Year	3
1975	1.000
1976	1.000
1977	1.000
1978	1.000
1979	1.000
1980	1.000
1981	1.000
1982	1.000
1983	1.000
1984	1.000
1985	1.000
1986	1.000
1987	1.000
1988	1.000

1989	1.000
1990	1.000
1991	1.000
1992	1.000
1993	1.000
1994	1.000
1995	1.000
1996	1.000
1997	1.000
1998	1.000
1999	1.000
2000	1.000
2001	1.000
2002	1.000
2003	1.000
2004	1.000
2005	1.000
2006	1.000

5.5 ESP BB 4

Not used

5.6 ESP BB 5

Not used

5.7 JLL EastMed

Lognormal dist.
average numbers
Ages 4 - 10
log-likelihood = 0.48
deviance = 14.04
Chi-sq. discrepancy= 7.95

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1975	0.357	0.200	0.156	0.791	0.185E-05	1.956	1.673	0.024
1976	0.472	0.144	0.327	0.791	0.185E-05	2.194	1.582	0.000
1977	0.979	0.112	0.867	0.791	0.185E-05	3.647	1.532	0.631
1978	0.131	0.117	0.014	0.791	0.185E-05	1.561	1.540	0.077
1979	0.705	0.153	0.551	0.791	0.185E-05	2.771	1.596	0.083
1980	0.253	0.151	0.102	0.791	0.185E-05	1.763	1.593	0.042
1981	0.223	0.168	0.055	0.791	0.185E-05	1.712	1.620	0.059
1982	0.904	0.149	0.756	0.791	0.185E-05	3.382	1.589	0.357
1983	0.458	0.120	0.338	0.791	0.185E-05	2.165	1.544	0.001
1984	0.192	0.050	0.143	0.791	0.185E-05	1.660	1.439	0.028
1985	0.261	-0.048	0.309	0.791	0.185E-05	1.778	1.305	0.000
1986	-0.010	-0.066	0.057	0.791	0.185E-05	1.356	1.281	0.059
1987	0.477	-0.056	0.533	0.791	0.185E-05	2.207	1.295	0.070
1988	0.008	-0.032	0.040	0.791	0.185E-05	1.380	1.326	0.066
1989	-0.242	0.011	-0.253	0.791	0.185E-05	1.075	1.384	0.215
1990	0.064	0.037	0.027	0.791	0.185E-05	1.460	1.421	0.071
1991	-0.088	-0.003	-0.085	0.791	0.185E-05	1.254	1.366	0.124

1992	-0.252	-0.029	-0.223	0.791	0.185E-05	1.064	1.331	0.198
1993	-0.248	-0.028	-0.220	0.791	0.185E-05	1.069	1.332	0.196
1994	-0.186	-0.009	-0.177	0.791	0.185E-05	1.137	1.357	0.172
1995	0.022	-0.010	0.032	0.791	0.185E-05	1.400	1.356	0.069
1996	-1.054	0.040	-1.094	0.791	0.185E-05	0.477	1.425	0.656
1997	-0.984	0.092	-1.075	0.791	0.185E-05	0.512	1.501	0.648
1998	-0.677	0.132	-0.809	0.791	0.185E-05	0.696	1.563	0.523
1999	-0.789	0.151	-0.940	0.791	0.185E-05	0.622	1.593	0.586
2000	-0.643	0.084	-0.727	0.791	0.185E-05	0.720	1.489	0.480
2001	-0.393	0.018	-0.412	0.791	0.185E-05	0.924	1.395	0.305
2002	0.372	-0.087	0.459	0.791	0.185E-05	1.986	1.256	0.028
2003	0.182	-0.207	0.389	0.791	0.185E-05	1.643	1.114	0.007
2004	-0.562	-0.326	-0.236	0.791	0.185E-05	0.781	0.988	0.205
2005	-0.481	-0.441	-0.040	0.791	0.185E-05	0.846	0.881	0.102
2006	0.547	-0.588	1.135	0.791	0.185E-05	2.366	0.761	1.867

Selectivities by age

Year	4	5	6	7	8	9	10
1975	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1976	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1977	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1978	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1979	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1980	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1981	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1982	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1983	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1984	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1985	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1986	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1987	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1988	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1989	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1990	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1991	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1992	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1993	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1994	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1995	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1996	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1997	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1998	0.042	0.086	0.228	0.470	0.797	1.000	0.722
1999	0.042	0.086	0.228	0.470	0.797	1.000	0.722
2000	0.042	0.086	0.228	0.470	0.797	1.000	0.722
2001	0.042	0.086	0.228	0.470	0.797	1.000	0.722
2002	0.042	0.086	0.228	0.470	0.797	1.000	0.722
2003	0.042	0.086	0.228	0.470	0.797	1.000	0.722
2004	0.042	0.086	0.228	0.470	0.797	1.000	0.722
2005	0.042	0.086	0.228	0.470	0.797	1.000	0.722
2006	0.042	0.086	0.228	0.470	0.797	1.000	0.722

5.8 MAR Trap

Not used

5.9 ESP Trap

Not used

5.10 FR BB

Lognormal dist.
average biomass
Ages 2 - 5
log-likelihood = 0.26
deviance = 8.85
Chi-sq. discrepancy= 4.91

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1955	0.879	0.748	0.130	0.791	0.135E-04	808.267	709.583	0.032
1956	0.212	0.645	-0.433	0.791	0.135E-04	415.143	640.029	0.318
1957	0.048	0.384	-0.336	0.791	0.135E-04	352.273	492.792	0.262
1958	-0.125	0.007	-0.133	0.791	0.135E-04	296.136	338.124	0.149
1959	0.426	-0.304	0.730	0.791	0.135E-04	514.177	247.680	0.309
1960	-0.754	-0.409	-0.345	0.791	0.135E-04	158.000	223.128	0.267
1961	-0.315	-0.471	0.157	0.791	0.135E-04	245.135	209.607	0.024
1962	-0.343	-0.478	0.135	0.791	0.135E-04	238.272	208.110	0.030
1963	-0.698	-0.250	-0.448	0.791	0.135E-04	167.077	261.455	0.326
1964	-0.907	0.050	-0.957	0.791	0.135E-04	135.593	353.030	0.595
1965	-0.340	0.236	-0.577	0.791	0.135E-04	238.846	425.138	0.399
1966	0.413	0.450	-0.037	0.791	0.135E-04	507.500	526.398	0.100
1967	0.108	0.585	-0.477	0.791	0.135E-04	373.913	602.502	0.343
1968	-0.381	0.407	-0.788	0.791	0.135E-04	229.412	504.229	0.512
1969	0.241	0.048	0.193	0.791	0.135E-04	427.200	352.320	0.015
1970	0.249	-0.332	0.581	0.791	0.135E-04	430.588	240.960	0.108
1971	0.175	-0.581	0.756	0.791	0.135E-04	400.000	187.749	0.358
1972	0.461	-0.399	0.860	0.791	0.135E-04	532.374	225.368	0.609
1973	0.104	-0.256	0.360	0.791	0.135E-04	372.414	259.871	0.003
1974	0.547	-0.080	0.627	0.791	0.135E-04	580.000	309.781	0.157

Selectivities by age

Year	2	3	4	5
1955	0.808	1.000	0.446	0.173
1956	0.808	1.000	0.446	0.173
1957	0.808	1.000	0.446	0.173
1958	0.808	1.000	0.446	0.173
1959	0.808	1.000	0.446	0.173
1960	0.808	1.000	0.446	0.173
1961	0.808	1.000	0.446	0.173
1962	0.808	1.000	0.446	0.173
1963	0.808	1.000	0.446	0.173
1964	0.808	1.000	0.446	0.173
1965	0.808	1.000	0.446	0.173
1966	0.808	1.000	0.446	0.173
1967	0.808	1.000	0.446	0.173
1968	0.808	1.000	0.446	0.173
1969	0.808	1.000	0.446	0.173
1970	0.808	1.000	0.446	0.173
1971	0.808	1.000	0.446	0.173
1972	0.808	1.000	0.446	0.173
1973	0.808	1.000	0.446	0.173
1974	0.808	1.000	0.446	0.173

5.11 NOR PS

Lognormal dist.
average biomass
Ages 10 - 10
log-likelihood = -8.49
deviance = 29.17
Chi-sq. discrepancy= 5.93

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1955	0.235	-0.437	0.672	0.791	0.164E-06	36.199	18.494	0.214
1956	-0.298	-0.340	0.042	0.791	0.164E-06	21.254	20.378	0.065
1957	-0.001	-0.171	0.170	0.791	0.164E-06	28.607	24.128	0.020
1958	-0.171	-0.145	-0.026	0.791	0.164E-06	24.126	24.773	0.095
1959	0.124	-0.143	0.268	0.791	0.164E-06	32.408	24.800	0.002
1960	0.492	-0.160	0.652	0.791	0.164E-06	46.831	24.388	0.188
1961	0.594	-0.027	0.621	0.791	0.164E-06	51.836	27.867	0.149
1962	0.815	0.037	0.778	0.791	0.164E-06	64.669	29.691	0.404
1963	-2.841	0.009	-2.851	0.791	0.164E-06	1.671	28.897	1.055
1964	0.171	0.094	0.078	0.791	0.164E-06	33.978	31.432	0.050
1965	0.889	0.139	0.750	0.791	0.164E-06	69.604	32.894	0.345
1966	0.221	-0.013	0.234	0.791	0.164E-06	35.705	28.254	0.007
1967	0.758	-0.022	0.779	0.791	0.164E-06	61.057	28.004	0.406
1968	-0.196	-0.085	-0.110	0.791	0.164E-06	23.532	26.281	0.137
1969	-0.020	-0.111	0.090	0.791	0.164E-06	28.056	25.629	0.046
1970	0.401	-0.289	0.690	0.791	0.164E-06	42.755	21.450	0.241
1971	0.419	-0.063	0.482	0.791	0.164E-06	43.519	26.885	0.039
1972	0.408	0.078	0.330	0.791	0.164E-06	43.047	30.951	0.000
1973	0.387	0.130	0.257	0.791	0.164E-06	42.148	32.602	0.003
1974	0.468	0.318	0.150	0.791	0.164E-06	45.719	39.348	0.026
1975	0.283	0.342	-0.059	0.791	0.164E-06	38.000	40.311	0.111
1976	-0.302	0.320	-0.622	0.791	0.164E-06	21.160	39.432	0.424
1977	0.394	0.256	0.138	0.791	0.164E-06	42.444	36.960	0.029
1978	-0.846	0.176	-1.023	0.791	0.164E-06	12.278	34.143	0.625
1979	-2.033	0.064	-2.096	0.791	0.164E-06	3.750	30.511	0.952
1980	-0.351	0.041	-0.393	0.791	0.164E-06	20.143	29.834	0.295

Selectivities by age

Year	10
1955	1.000
1956	1.000
1957	1.000
1958	1.000
1959	1.000
1960	1.000
1961	1.000
1962	1.000
1963	1.000
1964	1.000
1965	1.000
1966	1.000
1967	1.000
1968	1.000
1969	1.000

1970	1.000
1971	1.000
1972	1.000
1973	1.000
1974	1.000
1975	1.000
1976	1.000
1977	1.000
1978	1.000
1979	1.000
1980	1.000

===

TOTAL NUMBER OF FUNCTION EVALUATIONS = 2202

BFT _Western stock_Report file for the VPA base model.

BFT _Western stock_Report file for the VPA base model and Case 9 sensitivity run.

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                ****************************************
                                VPA-2BOX
                SUMMARY STATISTICS AND DIAGNOSTIC OUTPUT
                ****************************************

BFT West 1970-2007 BASE RUN
 9:04,  1      July 2008

=======================================================================
Total objective function =        7.46
      (with constants)   =      306.46
Number of parameters (P) =          24
Number of data points (D)=         214
AIC : 2*objective+2P     =      660.92
AICc: 2*objective+2P(...)=      667.27
BIC : 2*objective+Plog(D)=      741.70
Chi-square discrepancy   =      190.95

Loglikelihoods (deviance)=        5.75 (      214.17)
   effort data           =        5.75 (      214.17)

Log-posteriors           =        1.38
   catchability          =        0.00
   f-ratio               =        1.38
   natural mortality     =        0.00
   mixing coeff.         =        0.00

Constraints              =      -14.58
   terminal F            =      -14.58
   stock-rec./sex ratio  =        0.00

Out of bounds penalty    =        0.00
=======================================================================
```

TABLE 1. FISHING MORTALITY RATE

	1	2	3	4	5	6	7	8	9	10
1970	0.224	0.741	0.933	0.254	0.091	0.032	0.016	0.005	0.024	0.024
1971	0.292	1.183	0.637	1.032	0.011	0.051	0.093	0.154	0.041	0.041
1972	0.242	0.957	0.875	0.106	0.194	0.002	0.021	0.031	0.038	0.038
1973	0.041	0.685	0.813	0.409	0.076	0.097	0.020	0.069	0.036	0.036
1974	0.133	0.212	0.404	0.387	0.307	0.030	0.077	0.023	0.059	0.107
1975	0.396	0.556	0.120	0.394	0.070	0.071	0.016	0.070	0.050	0.089
1976	0.043	0.288	0.542	0.053	0.145	0.036	0.034	0.072	0.072	0.129
1977	0.016	0.241	0.213	0.462	0.110	0.254	0.125	0.104	0.085	0.153
1978	0.100	0.171	0.326	0.196	0.250	0.118	0.062	0.079	0.088	0.158
1979	0.037	0.288	0.390	0.405	0.147	0.116	0.098	0.070	0.118	0.213
1980	0.056	0.297	0.514	0.356	0.117	0.171	0.252	0.170	0.159	0.287
1981	0.113	0.221	0.518	0.456	0.405	0.205	0.232	0.213	0.186	0.336
1982	0.068	0.089	0.051	0.024	0.045	0.075	0.034	0.056	0.079	0.094
1983	0.041	0.058	0.098	0.033	0.051	0.151	0.183	0.115	0.130	0.153
1984	0.014	0.105	0.053	0.078	0.093	0.120	0.129	0.132	0.125	0.148
1985	0.008	0.106	0.235	0.101	0.218	0.245	0.094	0.179	0.162	0.191
1986	0.006	0.104	0.181	0.089	0.050	0.118	0.076	0.059	0.185	0.218
1987	0.023	0.192	0.215	0.202	0.146	0.143	0.156	0.135	0.156	0.184
1988	0.056	0.174	0.247	0.133	0.189	0.194	0.170	0.176	0.185	0.219
1989	0.016	0.189	0.045	0.121	0.072	0.147	0.170	0.191	0.233	0.275
1990	0.026	0.099	0.407	0.071	0.094	0.095	0.156	0.208	0.227	0.268
1991	0.039	0.200	0.364	0.118	0.062	0.107	0.161	0.249	0.237	0.280
1992	0.008	0.086	0.039	0.067	0.070	0.053	0.130	0.171	0.261	0.308
1993	0.006	0.024	0.095	0.076	0.126	0.111	0.095	0.204	0.194	0.229
1994	0.048	0.014	0.040	0.059	0.074	0.139	0.151	0.169	0.170	0.200
1995	0.015	0.035	0.094	0.129	0.124	0.085	0.080	0.152	0.175	0.206
1996	0.006	0.162	0.069	0.193	0.102	0.061	0.120	0.119	0.175	0.206
1997	0.005	0.017	0.151	0.056	0.079	0.084	0.106	0.127	0.182	0.214
1998	0.005	0.023	0.084	0.095	0.060	0.062	0.125	0.196	0.197	0.232
1999	0.001	0.012	0.068	0.052	0.064	0.060	0.151	0.188	0.227	0.268
2000	0.002	0.006	0.026	0.068	0.152	0.134	0.147	0.166	0.190	0.224
2001	0.028	0.009	0.073	0.134	0.058	0.084	0.172	0.115	0.233	0.275
2002	0.008	0.147	0.154	0.208	0.153	0.057	0.213	0.267	0.258	0.304
2003	0.002	0.057	0.173	0.198	0.089	0.040	0.120	0.225	0.182	0.214
2004	0.004	0.054	0.191	0.163	0.216	0.162	0.131	0.116	0.135	0.160
2005	0.006	0.084	0.060	0.087	0.089	0.083	0.091	0.092	0.158	0.187
2006	0.007	0.012	0.028	0.072	0.101	0.156	0.175	0.199	0.155	0.183
2007	0.007	0.016	0.221	0.188	0.086	0.090	0.082	0.114	0.082	0.097

TABLE 2. ABUNDANCE AT THE BEGINNING OF THE YEAR

	1	2	3	4	5	6	7	8	9	10
1970	329661.	208096.	221232.	100395.	44442.	30387.	11810.	34915.	23096.	164601.
1971	259140.	229067.	86186.	75657.	67679.	35259.	25582.	10106.	30203.	159271.
1972	225523.	168174.	61027.	39614.	23429.	58220.	29120.	20274.	7529.	158111.

1973	133767.	153951.	56125.	22115.	30968.
16784.	50504.	24787.	17091.	138654.	
1974	481004.	111663.	67477.	21640.	12769.
24943.	13242.	43020.	20114.	130668.	
1975	141253.	366230.	78525.	39164.	12777.
8164.	21051.	10662.	36549.	118537.	
1976	133775.	82607.	182508.	60524.	22957.
10360.	6610.	18009.	8645.	124489.	
1977	85851.	111363.	53842.	92267.	49906.
17259.	8686.	5555.	14569.	102110.	
1978	57245.	73452.	76058.	37809.	50557.
38865.	11634.	6661.	4352.	87787.	
1979	80320.	45018.	53803.	47746.	27019.
34215.	30037.	9505.	5352.	68625.	
1980	62645.	67271.	29339.	31669.	27678.
20284.	26495.	23683.	7707.	52349.	
1981	60453.	51519.	43459.	15258.	19294.
21396.	14862.	17896.	17379.	39858.	
1982	57260.	46930.	35915.	22505.	8408.
11192.	15147.	10243.	12575.	37300.	
1983	96297.	46495.	37329.	29682.	19100.
6990.	9029.	12723.	8422.	39626.	
1984	68711.	80364.	38151.	29434.	24974.
15785.	5223.	6535.	9863.	35996.	
1985	74826.	58926.	62885.	31449.	23663.
19787.	12171.	3990.	4977.	34551.	
1986	94481.	64521.	46089.	43235.	24723.
16549.	13469.	9628.	2900.	28490.	
1987	73141.	81614.	50567.	33440.	34395.
20455.	12790.	10849.	7889.	22007.	
1988	97382.	62157.	58563.	35446.	23745.
25830.	15413.	9515.	8240.	21793.	
1989	56490.	80074.	45407.	39761.	26980.
17083.	18489.	11299.	6935.	21176.	
1990	101361.	48332.	57599.	37751.	30619.
21836.	12820.	13557.	8112.	18752.	
1991	93532.	85884.	38067.	33316.	30566.
24230.	17258.	9539.	9568.	18087.	
1992	59639.	78181.	61148.	22989.	25735.
24982.	18931.	12769.	6466.	18444.	
1993	59689.	51415.	62369.	51138.	18698.
20854.	20595.	14458.	9353.	16108.	
1994	45855.	51569.	43642.	49301.	41205.
14336.	16222.	16282.	10246.	17834.	
1995	79211.	37989.	44188.	36440.	40422.
33273.	10842.	12130.	11958.	20203.	
1996	72394.	67850.	31903.	34986.	27844.
31053.	26572.	8699.	9059.	23016.	
1997	50360.	62551.	50177.	25886.	25067.
21867.	25395.	20494.	6715.	22888.	
1998	60097.	43577.	53453.	37492.	21275.
20143.	17485.	19857.	15699.	20928.	
1999	58648.	52004.	37027.	42735.	29629.
17414.	16458.	13414.	14193.	25630.	
2000	42839.	50918.	44661.	30073.	35254.
24160.	14252.	12301.	9665.	26874.	
2001	53856.	37151.	44007.	37826.	24418.
26339.	18376.	10692.	9058.	25625.	

2002	61476.	45518.	31997.	35567.	28769.	20022.	21051.	13454.	8282.	23155.
2003	73714.	53002.	34171.	23858.	25103.	21465.	16443.	14794.	8954.	20410.
2004	78127.	63930.	43519.	24979.	17011.	19962.	17923.	12685.	10265.	20808.
2005	62284.	67635.	52661.	31249.	18442.	11919.	14756.	13663.	9820.	23212.
2006	19472.	53804.	54059.	43116.	24903.	14665.	9533.	11709.	10830.	24033.
2007	9486.	16816.	46217.	45711.	34894.	19576.	10906.	6959.	8345.	25468.
2008		8186.	14384.	32197.	32921.	27829.	15547.	8731.	5398.	26781.

TABLE 3. CATCH OF BFT

	1	2	3	4	5	6	7	8	9	10
1970	61909.	102549.	126581.	21101.	3629.	897.	173.	162.	513.	3656.
1971	61511.	150254.	38184.	45991.	663.	1646.	2112.	1351.	1134.	5980.
1972	45326.	97755.	33545.	3730.	3856.	118.	568.	574.	261.	5481.
1973	4971.	71796.	29419.	6964.	2126.	1450.	951.	1541.	559.	4535.
1974	55834.	19960.	21028.	6508.	3164.	681.	913.	914.	1083.	12401.
1975	43341.	146792.	8323.	11959.	803.	523.	313.	671.	1650.	9468.
1976	5301.	19357.	71719.	2911.	2901.	344.	206.	1168.	558.	14098.
1977	1270.	22341.	9683.	32004.	4860.	3629.	957.	513.	1109.	13568.
1978	5103.	10813.	19800.	6294.	10482.	4031.	654.	472.	341.	11996.
1979	2745.	10552.	16287.	14915.	3447.	3493.	2611.	598.	557.	12315.
1980	3160.	16182.	11066.	8879.	2865.	2981.	5531.	3453.	1061.	12240.
1981	6046.	9549.	16496.	5241.	6019.	3717.	2882.	3210.	2763.	10658.
1982	3528.	3729.	1655.	499.	343.	753.	478.	518.	896.	3114.
1983	3600.	2438.	3243.	891.	880.	918.	1414.	1287.	957.	5253.
1984	868.	7501.	1845.	2069.	2068.	1668.	592.	757.	1087.	4630.
1985	568.	5523.	12308.	2813.	4329.	4019.	1024.	612.	696.	5622.
1986	563.	5938.	7129.	3429.	1115.	1716.	924.	517.	458.	5226.

1987	1534.	13328.	9162.	5731.	4378.	2548.	1725.	1281.	1063.	3452.
1988	4925.	9282.	12004.	4123.	3829.	4267.	2259.	1438.	1304.	4005.
1989	835.	12925.	1851.	4243.	1740.	2184.	2707.	1840.	1351.	4772.
1990	2400.	4245.	18073.	2420.	2567.	1854.	1727.	2386.	1543.	4128.
1991	3364.	14542.	10893.	3470.	1709.	2293.	2403.	1967.	1892.	4136.
1992	464.	6015.	2171.	1383.	1632.	1207.	2150.	1880.	1392.	4583.
1993	346.	1134.	5287.	3494.	2063.	2050.	1743.	2500.	1543.	3084.
1994	2015.	691.	1611.	2619.	2738.	1743.	2121.	2363.	1497.	3030.
1995	1088.	1206.	3685.	4123.	4394.	2530.	781.	1598.	1794.	3523.
1996	414.	9473.	1986.	5754.	2514.	1720.	2802.	911.	1360.	4016.
1997	219.	994.	6591.	1320.	1772.	1639.	2386.	2276.	1043.	4130.
1998	260.	920.	4013.	3186.	1162.	1131.	1921.	3303.	2625.	4060.
1999	73.	589.	2274.	2038.	1717.	953.	2158.	2147.	2699.	5641.
2000	98.	278.	1074.	1854.	4634.	2825.	1826.	1760.	1563.	5045.
2001	1398.	323.	2891.	4424.	1295.	1984.	2712.	1089.	1763.	5770.
2002	476.	5807.	4257.	6259.	3813.	1035.	3774.	2953.	1763.	5691.
2003	165.	2748.	5085.	4013.	2001.	792.	1731.	2794.	1392.	3686.
2004	306.	3133.	7084.	3520.	3088.	2794.	2063.	1298.	1215.	2872.
2005	369.	5093.	2863.	2432.	1470.	891.	1202.	1126.	1343.	3695.
2006	120.	599.	1380.	2781.	2228.	1982.	1429.	1974.	1453.	3754.
2007	65.	253.	8590.	7335.	2693.	1582.	806.	700.	614.	2195.

TABLE 4. SPAWNING STOCK FECUNDITY AND RECRUITMENT

year	spawning biomass	recruits from VPA
1970	49482.	329661.
1971	44743.	259140.
1972	44686.	225523.
1973	42422.	133767.
1974	42659.	481004.
1975	36221.	141253.
1976	34066.	133775.
1977	28643.	85851.

1978	25643.	57245.
1979	19749.	80320.
1980	17657.	62645.
1981	15012.	60453.
1982	13943.	57260.
1983	13829.	96297.
1984	11817.	68711.
1985	9350.	74826.
1986	8941.	94481.
1987	7936.	73141.
1988	7704.	97382.
1989	7297.	56490.
1990	7276.	101361.
1991	6723.	93532.
1992	6511.	59639.
1993	7029.	59689.
1994	7576.	45855.
1995	8393.	79211.
1996	8109.	72394.
1997	9093.	50360.
1998	9738.	60097.
1999	9351.	58648.
2000	9411.	42839.
2001	8629.	53856.
2002	8031.	61476.
2003	8084.	73714.
2004	8202.	78127.
2005	8542.	62284.
2006	8681.	19472.
2007	8693.	9486.

===

TABLE 5. FITS TO INDEX DATA

===

5.1 CAN GSL ADJ

Lognormal dist.
average numbers
Ages 10 - 10
log-likelihood = 3.13
deviance = 22.21
Chi-sq. discrepancy= 15.65

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1981	0.479	0.975	-0.496	0.590	0.132E-03	1.614	2.651	0.573
1982	0.427	0.766	-0.339	0.590	0.132E-03	1.532	2.151	0.387
1983	0.850	0.750	0.101	0.590	0.132E-03	2.341	2.117	0.012

```
    1984        0.278       0.289      -0.010       0.590    0.132E-03
1.321       1.334       0.068
    1985       -0.695       0.126      -0.822       0.590    0.132E-03
0.499       1.135       0.954
    1986       -0.447       0.260      -0.707       0.590    0.132E-03
0.640       1.297       0.823
    1987       -0.983      -0.206      -0.778       0.590    0.132E-03
0.374       0.814       0.905
    1988       -0.347      -0.143      -0.204       0.590    0.132E-03
0.707       0.867       0.238
    1989       -0.344      -0.308      -0.035       0.590    0.132E-03
0.709       0.735       0.086
    1990       -0.909      -0.365      -0.544       0.590    0.132E-03
0.403       0.694       0.630
    1991       -0.346      -0.619       0.273       0.590    0.132E-03
0.708       0.539       0.026
    1992       -0.265      -0.645       0.380       0.590    0.132E-03
0.767       0.525       0.125
    1993       -0.158      -0.411       0.253       0.590    0.132E-03
0.854       0.663       0.016
    1994       -1.230      -0.528      -0.703       0.590    0.132E-03
0.292       0.590       0.818
    1995        0.034      -0.153       0.187       0.590    0.132E-03
1.035       0.858       0.000
    1996       -1.039      -0.269      -0.770       0.590    0.132E-03
0.354       0.764       0.895
    1997       -1.049      -0.279      -0.770       0.590    0.132E-03
0.350       0.756       0.896
    1998       -0.412      -0.494       0.082       0.590    0.132E-03
0.663       0.610       0.018
    1999       -0.053      -0.485       0.433       0.590    0.132E-03
0.949       0.615       0.209
    2000       -0.247      -0.328       0.081       0.590    0.132E-03
0.781       0.721       0.019
    2001       -0.225      -0.709       0.484       0.590    0.132E-03
0.799       0.492       0.316
    2002       -0.434      -0.759       0.326       0.590    0.132E-03
0.648       0.468       0.064
    2003       -0.104      -0.531       0.427       0.590    0.132E-03
0.901       0.588       0.198
    2004        0.557      -0.329       0.886       0.590    0.132E-03
1.746       0.719       2.588
    2005        0.386      -0.447       0.833       0.590    0.132E-03
1.471       0.639       2.086
    2006        0.398      -0.214       0.612       0.590    0.132E-03
1.489       0.807       0.725
    2007        0.774      -0.046       0.820       0.590    0.132E-03
2.168       0.955       1.976

    Selectivities by age
    Year     10
    ----    -----
    1981    0.631
    1982    0.488
    1983    0.465
    1984    0.322
    1985    0.291
    1986    0.409
    1987    0.327
```

```
    1988    0.358
    1989    0.320
    1990    0.341
    1991    0.275
    1992    0.267
    1993    0.372
    1994    0.295
    1995    0.380
    1996    0.297
    1997    0.296
    1998    0.264
    1999    0.221
    2000    0.242
    2001    0.177
    2002    0.189
    2003    0.259
    2004    0.302
    2005    0.244
    2006    0.297
    2007    0.318


    --------------------
    5.2 CAN SWNS
    --------------------
    Lognormal dist.
    average numbers
    Ages  7 - 10
    log-likelihood     =        -8.86
    deviance           =        38.81
    Chi-sq. discrepancy=        48.11

                                    Residuals    Standard         Q
Untransfrmd  Untransfrmd  Chi-square
    Year    Observed    Predicted    (Obs-pred)   Deviation    Catchabil.
Observed    Predicted   Discrepancy
    ----  -----------  -----------  -----------  -----------  -----------  -------
----  -----------  -----------
    1988        0.742       -0.356        1.098        0.590    0.222E-04
2.100        0.700        5.537
    1989        1.244       -0.367        1.611        0.590    0.222E-04
3.470        0.693       24.697
    1990        0.775       -0.413        1.188        0.590    0.222E-04
2.170        0.661        7.404
    1991        0.247       -0.442        0.689        0.590    0.222E-04
1.280        0.643        1.086
    1992        0.262       -0.428        0.690        0.590    0.222E-04
1.300        0.652        1.093
    1993       -1.050       -0.372       -0.678        0.590    0.222E-04
0.350        0.689        0.789
    1994        0.199       -0.305        0.503        0.590    0.222E-04
1.220        0.737        0.365
    1995       -0.163       -0.309        0.147        0.590    0.222E-04
0.850        0.734        0.002
    1996       -1.022       -0.236       -0.786        0.590    0.222E-04
0.360        0.790        0.914
    1997       -1.386       -0.127       -1.260        0.590    0.222E-04
0.250        0.881        1.392
```

```
    1998       -0.994       -0.099       -0.895        0.590    0.222E-04
0.370       0.906       1.035
    1999       -0.094       -0.121        0.026        0.590    0.222E-04
0.910       0.886       0.045
    2000       -1.772       -0.175       -1.597        0.590    0.222E-04
0.170       0.839       1.652
    2001       -0.478       -0.224       -0.254        0.590    0.222E-04
0.620       0.799       0.291
    2002       -0.892       -0.263       -0.629        0.590    0.222E-04
0.410       0.769       0.731
    2003        0.104       -0.292        0.397        0.590    0.222E-04
1.110       0.747       0.149
    2004       -0.713       -0.252       -0.461        0.590    0.222E-04
0.490       0.777       0.530
    2005       -0.528       -0.213       -0.314        0.590    0.222E-04
0.590       0.808       0.358
    2006        0.020       -0.248        0.268        0.590    0.222E-04
1.020       0.780       0.023
    2007       -0.020       -0.276        0.256        0.590    0.222E-04
0.980       0.759       0.018

    Selectivities by age
    Year      7      8      9     10
    ----    -----  -----  -----  -----
    1988    0.262  0.577  0.716  1.000
    1989    0.262  0.577  0.716  1.000
    1990    0.262  0.577  0.716  1.000
    1991    0.262  0.577  0.716  1.000
    1992    0.262  0.577  0.716  1.000
    1993    0.262  0.577  0.716  1.000
    1994    0.262  0.577  0.716  1.000
    1995    0.262  0.577  0.716  1.000
    1996    0.262  0.577  0.716  1.000
    1997    0.262  0.577  0.716  1.000
    1998    0.262  0.577  0.716  1.000
    1999    0.262  0.577  0.716  1.000
    2000    0.262  0.577  0.716  1.000
    2001    0.262  0.577  0.716  1.000
    2002    0.262  0.577  0.716  1.000
    2003    0.262  0.577  0.716  1.000
    2004    0.262  0.577  0.716  1.000
    2005    0.262  0.577  0.716  1.000
    2006    0.262  0.577  0.716  1.000
    2007    0.262  0.577  0.716  1.000


    --------------------
    5.3 US RR<145
    --------------------
    Lognormal dist.
    average numbers
    Ages  1 -  5
    log-likelihood     =         3.38
    deviance           =         5.89
    Chi-sq. discrepancy=         7.26

                                        Residuals    Standard         Q
Untransfrmd  Untransfrmd  Chi-square
```

Year	Observed	Predicted	(Obs-pred)	Deviation	Catchabil.	Observed	Predicted	Discrepancy
1980	-0.224	-0.278	0.054	0.590	0.809E-05	0.799	0.757	0.031
1981	-0.919	-0.334	-0.585	0.590	0.809E-05	0.399	0.716	0.679
1982	0.743	-0.325	1.068	0.590	0.809E-05	2.102	0.723	5.002
1983	0.108	-0.208	0.316	0.590	0.809E-05	1.114	0.812	0.056
1985	-0.462	0.015	-0.477	0.590	0.809E-05	0.630	1.015	0.549
1986	-0.251	0.003	-0.254	0.590	0.809E-05	0.778	1.003	0.291
1987	0.198	0.068	0.130	0.590	0.809E-05	1.219	1.071	0.005
1988	-0.012	0.031	-0.043	0.590	0.809E-05	0.988	1.032	0.092
1989	-0.012	0.033	-0.046	0.590	0.809E-05	0.988	1.034	0.093
1990	-0.101	-0.065	-0.036	0.590	0.809E-05	0.904	0.937	0.086
1991	0.232	0.027	0.205	0.590	0.809E-05	1.261	1.027	0.002
1992	-0.198	0.134	-0.332	0.590	0.809E-05	0.820	1.143	0.379

Selectivities by age

Year	1	2	3	4	5
1980	0.221	0.949	1.000	0.231	0.082
1981	0.221	0.949	1.000	0.231	0.082
1982	0.221	0.949	1.000	0.231	0.082
1983	0.221	0.949	1.000	0.231	0.082
1985	0.221	0.949	1.000	0.231	0.082
1986	0.221	0.949	1.000	0.231	0.082
1987	0.221	0.949	1.000	0.231	0.082
1988	0.221	0.949	1.000	0.231	0.082
1989	0.221	0.949	1.000	0.231	0.082
1990	0.221	0.949	1.000	0.231	0.082
1991	0.221	0.949	1.000	0.231	0.082
1992	0.221	0.949	1.000	0.231	0.082

```
--------------------
5.4 US RR66-114
--------------------
Lognormal dist.
average numbers
Ages  2 -  3
log-likelihood     =         0.58
deviance           =        14.66
Chi-sq. discrepancy=         8.46

                                   Residuals    Standard        Q
Untransfrmd  Untransfrmd  Chi-square
```

Year	Observed	Predicted	(Obs-pred)	Deviation	Catchabil.	Observed	Predicted	Discrepancy
1993	0.146	0.070	0.076	0.590	0.136E-04	1.157	1.073	0.021
1994	-1.514	-0.149	-1.365	0.590	0.136E-04	0.220	0.862	1.481
1995	-0.278	-0.263	-0.015	0.590	0.136E-04	0.757	0.769	0.071
1996	0.441	-0.247	0.688	0.590	0.136E-04	1.554	0.781	1.081
1997	0.854	-0.023	0.876	0.590	0.136E-04	2.348	0.978	2.485
1998	0.332	-0.083	0.416	0.590	0.136E-04	1.394	0.920	0.179
1999	-0.006	-0.254	0.248	0.590	0.136E-04	0.994	0.776	0.014
2000	-0.121	-0.133	0.012	0.590	0.136E-04	0.886	0.876	0.054
2001	-0.947	-0.262	-0.685	0.590	0.136E-04	0.388	0.769	0.797
2002	-0.139	-0.445	0.306	0.590	0.136E-04	0.870	0.641	0.048
2003	-0.919	-0.330	-0.589	0.590	0.136E-04	0.399	0.719	0.684
2004	0.452	-0.116	0.568	0.590	0.136E-04	1.572	0.891	0.559
2005	0.336	0.052	0.285	0.590	0.136E-04	1.400	1.053	0.033
2006	-0.637	0.010	-0.647	0.590	0.136E-04	0.529	1.010	0.752
2007	-0.631	-0.459	-0.172	0.590	0.136E-04	0.532	0.632	0.206

Selectivities by age

Year	2	3
1993	0.487	1.000
1994	0.487	1.000
1995	0.487	1.000
1996	0.487	1.000
1997	0.487	1.000
1998	0.487	1.000
1999	0.487	1.000
2000	0.487	1.000
2001	0.487	1.000
2002	0.487	1.000
2003	0.487	1.000
2004	0.487	1.000
2005	0.487	1.000
2006	0.487	1.000
2007	0.487	1.000

5.5 US RR115-144

Lognormal dist.

average numbers
Ages 4 - 5
log-likelihood = -1.02
deviance = 17.86
Chi-sq. discrepancy= 14.98

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1993	0.588	-0.014	0.602	0.590	0.179E-04	1.800	0.986	0.684
1994	-0.872	0.154	-1.026	0.590	0.179E-04	0.418	1.167	1.172
1995	-1.041	-0.081	-0.961	0.590	0.179E-04	0.353	0.922	1.105
1996	-0.467	-0.253	-0.214	0.590	0.179E-04	0.627	0.777	0.248
1997	-1.465	-0.442	-1.024	0.590	0.179E-04	0.231	0.643	1.170
1998	-0.130	-0.238	0.107	0.590	0.179E-04	0.878	0.789	0.010
1999	-0.238	-0.040	-0.198	0.590	0.179E-04	0.788	0.961	0.232
2000	0.601	-0.239	0.840	0.590	0.179E-04	1.824	0.788	2.146
2001	0.524	-0.209	0.733	0.590	0.179E-04	1.688	0.811	1.344
2002	0.892	-0.244	1.136	0.590	0.179E-04	2.440	0.784	6.263
2003	-0.794	-0.538	-0.256	0.590	0.179E-04	0.452	0.584	0.293
2004	-0.699	-0.640	-0.059	0.590	0.179E-04	0.497	0.527	0.104
2005	-0.566	-0.411	-0.155	0.590	0.179E-04	0.568	0.663	0.189
2006	0.132	-0.090	0.221	0.590	0.179E-04	1.141	0.914	0.006
2007	0.259	0.006	0.253	0.590	0.179E-04	1.295	1.006	0.016

Selectivities by age

Year	4	5
1993	1.000	0.549
1994	1.000	0.549
1995	1.000	0.549
1996	1.000	0.549
1997	1.000	0.549
1998	1.000	0.549
1999	1.000	0.549
2000	1.000	0.549
2001	1.000	0.549
2002	1.000	0.549
2003	1.000	0.549
2004	1.000	0.549
2005	1.000	0.549

2006	1.000	0.549
2007	1.000	0.549

5.6 US RR145-177

Not used

5.7 US RR>195

Lognormal dist.
average numbers
Ages 8 - 10
log-likelihood = 3.41
deviance = 3.72
Chi-sq. discrepancy= 3.07

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1983	1.031	0.305	0.726	0.590	0.330E-04	2.805	1.357	1.301
1984	0.220	0.196	0.024	0.590	0.330E-04	1.246	1.217	0.047
1985	-0.154	0.066	-0.221	0.590	0.330E-04	0.857	1.069	0.255
1986	-0.687	-0.087	-0.600	0.590	0.330E-04	0.503	0.917	0.697
1987	-0.637	-0.201	-0.435	0.590	0.330E-04	0.529	0.818	0.500
1988	-0.061	-0.235	0.174	0.590	0.330E-04	0.941	0.791	0.000
1989	-0.270	-0.281	0.010	0.590	0.330E-04	0.763	0.755	0.055
1990	-0.468	-0.322	-0.147	0.590	0.330E-04	0.626	0.725	0.181
1991	-0.198	-0.379	0.180	0.590	0.330E-04	0.820	0.685	0.000
1992	-0.094	-0.384	0.289	0.590	0.330E-04	0.910	0.681	0.036

Selectivities by age

Year	8	9	10
1983	0.314	0.437	1.000
1984	0.314	0.437	1.000
1985	0.314	0.437	1.000
1986	0.314	0.437	1.000
1987	0.314	0.437	1.000
1988	0.314	0.437	1.000
1989	0.314	0.437	1.000
1990	0.314	0.437	1.000
1991	0.314	0.437	1.000
1992	0.314	0.437	1.000

5.8 US RR>195 COMB

Not used

5.9 US RR>177

Lognormal dist.
average numbers
Ages 7 - 10
log-likelihood = -0.90
deviance = 17.63
Chi-sq. discrepancy= 12.14

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1993	-0.188	-0.300	0.112	0.590	0.209E-04	0.829	0.741	0.009
1994	-0.088	-0.275	0.187	0.590	0.209E-04	0.916	0.760	0.000
1995	0.272	-0.312	0.584	0.590	0.209E-04	1.313	0.732	0.617
1996	0.822	-0.142	0.964	0.590	0.209E-04	2.275	0.868	3.472
1997	-0.013	-0.057	0.044	0.590	0.209E-04	0.987	0.944	0.036
1998	0.287	-0.084	0.371	0.590	0.209E-04	1.333	0.920	0.114
1999	0.383	-0.106	0.488	0.590	0.209E-04	1.466	0.899	0.327
2000	-0.371	-0.165	-0.206	0.590	0.209E-04	0.690	0.848	0.240
2001	0.385	-0.185	0.570	0.590	0.209E-04	1.469	0.831	0.564
2002	0.641	-0.206	0.847	0.590	0.209E-04	1.898	0.814	2.208
2003	-0.916	-0.258	-0.658	0.590	0.209E-04	0.400	0.773	0.766
2004	-0.757	-0.214	-0.543	0.590	0.209E-04	0.469	0.808	0.629
2005	-0.919	-0.196	-0.723	0.590	0.209E-04	0.399	0.822	0.842
2006	-1.152	-0.264	-0.888	0.590	0.209E-04	0.316	0.768	1.027
2007	-1.423	-0.274	-1.149	0.590	0.209E-04	0.241	0.760	1.292

Selectivities by age

Year	7	8	9	10
1993	0.538	0.551	0.672	1.000
1994	0.538	0.551	0.672	1.000

1995	0.538	0.551	0.672	1.000
1996	0.538	0.551	0.672	1.000
1997	0.538	0.551	0.672	1.000
1998	0.538	0.551	0.672	1.000
1999	0.538	0.551	0.672	1.000
2000	0.538	0.551	0.672	1.000
2001	0.538	0.551	0.672	1.000
2002	0.538	0.551	0.672	1.000
2003	0.538	0.551	0.672	1.000
2004	0.538	0.551	0.672	1.000
2005	0.538	0.551	0.672	1.000
2006	0.538	0.551	0.672	1.000
2007	0.538	0.551	0.672	1.000

5.10 JLL AREA 2 (WEST)

Lognormal dist.
month 0 numbers
Ages 2 - 10
log-likelihood = 3.72
deviance = 25.24
Chi-sq. discrepancy= 14.29

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1976	-0.363	0.377	-0.740	0.590	0.632E-05	0.696	1.458	0.861
1977	0.817	0.305	0.512	0.590	0.632E-05	2.263	1.357	0.386
1978	0.088	0.238	-0.150	0.590	0.632E-05	1.091	1.268	0.184
1979	-0.172	0.137	-0.309	0.590	0.632E-05	0.842	1.147	0.353
1980	0.297	-0.058	0.356	0.590	0.632E-05	1.346	0.943	0.095
1981	0.652	-0.256	0.909	0.590	0.632E-05	1.920	0.774	2.821
1982	-0.510	-0.507	-0.004	0.590	0.632E-05	0.600	0.602	0.064
1983	-1.253	-0.455	-0.798	0.590	0.632E-05	0.286	0.635	0.928
1984	-0.070	-0.387	0.317	0.590	0.632E-05	0.932	0.679	0.057
1985	0.165	-0.262	0.427	0.590	0.632E-05	1.180	0.770	0.199
1986	-2.052	-0.266	-1.787	0.590	0.632E-05	0.128	0.767	1.772
1987	-0.626	-0.198	-0.428	0.590	0.632E-05	0.535	0.820	0.491
1988	-0.020	-0.188	0.168	0.590	0.632E-05	0.981	0.829	0.000
1989	-0.183	-0.224	0.041	0.590	0.632E-05	0.833	0.799	0.037

1990	-0.496	-0.179	-0.317	0.590	0.632E-05	0.609	0.836	0.361
1991	-0.245	-0.216	-0.029	0.590	0.632E-05	0.783	0.805	0.081
1992	0.131	-0.205	0.335	0.590	0.632E-05	1.140	0.815	0.073
1993	0.050	-0.131	0.181	0.590	0.632E-05	1.051	0.877	0.000
1994	0.313	-0.114	0.426	0.590	0.632E-05	1.367	0.892	0.198
1995	-0.262	-0.086	-0.176	0.590	0.632E-05	0.769	0.917	0.209
1996	0.663	-0.127	0.789	0.590	0.632E-05	1.940	0.881	1.732
1997	0.218	-0.157	0.375	0.590	0.632E-05	1.244	0.855	0.119
1998	-0.271	-0.164	-0.107	0.590	0.632E-05	0.762	0.849	0.144
1999	-0.454	-0.184	-0.271	0.590	0.632E-05	0.635	0.832	0.309
2000	-0.331	-0.168	-0.163	0.590	0.632E-05	0.718	0.845	0.196
2001	-0.753	-0.180	-0.573	0.590	0.632E-05	0.471	0.836	0.665
2002	-0.425	-0.224	-0.201	0.590	0.632E-05	0.654	0.799	0.235
2003	-0.607	-0.324	-0.283	0.590	0.632E-05	0.545	0.724	0.324
2004	-0.011	-0.346	0.335	0.590	0.632E-05	0.989	0.708	0.073
2005	0.147	-0.347	0.494	0.590	0.632E-05	1.159	0.707	0.342
2006	0.411	-0.258	0.669	0.590	0.632E-05	1.509	0.773	0.985

Selectivities by age

Year	2	3	4	5	6	7	8	9	10
1976	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1977	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1978	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1979	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1980	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1981	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1982	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1983	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1984	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1985	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1986	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1987	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1988	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1989	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1990	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1991	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1992	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1993	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1994	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1995	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1996	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484

1997	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1998	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
1999	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
2000	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
2001	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
2002	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
2003	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
2004	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
2005	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484
2006	0.053	0.411	0.631	0.851	1.000	0.900	0.702	0.537	0.484

5.11 JLL AREA 3 (31+32)

Not used

5.12 JLL AREAS 17+18

Not used

5.13 LARVAL ZERO INFLATED

Lognormal dist.
average biomass
Ages 8 - 10
log-likelihood = 2.53
deviance = 24.46
Chi-sq. discrepancy= 19.77

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1977	0.918	0.508	0.410	0.590	0.578E-07	2.504	1.663	0.169
1978	1.583	0.398	1.185	0.590	0.578E-07	4.869	1.489	7.332
1981	-0.309	-0.133	-0.175	0.590	0.578E-07	0.735	0.875	0.209
1982	0.305	-0.213	0.518	0.590	0.578E-07	1.356	0.808	0.403
1983	0.184	-0.220	0.404	0.590	0.578E-07	1.202	0.803	0.160
1984	-1.001	-0.377	-0.624	0.590	0.578E-07	0.367	0.686	0.726
1986	-0.907	-0.655	-0.252	0.590	0.578E-07	0.404	0.520	0.289
1987	-1.062	-0.775	-0.287	0.590	0.578E-07	0.346	0.461	0.328
1988	0.080	-0.803	0.884	0.590	0.578E-07	1.084	0.448	2.561
1989	-0.268	-0.856	0.588	0.590	0.578E-07	0.765	0.425	0.630

```
    1990      -1.103      -0.859      -0.244       0.590   0.578E-07
0.332      0.424      0.280
    1991      -0.946      -0.938      -0.009       0.590   0.578E-07
0.388      0.392      0.067
    1992      -0.640      -0.969       0.329       0.590   0.578E-07
0.527      0.379      0.068
    1993      -0.696      -0.895       0.198       0.590   0.578E-07
0.498      0.409      0.001
    1994      -0.719      -0.821       0.102       0.590   0.578E-07
0.487      0.440      0.012
    1995      -1.056      -0.718      -0.338       0.590   0.578E-07
0.348      0.488      0.386
    1996      -0.035      -0.752       0.717       0.590   0.578E-07
0.966      0.471      1.249
    1997      -0.897      -0.638      -0.259       0.590   0.578E-07
0.408      0.528      0.296
    1998      -2.142      -0.569      -1.573       0.590   0.578E-07
0.117      0.566      1.636
    1999      -0.669      -0.608      -0.060       0.590   0.578E-07
0.512      0.544      0.105
    2000      -1.068      -0.603      -0.465       0.590   0.578E-07
0.344      0.547      0.535
    2001      -0.949      -0.689      -0.260       0.590   0.578E-07
0.387      0.502      0.298
    2002      -1.190      -0.759      -0.430       0.590   0.578E-07
0.304      0.468      0.494
    2003      -0.305      -0.755       0.450       0.590   0.578E-07
0.737      0.470      0.242
    2004      -0.614      -0.742       0.128       0.590   0.578E-07
0.541      0.476      0.005
    2005      -1.468      -0.701      -0.767       0.590   0.578E-07
0.230      0.496      0.892
    2006      -0.502      -0.685       0.183       0.590   0.578E-07
0.605      0.504      0.000
    2007      -1.036      -0.685      -0.351       0.590   0.578E-07
0.355      0.504      0.400

    Selectivities by age
    Year      8     9    10
    ----    ----- ----- -----
    1977    1.000 1.000 1.000
    1978    1.000 1.000 1.000
    1981    1.000 1.000 1.000
    1982    1.000 1.000 1.000
    1983    1.000 1.000 1.000
    1984    1.000 1.000 1.000
    1986    1.000 1.000 1.000
    1987    1.000 1.000 1.000
    1988    1.000 1.000 1.000
    1989    1.000 1.000 1.000
    1990    1.000 1.000 1.000
    1991    1.000 1.000 1.000
    1992    1.000 1.000 1.000
    1993    1.000 1.000 1.000
    1994    1.000 1.000 1.000
    1995    1.000 1.000 1.000
    1996    1.000 1.000 1.000
    1997    1.000 1.000 1.000
    1998    1.000 1.000 1.000
```

1999	1.000	1.000	1.000
2000	1.000	1.000	1.000
2001	1.000	1.000	1.000
2002	1.000	1.000	1.000
2003	1.000	1.000	1.000
2004	1.000	1.000	1.000
2005	1.000	1.000	1.000
2006	1.000	1.000	1.000
2007	1.000	1.000	1.000

5.14 GOMPLL 1-6

Lognormal dist.
month 0 numbers
Ages 8 - 10
log-likelihood = -3.16
deviance = 28.47
Chi-sq. discrepancy= 35.04

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1987	1.044	-0.255	1.299	0.590	0.248E-04	2.840	0.775	10.387
1988	0.405	-0.270	0.675	0.590	0.248E-04	1.500	0.763	1.016
1989	0.908	-0.299	1.207	0.590	0.248E-04	2.480	0.742	7.851
1990	0.507	-0.327	0.834	0.590	0.248E-04	1.660	0.721	2.091
1991	0.788	-0.365	1.154	0.590	0.248E-04	2.200	0.694	6.639
1992	-0.094	-0.387	0.293	0.590	0.248E-04	0.910	0.679	0.038
1993	-0.580	-0.379	-0.201	0.590	0.248E-04	0.560	0.684	0.235
1994	-0.844	-0.277	-0.567	0.590	0.248E-04	0.430	0.758	0.658
1995	-1.109	-0.211	-0.897	0.590	0.248E-04	0.330	0.810	1.037
1996	-1.347	-0.223	-1.124	0.590	0.248E-04	0.260	0.800	1.269
1997	-0.598	-0.149	-0.449	0.590	0.248E-04	0.550	0.861	0.516
1998	-0.916	-0.042	-0.874	0.590	0.248E-04	0.400	0.958	1.012
1999	-0.248	-0.007	-0.242	0.590	0.248E-04	0.780	0.993	0.278
2000	-0.223	-0.064	-0.159	0.590	0.248E-04	0.800	0.938	0.193
2001	-0.545	-0.125	-0.420	0.590	0.248E-04	0.580	0.883	0.481
2002	-0.528	-0.183	-0.344	0.590	0.248E-04	0.590	0.833	0.393

```
    2003      -0.301      -0.239      -0.062       0.590    0.248E-04
0.740       0.787       0.106
    2004       0.086      -0.222       0.308       0.590    0.248E-04
1.090       0.801       0.049
    2005      -0.329      -0.149      -0.180       0.590    0.248E-04
0.720       0.862       0.213
    2006      -0.616      -0.126      -0.491       0.590    0.248E-04
0.540       0.882       0.566
    2007       0.058      -0.182       0.240       0.590    0.248E-04
1.060       0.834       0.011

    Selectivities by age
    Year      8      9     10
    ----    -----  -----  -----
    1987    0.354  0.678  1.000
    1988    0.354  0.678  1.000
    1989    0.354  0.678  1.000
    1990    0.354  0.678  1.000
    1991    0.354  0.678  1.000
    1992    0.354  0.678  1.000
    1993    0.354  0.678  1.000
    1994    0.354  0.678  1.000
    1995    0.354  0.678  1.000
    1996    0.354  0.678  1.000
    1997    0.354  0.678  1.000
    1998    0.354  0.678  1.000
    1999    0.354  0.678  1.000
    2000    0.354  0.678  1.000
    2001    0.354  0.678  1.000
    2002    0.354  0.678  1.000
    2003    0.354  0.678  1.000
    2004    0.354  0.678  1.000
    2005    0.354  0.678  1.000
    2006    0.354  0.678  1.000
    2007    0.354  0.678  1.000


    --------------------
    5.15 GOMPLL 1-6 Split Early
    --------------------
    Not used

    --------------------
    5.16 GOMPLL 1-6 Split Late
    --------------------
    Not used

    --------------------
    5.17 JLL GOM
    --------------------
    Lognormal dist.
    month  0 numbers
    Ages 10 - 10
    log-likelihood     =         0.97
    deviance           =         6.49
    Chi-sq. discrepancy=         4.93

                                     Residuals    Standard        Q
Untransfrmd  Untransfrmd  Chi-square
```

```
    Year    Observed    Predicted    (Obs-pred)   Deviation    Catchabil.
Observed    Predicted   Discrepancy
    ----  -----------  -----------  -----------  -----------  -----------  -------
----  -----------  -----------
    1974      -0.033        0.257       -0.289        0.590    0.989E-05
0.968        1.293        0.330
    1975      -0.627        0.159       -0.787        0.590    0.989E-05
0.534        1.173        0.915
    1976      -0.406        0.208       -0.615        0.590    0.989E-05
0.666        1.231        0.714
    1977      -0.091        0.010       -0.101        0.590    0.989E-05
0.913        1.010        0.139
    1978      -0.132       -0.141        0.009        0.590    0.989E-05
0.876        0.868        0.056
    1979       0.252       -0.387        0.640        0.590    0.989E-05
1.287        0.679        0.843
    1980       0.147       -0.658        0.805        0.590    0.989E-05
1.158        0.518        1.853
    1981      -0.592       -0.931        0.338        0.590    0.989E-05
0.553        0.394        0.076

    Selectivities by age
    Year     10
    ----    -----
    1974    1.000
    1975    1.000
    1976    1.000
    1977    1.000
    1978    1.000
    1979    1.000
    1980    1.000
    1981    1.000


    --------------------
    5.18 TAGGING
    --------------------
    Lognormal dist.
    average numbers
    Ages  1 -  3
    log-likelihood     =         1.95
    deviance           =         8.74
    Chi-sq. discrepancy=         7.22

                                    Residuals    Standard         Q
Untransfrmd  Untransfrmd  Chi-square
    Year    Observed    Predicted    (Obs-pred)   Deviation    Catchabil.
Observed    Predicted   Discrepancy
    ----  -----------  -----------  -----------  -----------  -----------  -------
----  -----------  -----------
    1970      13.879       13.359        0.520        0.590    0.115E+01
1065132.000   633429.942        0.409
    1971      13.817       13.033        0.784        0.590    0.115E+01
1001624.000   457379.162        1.693
    1972      12.976       12.841        0.135        0.590    0.115E+01
431955.000   377443.365        0.004
    1973      12.121       12.622       -0.502        0.590    0.115E+01
183616.000   303199.322        0.579
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    1974       12.741       13.389       -0.648        0.590    0.115E+01
341589.000   652872.386        0.754
    1975       13.226       13.140        0.086        0.590    0.115E+01
554596.000   509062.771        0.017
    1976       12.442       12.822       -0.380        0.590    0.115E+01
253265.000   370333.577        0.434
    1977       12.458       12.430        0.028        0.590    0.115E+01
257385.000   250287.805        0.044
    1978       11.704       12.212       -0.508        0.590    0.115E+01
121110.000   201224.523        0.586
    1979       11.501       12.072       -0.571        0.590    0.115E+01
98815.000   174948.782        0.663
    1980       12.168       11.938        0.230        0.590    0.115E+01
192541.000   153022.419        0.008
    1981       12.731       11.904        0.826        0.590    0.115E+01
337995.000   147910.254        2.030

    Selectivities by age
    Year      1      2      3
    ----    -----  -----  -----
    1970    1.000  1.000  1.000
    1971    1.000  1.000  1.000
    1972    1.000  1.000  1.000
    1973    1.000  1.000  1.000
    1974    1.000  1.000  1.000
    1975    1.000  1.000  1.000
    1976    1.000  1.000  1.000
    1977    1.000  1.000  1.000
    1978    1.000  1.000  1.000
    1979    1.000  1.000  1.000
    1980    1.000  1.000  1.000
    1981    1.000  1.000  1.000

=======================================================================
TOTAL NUMBER OF FUNCTION EVALUATIONS =         3285
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                VPA-2BOX
SUMMARY STATISTICS AND DIAGNOSTIC OUTPUT
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BFT West 1970-2007 CASE 9
18:48, 30   June 2008

```
======================================================================
Total objective function =         9.25
      (with constants)   =       288.54
Number of parameters (P) =           23
Number of data points (D)=          187
AIC : 2*objective+2P     =       623.09
AICc: 2*objective+2P(...)=       629.86
BIC : 2*objective+Plog(D)=       697.40
Chi-square discrepancy   =       159.35

Loglikelihoods (deviance)=         4.94 (      187.49)
   effort data           =         4.94 (      187.49)

Log-posteriors           =         1.35
   catchability          =         0.00
   f-ratio               =         1.35
   natural mortality     =         0.00
   mixing coeff.         =         0.00

Constraints              =       -15.54
   terminal F            =       -15.54
   stock-rec./sex ratio  =         0.00

Out of bounds penalty    =         0.00
======================================================================
```

TABLE 1. FISHING MORTALITY RATE

	1	2	3	4	5	6	7	8	9	10
1970	0.227	0.800	0.972	0.307	0.107	0.023	0.012	0.004	0.017	0.017
1971	0.298	1.217	0.746	1.157	0.013	0.061	0.066	0.112	0.029	0.029
1972	0.249	0.996	0.946	0.134	0.239	0.003	0.025	0.022	0.027	0.027
1973	0.045	0.720	0.896	0.476	0.099	0.124	0.025	0.083	0.025	0.025
1974	0.132	0.240	0.440	0.463	0.384	0.039	0.101	0.029	0.073	0.073
1975	0.395	0.554	0.139	0.449	0.088	0.093	0.021	0.094	0.063	0.063
1976	0.043	0.286	0.539	0.062	0.173	0.046	0.045	0.097	0.099	0.100
1977	0.016	0.240	0.212	0.457	0.131	0.316	0.164	0.143	0.118	0.118
1978	0.100	0.171	0.324	0.194	0.247	0.143	0.080	0.107	0.125	0.126
1979	0.037	0.287	0.389	0.402	0.145	0.114	0.122	0.092	0.166	0.167
1980	0.055	0.293	0.510	0.354	0.116	0.169	0.247	0.220	0.219	0.221
1981	0.112	0.217	0.508	0.451	0.402	0.203	0.229	0.207	0.257	0.258
1982	0.067	0.088	0.050	0.023	0.044	0.074	0.034	0.055	0.077	0.082
1983	0.040	0.057	0.096	0.032	0.049	0.149	0.181	0.113	0.127	0.135
1984	0.013	0.104	0.052	0.077	0.091	0.117	0.127	0.131	0.123	0.131
1985	0.008	0.104	0.231	0.098	0.213	0.239	0.091	0.176	0.160	0.170
1986	0.006	0.101	0.178	0.087	0.048	0.115	0.074	0.057	0.181	0.193
1987	0.022	0.189	0.210	0.199	0.143	0.139	0.152	0.131	0.150	0.160

1988	0.055	0.171	0.242	0.129	0.185	0.189	0.165	0.171	0.179	0.191
1989	0.016	0.188	0.044	0.118	0.069	0.143	0.165	0.184	0.225	0.240
1990	0.026	0.098	0.404	0.070	0.092	0.092	0.151	0.201	0.217	0.232
1991	0.040	0.199	0.363	0.117	0.060	0.104	0.155	0.240	0.226	0.241
1992	0.009	0.087	0.039	0.066	0.070	0.052	0.125	0.163	0.249	0.265
1993	0.006	0.024	0.096	0.076	0.125	0.110	0.093	0.196	0.183	0.195
1994	0.050	0.015	0.041	0.059	0.073	0.138	0.149	0.164	0.162	0.173
1995	0.015	0.036	0.096	0.132	0.125	0.084	0.080	0.150	0.169	0.180
1996	0.006	0.167	0.072	0.199	0.104	0.062	0.119	0.118	0.172	0.183
1997	0.005	0.018	0.157	0.059	0.081	0.086	0.107	0.126	0.180	0.192
1998	0.005	0.025	0.089	0.100	0.063	0.064	0.128	0.198	0.195	0.208
1999	0.001	0.014	0.075	0.056	0.067	0.063	0.157	0.194	0.231	0.246
2000	0.003	0.007	0.029	0.076	0.162	0.141	0.155	0.174	0.197	0.210
2001	0.030	0.010	0.082	0.152	0.066	0.091	0.183	0.123	0.246	0.263
2002	0.009	0.157	0.165	0.238	0.177	0.064	0.232	0.289	0.278	0.296
2003	0.003	0.061	0.187	0.217	0.104	0.047	0.137	0.252	0.201	0.214
2004	0.005	0.059	0.206	0.179	0.241	0.194	0.157	0.135	0.155	0.165
2005	0.008	0.095	0.066	0.095	0.099	0.095	0.112	0.113	0.189	0.202
2006	0.008	0.015	0.032	0.079	0.110	0.176	0.203	0.254	0.195	0.208
2007	0.009	0.020	0.276	0.218	0.096	0.100	0.094	0.136	0.109	0.117

TABLE 2. ABUNDANCE AT THE BEGINNING OF THE YEAR

	1	2	3	4	5	6	7	8	9	10
1970	325739.	197667.	215745.	85332.	38240.	41483.	15902.	48612.	31985.	227946.
1971	254600.	225660.	77182.	70938.	54596.	29867.	35228.	13663.	42110.	222063.
1972	219474.	164231.	58116.	31829.	19384.	46846.	24433.	28660.	10621.	223045.
1973	120469.	148696.	52736.	19609.	24202.	13269.	40616.	20712.	24381.	197796.
1974	482216.	100102.	62936.	18719.	10595.	19062.	10186.	34424.	16572.	188431.
1975	141751.	367284.	68481.	35223.	10243.	6276.	15937.	8006.	29076.	165670.
1976	134317.	83039.	183420.	51793.	19538.	8157.	4970.	13564.	6336.	158966.
1977	86060.	111833.	54217.	93057.	42316.	14289.	6771.	4128.	10705.	130069.
1978	57444.	73633.	76467.	38135.	51241.	32267.	9054.	4997.	3112.	108730.
1979	81210.	45191.	53960.	48100.	27303.	34810.	24302.	7262.	3905.	85755.
1980	63492.	68044.	29489.	31806.	27985.	20530.	27012.	18698.	5757.	65980.
1981	61170.	52256.	44130.	15388.	19412.	21664.	15076.	18345.	13047.	50006.
1982	58282.	47553.	36555.	23087.	8521.	11295.	15379.	10429.	12965.	42349.
1983	97583.	47384.	37870.	30239.	19606.	7088.	9118.	12925.	8584.	44353.

1984	69589.	81482.	38924.	29905.	25458.	16225.	5308.	6613.	10039.	40244.
1985	76375.	59689.	63858.	32121.	24072.	20208.	12554.	4064.	5045.	38396.
1986	95894.	65868.	46752.	44079.	25307.	16904.	13834.	9961.	2964.	31890.
1987	74326.	82842.	51738.	34016.	35130.	20962.	13099.	11167.	8178.	25016.
1988	97863.	63187.	59630.	36464.	24246.	26468.	15854.	9784.	8516.	24660.
1989	56691.	80492.	46302.	40688.	27865.	17518.	19044.	11682.	7169.	23907.
1990	101758.	48507.	57962.	38530.	31425.	22604.	13199.	14039.	8445.	21327.
1991	92928.	86229.	38220.	33631.	31244.	24931.	17926.	9868.	9987.	20613.
1992	58634.	77655.	61448.	23121.	26009.	25571.	19540.	13350.	6752.	21002.
1993	58389.	50542.	61912.	51398.	18813.	21092.	21106.	14987.	9857.	18578.
1994	44286.	50439.	42883.	48904.	41431.	14436.	16429.	16727.	10706.	20419.
1995	76858.	36625.	43206.	35781.	40077.	33470.	10929.	12310.	12344.	22848.
1996	68700.	65804.	30717.	34132.	27271.	30753.	26743.	8774.	9216.	25652.
1997	45800.	59339.	48399.	24855.	24325.	21369.	25134.	20642.	6780.	25314.
1998	53760.	39612.	50661.	35947.	20379.	19498.	17052.	19631.	15828.	23092.
1999	52516.	46494.	33581.	40308.	28286.	16635.	15898.	13037.	13996.	27623.
2000	40007.	45587.	39872.	27077.	33144.	22992.	13575.	11814.	9338.	28434.
2001	50782.	34689.	39372.	33662.	21814.	24505.	17361.	10103.	8634.	26696.
2002	57813.	42845.	29856.	31538.	25150.	17759.	19457.	12572.	7770.	23718.
2003	67778.	49816.	31848.	21997.	21603.	18320.	14475.	13409.	8187.	20454.
2004	69450.	58770.	40750.	22960.	15394.	16918.	15189.	10974.	9062.	20181.
2005	51440.	60092.	48175.	28842.	16688.	10514.	12111.	11286.	8333.	21622.
2006	15829.	44376.	47502.	39216.	22811.	13140.	8312.	9411.	8764.	21359.
2007	7877.	13650.	38021.	40011.	31504.	17758.	9581.	5898.	6348.	21348.
2008		6787.	11631.	25077.	27968.	24883.	13966.	7579.	4476.	21464.

==

TABLE 3. CATCH OF BFT 2002 base case WEST OF 45

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	1	2	3	4	5	6	7	8	9	10

1970	61909.	102549.	126581.	21101.	3629.	897.	173.	162.	513.	3656.
1971	61511.	150254.	38184.	45991.	663.	1646.	2112.	1351.	1134.	5980.
1972	45326.	97755.	33545.	3730.	3856.	118.	568.	574.	261.	5481.
1973	4971.	71796.	29419.	6964.	2126.	1450.	951.	1541.	559.	4535.
1974	55834.	19960.	21028.	6508.	3164.	681.	913.	914.	1083.	12401.
1975	43341.	146792.	8323.	11959.	803.	523.	313.	671.	1650.	9468.
1976	5301.	19357.	71719.	2911.	2901.	344.	206.	1168.	558.	14098.
1977	1270.	22341.	9683.	32004.	4860.	3629.	957.	513.	1109.	13568.
1978	5103.	10813.	19800.	6294.	10482.	4031.	654.	472.	341.	11996.
1979	2745.	10552.	16287.	14915.	3447.	3493.	2611.	598.	557.	12315.
1980	3160.	16182.	11066.	8879.	2865.	2981.	5531.	3453.	1061.	12240.
1981	6046.	9549.	16496.	5241.	6019.	3717.	2882.	3210.	2763.	10658.
1982	3528.	3729.	1655.	499.	343.	753.	478.	518.	896.	3114.
1983	3600.	2438.	3243.	891.	880.	918.	1414.	1287.	957.	5253.
1984	868.	7501.	1845.	2069.	2068.	1668.	592.	757.	1087.	4630.
1985	568.	5523.	12308.	2813.	4329.	4019.	1024.	612.	696.	5622.
1986	563.	5938.	7129.	3429.	1115.	1716.	924.	517.	458.	5226.
1987	1534.	13328.	9162.	5731.	4378.	2548.	1725.	1281.	1063.	3452.
1988	4925.	9282.	12004.	4123.	3829.	4267.	2259.	1438.	1304.	4005.
1989	835.	12925.	1851.	4243.	1740.	2184.	2707.	1840.	1351.	4772.
1990	2400.	4245.	18073.	2420.	2567.	1854.	1727.	2386.	1543.	4128.
1991	3364.	14542.	10893.	3470.	1709.	2293.	2403.	1967.	1892.	4136.
1992	464.	6015.	2171.	1383.	1632.	1207.	2150.	1880.	1392.	4583.
1993	346.	1134.	5287.	3494.	2063.	2050.	1743.	2500.	1543.	3084.
1994	2015.	691.	1611.	2619.	2738.	1743.	2121.	2363.	1497.	3030.
1995	1088.	1206.	3685.	4123.	4394.	2530.	781.	1598.	1794.	3523.
1996	414.	9473.	1986.	5754.	2514.	1720.	2802.	911.	1360.	4016.
1997	219.	994.	6591.	1320.	1772.	1639.	2386.	2276.	1043.	4130.

1998	260.	920.	4013.	3186.	1162.	1131.	1921.	3303.	2625.	4060.
1999	73.	589.	2274.	2038.	1717.	953.	2158.	2147.	2699.	5641.
2000	98.	278.	1074.	1854.	4634.	2825.	1826.	1760.	1563.	5045.
2001	1398.	323.	2891.	4424.	1295.	1984.	2712.	1089.	1763.	5770.
2002	476.	5807.	4257.	6259.	3813.	1035.	3774.	2953.	1763.	5691.
2003	165.	2748.	5085.	4013.	2001.	792.	1731.	2794.	1392.	3686.
2004	306.	3133.	7084.	3520.	3088.	2794.	2063.	1298.	1215.	2872.
2005	369.	5093.	2863.	2432.	1470.	891.	1202.	1126.	1343.	3695.
2006	120.	599.	1380.	2781.	2228.	1982.	1429.	1974.	1453.	3754.
2007	65.	253.	8590.	7335.	2693.	1582.	806.	700.	614.	2195.

TABLE 4. SPAWNING STOCK FECUNDITY AND RECRUITMENT

year	spawning biomass	recruits from VPA
1970	68774.	325739.
1971	62726.	254600.
1972	63395.	219474.
1973	58918.	120469.
1974	56902.	482216.
1975	46948.	141751.
1976	42019.	134317.
1977	35514.	86060.
1978	31433.	57444.
1979	24146.	81210.
1980	20768.	63492.
1981	17506.	61170.
1982	15526.	58282.
1983	15280.	97583.
1984	13054.	69589.
1985	10375.	76375.
1986	9962.	95894.
1987	8847.	74326.
1988	8570.	97863.
1989	8121.	56691.
1990	8094.	101758.
1991	7505.	92928.
1992	7293.	58634.
1993	7858.	58389.
1994	8370.	44286.
1995	9218.	76858.
1996	8856.	68700.
1997	9778.	45800.
1998	10301.	53760.
1999	9766.	52516.

2000	9702.	40007.
2001	8748.	50782.
2002	7973.	57813.
2003	7779.	67778.
2004	7609.	69450.
2005	7579.	51440.
2006	7350.	15829.
2007	7117.	7877.

===

TABLE 5. FITS TO INDEX DATA

===

5.1 CAN GSL ADJ

Not used

5.2 CAN SWNS

Lognormal dist.
average numbers
Ages 7 - 10
log-likelihood = -8.39
deviance = 37.88
Chi-sq. discrepancy= 40.38

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1988	0.742	-0.283	1.025	0.590	0.209E-04	2.100	0.754	4.325
1989	1.244	-0.291	1.536	0.590	0.209E-04	3.470	0.747	20.234
1990	0.775	-0.333	1.108	0.590	0.209E-04	2.170	0.717	5.722
1991	0.247	-0.358	0.605	0.590	0.209E-04	1.280	0.699	0.696
1992	0.262	-0.341	0.604	0.590	0.209E-04	1.300	0.711	0.692
1993	-1.050	-0.284	-0.765	0.590	0.209E-04	0.350	0.752	0.891
1994	0.199	-0.227	0.426	0.590	0.209E-04	1.220	0.797	0.197
1995	-0.163	-0.243	0.080	0.590	0.209E-04	0.850	0.785	0.019
1996	-1.022	-0.181	-0.841	0.590	0.209E-04	0.360	0.835	0.976
1997	-1.386	-0.080	-1.306	0.590	0.209E-04	0.250	0.923	1.433
1998	-0.994	-0.061	-0.933	0.590	0.209E-04	0.370	0.941	1.077
1999	-0.094	-0.103	0.009	0.590	0.209E-04	0.910	0.902	0.056

```
    2000       -1.772       -0.177       -1.595        0.590    0.209E-04
0.170       0.838       1.653
    2001       -0.478       -0.242       -0.237        0.590    0.209E-04
0.620       0.785       0.272
    2002       -0.892       -0.300       -0.592        0.590    0.209E-04
0.410       0.741       0.688
    2003        0.104       -0.359        0.463        0.590    0.209E-04
1.110       0.699       0.270
    2004       -0.713       -0.357       -0.357        0.590    0.209E-04
0.490       0.700       0.407
    2005       -0.528       -0.361       -0.167        0.590    0.209E-04
0.590       0.697       0.200
    2006        0.020       -0.438        0.458        0.590    0.209E-04
1.020       0.645       0.259
    2007       -0.020       -0.501        0.481        0.590    0.209E-04
0.980       0.606       0.309

    Selectivities by age
    Year      7      8      9     10
    ----    -----  -----  -----  -----
    1988    0.293  0.639  0.782  1.000
    1989    0.293  0.639  0.782  1.000
    1990    0.293  0.639  0.782  1.000
    1991    0.293  0.639  0.782  1.000
    1992    0.293  0.639  0.782  1.000
    1993    0.293  0.639  0.782  1.000
    1994    0.293  0.639  0.782  1.000
    1995    0.293  0.639  0.782  1.000
    1996    0.293  0.639  0.782  1.000
    1997    0.293  0.639  0.782  1.000
    1998    0.293  0.639  0.782  1.000
    1999    0.293  0.639  0.782  1.000
    2000    0.293  0.639  0.782  1.000
    2001    0.293  0.639  0.782  1.000
    2002    0.293  0.639  0.782  1.000
    2003    0.293  0.639  0.782  1.000
    2004    0.293  0.639  0.782  1.000
    2005    0.293  0.639  0.782  1.000
    2006    0.293  0.639  0.782  1.000
    2007    0.293  0.639  0.782  1.000


    --------------------
    5.3 US RR<145
    --------------------
    Lognormal dist.
    average numbers
    Ages  1 -  5
    log-likelihood     =         3.40
    deviance           =         5.87
    Chi-sq. discrepancy=         7.20

                                     Residuals    Standard         Q
Untransfrmd  Untransfrmd  Chi-square
    Year     Observed     Predicted    (Obs-pred)   Deviation    Catchabil.
Observed     Predicted    Discrepancy
    ----  -----------  -----------  -----------  -----------  -----------  -------
----  -----------  -----------
```

```
    1980       -0.224       -0.280        0.055        0.590    0.798E-05
0.799        0.756        0.030
    1981       -0.919       -0.330       -0.589        0.590    0.798E-05
0.399        0.719        0.684
    1982        0.743       -0.321        1.064        0.590    0.798E-05
2.102        0.726        4.942
    1983        0.108       -0.204        0.312        0.590    0.798E-05
1.114        0.816        0.052
    1985       -0.462        0.018       -0.480        0.590    0.798E-05
0.630        1.019        0.554
    1986       -0.251        0.008       -0.259        0.590    0.798E-05
0.778        1.008        0.297
    1987        0.198        0.075        0.123        0.590    0.798E-05
1.219        1.078        0.006
    1988       -0.012        0.036       -0.048        0.590    0.798E-05
0.988        1.037        0.095
    1989       -0.012        0.032       -0.044        0.590    0.798E-05
0.988        1.033        0.092
    1990       -0.101       -0.071       -0.030        0.590    0.798E-05
0.904        0.932        0.082
    1991        0.232        0.017        0.214        0.590    0.798E-05
1.261        1.018        0.004
    1992       -0.198        0.119       -0.317        0.590    0.798E-05
0.820        1.126        0.362

    Selectivities by age
    Year      1      2      3      4      5
    ----    -----  -----  -----  -----  -----
    1980    0.222  0.951  1.000  0.230  0.080
    1981    0.222  0.951  1.000  0.230  0.080
    1982    0.222  0.951  1.000  0.230  0.080
    1983    0.222  0.951  1.000  0.230  0.080
    1985    0.222  0.951  1.000  0.230  0.080
    1986    0.222  0.951  1.000  0.230  0.080
    1987    0.222  0.951  1.000  0.230  0.080
    1988    0.222  0.951  1.000  0.230  0.080
    1989    0.222  0.951  1.000  0.230  0.080
    1990    0.222  0.951  1.000  0.230  0.080
    1991    0.222  0.951  1.000  0.230  0.080
    1992    0.222  0.951  1.000  0.230  0.080


    --------------------
    5.4 US RR66-114
    --------------------
    Lognormal dist.
    average numbers
    Ages  2 -  3
    log-likelihood     =         0.68
    deviance           =        14.47
    Chi-sq. discrepancy=         7.80

                                     Residuals    Standard         Q
Untransfrmd  Untransfrmd  Chi-square
    Year     Observed    Predicted    (Obs-pred)   Deviation    Catchabil.
Observed    Predicted   Discrepancy
    ----  -----------  -----------  -----------  -----------  -----------  -------
----  -----------  -----------
```

```
    1993        0.146        0.142        0.004        0.590    0.149E-04
1.157        1.152        0.059
    1994       -1.514       -0.087       -1.427        0.590    0.149E-04
0.220        0.917        1.531
    1995       -0.278       -0.209       -0.070        0.590    0.149E-04
0.757        0.812        0.112
    1996        0.441       -0.203        0.644        0.590    0.149E-04
1.554        0.816        0.865
    1997        0.854        0.014        0.840        0.590    0.149E-04
2.348        1.014        2.148
    1998        0.332       -0.069        0.401        0.590    0.149E-04
1.394        0.934        0.156
    1999       -0.006       -0.279        0.273        0.590    0.149E-04
0.994        0.757        0.026
    2000       -0.121       -0.165        0.044        0.590    0.149E-04
0.886        0.848        0.036
    2001       -0.947       -0.281       -0.665        0.590    0.149E-04
0.388        0.755        0.775
    2002       -0.139       -0.435        0.296        0.590    0.149E-04
0.870        0.647        0.040
    2003       -0.919       -0.320       -0.599        0.590    0.149E-04
0.399        0.726        0.696
    2004        0.452       -0.114        0.566        0.590    0.149E-04
1.572        0.893        0.553
    2005        0.336        0.029        0.307        0.590    0.149E-04
1.400        1.029        0.049
    2006       -0.637       -0.060       -0.577        0.590    0.149E-04
0.529        0.942        0.670
    2007       -0.631       -0.594       -0.037        0.590    0.149E-04
0.532        0.552        0.087

    Selectivities by age
    Year      2      3
    ----    -----  -----
    1993    0.481  1.000
    1994    0.481  1.000
    1995    0.481  1.000
    1996    0.481  1.000
    1997    0.481  1.000
    1998    0.481  1.000
    1999    0.481  1.000
    2000    0.481  1.000
    2001    0.481  1.000
    2002    0.481  1.000
    2003    0.481  1.000
    2004    0.481  1.000
    2005    0.481  1.000
    2006    0.481  1.000
    2007    0.481  1.000


    --------------------
    5.5 US RR115-144
    --------------------
    Lognormal dist.
    average numbers
    Ages  4 -  5
    log-likelihood     =        -1.81
    deviance           =        19.45
```

Chi-sq. discrepancy= 16.97

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1993	0.588	0.063	0.525	0.590	0.193E-04	1.800	1.065	0.425
1994	-0.872	0.221	-1.093	0.590	0.193E-04	0.418	1.247	1.240
1995	-1.041	-0.026	-1.016	0.590	0.193E-04	0.353	0.975	1.163
1996	-0.467	-0.207	-0.259	0.590	0.193E-04	0.627	0.813	0.297
1997	-1.465	-0.409	-1.056	0.590	0.193E-04	0.231	0.664	1.203
1998	-0.130	-0.211	0.081	0.590	0.193E-04	0.878	0.810	0.019
1999	-0.238	-0.026	-0.212	0.590	0.193E-04	0.788	0.974	0.247
2000	0.601	-0.261	0.862	0.590	0.193E-04	1.824	0.771	2.349
2001	0.524	-0.261	0.785	0.590	0.193E-04	1.688	0.770	1.701
2002	0.892	-0.311	1.203	0.590	0.193E-04	2.440	0.733	7.759
2003	-0.794	-0.583	-0.211	0.590	0.193E-04	0.452	0.558	0.246
2004	-0.699	-0.666	-0.033	0.590	0.193E-04	0.497	0.514	0.084
2005	-0.566	-0.428	-0.137	0.590	0.193E-04	0.568	0.652	0.172
2006	0.132	-0.115	0.247	0.590	0.193E-04	1.141	0.891	0.014
2007	0.259	-0.058	0.317	0.590	0.193E-04	1.295	0.944	0.056

Selectivities by age

Year	4	5
1993	1.000	0.548
1994	1.000	0.548
1995	1.000	0.548
1996	1.000	0.548
1997	1.000	0.548
1998	1.000	0.548
1999	1.000	0.548
2000	1.000	0.548
2001	1.000	0.548
2002	1.000	0.548
2003	1.000	0.548
2004	1.000	0.548
2005	1.000	0.548
2006	1.000	0.548
2007	1.000	0.548

5.6 US RR145-177

Not used

5.7 US RR>195

Lognormal dist.
average numbers
Ages 8 - 10
log-likelihood = 3.43
deviance = 3.70
Chi-sq. discrepancy= 3.13

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1983	1.031	0.292	0.739	0.590	0.288E-04	2.805	1.339	1.388
1984	0.220	0.182	0.038	0.590	0.288E-04	1.246	1.200	0.039
1985	-0.154	0.048	-0.202	0.590	0.288E-04	0.857	1.049	0.236
1986	-0.687	-0.096	-0.591	0.590	0.288E-04	0.503	0.909	0.687
1987	-0.637	-0.196	-0.441	0.590	0.288E-04	0.529	0.822	0.507
1988	-0.061	-0.232	0.171	0.590	0.288E-04	0.941	0.793	0.000
1989	-0.270	-0.276	0.006	0.590	0.288E-04	0.763	0.759	0.058
1990	-0.468	-0.310	-0.158	0.590	0.288E-04	0.626	0.733	0.192
1991	-0.198	-0.364	0.165	0.590	0.288E-04	0.820	0.695	0.000
1992	-0.094	-0.368	0.273	0.590	0.288E-04	0.910	0.692	0.026

Selectivities by age

Year	8	9	10
1983	0.346	0.493	1.000
1984	0.346	0.493	1.000
1985	0.346	0.493	1.000
1986	0.346	0.493	1.000
1987	0.346	0.493	1.000
1988	0.346	0.493	1.000
1989	0.346	0.493	1.000
1990	0.346	0.493	1.000
1991	0.346	0.493	1.000
1992	0.346	0.493	1.000

5.8 US RR>195 COMB

Not used

5.9 US RR>177

Lognormal dist.
average numbers
Ages 7 - 10
log-likelihood = 0.97
deviance = 13.89
Chi-sq. discrepancy= 10.36

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1993	-0.188	-0.187	0.000	0.590	0.201E-04	0.829	0.829	0.062
1994	-0.088	-0.171	0.084	0.590	0.201E-04	0.916	0.842	0.018
1995	0.272	-0.219	0.491	0.590	0.201E-04	1.313	0.803	0.335
1996	0.822	-0.061	0.883	0.590	0.201E-04	2.275	0.940	2.563
1997	-0.013	0.014	-0.027	0.590	0.201E-04	0.987	1.014	0.080
1998	0.287	-0.019	0.307	0.590	0.201E-04	1.333	0.981	0.048
1999	0.383	-0.062	0.445	0.590	0.201E-04	1.466	0.940	0.232
2000	-0.371	-0.141	-0.230	0.590	0.201E-04	0.690	0.869	0.266
2001	0.385	-0.176	0.560	0.590	0.201E-04	1.469	0.839	0.535
2002	0.641	-0.217	0.858	0.590	0.201E-04	1.898	0.805	2.314
2003	-0.916	-0.300	-0.616	0.590	0.201E-04	0.400	0.741	0.717
2004	-0.757	-0.294	-0.463	0.590	0.201E-04	0.469	0.745	0.533
2005	-0.919	-0.318	-0.601	0.590	0.201E-04	0.399	0.728	0.698
2006	-1.152	-0.422	-0.730	0.590	0.201E-04	0.316	0.656	0.850
2007	-1.423	-0.462	-0.961	0.590	0.201E-04	0.241	0.630	1.106

Selectivities by age

Year	7	8	9	10
1993	0.604	0.617	0.748	1.000
1994	0.604	0.617	0.748	1.000
1995	0.604	0.617	0.748	1.000
1996	0.604	0.617	0.748	1.000
1997	0.604	0.617	0.748	1.000
1998	0.604	0.617	0.748	1.000

1999	0.604	0.617	0.748	1.000
2000	0.604	0.617	0.748	1.000
2001	0.604	0.617	0.748	1.000
2002	0.604	0.617	0.748	1.000
2003	0.604	0.617	0.748	1.000
2004	0.604	0.617	0.748	1.000
2005	0.604	0.617	0.748	1.000
2006	0.604	0.617	0.748	1.000
2007	0.604	0.617	0.748	1.000

5.10 JLL AREA 2 (WEST)

Lognormal dist.
month 0 numbers
Ages 2 - 10
log-likelihood = 3.45
deviance = 25.82
Chi-sq. discrepancy= 14.74

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1976	-0.363	0.336	-0.699	0.590	0.660E-05	0.696	1.400	0.815
1977	0.817	0.274	0.542	0.590	0.660E-05	2.263	1.316	0.476
1978	0.088	0.216	-0.129	0.590	0.660E-05	1.091	1.242	0.164
1979	-0.172	0.135	-0.308	0.590	0.660E-05	0.842	1.145	0.351
1980	0.297	-0.039	0.337	0.590	0.660E-05	1.346	0.961	0.075
1981	0.652	-0.220	0.873	0.590	0.660E-05	1.920	0.802	2.456
1982	-0.510	-0.467	-0.043	0.590	0.660E-05	0.600	0.627	0.092
1983	-1.253	-0.422	-0.830	0.590	0.660E-05	0.286	0.655	0.965
1984	-0.070	-0.353	0.283	0.590	0.660E-05	0.932	0.703	0.032
1985	0.165	-0.230	0.395	0.590	0.660E-05	1.180	0.795	0.147
1986	-2.052	-0.226	-1.826	0.590	0.660E-05	0.128	0.798	1.796
1987	-0.626	-0.149	-0.477	0.590	0.660E-05	0.535	0.861	0.550
1988	-0.020	-0.138	0.118	0.590	0.660E-05	0.981	0.871	0.007
1989	-0.183	-0.173	-0.010	0.590	0.660E-05	0.833	0.842	0.068
1990	-0.496	-0.127	-0.368	0.590	0.660E-05	0.609	0.881	0.421
1991	-0.245	-0.164	-0.081	0.590	0.660E-05	0.783	0.849	0.122

1992	0.131	-0.158	0.289	0.590	0.660E-05	1.140	0.854	0.035
1993	0.050	-0.090	0.140	0.590	0.660E-05	1.051	0.914	0.003
1994	0.313	-0.079	0.391	0.590	0.660E-05	1.367	0.924	0.141
1995	-0.262	-0.058	-0.204	0.590	0.660E-05	0.769	0.944	0.239
1996	0.663	-0.108	0.770	0.590	0.660E-05	1.940	0.898	1.596
1997	0.218	-0.146	0.365	0.590	0.660E-05	1.244	0.864	0.106
1998	-0.271	-0.163	-0.109	0.590	0.660E-05	0.762	0.850	0.146
1999	-0.454	-0.204	-0.251	0.590	0.660E-05	0.635	0.816	0.287
2000	-0.331	-0.209	-0.122	0.590	0.660E-05	0.718	0.811	0.158
2001	-0.753	-0.239	-0.514	0.590	0.660E-05	0.471	0.787	0.594
2002	-0.425	-0.295	-0.130	0.590	0.660E-05	0.654	0.744	0.165
2003	-0.607	-0.408	-0.199	0.590	0.660E-05	0.545	0.665	0.233
2004	-0.011	-0.436	0.426	0.590	0.660E-05	0.989	0.646	0.197
2005	0.147	-0.448	0.596	0.590	0.660E-05	1.159	0.639	0.661
2006	0.411	-0.365	0.777	0.590	0.660E-05	1.509	0.694	1.642

Selectivities by age

Year	2	3	4	5	6	7	8	9	10
----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1976	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1977	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1978	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1979	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1980	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1981	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1982	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1983	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1984	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1985	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1986	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1987	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1988	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1989	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1990	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1991	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1992	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1993	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1994	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1995	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1996	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1997	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1998	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
1999	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384
2000	0.051	0.394	0.611	0.841	1.000	0.907	0.736	0.588	0.384

```
    2001    0.051  0.394  0.611  0.841  1.000  0.907  0.736  0.588  0.384
    2002    0.051  0.394  0.611  0.841  1.000  0.907  0.736  0.588  0.384
    2003    0.051  0.394  0.611  0.841  1.000  0.907  0.736  0.588  0.384
    2004    0.051  0.394  0.611  0.841  1.000  0.907  0.736  0.588  0.384
    2005    0.051  0.394  0.611  0.841  1.000  0.907  0.736  0.588  0.384
    2006    0.051  0.394  0.611  0.841  1.000  0.907  0.736  0.588  0.384


    --------------------
    5.11 JLL AREA 3 (31+32)
    --------------------
    Not used

    --------------------
    5.12 JLL AREAS 17+18
    --------------------
    Not used

    --------------------
    5.13 LARVAL ZERO INFLATED
    --------------------
    Lognormal dist.
    average biomass
    Ages  8 - 10
    log-likelihood     =         3.55
    deviance           =        22.45
    Chi-sq. discrepancy=        16.07

                                     Residuals    Standard         Q
Untransfrmd  Untransfrmd  Chi-square
    Year    Observed    Predicted    (Obs-pred)   Deviation    Catchabil.
Observed    Predicted   Discrepancy
    ----  -----------  -----------  -----------  -----------  -----------  -------
----  -----------  -----------
    1977        0.918        0.664        0.254        0.590    0.546E-07
2.504       1.943       0.016
    1978        1.583        0.542        1.040        0.590    0.546E-07
4.869       1.720       4.564
    1981       -0.309       -0.039       -0.269        0.590    0.546E-07
0.735       0.961       0.308
    1982        0.305       -0.164        0.469        0.590    0.546E-07
1.356       0.849       0.282
    1983        0.184       -0.179        0.363        0.590    0.546E-07
1.202       0.836       0.104
    1984       -1.001       -0.336       -0.665        0.590    0.546E-07
0.367       0.714       0.775
    1986       -0.907       -0.605       -0.301        0.590    0.546E-07
0.404       0.546       0.344
    1987       -1.062       -0.725       -0.337        0.590    0.546E-07
0.346       0.485       0.385
    1988        0.080       -0.756        0.836        0.590    0.546E-07
1.084       0.470       2.117
    1989       -0.268       -0.808        0.540        0.590    0.546E-07
0.765       0.446       0.470
    1990       -1.103       -0.812       -0.291        0.590    0.546E-07
0.332       0.444       0.333
    1991       -0.946       -0.887       -0.060        0.590    0.546E-07
0.388       0.412       0.104
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    1992       -0.640       -0.915        0.275        0.590    0.546E-07
0.527       0.400       0.027
    1993       -0.696       -0.842        0.146        0.590    0.546E-07
0.498       0.431       0.002
    1994       -0.719       -0.780        0.061        0.590    0.546E-07
0.487       0.459       0.028
    1995       -1.056       -0.683       -0.373        0.590    0.546E-07
0.348       0.505       0.427
    1996       -0.035       -0.723        0.688        0.590    0.546E-07
0.966       0.485       1.084
    1997       -0.897       -0.624       -0.273        0.590    0.546E-07
0.408       0.536       0.312
    1998       -2.142       -0.571       -1.571        0.590    0.546E-07
0.117       0.565       1.636
    1999       -0.669       -0.624       -0.045        0.590    0.546E-07
0.512       0.536       0.093
    2000       -1.068       -0.631       -0.437        0.590    0.546E-07
0.344       0.532       0.502
    2001       -0.949       -0.733       -0.216        0.590    0.546E-07
0.387       0.480       0.250
    2002       -1.190       -0.824       -0.365        0.590    0.546E-07
0.304       0.438       0.417
    2003       -0.305       -0.852        0.546        0.590    0.546E-07
0.737       0.427       0.489
    2004       -0.614       -0.875        0.261        0.590    0.546E-07
0.541       0.417       0.020
    2005       -1.468       -0.879       -0.589        0.590    0.546E-07
0.230       0.415       0.685
    2006       -0.502       -0.908        0.406        0.590    0.546E-07
0.605       0.403       0.164
    2007       -1.036       -0.943       -0.093        0.590    0.546E-07
0.355       0.389       0.132
```

```
    Selectivities by age
    Year      8      9     10
    ----    -----  -----  -----
    1977    1.000  1.000  1.000
    1978    1.000  1.000  1.000
    1981    1.000  1.000  1.000
    1982    1.000  1.000  1.000
    1983    1.000  1.000  1.000
    1984    1.000  1.000  1.000
    1986    1.000  1.000  1.000
    1987    1.000  1.000  1.000
    1988    1.000  1.000  1.000
    1989    1.000  1.000  1.000
    1990    1.000  1.000  1.000
    1991    1.000  1.000  1.000
    1992    1.000  1.000  1.000
    1993    1.000  1.000  1.000
    1994    1.000  1.000  1.000
    1995    1.000  1.000  1.000
    1996    1.000  1.000  1.000
    1997    1.000  1.000  1.000
    1998    1.000  1.000  1.000
    1999    1.000  1.000  1.000
    2000    1.000  1.000  1.000
    2001    1.000  1.000  1.000
    2002    1.000  1.000  1.000
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    2003    1.000  1.000  1.000
    2004    1.000  1.000  1.000
    2005    1.000  1.000  1.000
    2006    1.000  1.000  1.000
    2007    1.000  1.000  1.000


    --------------------
    5.14 GOMPLL 1-6
    --------------------
    Lognormal dist.
    month  0 numbers
    Ages  8 - 10
    log-likelihood     =        -2.85
    deviance           =        27.87
    Chi-sq. discrepancy=        29.93

                                     Residuals    Standard         Q
Untransfrmd  Untransfrmd  Chi-square
    Year    Observed    Predicted    (Obs-pred)   Deviation    Catchabil.
Observed    Predicted   Discrepancy
    ----  -----------  -----------  -----------  -----------  -----------  -------
----  -----------  -----------
    1987        1.044       -0.190        1.234        0.590    0.231E-04
2.840       0.827       8.535
    1988        0.405       -0.208        0.614        0.590    0.231E-04
1.500       0.812       0.733
    1989        0.908       -0.238        1.146        0.590    0.231E-04
2.480       0.789       6.482
    1990        0.507       -0.257        0.764        0.590    0.231E-04
1.660       0.774       1.550
    1991        0.788       -0.294        1.083        0.590    0.231E-04
2.200       0.745       5.267
    1992       -0.094       -0.315        0.221        0.590    0.231E-04
0.910       0.730       0.006
    1993       -0.580       -0.296       -0.284        0.590    0.231E-04
0.560       0.744       0.324
    1994       -0.844       -0.201       -0.643        0.590    0.231E-04
0.430       0.818       0.748
    1995       -1.109       -0.149       -0.959        0.590    0.231E-04
0.330       0.861       1.104
    1996       -1.347       -0.177       -1.170        0.590    0.231E-04
0.260       0.838       1.313
    1997       -0.598       -0.107       -0.490        0.590    0.231E-04
0.550       0.898       0.566
    1998       -0.916       -0.003       -0.913        0.590    0.231E-04
0.400       0.997       1.056
    1999       -0.248        0.008       -0.256        0.590    0.231E-04
0.780       1.008       0.294
    2000       -0.223       -0.070       -0.153        0.590    0.231E-04
0.800       0.933       0.187
    2001       -0.545       -0.146       -0.399        0.590    0.231E-04
0.580       0.864       0.457
    2002       -0.528       -0.219       -0.308        0.590    0.231E-04
0.590       0.803       0.352
    2003       -0.301       -0.297       -0.004        0.590    0.231E-04
0.740       0.743       0.064
    2004        0.086       -0.316        0.402        0.590    0.231E-04
1.090       0.729       0.157
```

```
    2005       -0.329       -0.284       -0.044        0.590    0.231E-04
0.720        0.753        0.092
    2006       -0.616       -0.306       -0.310        0.590    0.231E-04
0.540        0.737        0.354
    2007        0.058       -0.414        0.473        0.590    0.231E-04
1.060        0.661        0.291

    Selectivities by age
    Year      8      9     10
    ----    -----  -----  -----
    1987    0.405  0.764  1.000
    1988    0.405  0.764  1.000
    1989    0.405  0.764  1.000
    1990    0.405  0.764  1.000
    1991    0.405  0.764  1.000
    1992    0.405  0.764  1.000
    1993    0.405  0.764  1.000
    1994    0.405  0.764  1.000
    1995    0.405  0.764  1.000
    1996    0.405  0.764  1.000
    1997    0.405  0.764  1.000
    1998    0.405  0.764  1.000
    1999    0.405  0.764  1.000
    2000    0.405  0.764  1.000
    2001    0.405  0.764  1.000
    2002    0.405  0.764  1.000
    2003    0.405  0.764  1.000
    2004    0.405  0.764  1.000
    2005    0.405  0.764  1.000
    2006    0.405  0.764  1.000
    2007    0.405  0.764  1.000


    --------------------
    5.15 GOMPLL 1-6 Split Early
    --------------------
    Not used

    --------------------
    5.16 GOMPLL 1-6 Split Late
    --------------------
    Not used

    --------------------
    5.17 JLL GOM
    --------------------
    Lognormal dist.
    month  0 numbers
    Ages 10 - 10
    log-likelihood     =         0.55
    deviance           =         7.35
    Chi-sq. discrepancy=         5.54

                                           Residuals    Standard         Q
Untransfrmd  Untransfrmd  Chi-square
    Year    Observed    Predicted    (Obs-pred)   Deviation    Catchabil.
Observed    Predicted   Discrepancy
    ----  -----------  -----------  -----------  -----------  -----------  -------
----  -----------  -----------
```

```
    1974       -0.033        0.362       -0.395        0.590    0.763E-05
0.968        1.437        0.452
    1975       -0.627        0.234       -0.861        0.590    0.763E-05
0.534        1.263        0.999
    1976       -0.406        0.192       -0.599        0.590    0.763E-05
0.666        1.212        0.696
    1977       -0.091       -0.008       -0.083        0.590    0.763E-05
0.913        0.992        0.123
    1978       -0.132       -0.187        0.055        0.590    0.763E-05
0.876        0.829        0.030
    1979        0.252       -0.425        0.677        0.590    0.763E-05
1.287        0.654        1.027
    1980        0.147       -0.687        0.834        0.590    0.763E-05
1.158        0.503        2.096
    1981       -0.592       -0.964        0.372        0.590    0.763E-05
0.553        0.381        0.115

    Selectivities by age
    Year     10
    ----    -----
    1974    1.000
    1975    1.000
    1976    1.000
    1977    1.000
    1978    1.000
    1979    1.000
    1980    1.000
    1981    1.000


    --------------------
    5.18 TAGGING
    --------------------
    Lognormal dist.
    average numbers
    Ages  1 -  3
    log-likelihood     =         1.96
    deviance           =         8.75
    Chi-sq. discrepancy=         7.23

                                           Residuals    Standard        Q
Untransfrmd  Untransfrmd  Chi-square
    Year     Observed    Predicted    (Obs-pred)    Deviation    Catchabil.
Observed    Predicted    Discrepancy
    ----  -----------  -----------  -----------  -----------  -----------  -------
----  -----------  -----------
    1970       13.879       13.339        0.539        0.590    0.117E+01
1065132.000   621080.929        0.467
    1971       13.817       13.007        0.810        0.590    0.117E+01
1001624.000   445475.107        1.900
    1972       12.976       12.818        0.158        0.590    0.117E+01
431955.000   368922.862        0.001
    1973       12.121       12.556       -0.435        0.590    0.117E+01
183616.000   283733.477        0.500
    1974       12.741       13.380       -0.639        0.590    0.117E+01
341589.000   647089.000        0.744
    1975       13.226       13.138        0.088        0.590    0.117E+01
554596.000   508065.953        0.016
```

```
    1976       12.442       12.844       -0.402        0.590    0.117E+01
253265.000   378421.558       0.460
    1977       12.458       12.451        0.007        0.590    0.117E+01
257385.000   255500.090       0.057
    1978       11.704       12.232       -0.528        0.590    0.117E+01
121110.000   205351.802       0.611
    1979       11.501       12.096       -0.595        0.590    0.117E+01
98815.000   179120.687       0.691
    1980       12.168       11.967        0.201        0.590    0.117E+01
192541.000   157446.131       0.002
    1981       12.731       11.936        0.795        0.590    0.117E+01
337995.000   152646.729       1.779

    Selectivities by age
    Year      1      2      3
    ----    -----  -----  -----
    1970    1.000  1.000  1.000
    1971    1.000  1.000  1.000
    1972    1.000  1.000  1.000
    1973    1.000  1.000  1.000
    1974    1.000  1.000  1.000
    1975    1.000  1.000  1.000
    1976    1.000  1.000  1.000
    1977    1.000  1.000  1.000
    1978    1.000  1.000  1.000
    1979    1.000  1.000  1.000
    1980    1.000  1.000  1.000
    1981    1.000  1.000  1.000

=======================================================================


TOTAL NUMBER OF FUNCTION EVALUATIONS =         2846
```

Appendix 10

Tests for Positive Lag 1 Autocorrelation in Stock-Recruit Deviates

The VPA reconstructed spawner-recruit datasets were tested for positive lag 1 autocorrelation using a test statistic obtained from Anderson (1941) and Salas et al (1980). We test the null hypothesis that the lag auto-correlation coefficient is less than or equal to zero. The lag 1 autocorrelation coefficient was computed for each stock-recruit dataset using the Excel correlation function. The one–tailed test statistic (Anderson-Salsa test statistic) for this null hypothesis using an alpha of 0.05 is given by:

$$r(95\%) = \frac{-1 + 1.645\sqrt{N' - k - 1}}{N' - k}$$

Here *N'* is the effective sample size accounting for the degree of auto-correlation on the effective number of statistically independent samples (see below) and *k* is the lag tested for (*k* =1)

$$N' = N\frac{(1 - |r_k|)}{(1 + |r_k|)}$$

where *N* is the sample size and r_k is the maximum likelihood estimate of the correlation coefficient at lag *k*.

When all recruitment estimates up to 2004 are included in the analysis, i.e., excluding estimates for the last 3 years, test results for positive lag 1 autocorrelation were found to be significant at the 0.05 alpha level for all but one (VPA run 6) of the high recruitment scenarios **(Table Appendix 10.1)**. Test results were not significant for any of the low recruitment scenarios. Significant autocorrelation estimates for the high recruitment scenario ranged from about 0.4 to 0.7 **(Table Appendix 10.1)**.

Table Appendix 10.1 Results are shown for each VPA run and the two recruitment scenarios. The high recruitment scenario refers to a Beverton-Holt model fitted to the full time series and the low recruitment scenario refers to a hockey stick model fitted to the series starting in 1976. The remaining columns refer to, respectively, the estimated values for r_1, number of spawner-recruit data points (sample size *N*), effective sample size (*N'*), the Anderson-Salsa (A-S) test statistic, and the conclusion of whether it was significant at the alpha=0.05 level. All recruitment estimates to 2004 are included.

VPA Run	Recruitment	r_1	N	N'	A-S statistic	Significant?
Continuity	High	0.48	33	11.7	0.39	Yes
	Low	0.14	26	19.4	0.32	No
Case 1	High	0.52	36	11.5	0.39	Yes
	Low	0.14	26	19.5	0.32	No
Case 2	High	0.42	33	13.5	0.37	Yes
	Low	0.31	26	13.7	0.36	No
Case 3	High		36			
	Low		29			
Case 4	High	0.69	46	7.8	0.44	Yes
	Low	0.18	29	18.0	0.33	No
Case 5	High	0.38	33	14.7	0.35	Yes
	Low	0.12	26	20.3	0.31	No
Case 6	High	0.30	33	17.9	0.33	No
	Low	-0.02	26	24.9	0.29	No

Case 7	High	0.25	33	19.6	0.32	Yes
	Low	0.16	26	18.7	0.33	No
Case 8	High	0.37	33	15.1	0.35	Yes
	Low	0.09	26	21.7	0.30	No
Case 9	High	0.35	33	16.0	0.34	Yes
	Low	0.29	26	14.4	0.36	No

References

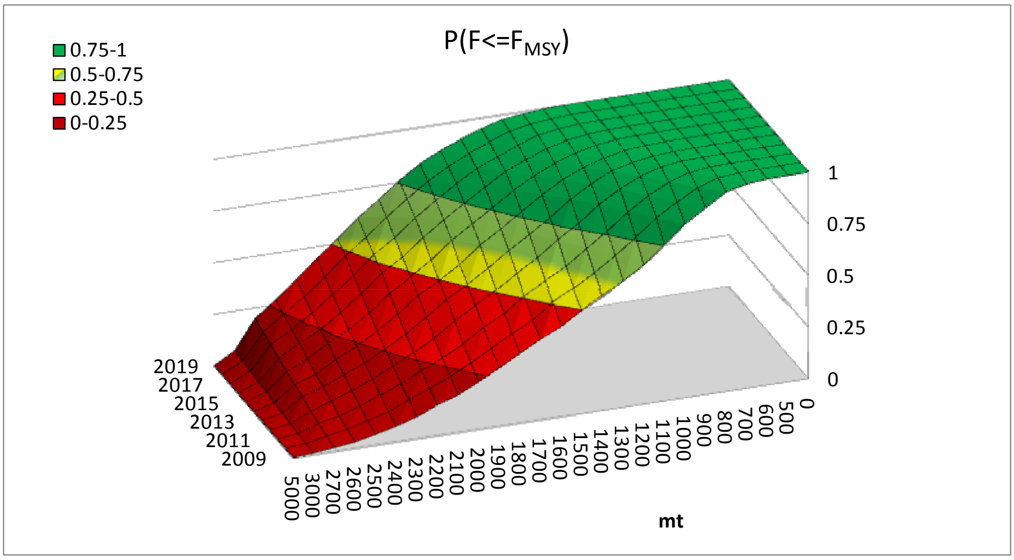
ANDERSON, R.L., 1941, Distribution of the serial correlation coefficients: Annals of Math. Statistics, v. 8, no. 1, p. 1-13.

SALAS, J.D., Delleur, J.W., Yevjevich, V.M., and Lane, W.L., 1980, Applied modeling of hydrologic time series: Littleton, Colorado, Water Resources Publications, 484 pp.

Appendix 11

Combined projections of western Atlantic bluefin tuna under the high and low recruitment scenarios

The implications of the projections of western Atlantic bluefin tuna stock status under the high and low recruitment scenarios were discussed further by the bluefin working group that met September 23-25, 2009. The Group agreed that it had no strong evidence to favor one recruitment hypothesis over the other and that management should consider this when deciding upon an appropriate TAC. Moreover, the Group felt that it would be useful to present the results in surface plots that would allow managers to consider TAC and probability levels other than the values given in Tables. Accordingly, **Figure Appendix 11.1** below summarizea the chance that various constant catch policies will allow rebuilding or end overfishing when the high and low recruitment scenarios are considered to be equally plausible. For comparison, similar plots are also provided for the cases where the high and low recruitment scenarios are considered separately (**Figure Appendix 11.2**).



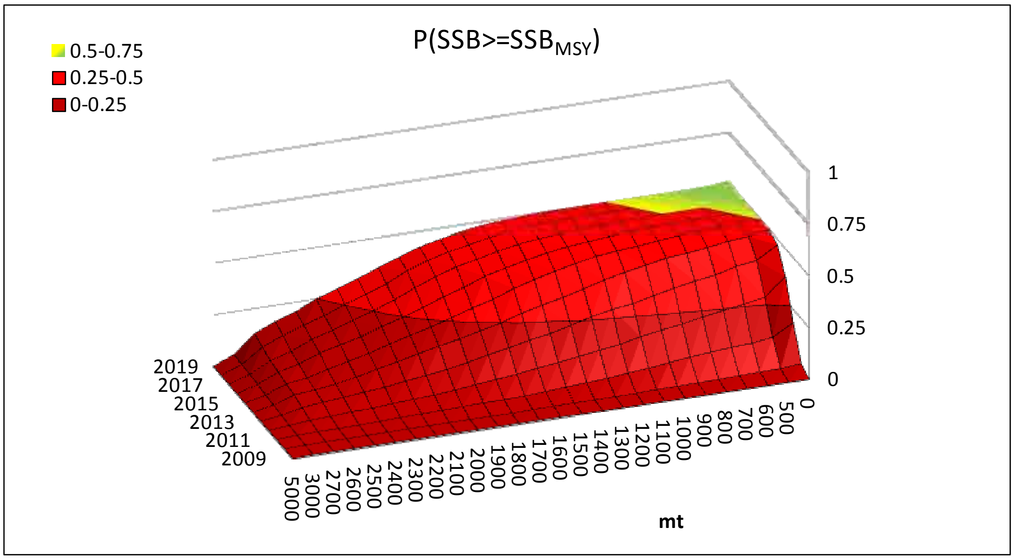


Figure Appendix 11.1 Estimated probability of rebuilding to spawning biomass levels above B_{MSY} (top) and probability of ending overfishing (bottom) by year under various constant catch levels and assuming the high and low recruitment scenarios are equally likely.

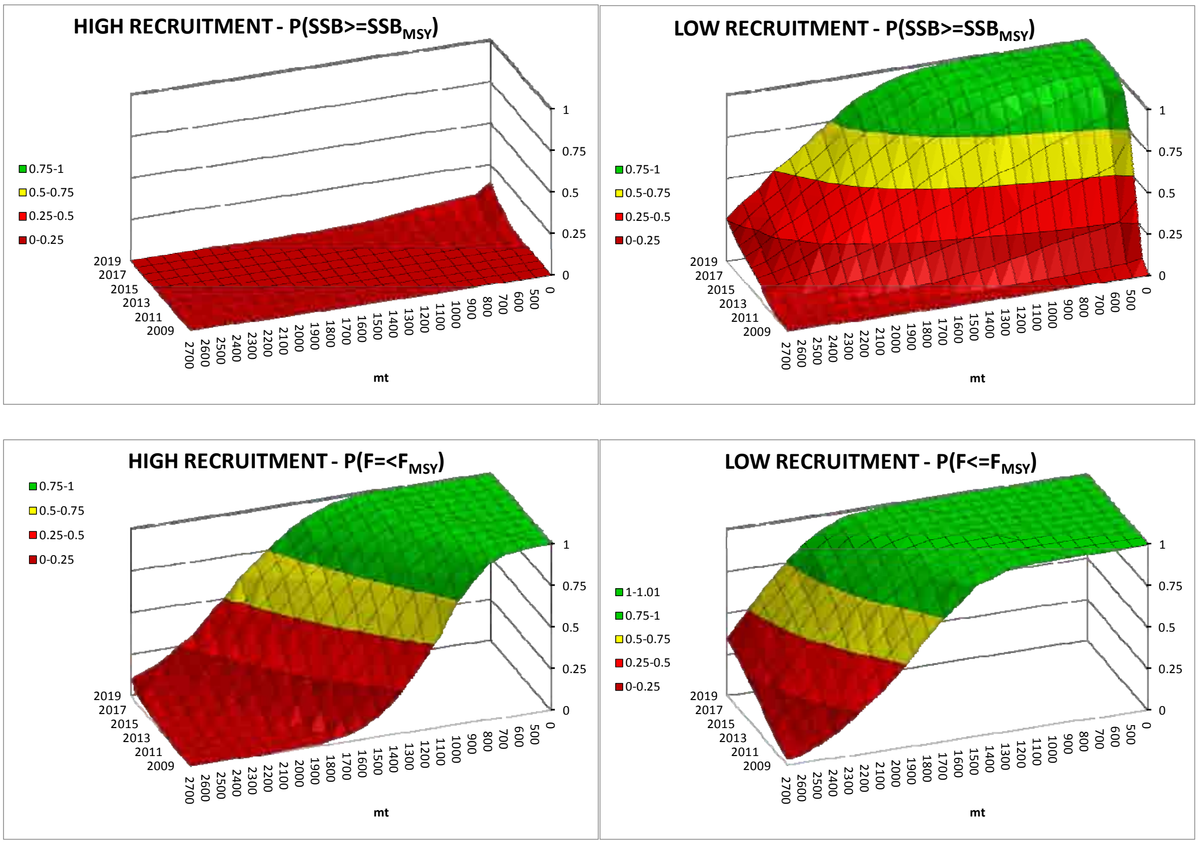


Figure Appendix 11.2 Estimated probability of rebuilding to spawning biomass levels above B_{MSY} (top) and probability of ending overfishing (bottom) by year under various constant catch levels and assuming either the high or low recruitment scenarios.

Appendix 12

Non-equilibrium projections for the East Atlantic and Mediterranean bluefin stock

Following the 2008 stock assessment meeting, the Working Group conducted non-equilibrium projections during the Species Group in September 2008, using two different models (FLR and PRO2BOX) for comparisons purposes. In addition to the 24 scenarios that were agreed on (see **Table 19**), the Group also considered additional scenarios including a medium recruitment level (i.e. equal to the mean of the estimated recruitment over the 1970-2006 period) and an implementation error of 20% of Rec[06.05] that would affect the selectivity pattern and future TAC. In total, 72 scenarios have been investigated to address the possible impact on stock status of future management given by Rec. [06-05] under several hypotheses of stock productivity and implementation error.

All of the 72 scenarios were implemented under the model Pro2Box, but only 24 of them were run under FLR because of a lack of time. Although there are some differences in results between the two tested models, particularly in the underlying stock recruitment relationship, when comparing the 24 common scenarios, both models are in general agreement, especially when regarding the overall trends in probability among the different scenarios (**Figure Appendix 12.1**). This validation exercise gives to the Group good confidence in the technical aspects of the projections. However both models possess some differences that lie different implementation of the stock recruitment relationship. The fact that FLR is more optimistic when looking at the probability of F to be lower than F_{MSY} under 20% implementation error is likely to come from different initial assumptions about the state of stock in 2006-2007 in the two sets of projections and from differences in the underlying stock-recruitment relationships.

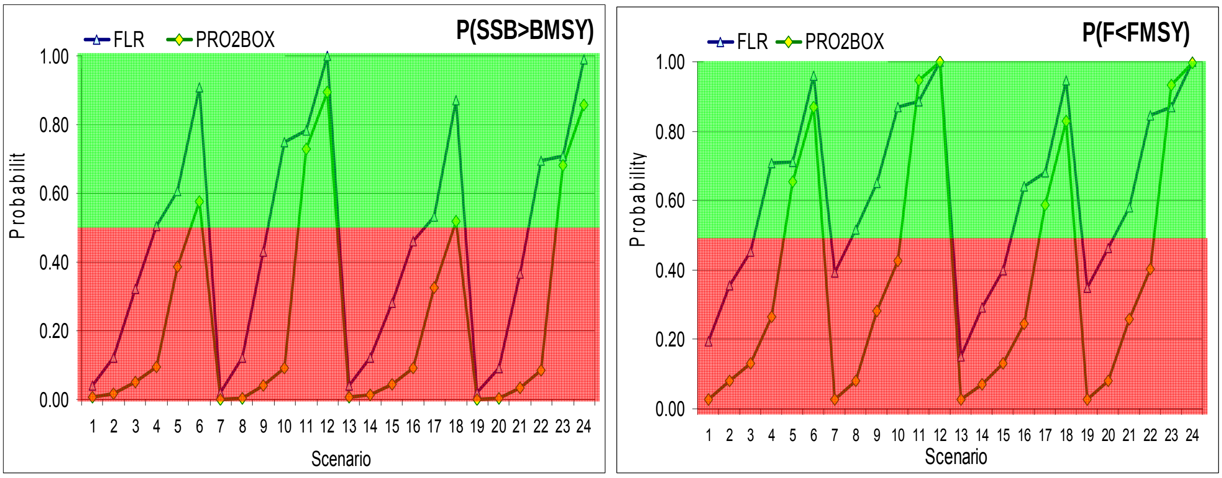


Figure Appendix 12.1 Comparison of the outputs of FLR and Pro2Box for the evaluation of Rec[06.05]. The outputs of the projections are summarised, for each of the 24 comparable scenarios, as the probability of F_{2023} to be lower than F_{MSY} and SSB_{2023} to be greater than B_{MSY} (see also and **Table Appendix 12.1 Table Appendix 12.2**).

The projection results are summarised in **Table Appendix 12.1 Table Appendix 12.2**. Whatever the model used, the results clearly indicate that only scenarios with medium to high recruitment levels together with a high steepness (0.75 to 0.99, i.e scenarios that assume that the stock will be highly productive over the next 15 years and that this productivity will not be affected by the current low level of the SSB) allow the rebuilding of the stock with probability greater than 50% by 2023. The remaining scenarios of a low or medium productivity of the stock which are considered to be as plausible as the high productivity scenarios would not allow the rebuilding of the stock by 2023. Furthermore, Rec[06.05] would be insufficient to avoid a collapse of the population in a substantial number of scenarios considered (**Figure Appendix 12.2**, below).

PRO2BOX							
Scenario	*Catch*	*Steepness*	*Recruitment level*	*Implementation*	*HCR*	*P(SSB>BMSY)*	*P(F<FMSY)*
1	reported	0.5	Medium	Perfect	TAC	0.006	0.026
2	adjusted	0.5	Medium	Perfect	TAC	0.018	0.08
3	reported	0.75	Medium	Perfect	TAC	0.05	0.132
4	adjusted	0.75	Medium	Perfect	TAC	0.096	0.266
5	reported	0.99	Medium	Perfect	TAC	0.388	0.656
6	adjusted	0.99	Medium	Perfect	TAC	0.576	0.87
7	reported	0.5	High (1990s)	Perfect	TAC	0	0.026
8	adjusted	0.5	High (1990s)	Perfect	TAC	0.002	0.082
9	reported	0.75	High (1990s)	Perfect	TAC	0.04	0.282
10	adjusted	0.75	High (1990s)	Perfect	TAC	0.09	0.426
11	reported	0.99	High (1990s)	Perfect	TAC	0.728	0.946
12	adjusted	0.99	High (1990s)	Perfect	TAC	0.896	1
13	reported	0.5	Medium	20% error	TAC	0.006	0.026
14	adjusted	0.5	Medium	20% error	TAC	0.014	0.07
15	reported	0.75	Medium	20% error	TAC	0.044	0.13
16	adjusted	0.75	Medium	20% error	TAC	0.09	0.246
17	reported	0.99	Medium	20% error	TAC	0.326	0.588
18	adjusted	0.99	Medium	20% error	TAC	0.518	0.83
19	reported	0.5	High (1990s)	20% error	TAC	0	0.026
20	adjusted	0.5	High (1990s)	20% error	TAC	0.002	0.082
21	reported	0.75	High (1990s)	20% error	TAC	0.034	0.258
22	adjusted	0.75	High (1990s)	20% error	TAC	0.084	0.404
23	reported	0.99	High (1990s)	20% error	TAC	0.682	0.934
24	adjusted	0.99	High (1990s)	20% error	TAC	0.856	0.996
25	reported	0.5	Low (1970's)	Perfect	TAC	0.032	0.022
26	adjusted	0.5	Low (1970's)	Perfect	TAC	0.084	0.058
27	reported	0.75	Low (1970's)	Perfect	TAC	0.076	0.066
28	adjusted	0.75	Low (1970's)	Perfect	TAC	0.168	0.156
29	reported	0.99	Low (1970's)	Perfect	TAC	0.206	0.214
30	adjusted	0.99	Low (1970's)	Perfect	TAC	0.352	0.368
31	reported	0.5	Low (1970's)	20% error	TAC	0.044	0.024
32	adjusted	0.5	Low (1970's)	20% error	TAC	0.08	0.046
33	reported	0.75	Low (1970's)	20% error	TAC	0.07	0.05
34	adjusted	0.75	Low (1970's)	20% error	TAC	0.15	0.138
35	reported	0.99	Low (1970's)	20% error	TAC	0.176	0.162
36	adjusted	0.99	Low (1970's)	20% error	TAC	0.318	0.318
37	reported	0.5	Medium	Perfect	TAC + 20%	0.002	0.004
38	adjusted	0.5	Medium	Perfect	TAC + 20%	0.008	0.02
39	reported	0.75	Medium	Perfect	TAC + 20%	0.016	0.034
40	adjusted	0.75	Medium	Perfect	TAC + 20%	0.04	0.106
41	reported	0.99	Medium	Perfect	TAC + 20%	0.132	0.27
42	adjusted	0.99	Medium	Perfect	TAC + 20%	0.316	0.552
43	reported	0.5	High (1990s)	Perfect	TAC + 20%	0	0.004
44	adjusted	0.5	High (1990s)	Perfect	TAC + 20%	0.002	0.024
45	reported	0.75	High (1990s)	Perfect	TAC + 20%	0.018	0.084
46	adjusted	0.75	High (1990s)	Perfect	TAC + 20%	0.04	0.204
47	reported	0.99	High (1990s)	Perfect	TAC + 20%	0.482	0.742
48	adjusted	0.99	High (1990s)	Perfect	TAC + 20%	0.742	0.942
49	reported	0.5	Medium	20% error	TAC + 20%	0.002	0.002
50	adjusted	0.5	Medium	20% error	TAC + 20%	0.008	0.02
51	reported	0.75	Medium	20% error	TAC + 20%	0.01	0.03
52	adjusted	0.75	Medium	20% error	TAC + 20%	0.034	0.096
53	reported	0.99	Medium	20% error	TAC + 20%	0.094	0.2
54	adjusted	0.99	Medium	20% error	TAC + 20%	0.25	0.496
55	reported	0.5	High (1990s)	20% error	TAC + 20%	0	0.004
56	adjusted	0.5	High (1990s)	20% error	TAC + 20%	0.002	0.022
57	reported	0.75	High (1990s)	20% error	TAC + 20%	0.01	0.07
58	adjusted	0.75	High (1990s)	20% error	TAC + 20%	0.032	0.174
59	reported	0.99	High (1990s)	20% error	TAC + 20%	0.428	0.702
60	adjusted	0.99	High (1990s)	20% error	TAC + 20%	0.68	0.93
61	reported	0.5	Low (1970's)	Perfect	TAC + 20%	0.012	0.002
62	adjusted	0.5	Low (1970's)	Perfect	TAC + 20%	0.04	0.02
63	reported	0.75	Low (1970's)	Perfect	TAC + 20%	0.026	0.016
64	adjusted	0.75	Low (1970's)	Perfect	TAC + 20%	0.086	0.044
65	reported	0.99	Low (1970's)	Perfect	TAC + 20%	0.054	0.034
66	adjusted	0.99	Low (1970's)	Perfect	TAC + 20%	0.158	0.132
67	reported	0.5	Low (1970's)	20% error	TAC + 20%	0.016	0.006
68	adjusted	0.5	Low (1970's)	20% error	TAC + 20%	0.034	0.016
69	reported	0.75	Low (1970's)	20% error	TAC + 20%	0.024	0.014
70	adjusted	0.75	Low (1970's)	20% error	TAC + 20%	0.08	0.036
71	reported	0.99	Low (1970's)	20% error	TAC + 20%	0.044	0.03
72	adjusted	0.99	Low (1970's)	20% error	TAC + 20%	0.138	0.112

Table Appendix 12.1 Results of the projections run under Pro2Box for the 72 scenarios (the 24 first scenarios being common with FLR, see Table 10.1.4). Results are summarised as the probability of F_{2023} to be lower than F_{MSY} and SSB_{2023} to be greater than SSB_{MSY}. Catch levels are either those officially reported, either those adjusted by the SCRS over the last decade. Steepness and recruitment levels correspond to the slope and the asymptotes in the Beverton & Holt models used. Implementation corresponds to the selectivity pattern under Rec[06.05] with or without 20% implementation error. HCR is the harvest control rule, i.e. TAC of 25,500 t from 2010 to 2023 under perfect implementation (see Rec[06.05]) while TAC+20% is 30,600 t.

FLR

Scenario	Catch	Steepness	Recruitment level	Implementation	HCR	$P(SSB>B_{MSY})$	$P(F<F_{MSY})$
1	reported	0.5	Medium	Perfect	TAC	0.04	0.19
2	adjusted	0.5	Medium	Perfect	TAC	0.12	0.36
3	reported	0.75	Medium	Perfect	TAC	0.32	0.45
4	adjusted	0.75	Medium	Perfect	TAC	0.51	0.71
5	reported	0.99	Medium	Perfect	TAC	0.61	0.71
6	adjusted	0.99	Medium	Perfect	TAC	0.91	0.96
7	reported	0.5	High (1990s)	Perfect	TAC	0.02	0.39
8	adjusted	0.5	High (1990s)	Perfect	TAC	0.12	0.52
9	reported	0.75	High (1990s)	Perfect	TAC	0.43	0.65
10	adjusted	0.75	High (1990s)	Perfect	FLR C	0.75	0.87
11	reported	0.99	High (1990s)	Perfect	TAC	0.78	0.89
12	adjusted	0.99	High (1990s)	Perfect	TAC	1.00	1.00
13	reported	0.5	Medium	20% error	TAC	0.04	0.15
14	adjusted	0.5	Medium	20% error	TAC	0.12	0.29
15	reported	0.75	Medium	20% error	TAC	0.28	0.40
16	adjusted	0.75	Medium	20% error	TAC	0.46	0.64
17	reported	0.99	Medium	20% error	TAC	0.53	0.68
18	adjusted	0.99	Medium	20% error	TAC	0.87	0.95
19	reported	0.5	High (1990s)	20% error	TAC	0.02	0.35
20	adjusted	0.5	High (1990s)	20% error	TAC	0.09	0.46
21	reported	0.75	High (1990s)	20% error	TAC	0.37	0.58
22	adjusted	0.75	High (1990s)	20% error	TAC	0.69	0.85
23	reported	0.99	High (1990s)	20% error	TAC	0.71	0.87
24	adjusted	0.99	High (1990s)	20% error	TAC	0.99	1.00

Table Appendix 12.2 Results of the projections run under FLR for 24 scenarios. Results are summarised as the probability of F_{2023} to be lower than F_{MSY} and SSB_{2023} to be greater than SSB_{MSY} and scenario about catch, steepness, recruitment level, implementation and HCR are the same as those in Table 10.1.3

The results of the projections are, however, highly dependent on the state of the stock in 2007 (i.e. the VPA outputs) and future recruitment levels which are unknown. Considering the WG has little confidence in the absolute magnitude of the VPA outputs because of the very poor quality of the catch statistics (see Section 5) and that the possibility of recruitment overfishing in the near future cannot be dismissed because of high *F* exerted on spawners for the last decade, the WG decided to contrast the above projections related to Rec[06.05] with additional management strategies, i.e.:

- $F_{0.1}$ and F_{MAX} strategies (implying short-term yields at about 14,000 t)
- Closure of the Mediterranean Sea in May-June-July together with a size limit (i.e. the recommendation by SCRS in 2006)
- Moratorium over the East Atlantic and Mediterranean Sea during 1, 3 and 5 years followed by an $F_{0.1}$ strategy
-

The results that are summarized in **Figure Appendix 12.2** (below) clearly indicate that all these alternative management strategies modeled (or any combination of them) would have a higher probability of rebuilding the stock by 2023 and a lower probability of stock collapse in the future than Rec[06.05], regardless of the assumed productivity of the stock. The moratorium scenarios and $F_{0.1}$ strategy lead to very close results while the closure of the Mediterranean Sea is quite similar as the F_{MAX} strategy (note that these last two scenarios are slightly less conservative than the first ones). As previously noted, the WG considers it unlikely that the rebuilding objectives of Rec[06-05] can be met without adjustments to the Plan, especially considering the uncertainties due to the lack/quality of data and the uncertainty about future productivity of the stock. The general advice is thus to follow an $F_{0.1}$ (or another adequate F_{MSY} proxy, such as F_{MAX}) strategy to rebuild the stock, because such strategies appear more robust to a wide range of uncertainty about current status and future productivity. The WG further believes that a time area closure could greatly facilitate the implementation and the monitoring of such a rebuilding strategy.

Fig. 10.2.a. Runs 1,37, reported, steepness =0.5, recruit=medium, implem.= perf.

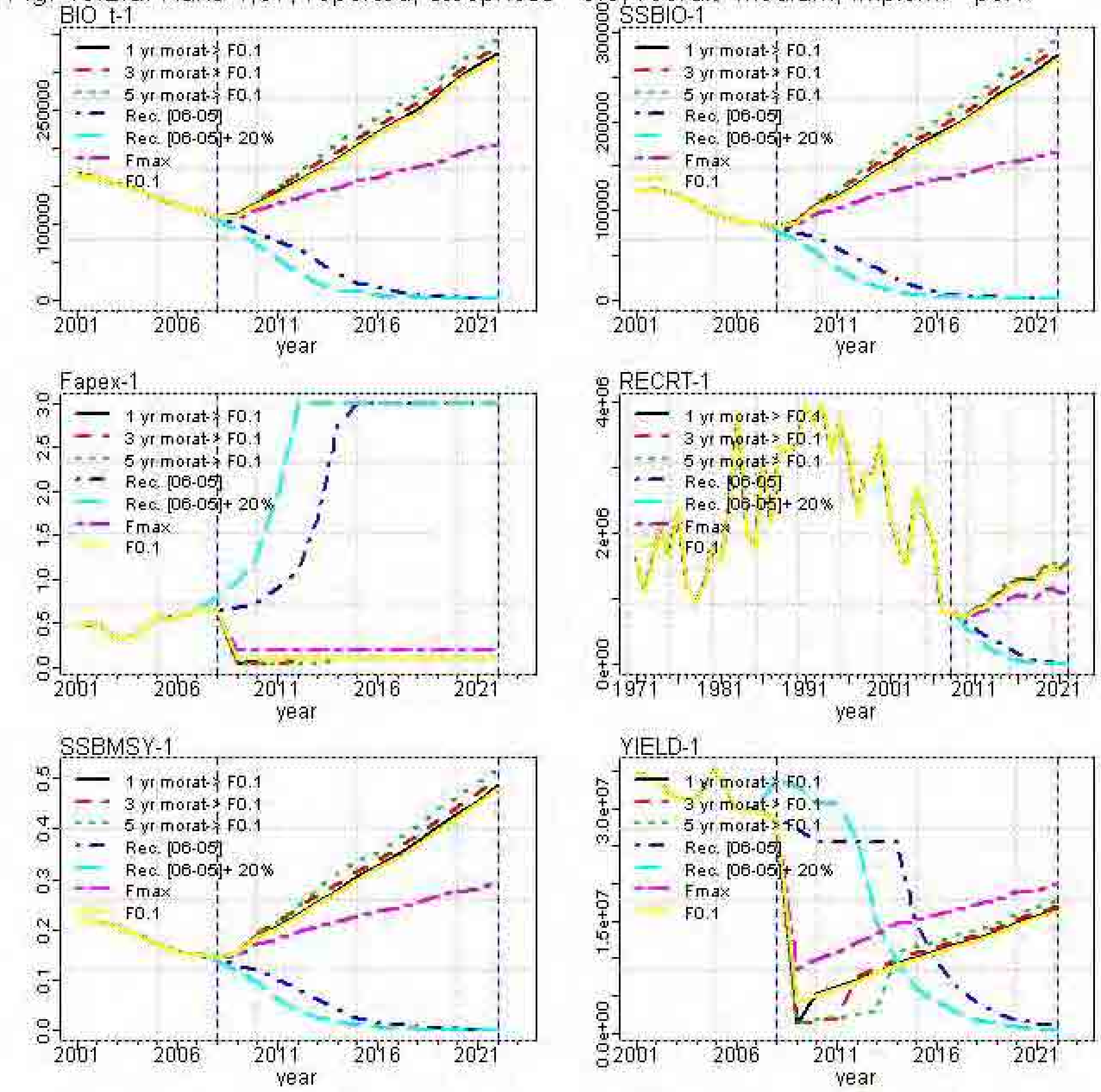


Fig. 10.2.b. Runs 2,38, adjusted, steepness =0.5, recruit=medium, implem = perf.

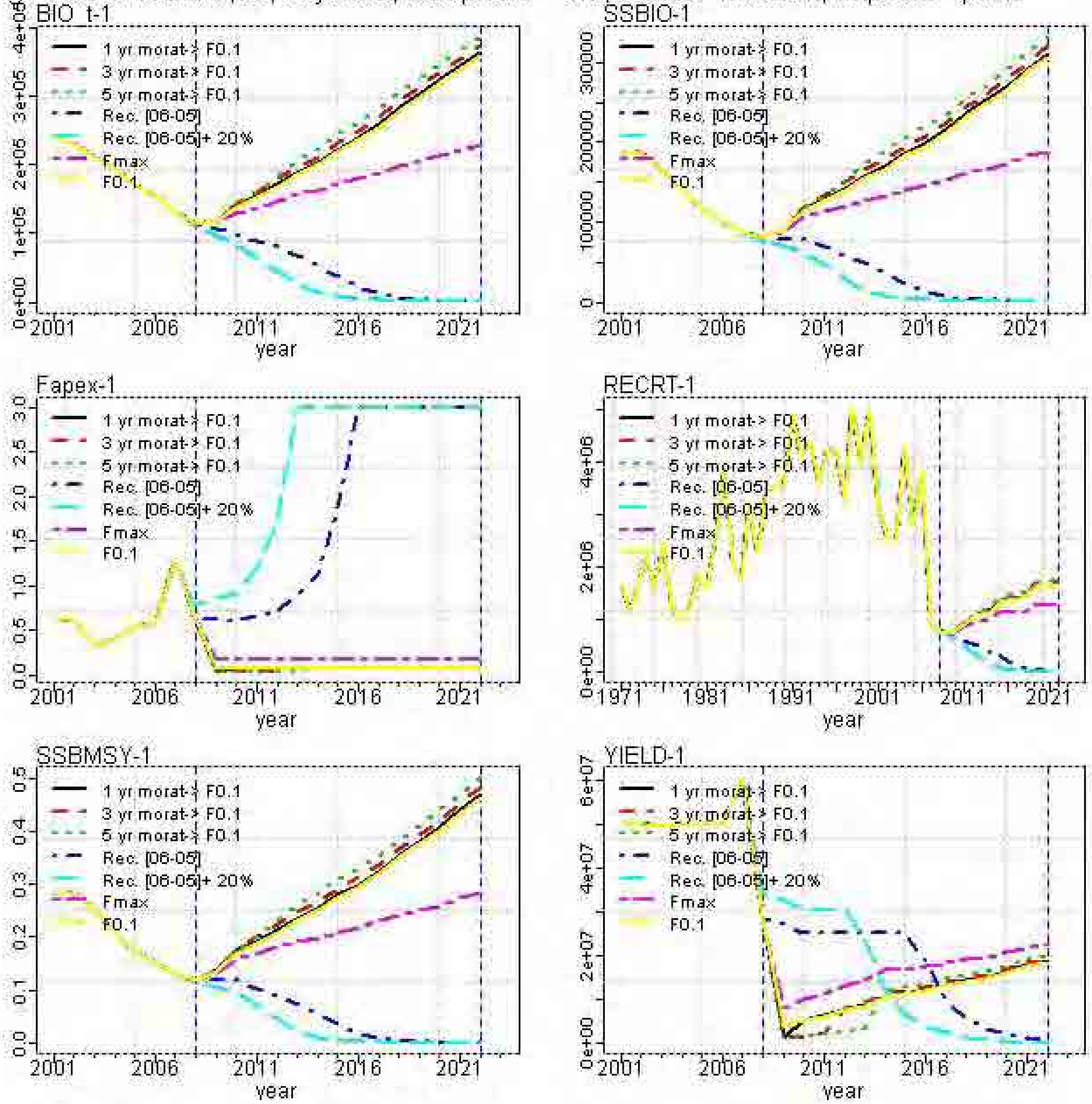


Fig. 10.2.c. Runs 3,39, reported, steepness =0.75, recruit=medium, implem.= perf.

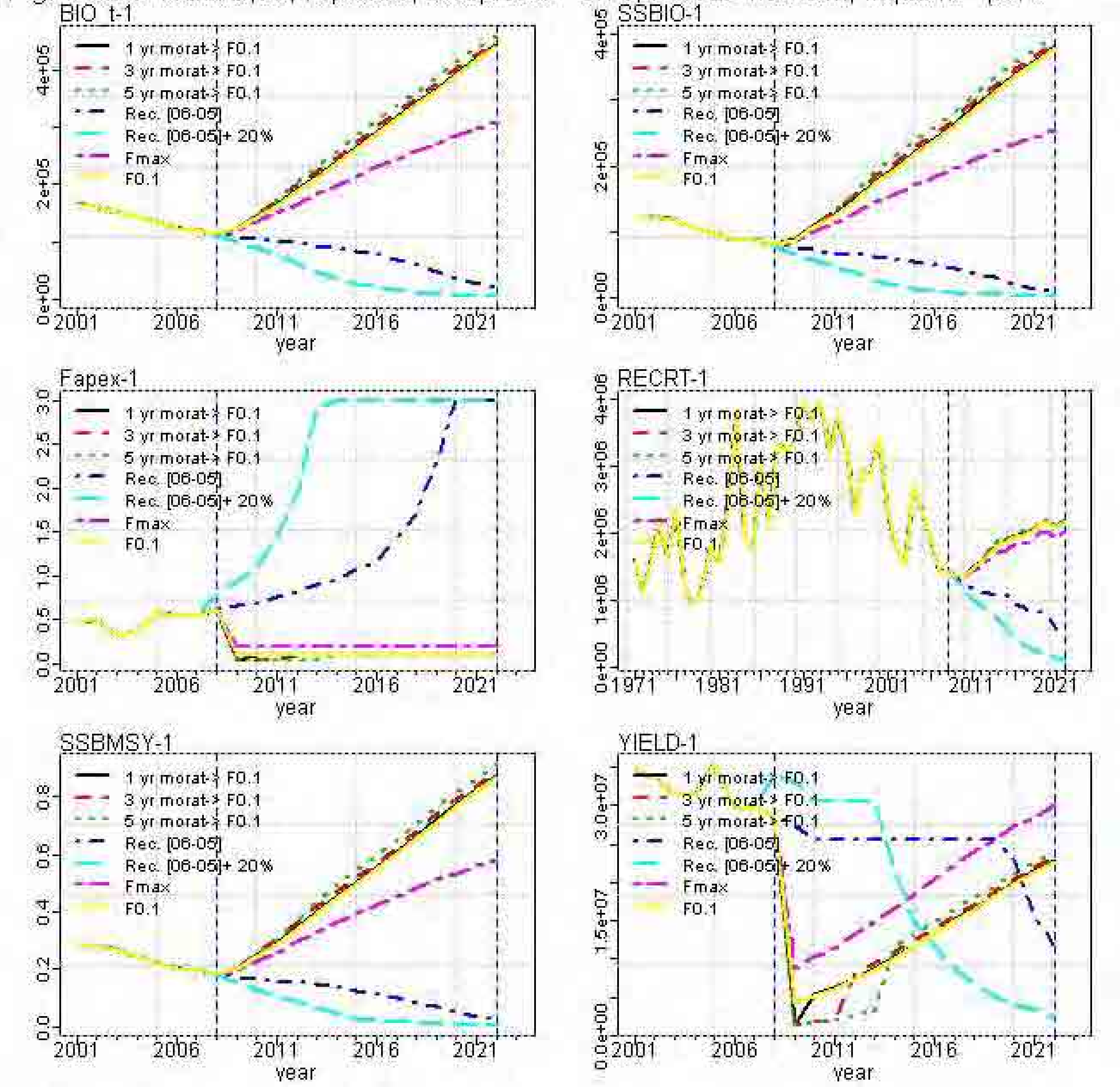


Fig. 10.2.d. Runs 4,40, adjusted, steepness =0.75, recruit=medium, implem.= perf.

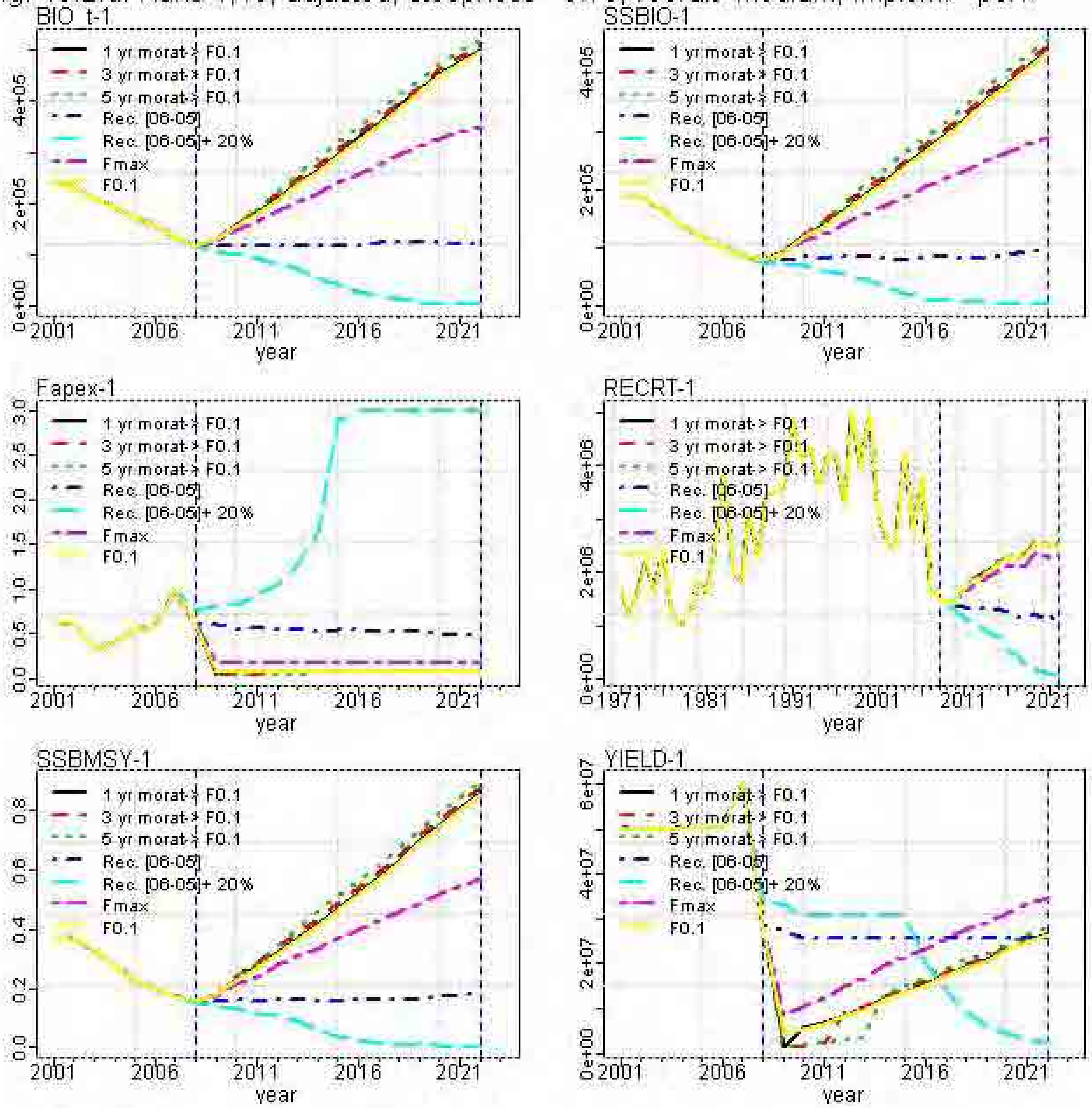


Fig. 10.2.e. Runs 5,41, reported, steepness =0.99, recruit=medium, implem.= perf.

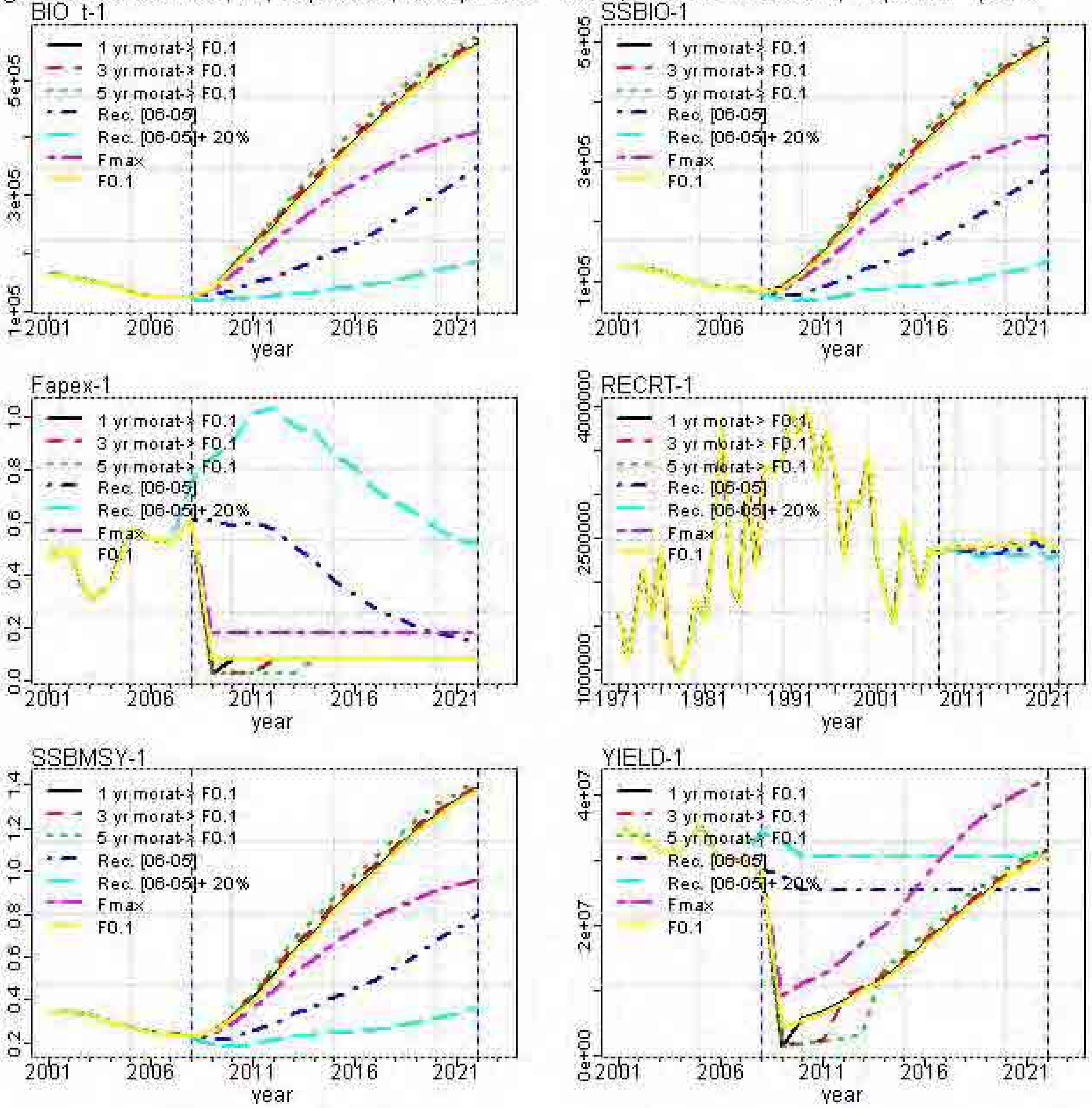


Fig. 10.2.f. Runs 6,42, adjusted, steepness =0.99, recruit=medium, implem.= perf.

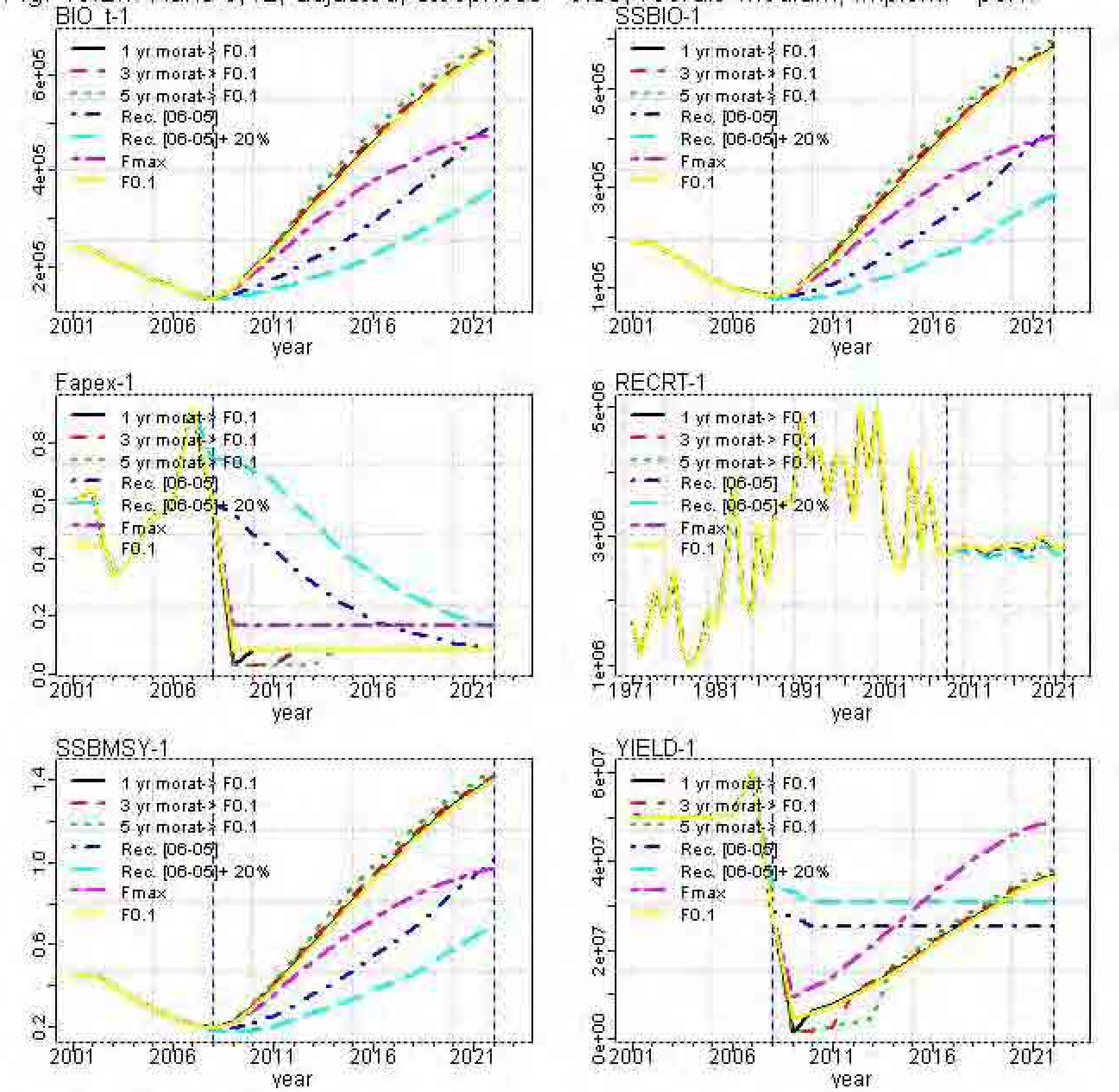


Fig. 10.2.g. Runs 7,43, reported, steepness =0.5, recruit=hi, implem.= perf.

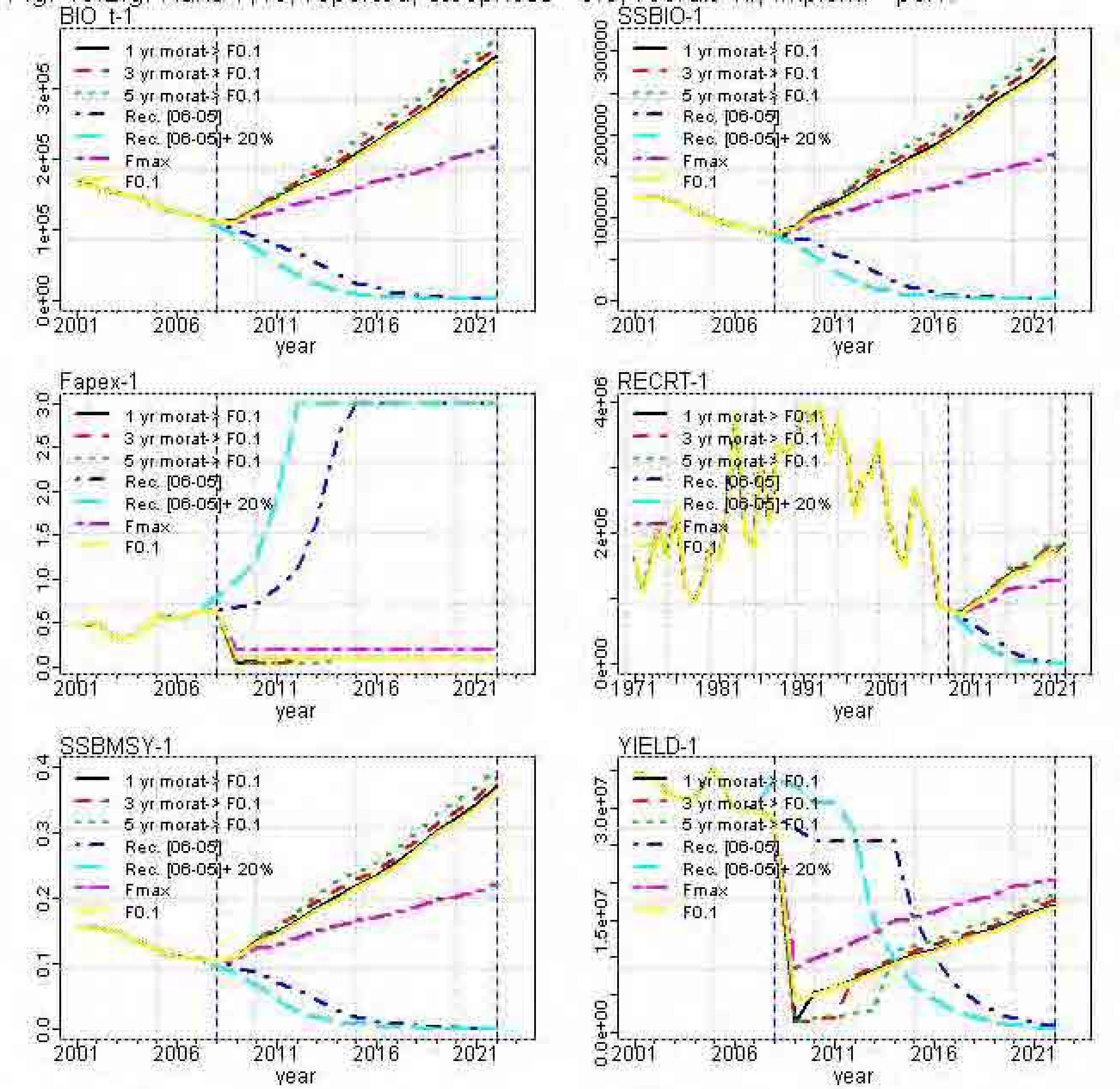
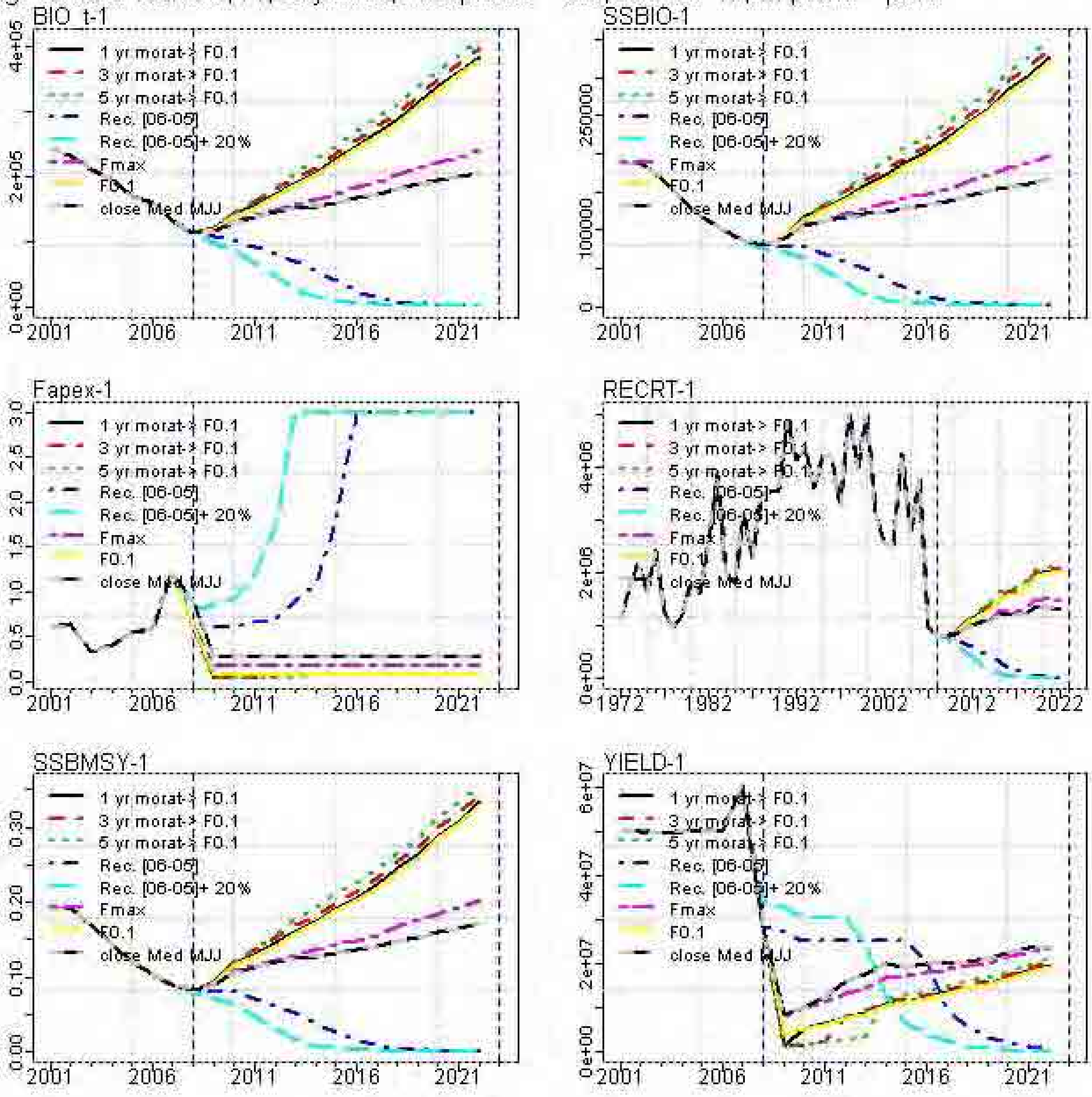


Fig. 10.2.h. Runs 8,44, adjusted, steepness =0.5, recruit=hi, implem.= perf.



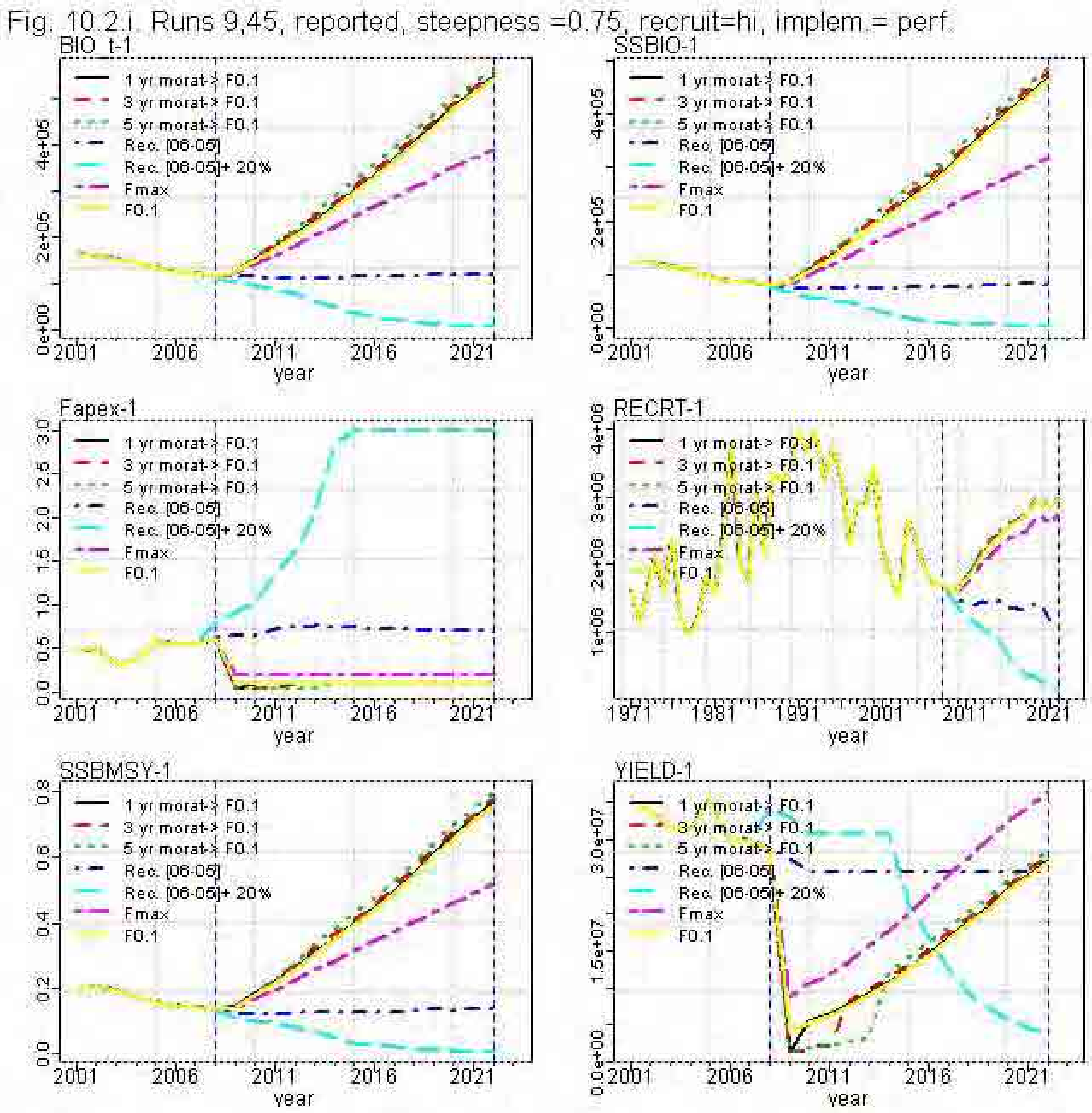


Fig. 10.2.i. Runs 9,45, reported, steepness =0.75, recruit=hi, implem.= perf.
BIO_t-1
SSBIO-1
Fapex-1
RECRT-1
SSBMSY-1
YIELD-1
1 yr morat-> F0.1
3 yr morat-> F0.1
5 yr morat-> F0.1
Rec. [06-05]
Rec. [06-05]+ 20%
Fmax
F0.1
year

Fig. 10.2.j. Runs 10,46, adjusted, steepness =0.75, recruit=hi, implem = perf

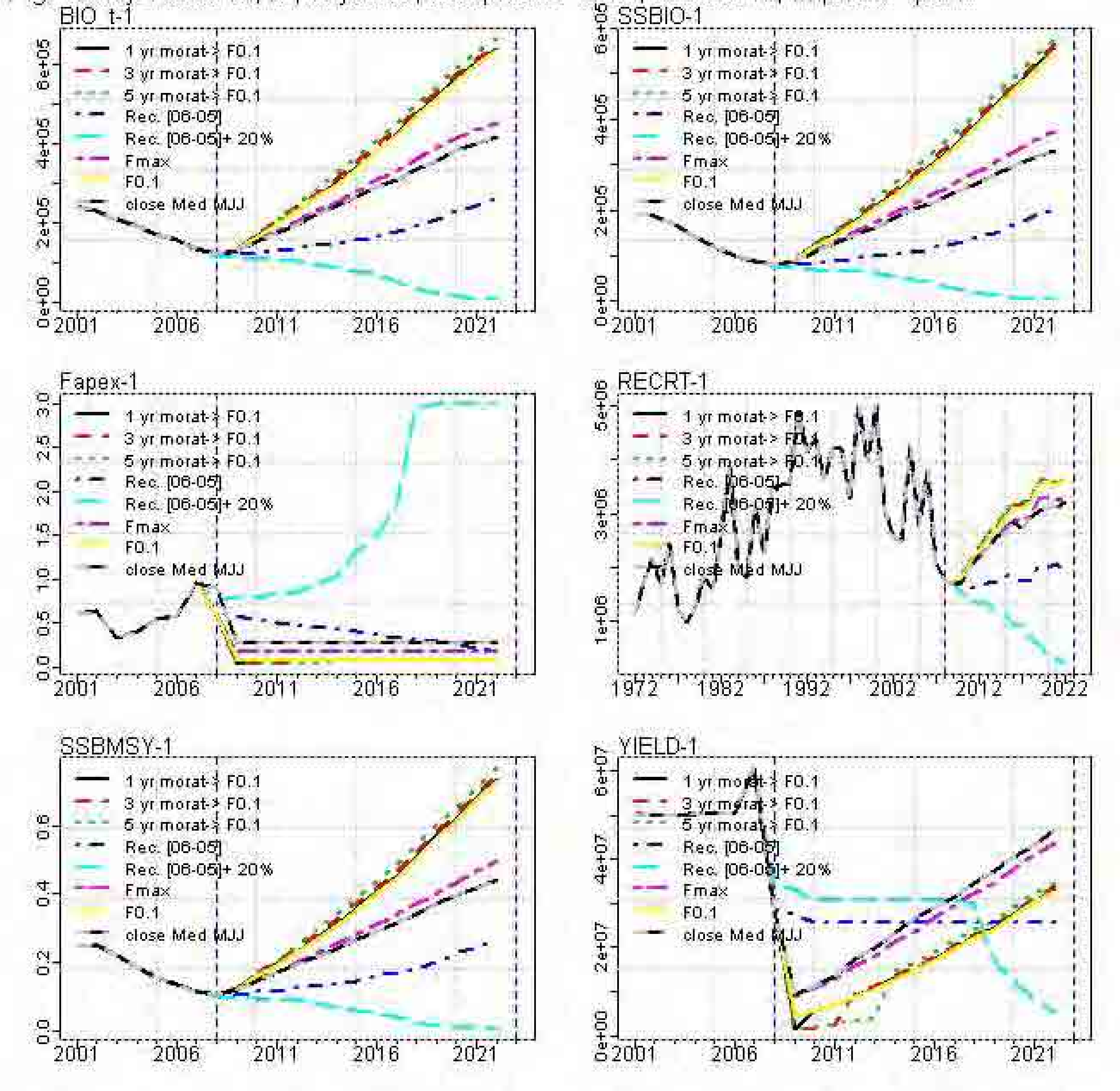


Fig. 10.2.k. Runs 11,47, reported, steepness =0.99, recruit=hi, implem.= perf.

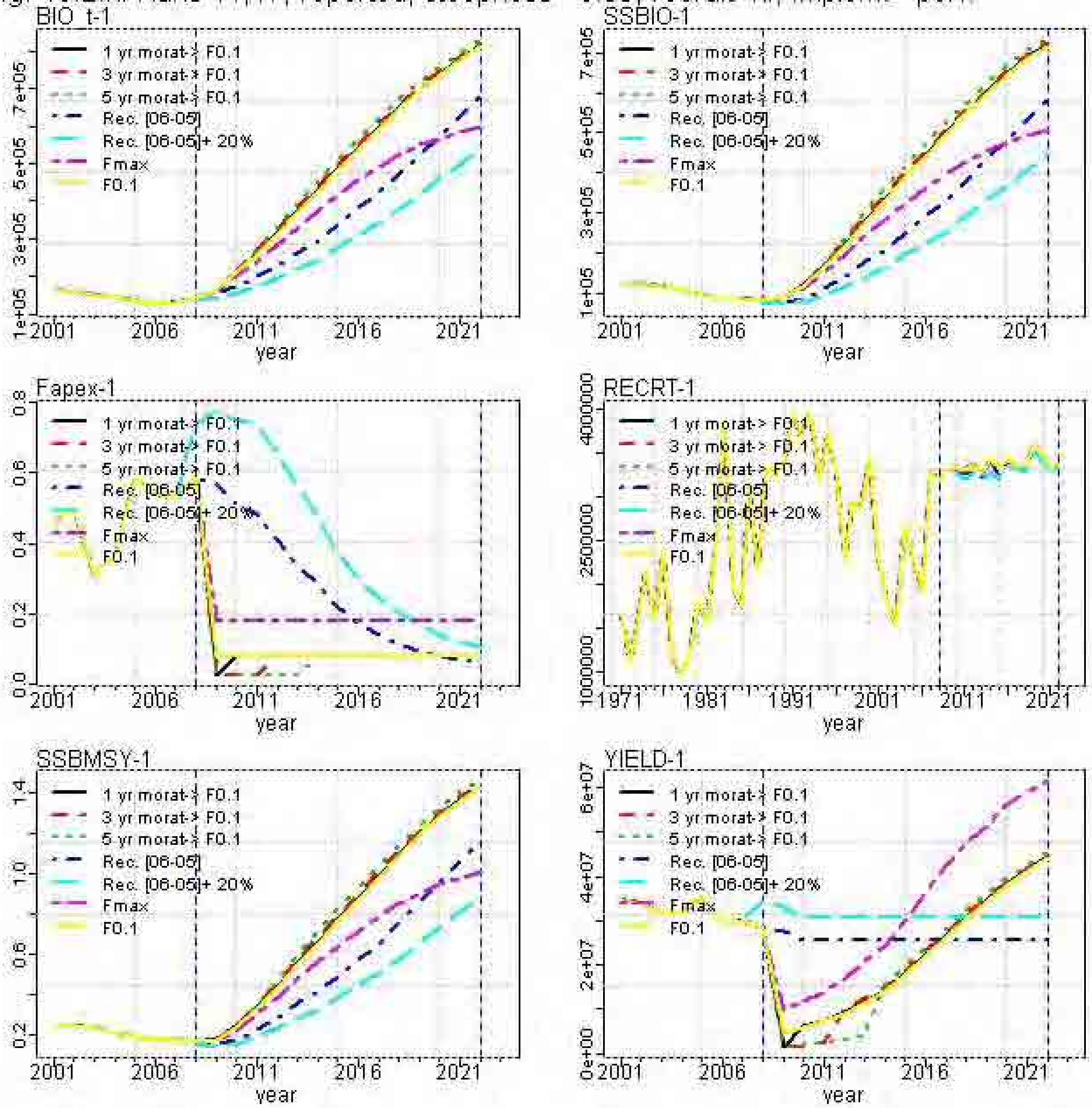


Fig. 10.2.l. Runs 12,48, adjusted, steepness =0.99, recruit=hi, implem = perf

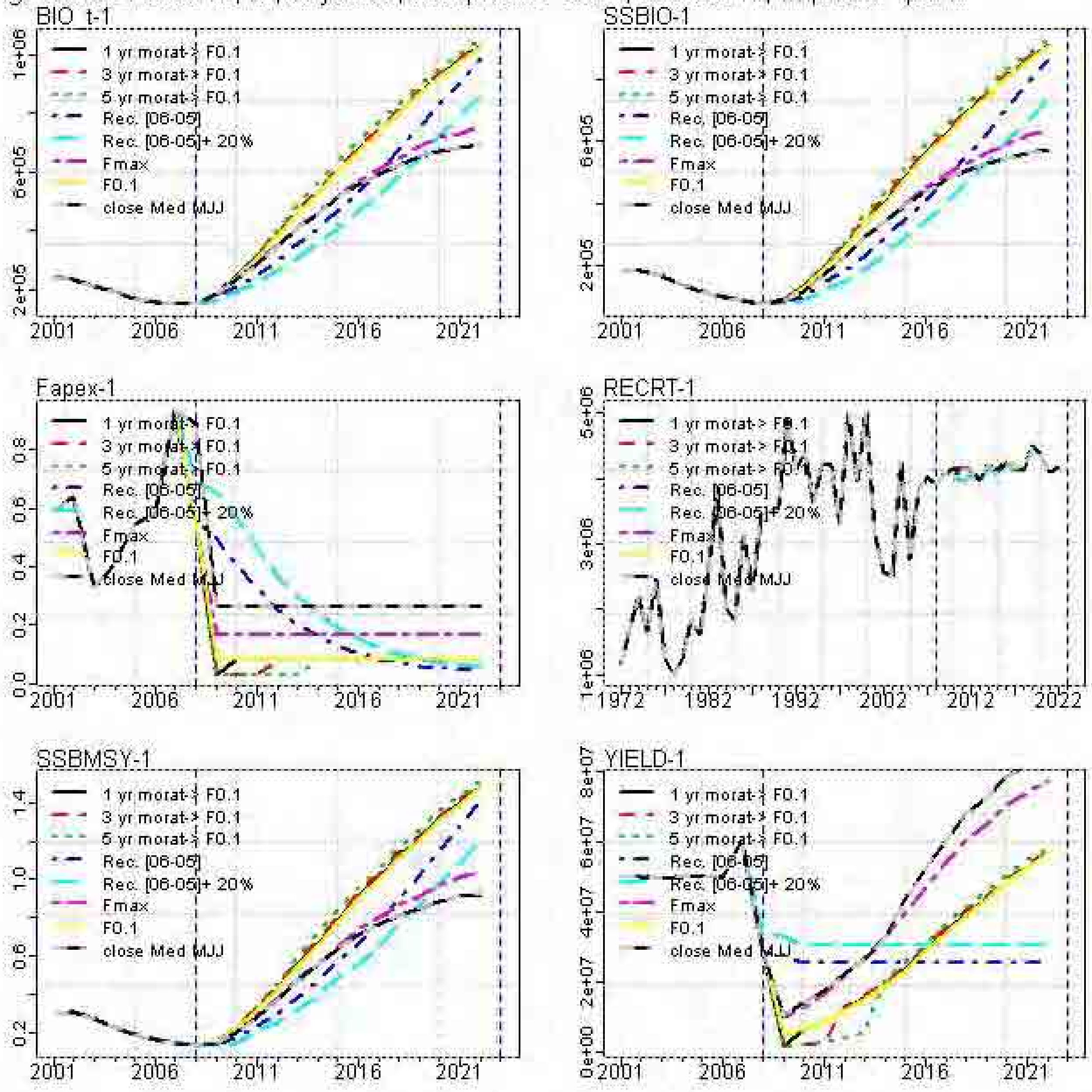


Fig. 10.2.m. Runs 13,49, reported, steepness =0.5, recruit=medium, implem.= 20% err.

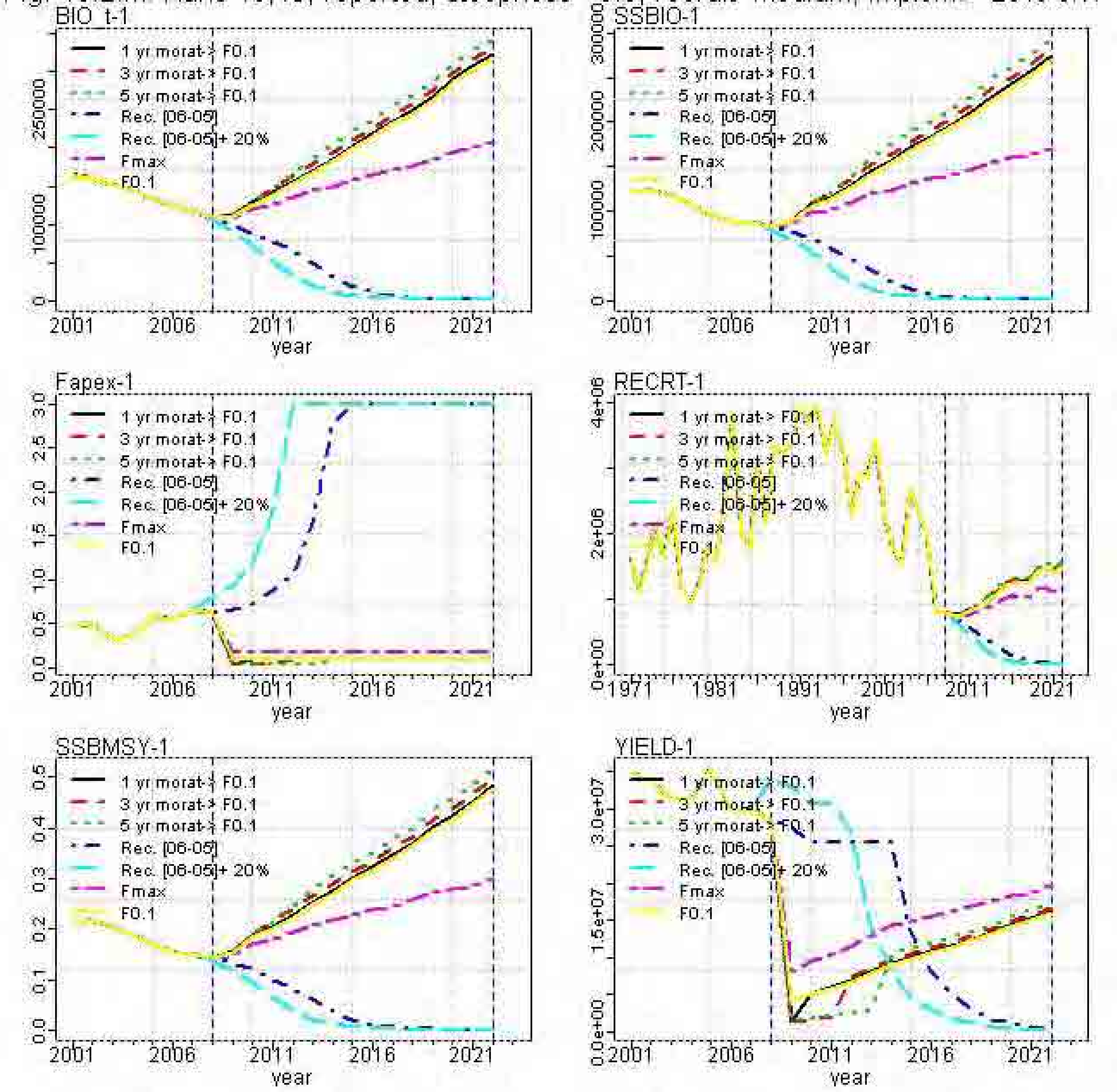


Fig. 10.2.n. Runs 14,50, adjusted, steepness =0.5, recruit=medium, implem.= 20% err.

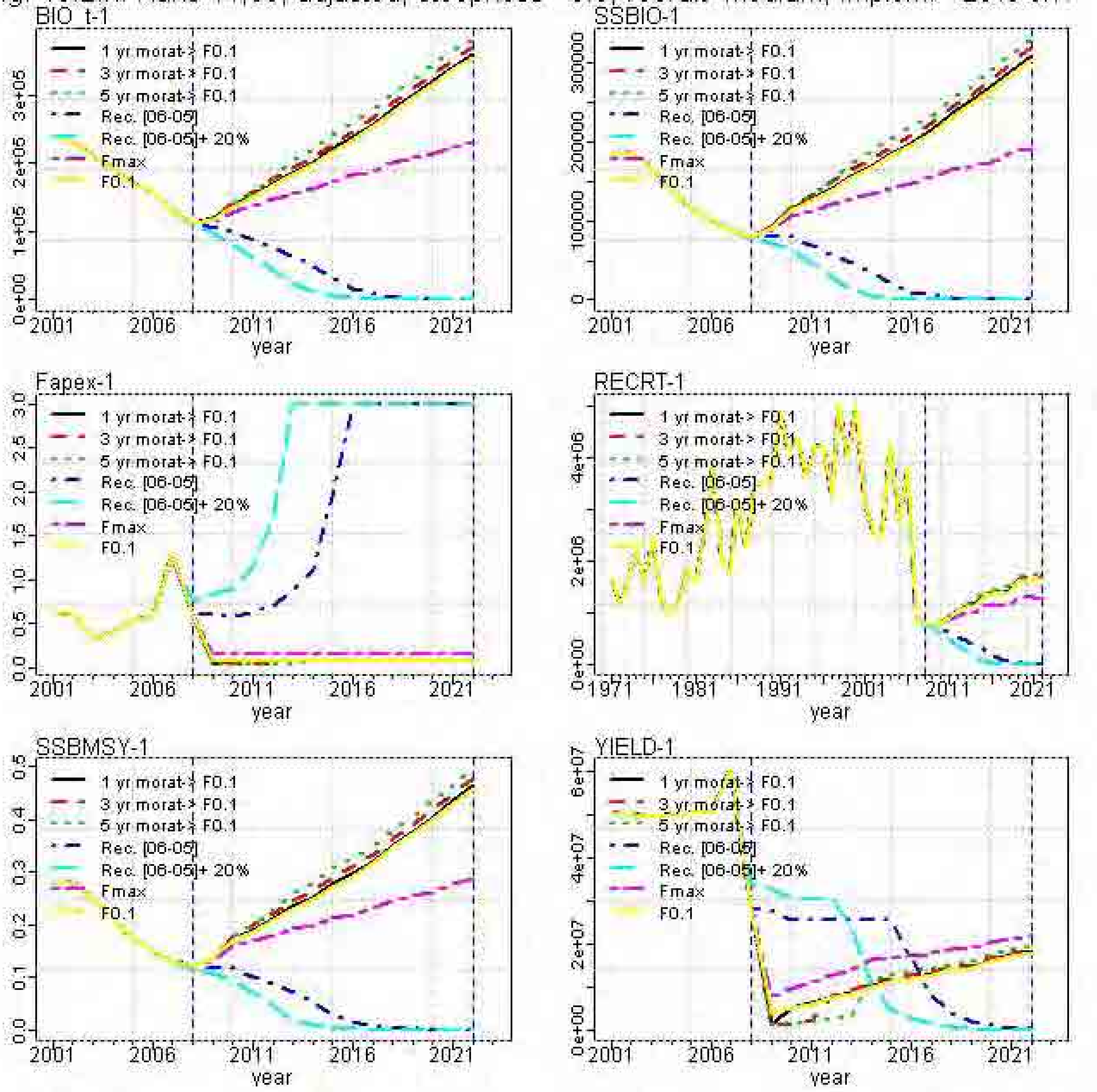


Fig. 10.2.o. Runs 15,51, reported, steepness =0.75, recruit=medium, implem.= 20% err

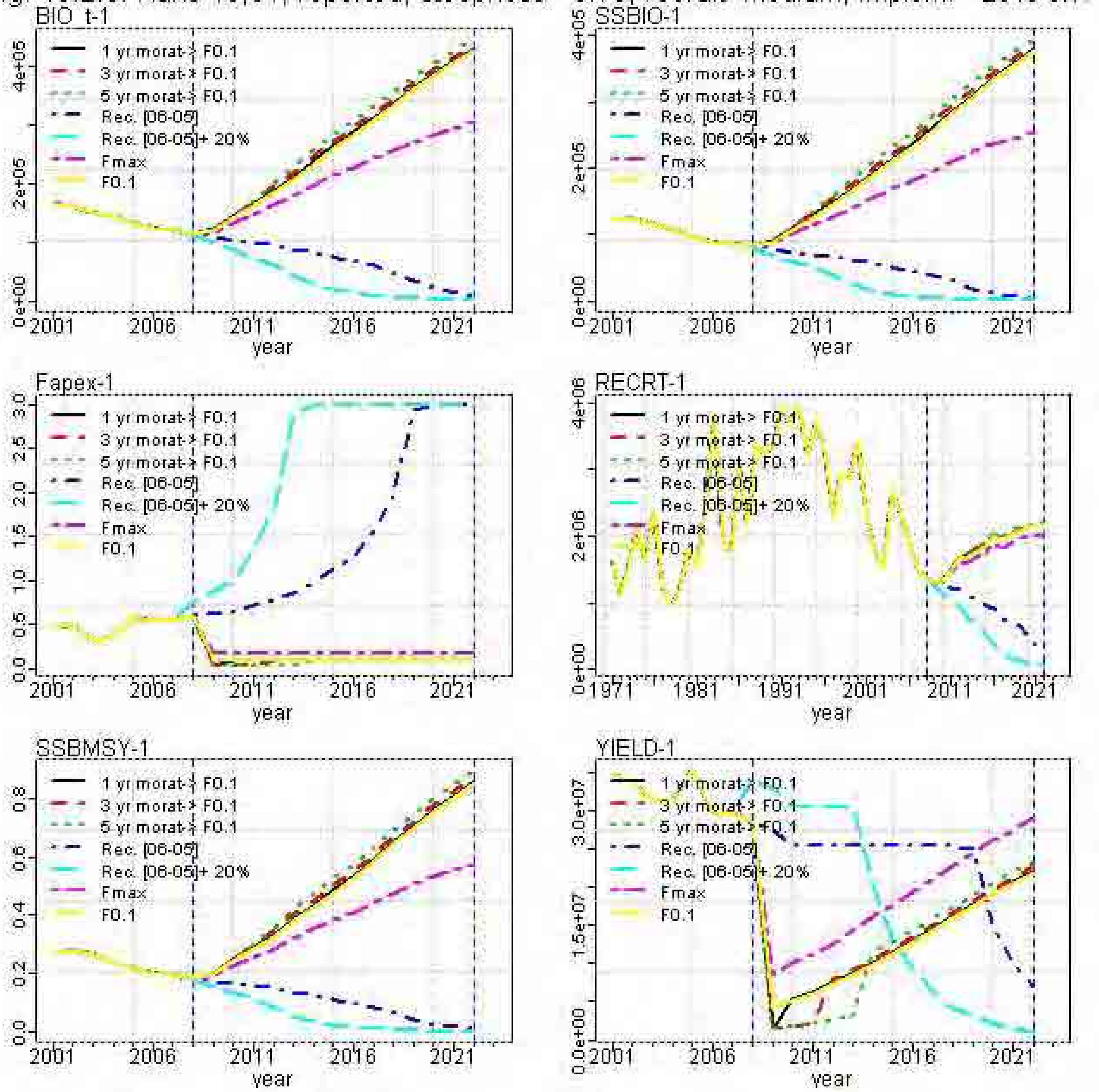


Fig. 10.2.p. Runs 16,52, adjusted, steepness =0.75, recruit=medium, implem.= 20% err.

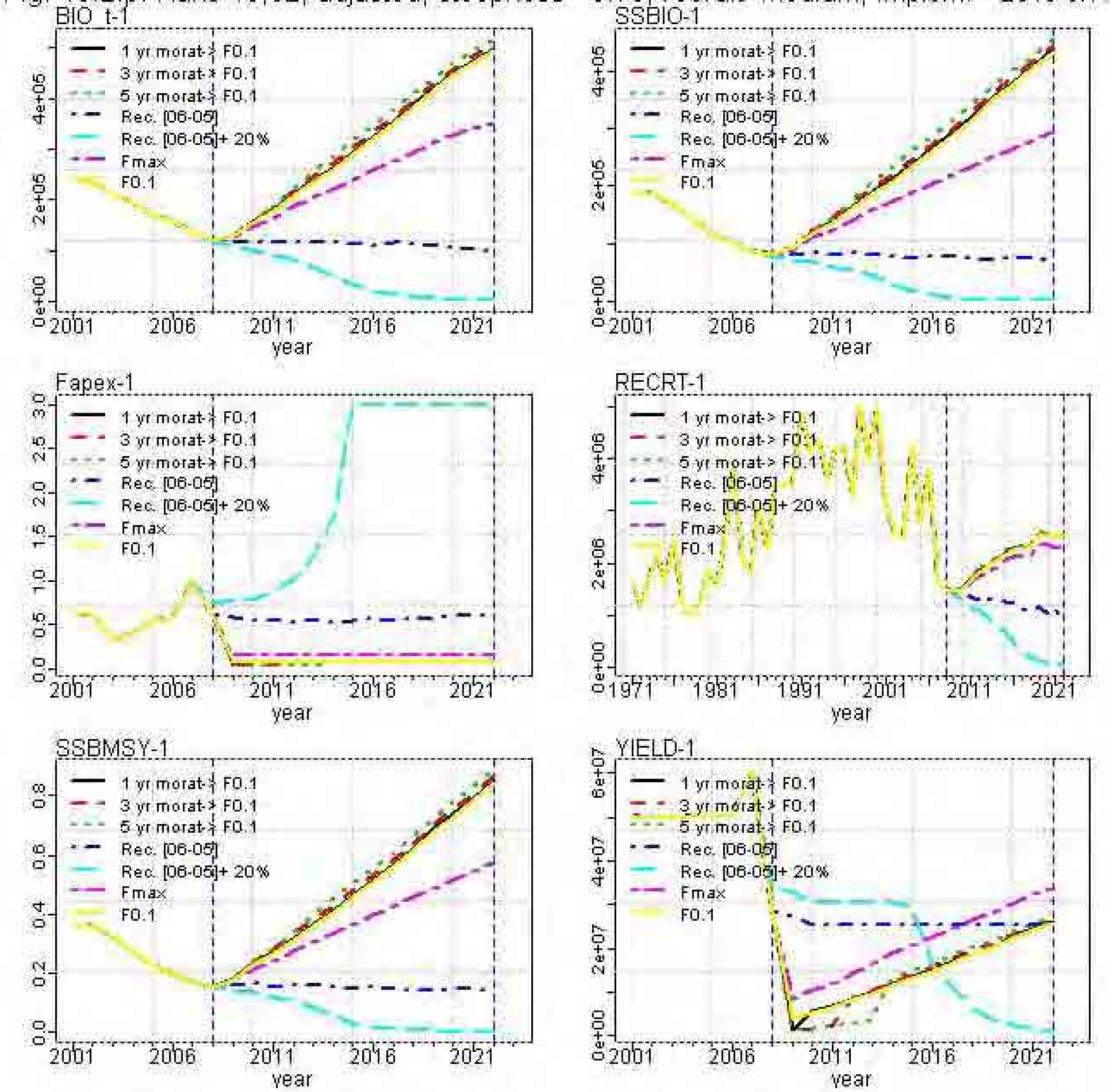


Fig. 10.2.q. Runs 17,53, reported, steepness =0.99, recruit=medium, implem.= 20% err

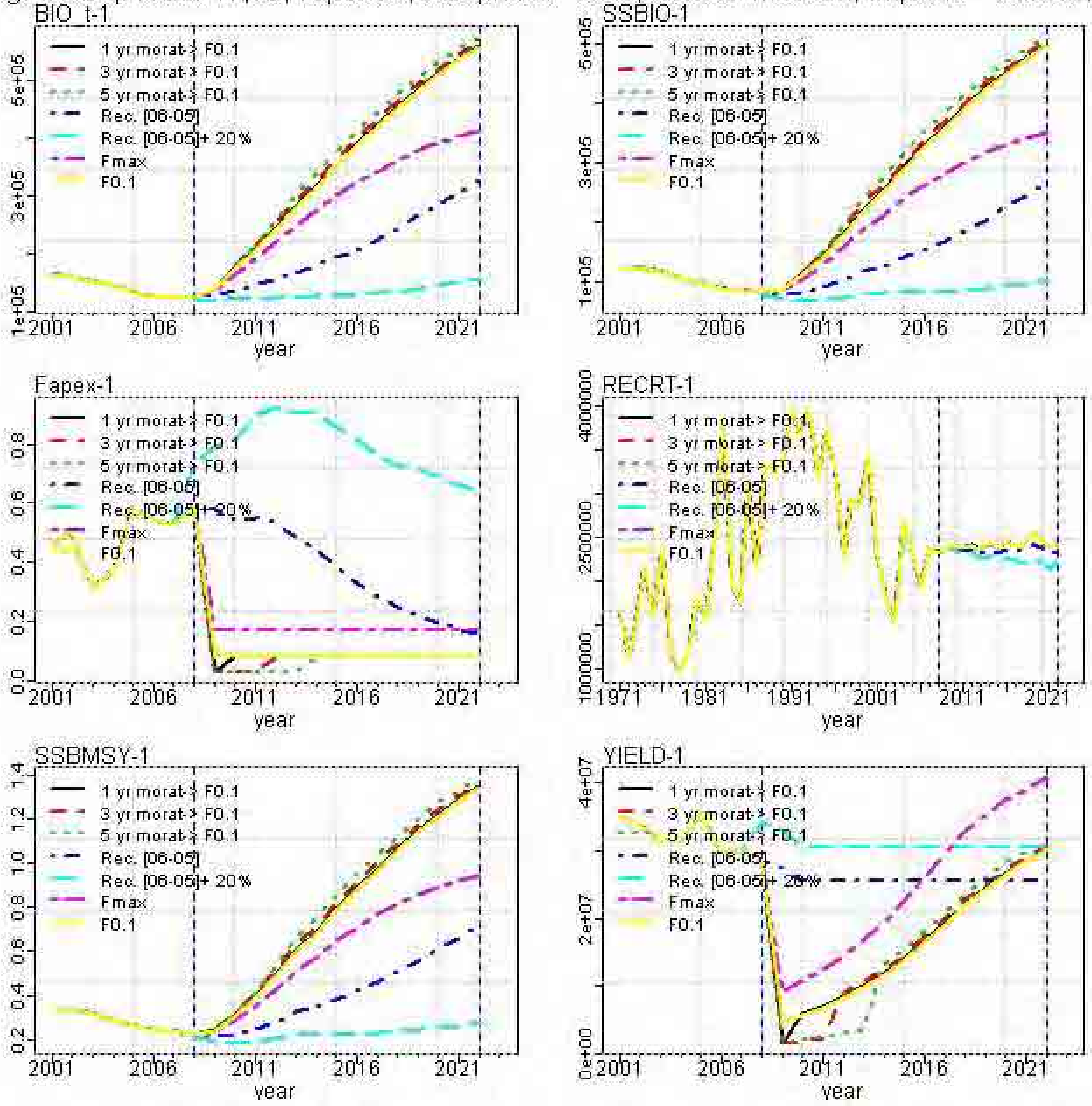


Fig. 10.2.r. Runs 18,54, adjusted, steepness =0.99, recruit=medium, implem = 20% err.

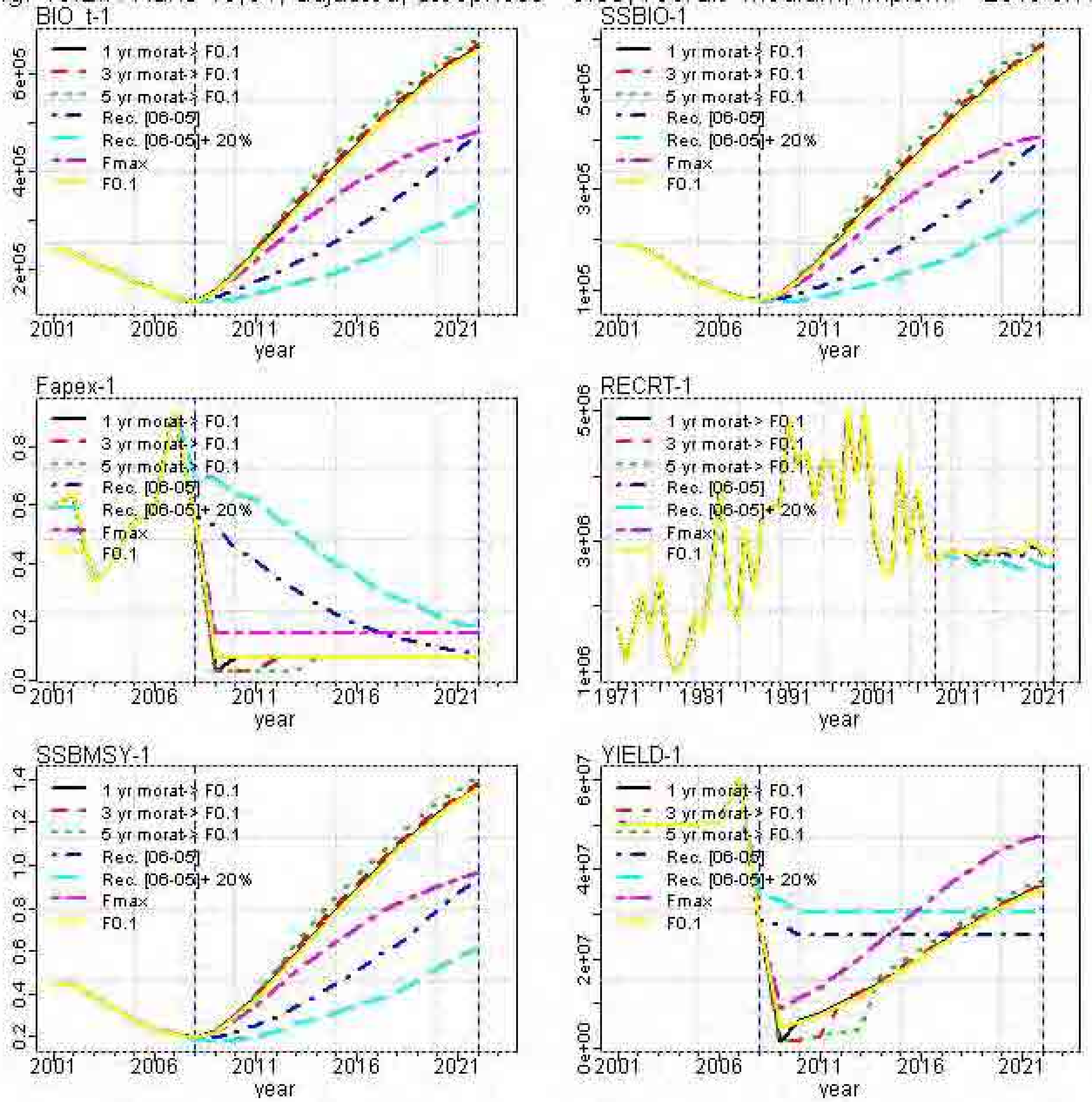


Fig. 10.2.s. Runs 19,55, reported, steepness =0.5, recruit=hi, implem.= 20% err

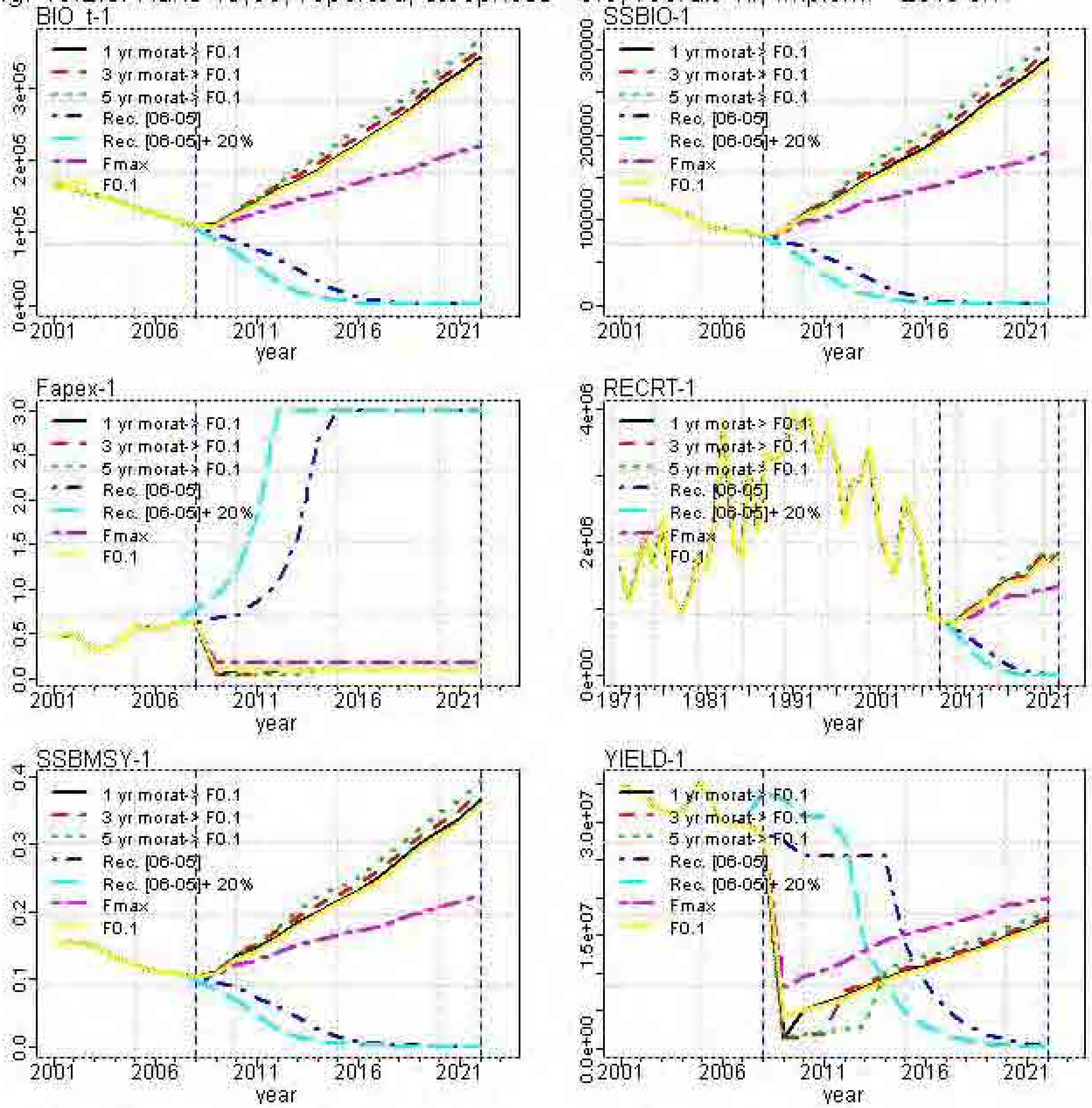


Fig. 10.2.t. Runs 20,56, adjusted, steepness =0.5, recruit=hi, implem.= 20% err.

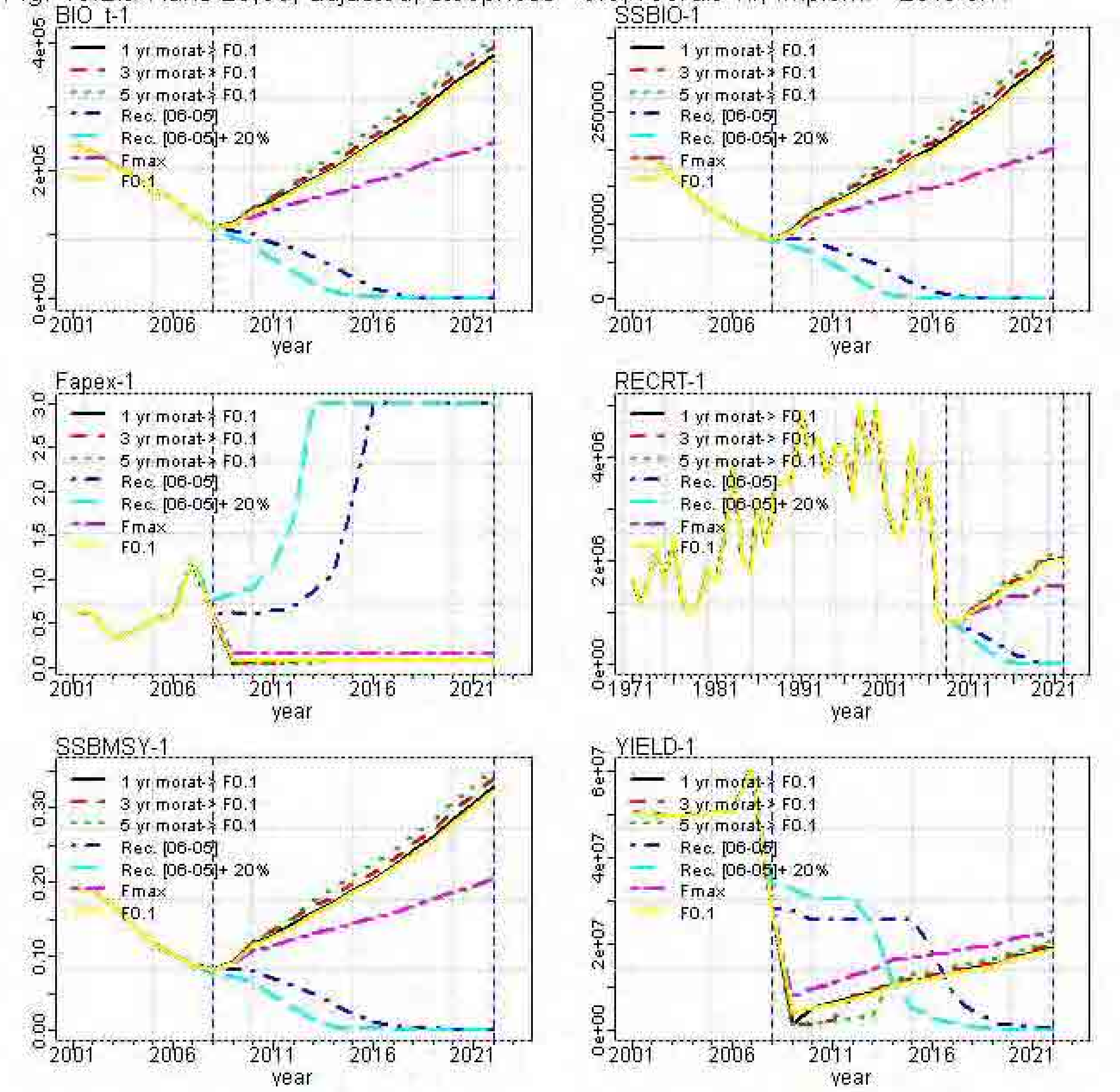


Fig. 10.2.u. Runs 21,57, reported, steepness =0.75, recruit=hi, implem = 20% err

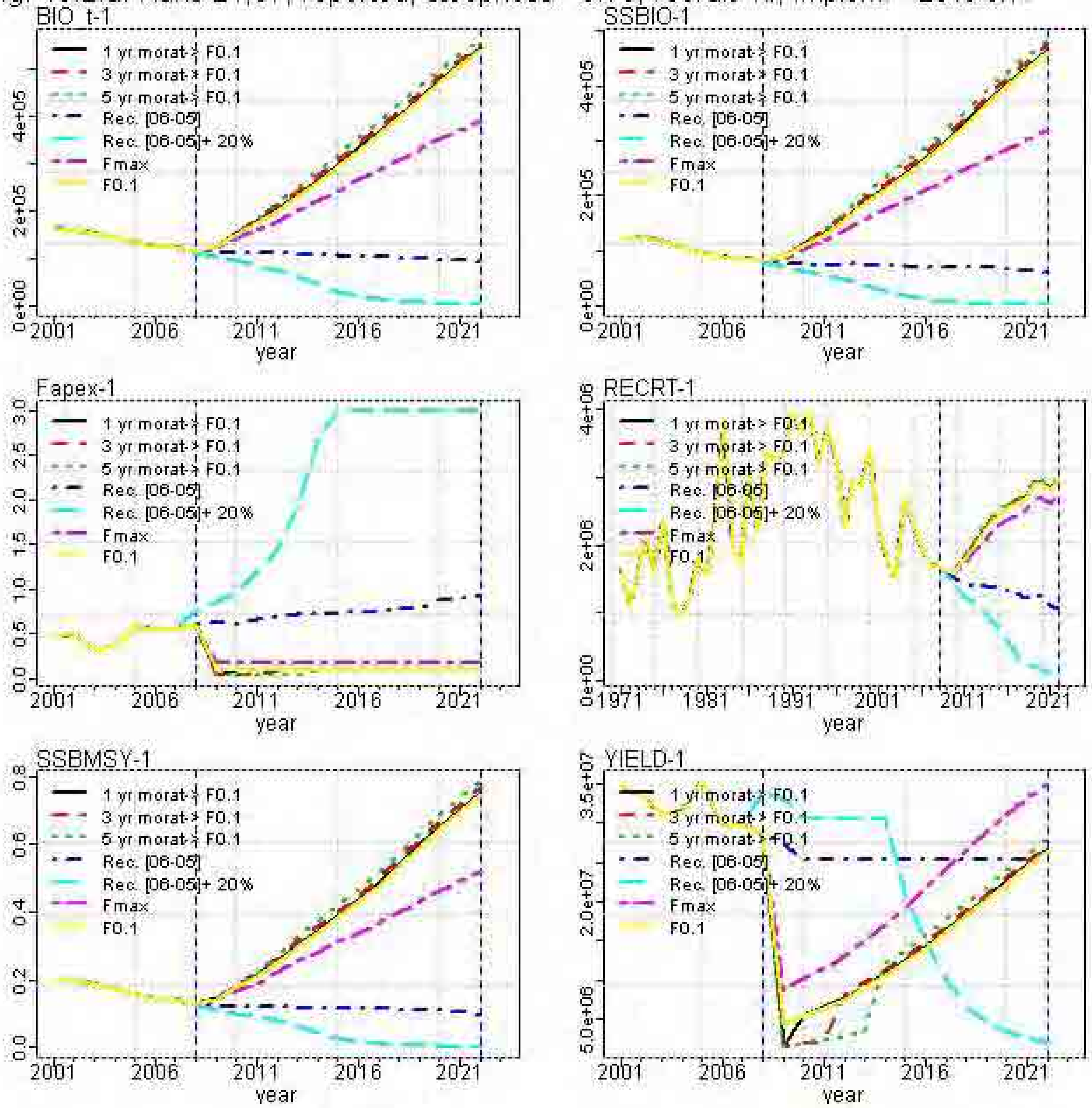


Fig. 10.2.v. Runs 22,58, adjusted, steepness =0.75, recruit=hi, implem.= 20% err.

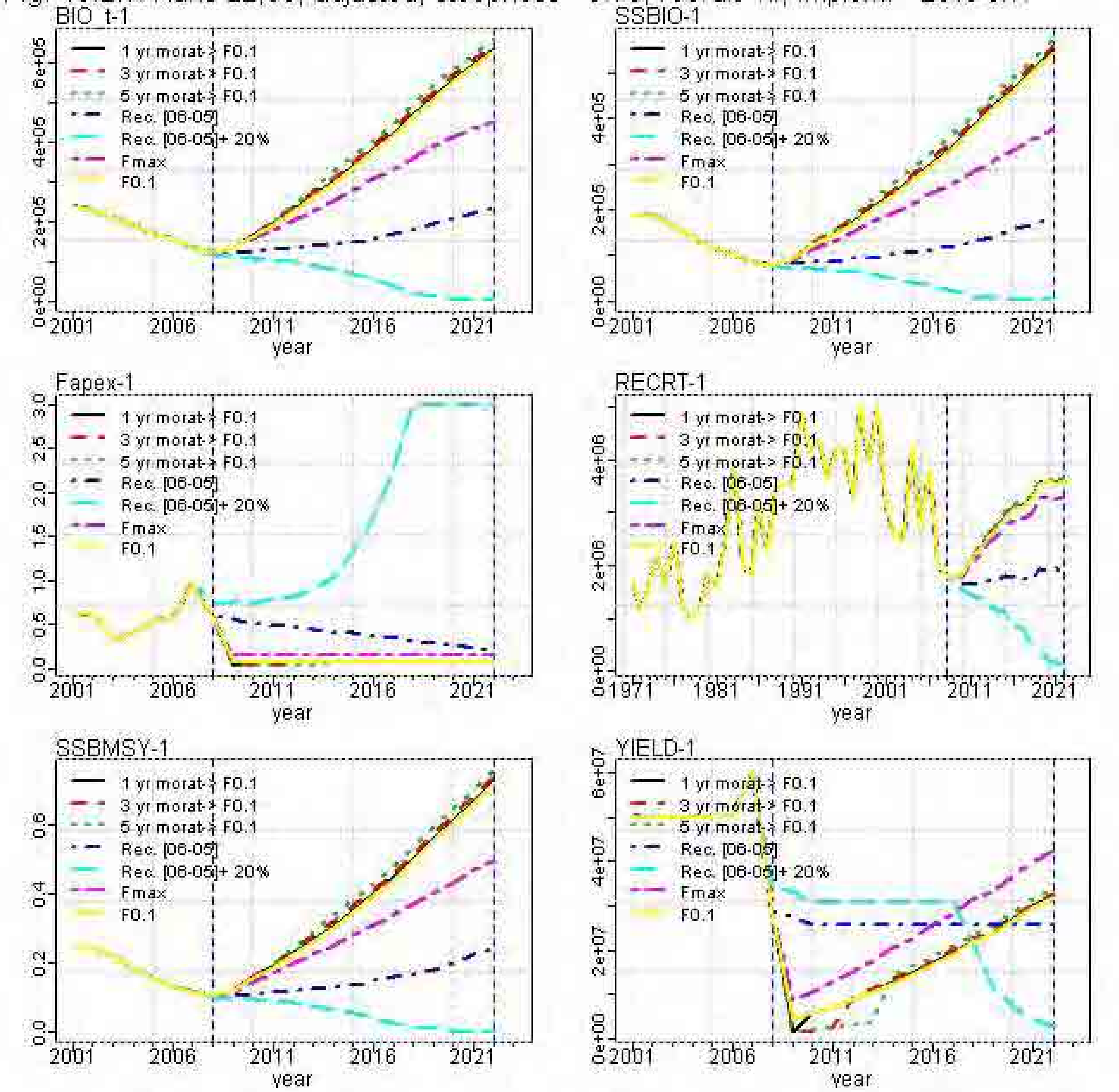
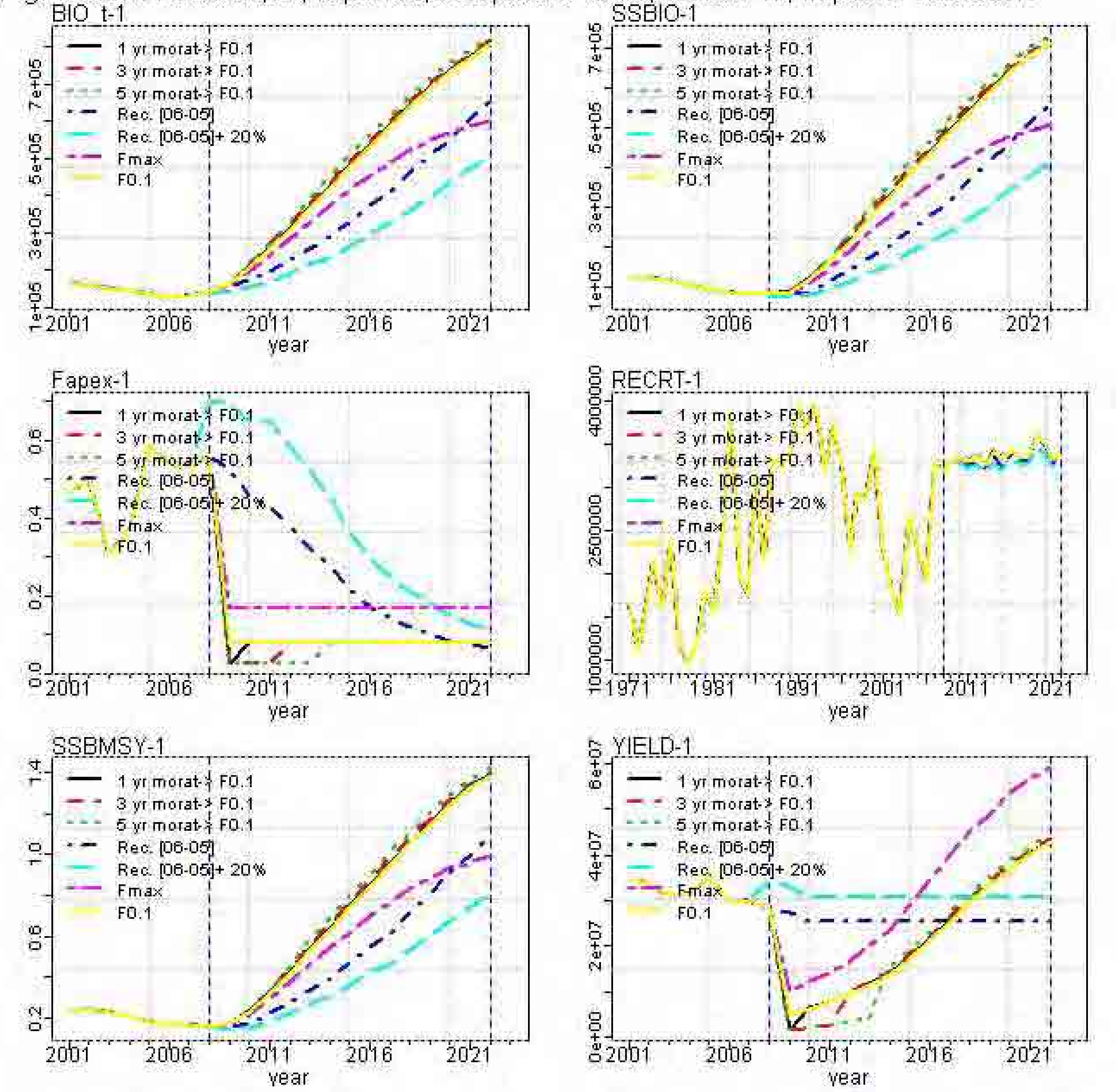


Fig. 10.2.w. Runs 23,59, reported, steepness =0.99, recruit=hi, implem.= 20% err.



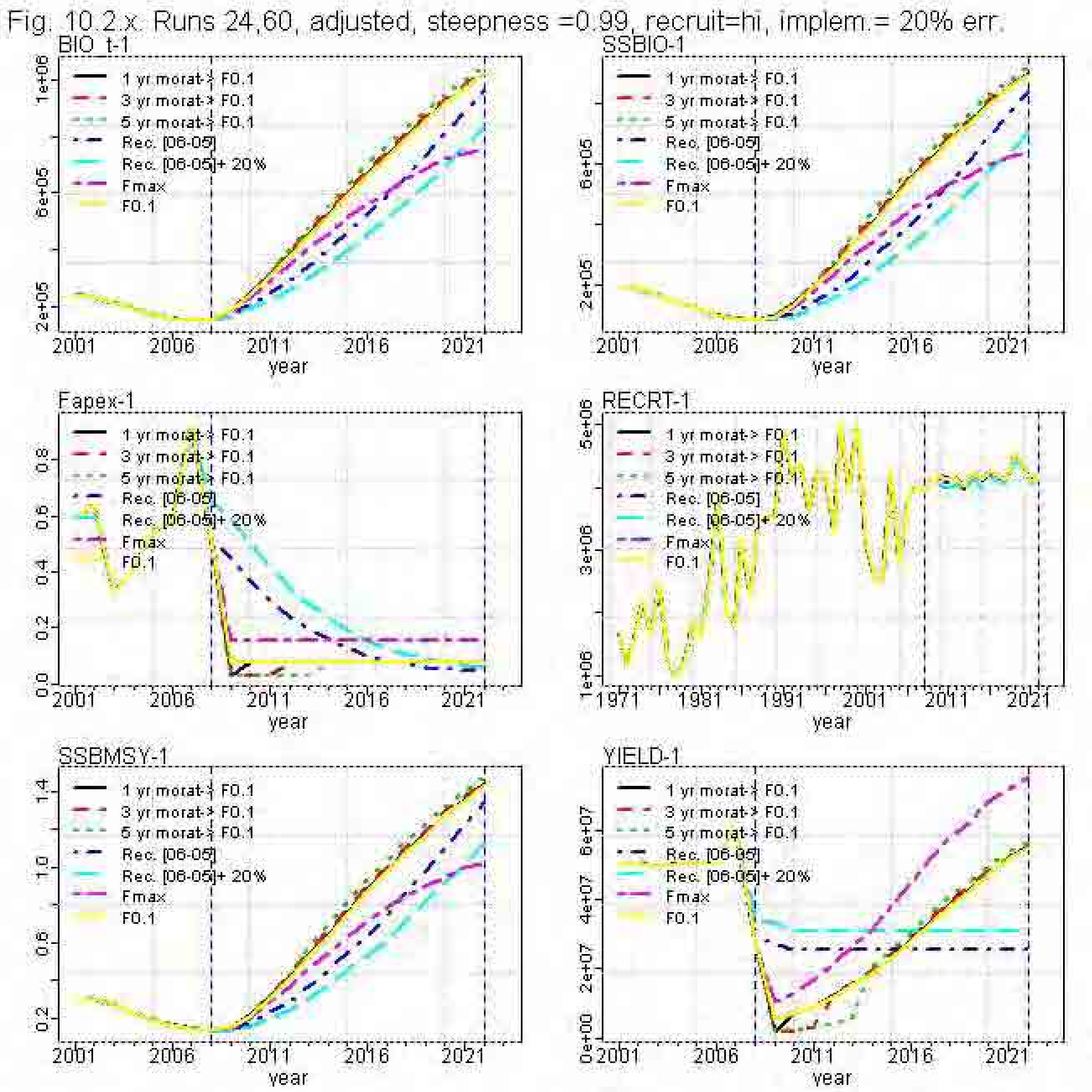


Fig. 10.2.x. Runs 24,60, adjusted, steepness =0.99, recruit=hi, implem.= 20% err.
BIO_t-1
SSBIO-1
Fapex-1
RECRT-1
SSBMSY-1
YIELD-1
1 yr morat-> F0.1
3 yr morat-> F0.1
5 yr morat-> F0.1
Rec. [06-05]
Rec. [06-05]+ 20%
Fmax
F0.1
year

Fig. 10.2.y. Runs 25,61, reported, steepness =0.5, recruit=low, implem.= perf.

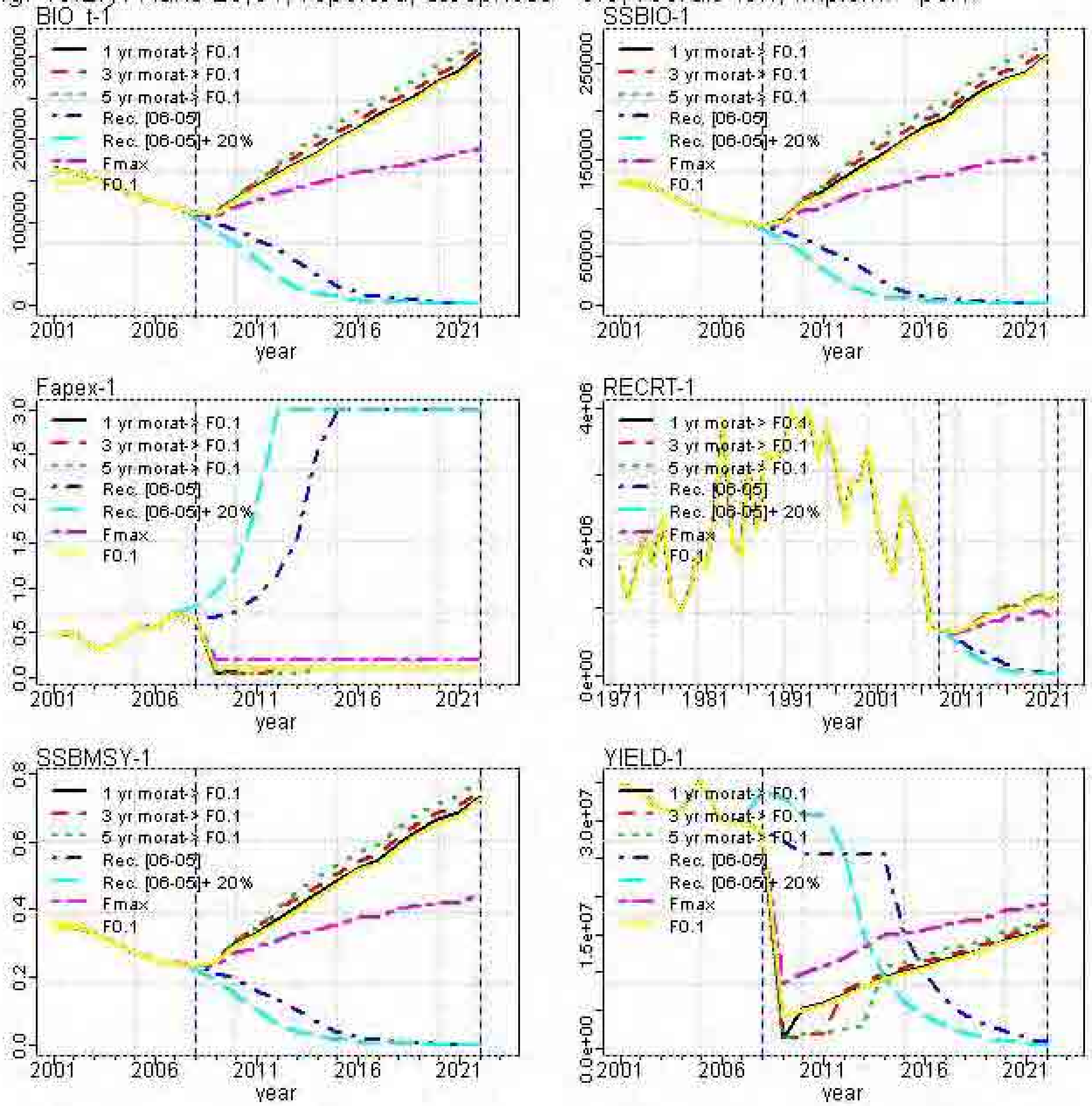


Fig. 10.2.z. Runs 26,62, adjusted, steepness =0.5, recruit=low, implem.= perf.

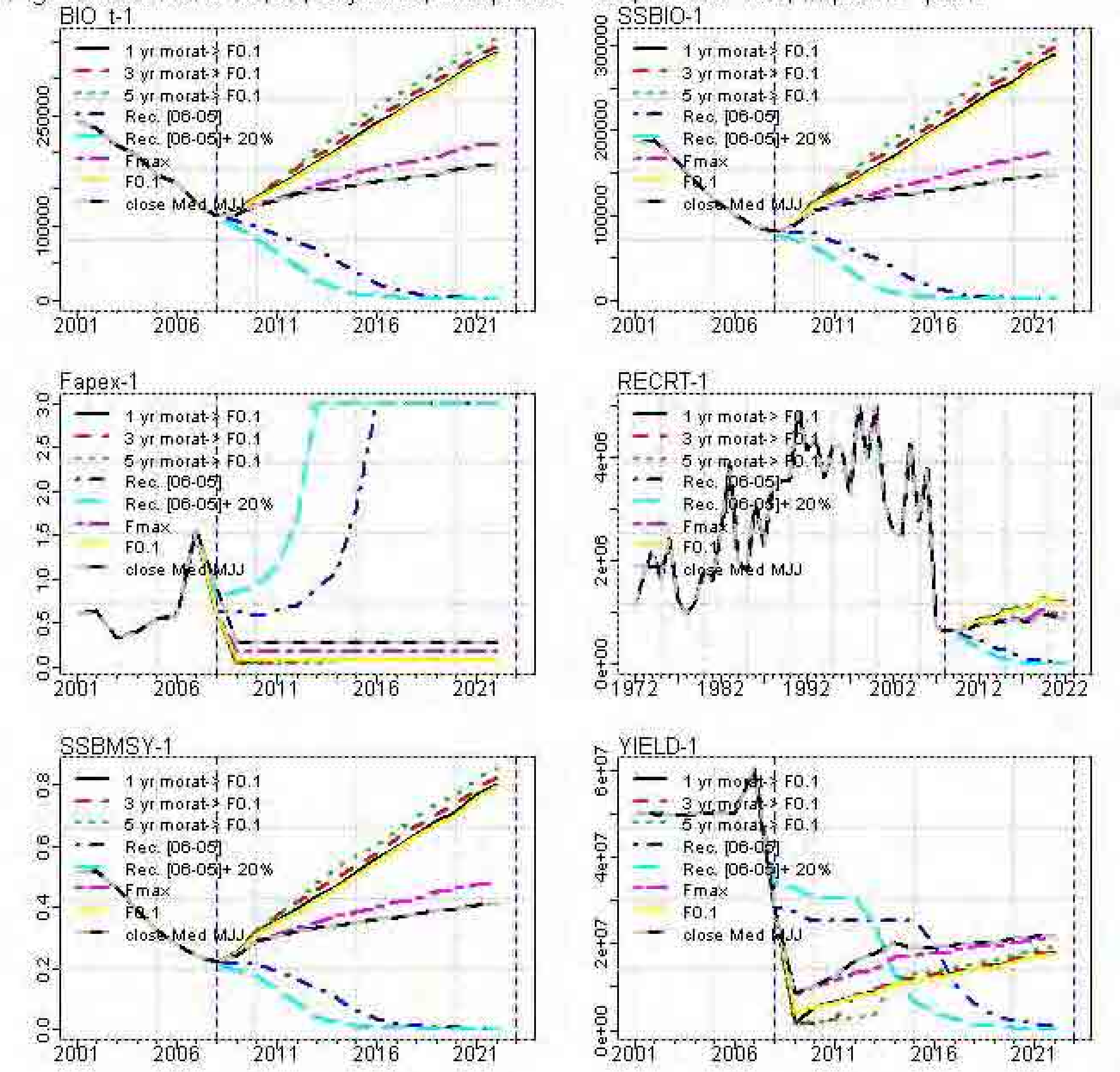


Fig. 10.2.aa. Runs 27,63, reported, steepness =0.75, recruit=low, implem.= perf.

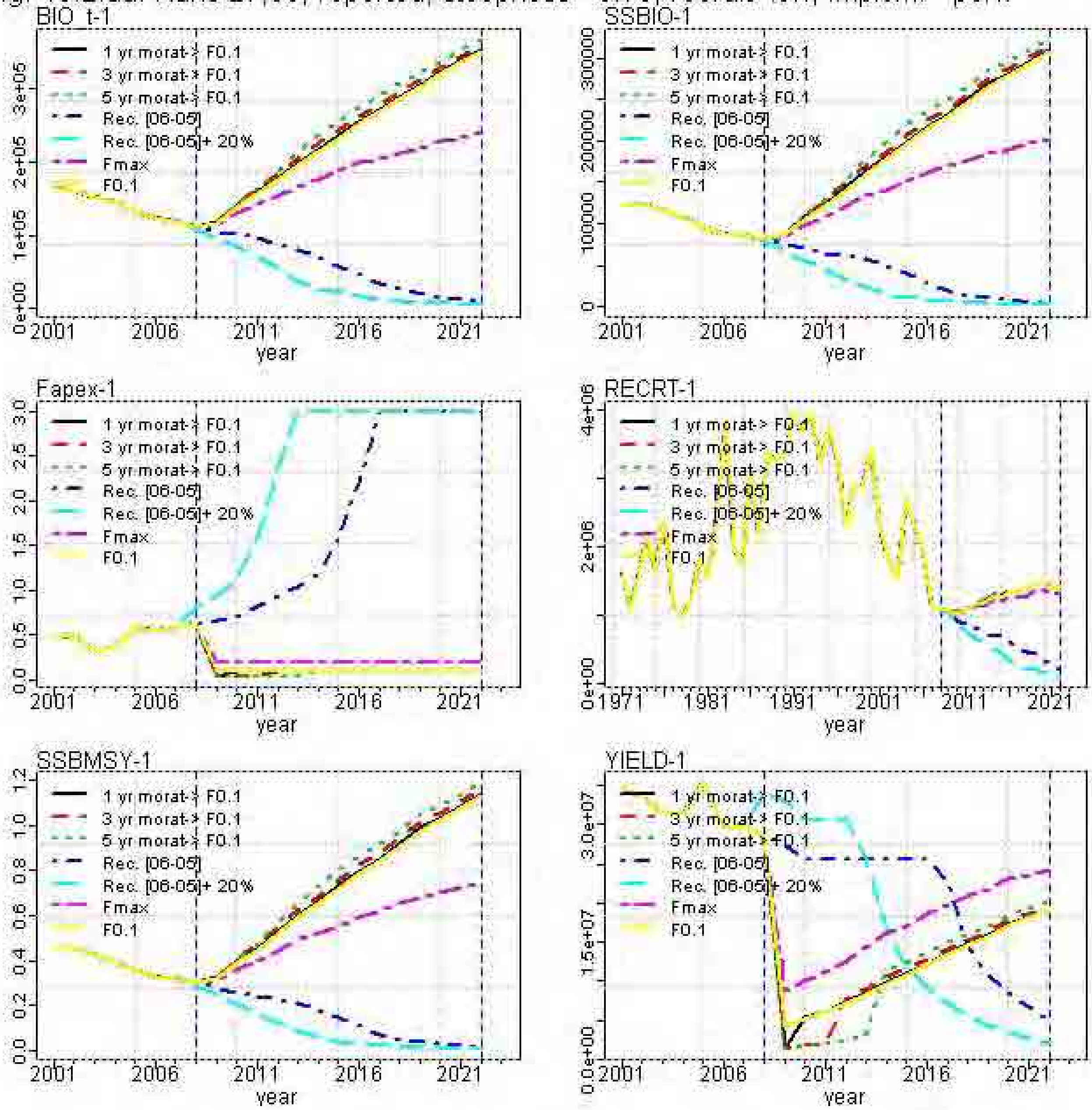


Fig. 10.2.bb. Runs 28,64, adjusted, steepness =0.75, recruit=low, Implem = perf.

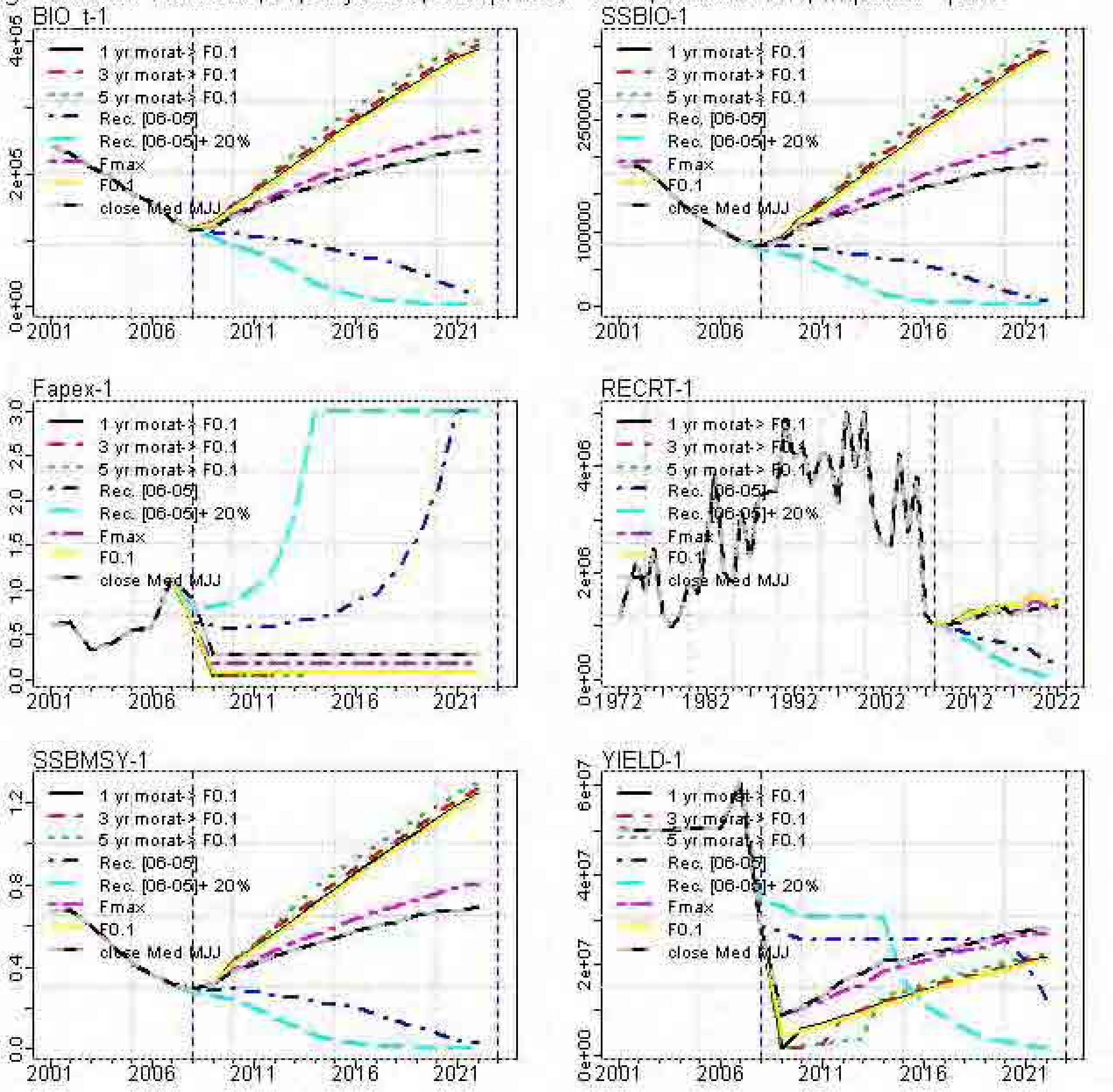


Fig. 10.2.cc. Runs 29,65, reported, steepness =0.99, recruit=low, implem.= perf.

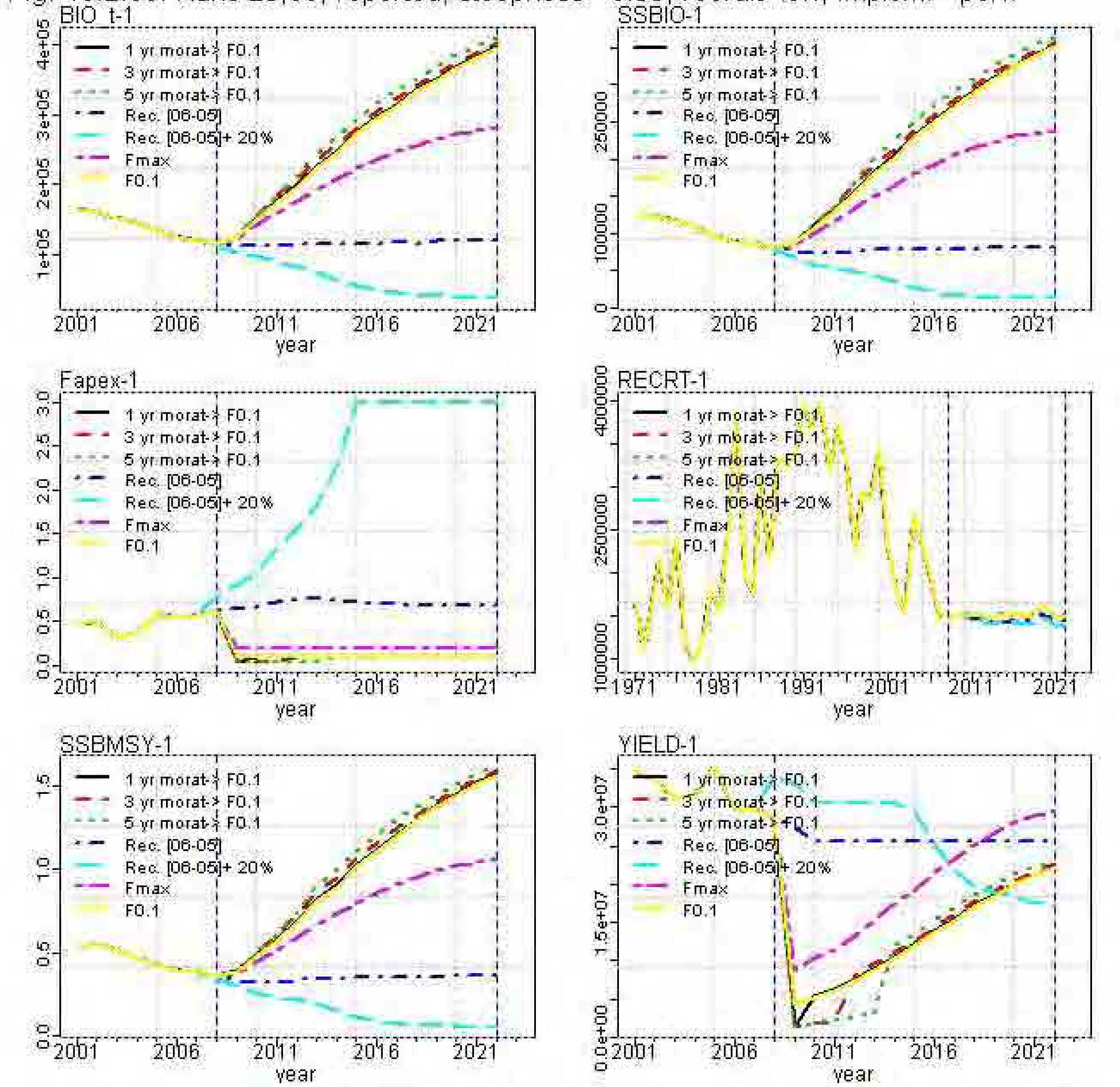


Fig. 10.2.dd. Runs 30,66, adjusted, steepness =0.99, recruit=low, Implem.= perf.

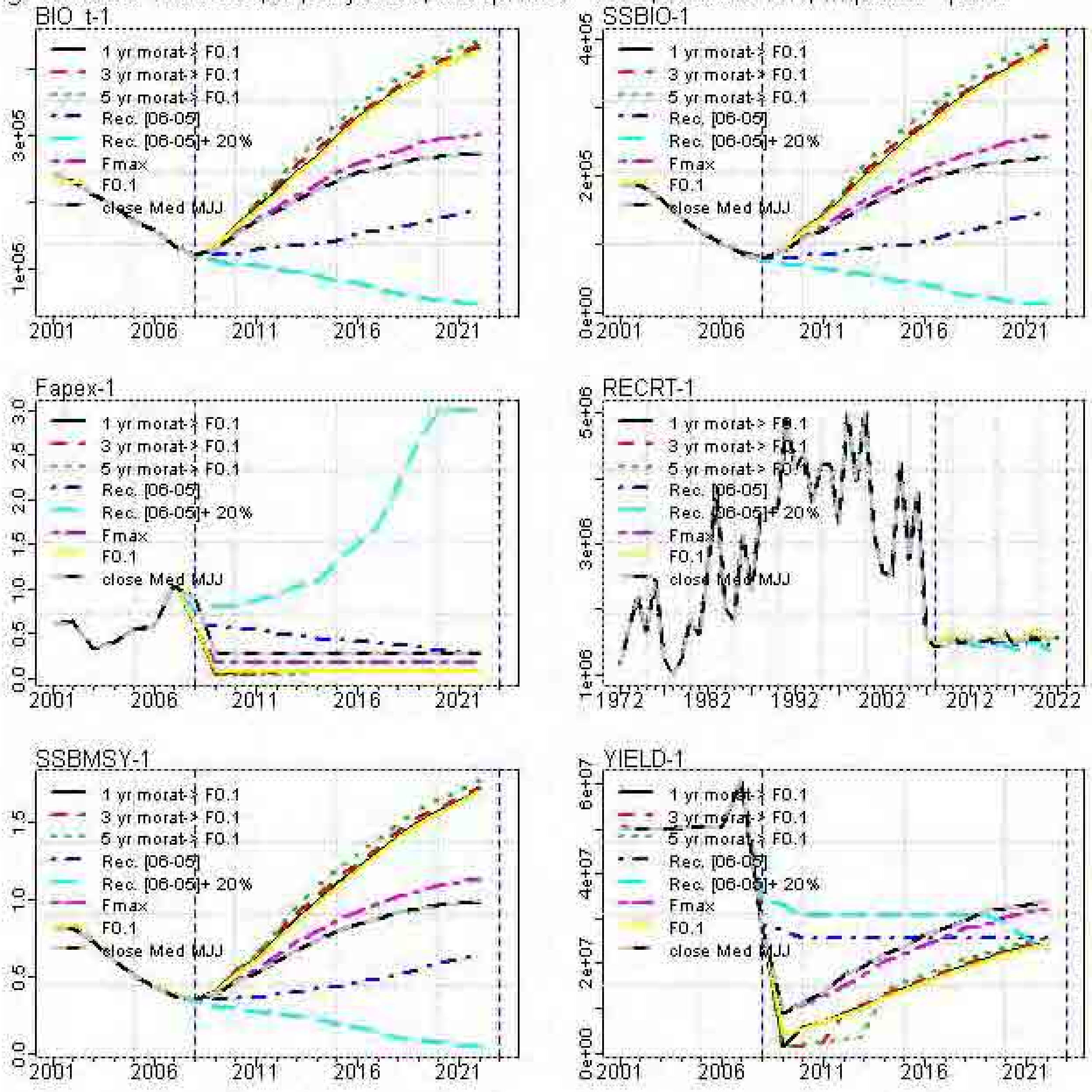


Fig. 10.2.ee. Runs 31,67, reported, steepness =0.5, recruit=low, implem.= 20% err.

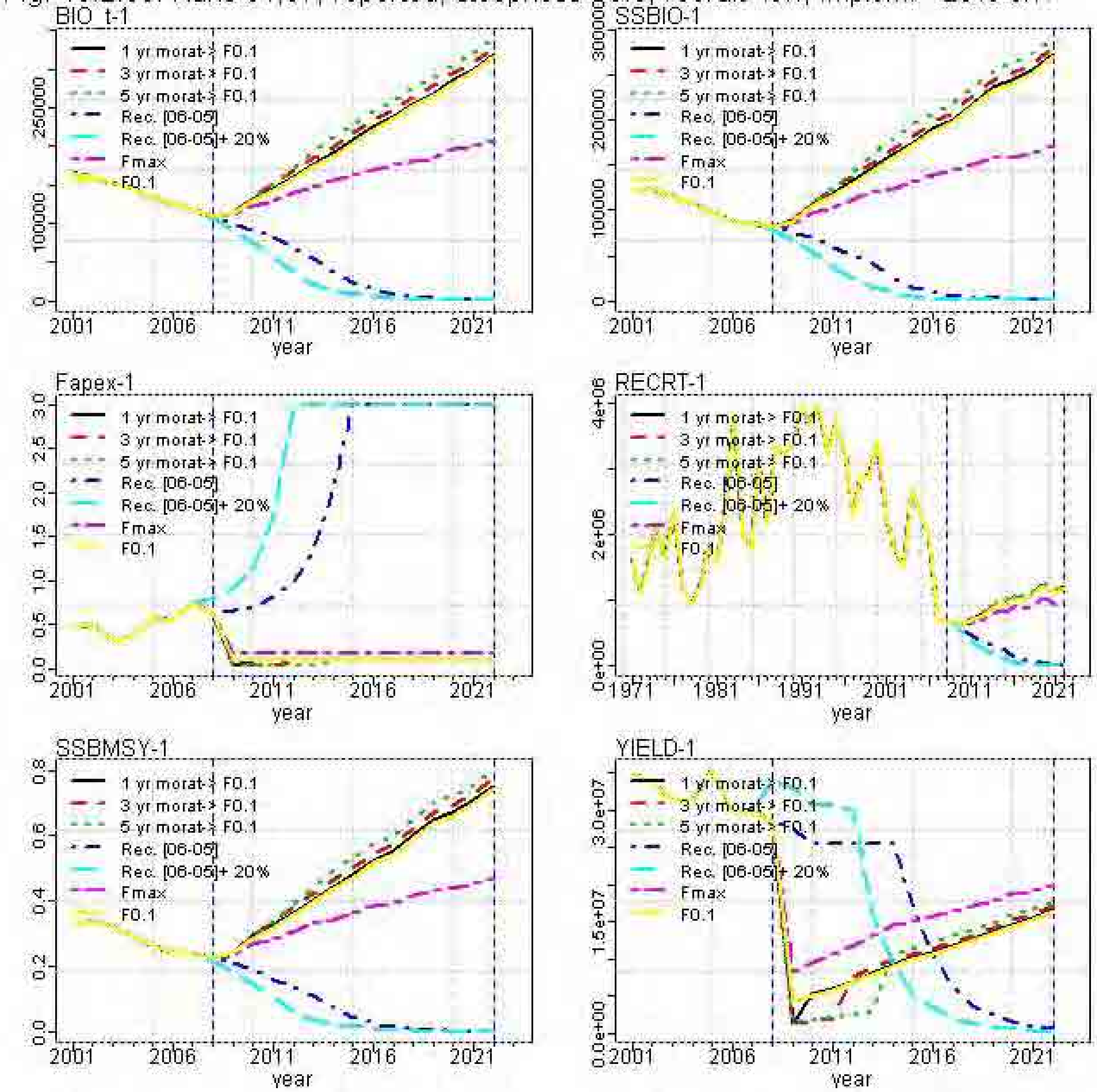


Fig. 10.2.ff. Runs 32,68, adjusted, steepness =0.5, recruit=low, implem.= 20% err.

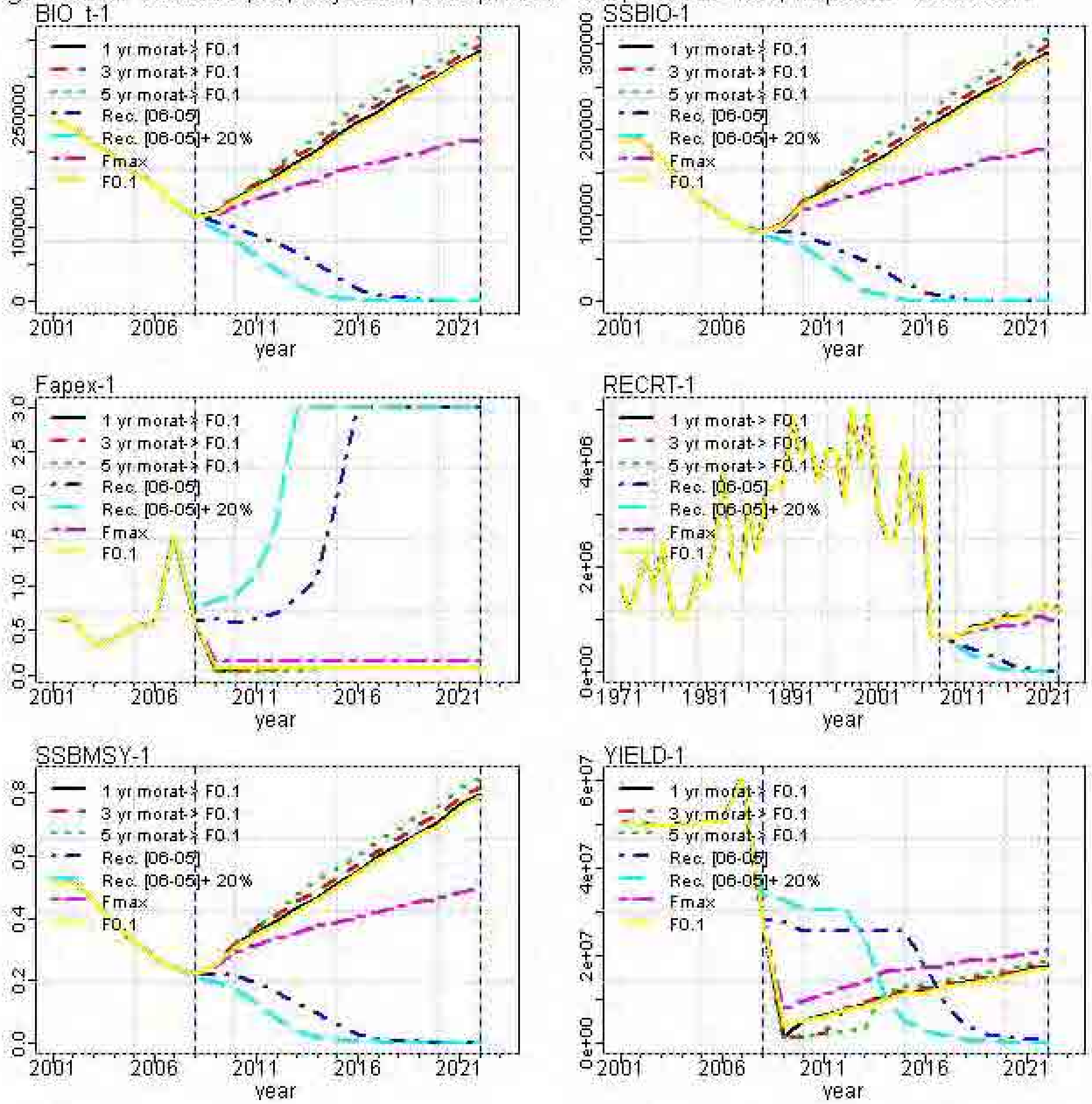


Fig. 10.2.gg. Runs 33,69, reported, steepness =0.75, recruit=low, implem.= 20% err.

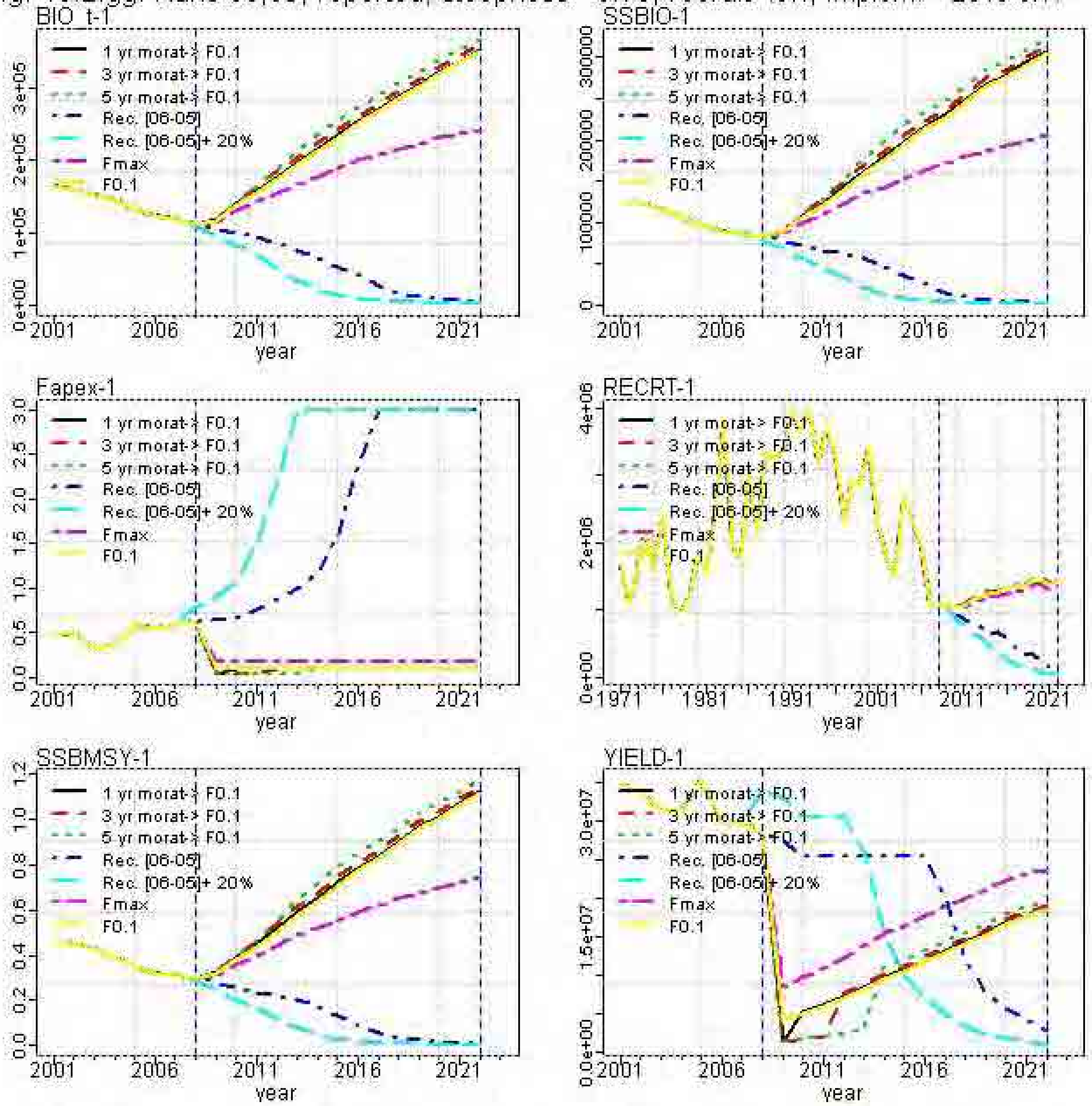


Fig. 10.2.hh. Runs 34,70, adjusted, steepness =0.75, recruit=low, implem.= 20% err.

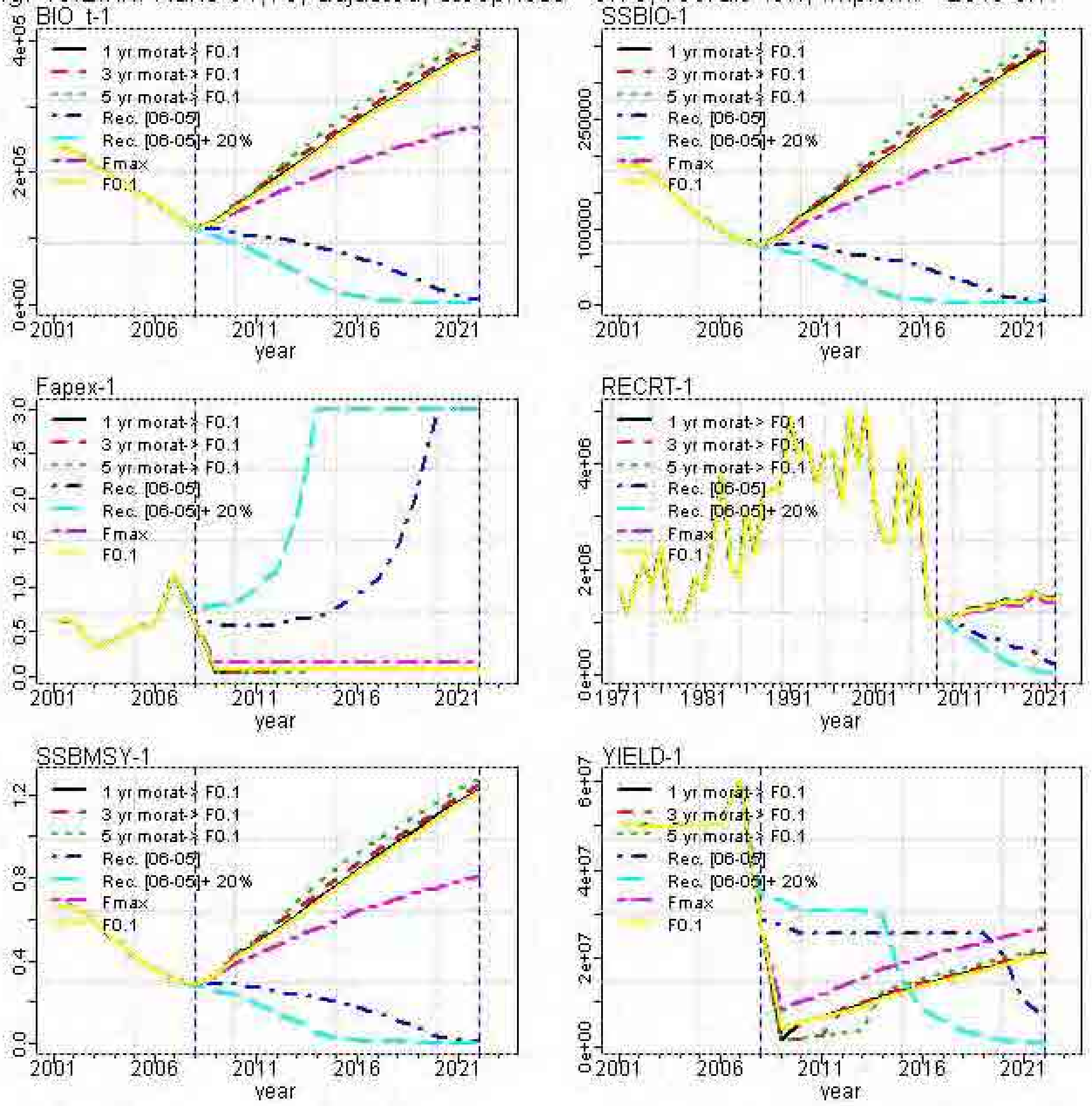


Fig. 10.2.ii. Runs 35,71, reported, steepness =0.99, recruit=low, implem.= 20% err.

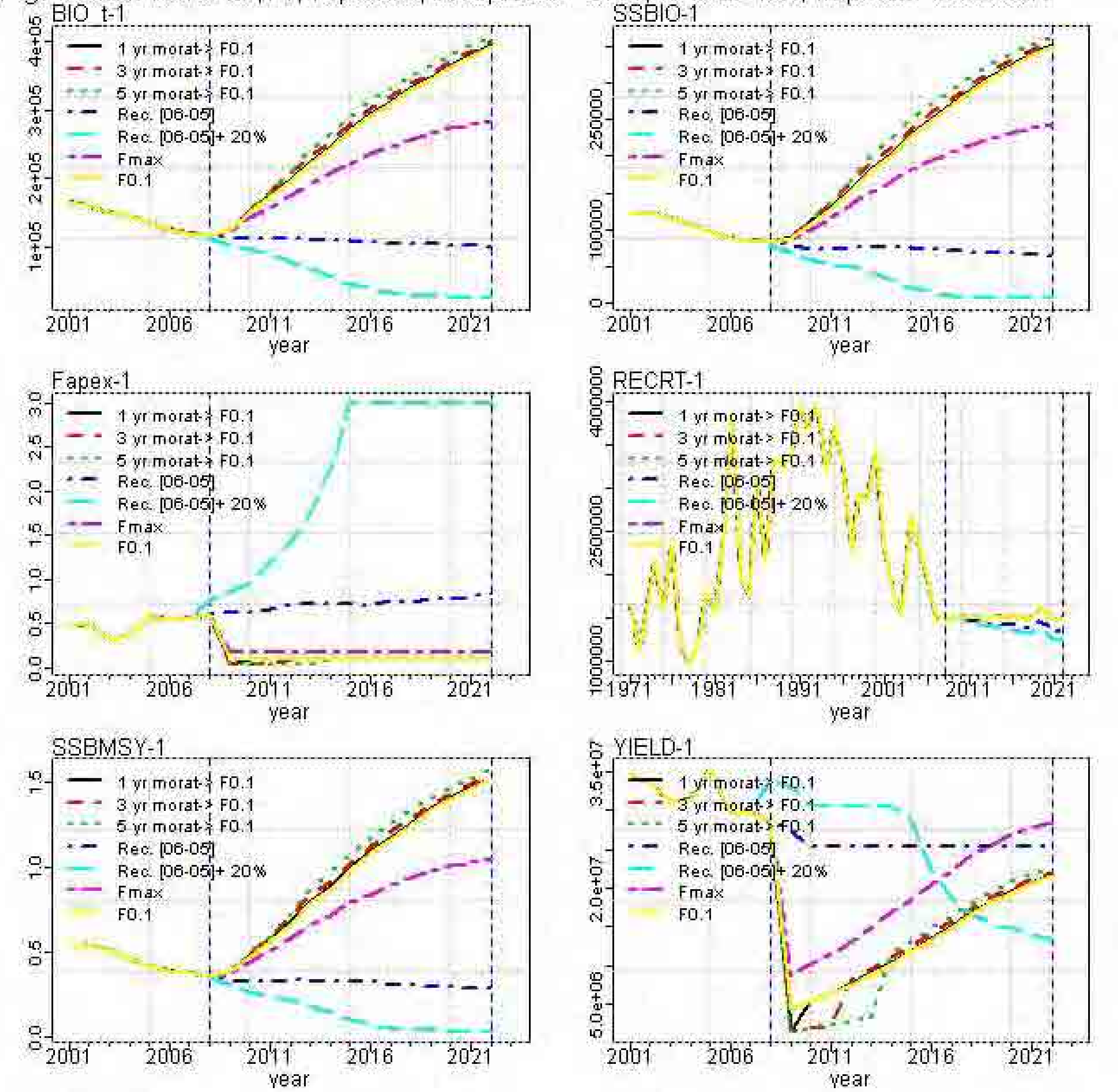
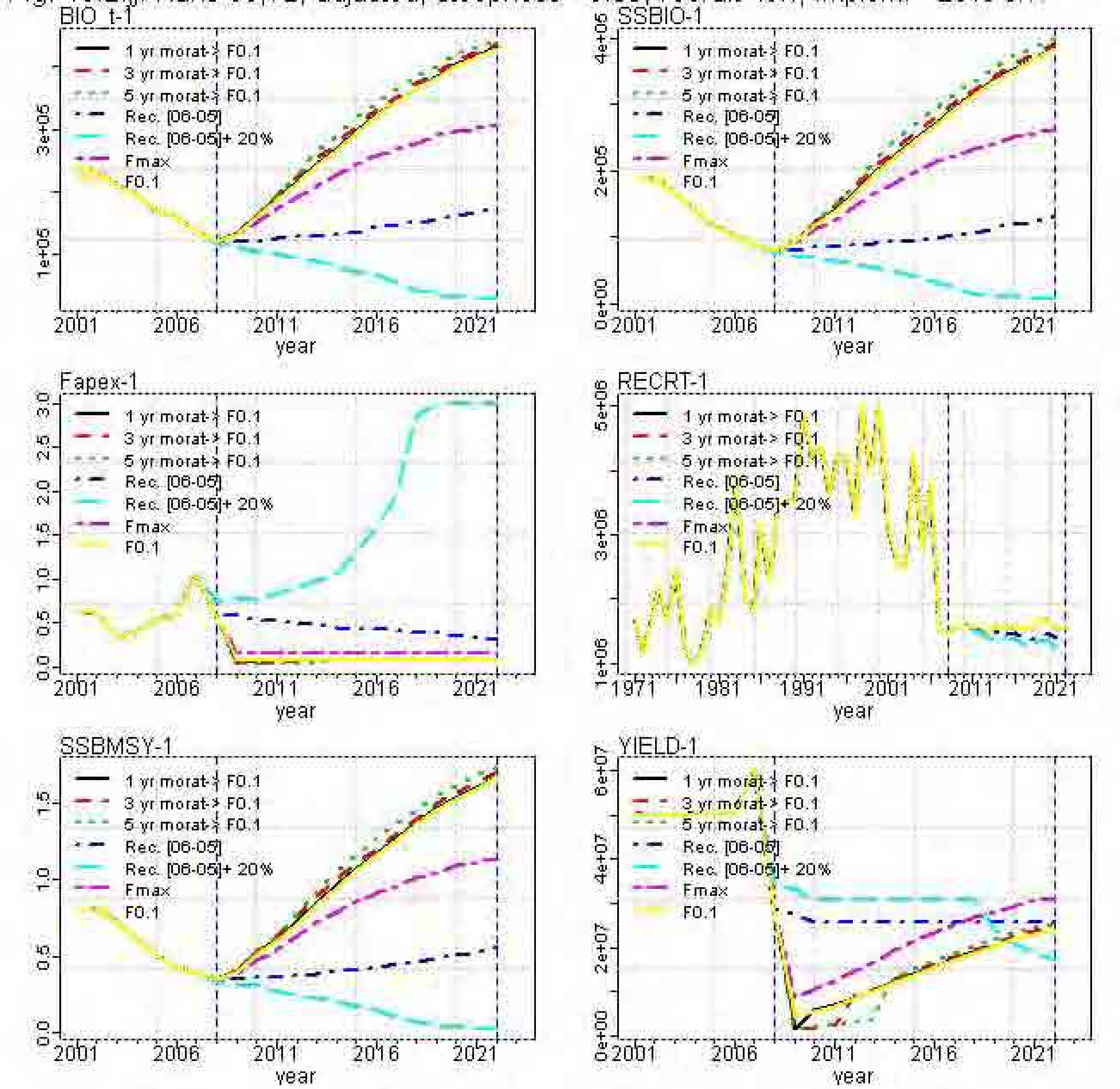


Fig. 10.2.jj. Runs 36,72, adjusted, steepness =0.99, recruit=low, implem.= 20% err.



8.5 BFT – ATLANTIC BLUEFIN TUNA

The SCRS conducted full assessments of the status of the bluefin tuna resource in the Atlantic and the Mediterranean in 2008, but not in 2009. In the case of the western stock, the available data included catch, effort and size statistics through 2007, while for the eastern stock, data for 2007 were unavailable for analysis during the assessment session (see ICCAT Circular #1227/08). There were considerable data limitations for the eastern stock until 2007. These included poor temporal and spatial coverage for detailed size and catch-effort statistics for many fisheries, especially in the Mediterranean. Substantial under-reporting of total catches was also evident in the last decade.

The Committee strongly and unanimously supports the Bluefin Tuna Research Program that will start in 2010, and welcomed the Commission's commitment to the Program. Without such a significant and sustained effort, it would be unlikely that the Committee could improve, in the near future, its scientific diagnosis and management advice.

BFT-1. Biology

Atlantic bluefin tuna (BFT) mainly live in the pelagic ecosystem of the entire North Atlantic and its adjacent seas, primarily the Mediterranean Sea. Bluefin tuna has a wide geographical distribution and is one of the only large pelagic fish living permanently in temperate Atlantic waters **(BFT-Figure 1)**. Archival tagging and tracking information confirmed that bluefin tuna can sustain cold as well as warm temperatures while maintaining stable internal body temperature. Until recently, it was assumed that bluefin tuna preferentially occupies the surface and subsurface waters of the coastal and open-sea areas, but archival tagging and ultrasonic telemetry data indicate that bluefin tuna frequently dive to depths of 500m to 1,000m. Bluefin tuna is also a highly migratory species that seems to display a homing behavior and spawning site fidelity in both the Mediterranean Sea and Gulf of Mexico, which constitute the two main spawning areas being clearly identified today. Less is known about feeding migrations within the Mediterranean and the North Atlantic, but results from electronic tagging indicated that bluefin tuna movement patterns vary considerably between individuals, years and areas. The appearance and disappearance of important past fisheries further suggest that important changes in the spatial dynamics of bluefin tuna may also have resulted from interactions between biological factors, environmental variations and fishing. Although the Atlantic bluefin tuna population is managed as two stocks, separated by the 45°W meridian, its population structure remains poorly understood and needs to be further investigated. Recent genetic and microchemistry studies as well as work based on historical fisheries tend to indicate that the bluefin tuna population structure is complex.

Currently, bluefin tuna is assumed to mature at four years of age (approximately 25 kg) in the Mediterranean and at eight years of age (approximately 140 kg) in the Gulf of Mexico. Juvenile and adult bluefin tuna are opportunistic feeders (as are most predators) and their diet can include jellyfish and salps, as well as demersal and sessile species such as, octopus, crabs and sponges. However, in general, juveniles feed on crustaceans, fish and cephalopods, while adults primarily feed on fish such as herring, anchovy, sand lance, sardine, sprat, bluefish and mackerel. Juvenile growth is rapid for a teleost fish (about 30cm/year), but slower than other tuna and billfish species. Fish born in June attain a length of about 30-40cm long and a weight of about 1 kg by October. After one year, fish reach about 4 kg and 60cm long. Growth in length tends to be lower for adults than juveniles, but growth in weight increases. At 10 years old, a bluefin tuna is about 200cm and 150 kg and reaches about 300cm and 400 kg at 20 years. Bluefin tuna is a long lived species, with a lifespan of about 40 years, as indicated by recent studies from radiocarbon deposition.

The information on natal origin derived from otolith microchemistry received by the SCRS indicated that there is an increasing contribution of eastern origin fish to the western fisheries with decreasing average size of the fish in the catch (*i.e.* up to 62% for fish in the 69-119 cm size class). In contrast, other western fisheries supported by the largest size classes had minimal or no eastern component in the catch. However, there remains considerable uncertainty and therefore additional samples are needed to improve our understanding of the relative contribution of the two populations to the different fisheries over time.

Remarkably, in 2009, considerable new information on the biology, the population structure and the spatial dynamics of Atlantic and Mediterranean bluefin tuna together with updated CPUE indices, fisheries independent surveys and research in farms have been presented. These new documents are summarized in SCRS/2009/192.

BLUEFIN TUNA - EAST

BFTE-2. Fishery Indicators – East Atlantic and Mediterranean

It is very well known that introduction of fattening and farming activities into the Mediterranean in 1997 and good market conditions resulted in rapid changes in the Mediterranean fisheries for bluefin tuna mainly due to increasing purse seine catches. In the last few years, nearly all of the declared Mediterranean bluefin fishery production was exported overseas. Declared catches in the East Atlantic and Mediterranean reached a peak of over 50,000 t in 1996 and, then decreased substantially, stabilizing around TAC levels established by ICCAT for the most recent period **(BFT-Table 1** and **BFTE-Figure 1)**. Both the increase and the subsequent decrease in declared production occurred mainly for the Mediterranean **(BFTE-Figure 1)**. In 2006, declared catch was about 30,647 t for the East Atlantic and Mediterranean, of which about 23,154 t were declared for the Mediterranean (note that 2007 catch reports were unavailable at the time of the assessment meeting). The 2007 and 2008 reported catches were, at the time of the meeting, at 34,514 t and 23,868 t, respectively **(BFT-Table 1)**.

Information available showed that catches of bluefin tuna from the eastern Atlantic and Mediterranean have been seriously under-reported from the mid-1990s until 2007. Lack of compliance with the TAC and underreporting of the catch undermines the conservation of the stock. An estimate made by the Committee in 2006 based on the number of vessels operating in the Mediterranean Sea and their respective catch rates, indicated that the volume of catch taken in recent years likely significantly exceeded TAC levels and probably was close to 43,000 t in the Mediterranean during the early 2000s. The Committee's evaluation in 2008 using the information from the ICCAT List of Bluefin Vessels, past catch rates and scientific knowledge of the fisheries led to an estimated 2007 catch of 47,800 t for the Mediterranean and 13,200 t for the East Atlantic, leading to a total of about 61,100 t for the eastern Atlantic bluefin tuna stock. The Committee's belief that significant underreporting was supported by examination of the information reported through various market data sources and which all led to the conclusion that the exports to the Japanese and US markets largely exceeded the reported catches. The Committee noted that up to 2007 most of the international trade of eastern bluefin went to the Japanese market, and thus such data were comparable to cross-check Task I data or estimating unreported catches. There is indication that this is no longer the case because there are other markets at present than Japan, so it is difficult to use Japanese trade data for the same purpose. Estimates of catch entered into the Mediterranean cages were about 16,000 t in 2008 which appears to be consistent with the estimates of 2008 purse seine catch (**BFTE-Table 1**).

In 2009, a much larger amount of information than in the past was available to the Committee. This included summaries of trade information, the list of authorized catching vessels, the weekly catch reports, caging declarations and the VMS data. Therefore, the Committee was able to estimate more precisely bluefin tuna catch levels in the East Atlantic and the Mediterranean Sea (**BFTE-Table 1**). The Committee's best estimate of catch for 2008 is 25,760 t, while the potential catch estimate (which may be seen as the utilized capacity under [Rec. 08-05]) is 34,120 t. The 2008 best catch estimate does not take any IUU catch into account while the potential 2008 catch estimate could include IUU from registered vessels, but not from unregistered ones. These two estimates can hardly be compared to previous "capacity" estimates because they are based on different sources of information. More importantly, they incorporate significant changes in catch rates due to the implementation of [Rec. 06-05] and [Rec. 08-05], with a much shorter fishing season, a higher size limit regulation and other controls, including individual vessel quotas for some vessels and observers on board programs. For comparison purposes with past "capacity tables" and to estimate the potential catch level that the fleet would have taken in 2008 if the rebuilding plan would have not been implemented, the Committee also considered the past catch rates (i.e. those that were used for the 2006 and 2007 capacity estimates when, among other things, the fishing season was considerably longer and the size limit lower). Using the 2008 list of vessels and past catch rates would have led to a catch capacity of 68,600 t (**BFTE-Table 1**).

Available indicators from small fish fisheries in the Bay of Biscay did not show any clear trend since the mid 1970s **(BFTE-Figure 2)**. This result is not particularly surprising because of strong inter-annual variation in year class strength.

Qualitative information from eastern fisheries since 2007 together with the preliminary results of the aerial surveys in 2009 give consistent indications of higher abundance or higher concentration of small bluefin tuna in the northwestern Mediterranean. This could reflect positive outcomes from increase minimum size regulation implemented under [Rec. 06-05] and/or recent recruitment success. However, the results remain preliminary and need to be confirmed by additional observations and quantitative analyses in future stock assessments.

Indicators from longliners and traps targeting large fish (spawners) in the East Atlantic and the Mediterranean Sea displayed a recent increase after a general decline since the mid-1970s **(BFTE-Figure 2)**. The Committee found it difficult to derive any clear conclusion from fisheries indicators in the absence of more precise information about the catch composition, effort and spatial distribution of the purse seine fisheries (which represent more than 60% of the total recent reported catch). Fisheries-independent indicators (scientific surveys) and a large scale tagging program in the Mediterranean Sea are also needed.

BFTE-3. State of the stock

There were considerable data limitations for the 2008 assessment of the stock. These included poor temporal and spatial coverage for detailed size and catch-effort statistics for many fisheries, especially in the Mediterranean. Substantial under-reporting of total catches was also evident. Nevertheless, the Committee assessed the stock in 2008 as requested by the Commission. Unless substantial improvements are made in the catch and effort statistics or new information on key issues is available, there is little scientific need to perform a stock assessment every two years because many results are based on equilibrium assumptions. Furthermore, any change in exploitation or management will take several years to have a detectable effect on the biomass because bluefin tuna is a long lived species. This explains why the Committee's diagnosis and advice remained similar to that of 2006 and 2007.

The assessment results indicated that the spawning stock biomass (SSB) has been declining rapidly in the last several years while fishing mortality (F) has been increasing rapidly, especially for large bluefin (i.e. ages 10+, **BFTE-Figure 3**). The increase in mortality for large bluefin tuna is consistent with a shift in targeting towards larger individuals destined for fattening and/or farming. The decline in SSB is evident from the results of analyses that used both reported and adjusted (for underreporting) catch and CPUE information. These analyses indicated that recent (2003-2007) SSB is less than 40% of the highest estimated levels (at the start of the time series 1970-1974 or 1955-1959, depending on the analysis). The decline in SSB appears to be more pronounced during the more recent years, especially under the scenarios with adjusted catches, although estimates for the last years should be judged with caution due to high uncertainties and lack of data. The absolute values estimated for F and SSB remained sensitive to the assumptions of the analysis. However, it is noteworthy that results were consistent between different types of models which made use of different assumptions (Section 8.1 of SCRS/2008/019). All the analyses indicated a general increase in *F* for large fish during the last years and, consequently, a decline in SSB.

Estimates of current stock status relative to MSY benchmarks are uncertain, but lead to the conclusion that recent F was too high and recent SSB too low to be consistent with the Convention Objectives. Depending on different assumed levels of resource productivity current F was most likely at least 3 times that which would result in MSY and SSB was most likely to be about 36% or less than the level needed to support MSY **(BFTE-Figure 4)**. Even in the most optimistic evaluation of the Committee, assuming recruitment will not decrease if SSB continues to decline, substantial overfishing was occurring and spawning biomass was well below levels needed to sustain MSY. The Committee was not in a position to estimate F and SSB for 2008 and 2009, which could be done in the 2010 assessment session.

BFTE- 4. Outlook

During the last decade, there has been an overall shift in targeting towards large bluefin tuna, mostly in the Mediterranean. As the majority of these fish are destined for fattening and/or farming operations, it is crucial to get precise information about the total catch, the size composition, the area and flag of capture, time in captivity as well as growth and death in farms.

The under-reporting of catches until 2007 of both small and large fish further undermined the assessment. These factors, combined with the lack of reliable historical information for several fleets and for the Mediterranean as a whole, means the stock could not be monitored with confidence and, therefore, severe depletion could easily go undetected.

It should be noted that if the overall selectivity pattern has shifted towards larger fish **(BFTE-Figure 3)**, this could result in improved yield-per-recruit levels in the long-term if F were reduced to F_{MSY}. However, such changes would take many years to translate into gains in yield due to the longevity of the species. Realization of higher long-term yields would further depend on future recruitment level, but the possibility of recruitment overfishing in the near future could not be dismissed considering the high current *F* on spawners.

Even considering uncertainties in the assessment, continuing fishing at the 2007 fishing mortality rates is expected to drive the spawning stock biomass to very low levels; i.e. to about 18% of the SSB in 1970 and 6% of the unfished SSB. This combination of high *F*, low SSB and severe overcapacity, as was estimated in the 2008 assessment, results in a high risk of fisheries and stock collapse **(BFTE-Table 1, BFTE-Figure 3)**. The outlook of the future assessments might improve if the positive signals given by some indicators in 2009 can be confirmed in the future.

The Committee also evaluated the potential effects of [Rec. 06-05]. As 2007 catch data from the fishery operating under these management measures were not available for comprehensive analysis at the 2008 assessment (Circular #1227/08), the Committee has performed equilibrium-based and non-equilibrium-based projections starting from the 2006 estimates. Acknowledging that there is insufficient scientific information to determine precisely the productivity of the stock, the Committee considered different contrasting and plausible productivity scenarios as well as different scenarios about the historical catches and the implementation of [Rec. 06-05] (Section 10.1 of SCRS/2008/019). The results clearly indicated that only scenarios with a high productivity over the next 15 years that will not be affected by the current low level of the SSB allow the rebuilding of the stock with probability greater than 50% by 2023. The remaining scenarios of a low or medium productivity of the stock which are considered to be as plausible as the high productivity scenarios would not allow the rebuilding of the stock by 2023. Furthermore, [Rec. 06-05] would not avoid a high risk of collapse of the population in a substantial number of scenarios considered.

Although the results of the projections are highly dependent on estimated state of the stock in 2007 and future recruitment levels (both being uncertain), the overall evaluation of [Rec. 06-05] is viewed by the Committee as unlikely to rebuild the stock in 15 years with 50% probability. Therefore, the Committee decided to contrast the above projections related to [Rec. 06-05] with additional management strategies, i.e. (i) $F_{0.1}$ or F_{MAX} strategies (implying short-term yields at 15,000 t or less), (ii) a closure of the Mediterranean Sea in May-June-July together with a size limit at 25 kg (as recommended by the SCRS in 2006) or (iii) a moratorium over the East Atlantic and Mediterranean Sea during 1, 3 or 5 years followed by an $F_{0.1}$ strategy. The results clearly indicated that all these alternative management strategies would have a higher probability of rebuilding the stock by 2023 and a lower probability of stock collapse in the future than [Rec. 06-05], regardless of the assumed productivity of the stock. The moratorium scenarios and $F_{0.1}$ strategy led to similar outcomes while the closure of the Mediterranean Sea in May-June-July was quite similar as the F_{MAX} strategy (note that these last two scenarios were slightly less conservative than the first ones). A preliminary analysis incorporating [Rec. 08-05] displays similar results as the 2008 SCRS analyses. The outputs are highly dependent on the productivity hypothesis, but in general, the $F_{0.1}$ and the low constant catch (8,000 t) strategies have higher probabilities of rebuilding the stock by 2023 than the F_{MAX} strategy or [Rec. 08-05].

BFTE-5. Effect of current regulations

Catch limits have been in place for the eastern Atlantic and Mediterranean management unit since 1998. In 2002, the Commission fixed the Total Allowable Catch (TAC) for the East Atlantic and Mediterranean bluefin tuna at 32,000 t for the years 2003 to 2006 [Rec. 02-08] and at 29,500 t and 28,500 t for 2007 and 2008, respectively [Rec. 06-05]. The reported catches for 2003, 2004 and 2006 were about TAC levels, but those for 2005 (35,732 t) and 2007 (34,514 t) were notably higher than TAC. However, the Committee strongly believed, based on the knowledge of the fisheries and trade statistics, that substantial under-reporting was occurring and that catches up to 2007 were well above TAC. The SCRS estimates since the late 1990s, catches were close to the levels reported in the mid-1990s, but for 2007, the estimates were higher *i.e.* about 61,000 t in 2007 for both the East Atlantic and Mediterranean Sea. The SCRS catch estimate for 2008 is 25,760 t. This estimate is consistent with the large decrease in the reported catch for 2008, which is about 10,000 t lower than the 2003-2007 reported catches. Although carefulness is needed when comparing this estimate to past SCRS estimates, the Committee's interpretation is that a substantial decrease in the catch occurred in the Mediterranean Sea by the implementation of the rebuilding plan and control enforcement. However, the Committee is concerned that if the fleet operated at its full capacity under [Rec. 08-05], the potential catch (34,120 t) would substantially exceed the 2008 and 2009 TAC (28,500 t and 22,000 t, respectively) and the past SCRS recommendation (15,000 t or less) (**BFTE-Table 1, BFTE-Figure 1**).

[Rec. 06-05] states that "*the SCRS shall monitor and review the progress of the plan and submit an assessment to the Commission for the first time in 2008, and each two years thereafter*". However, the lack of catch, effort and size data for 2007 from many Contracting Parties (ICCAT Circular #1227/08) as well as the inaccessibility of VMS data for 2007 did not allow the Committee in 2008 to evaluate the effects of the recovery plan on the basis of real observations. Consequently, the Committee had to make its evaluation in 2008 assuming that the 2007 selectivity pattern is similar to this of 2006 and that total catch in 2007 was at 61,000 t.

Based on the Committee's analysis, it is apparent that the TAC was overshot during a decade and was largely ineffective in controlling overall catch. In 2008, the SCRS best catch estimate (25,760 t) and the reported catch (23,868 t) are both under the TAC (28,500 t). This result is undoubtedly positive and encouraging, but it should be noted that the SCRS 2008 catch estimates as well as the 2008 reported catch do not take into account IUU catch which are suspected to continue at an unknown level. In 2009, the Committee could not measure the effects of [Rec. 08-05] on the stock because of the unavailability of the 2009 Task I and Task II. The Committee will attempt to fully evaluate the current management scheme ([Rec. 08-05]) in 2010 within the limits of the information made available to it. In the meantime, the Committee reiterates its past advice: unless fishing mortality rates are substantially reduced in the near future, further reduction in spawning stock biomass is likely to happen leading to a risk of fisheries and stock collapse.

BFTE-6. Management Recommendations

The available information indicated that the 2007 fishing mortality rate was, under the 2004-2007 overall fishing pattern, more than three times the level which would permit the stock to stabilize at the MSY level. The intention of [Rec. 06-05] and [Rec. 08-05] are seen as a step in the right direction, but as previously noted, the Committee consider that it is unlikely to fully fulfill the objective of the plan to rebuild the stock to the MSY level by 2023.

To address the various sources of uncertainties in the scientific diagnosis, especially regarding the data quality and availability, the Committee has investigated different quantitative approaches and it has considered a variety of scenarios for the projections. On this basis, the best advice of the Committee is currently to follow an $F_{0.1}$ (or another adequate F_{MSY} proxy) strategy to rebuild the stock, because such strategies appear much more robust than [Rec. 06-05] and possibly to [Rec. 08-05] (according to preliminary analyses) to a wide range of uncertainties about the data, the current status and future productivity. These strategies would imply much lower catches during the next few years (on the order of 15,000 t or less), but the long-term gain could lead to catches of about 50,000 t with substantial increases in spawning biomass. For a long lived species such as bluefin tuna, it will take some time (> 10 years) to realize the benefit. The Committee further believes that a time area closure could greatly facilitate the implementation and the monitoring of such rebuilding strategies.

Clearly, an overall reduction in fishing effort and mortality, as stated in 2008, is needed to reverse current trends. The 2007 fishing capacity largely exceeds the 2007 TAC, but the 2008 catch capacity might be under 2008 TAC if illegal fishing did not occur. However, the potential catch capacity is clearly above TAC. Therefore, management actions need to be pursued to mitigate the impacts of overcapacity as well as to eliminate illegal fishing. Deferring effective management measures will likely result in even more stringent measures being necessary in the future to achieve the Commission's objectives.

EAST ATLANTIC AND MEDITERRANEAN BLUEFIN TUNA SUMMARY		
Yield for 2008	Reported[1]: 23,868 t	Best SCRS estimate for 2008: 25,760 t. Potential catch estimated by SCRS for 2008: 34,120 t
Yield for 2007	Reported[1]: 34,514 t	SCRS Estimate for 2007: 61,000 t
Short-term Sustainable Yield[2]		
F_{MAX}	15,000 t or less	
$F_{0.1}$	8,500 t or less	
Long-term potential yield[3]	about 50,000 t	
SSB_{2007}/SSB_{FMAX}		
High recruitment (1990s)	0.14	
Low recruitment (1970s)	0.35	
F_{2007}/F_{MAX}[4]		
Reported catches	3.04	
Adjusted catches	3.42	
TAC (2007-2010)	29,500 - 28,500 - 22,000 - 19,950 t	

[1] Corresponds to the reported catches on the October 2, 2009.
[2] Approximated as a 4-years average yield expectation from the 2010-2013 constant F_{MAX} or $F_{0.1}$ projections.
[3] Approximated as the average of long-term yield at F_{MAX} or $F_{0.1}$ that were calculated over a broad range of scenarios including contrasting recruitment levels and different selectivity patterns (estimates from these scenarios ranged between 29,000 t and 91,000 t).
[4] The recruitment levels do not impact the F ratio.

BLUEFIN TUNA - WEST

BFTW-2. Fishery indicators

The total catch for the West Atlantic peaked at nearly 20,000 t in 1964, mostly due to the Japanese longline fishery for large fish off Brazil and the United States purse seine fishery for juvenile fish (**BFT-Table 1**, **BFTW-Figure 1**). Catches dropped sharply thereafter with the collapse of the longline fishery off Brazil and decline in purse seine catches, but increased again to average over 5,000 t in the 1970s due to the expansion of the Japanese longline fleet into the northwest Atlantic and Gulf of Mexico and an increase in purse seine effort targeting larger fish for the sashimi market. The total catch for the West Atlantic including discards has generally been relatively stable since 1982 due to the imposition of quotas. However, since a total catch level of 3,319 t in 2002 (the highest since 1981, with all three major fishing nations indicating higher catches), total catch in the West Atlantic declined steadily to a low of 1,638 t in 2007 and then increased in 2008 to 2,015 t. (**BFTW-Figure 1**). The decline through 2007 was primarily due to considerable reductions in catch levels for United States fisheries. Since 2002, the Canadian annual catches have been relatively stable at about 500-600 t (733 t in 2006); the 2006 catch was the highest recorded since 1977. The 2008 Canadian catch was 576 t. Japanese catches have generally fluctuated between 300-500 t, with the exception of 2003 (57 t), which was low for regulatory reasons. The overall number of Japanese vessels engaged in bluefin fishing has declined from more than 100 boats in recent years to 45 boats in 2008, of which 15 boats operated in the West Atlantic. After reaching 2,014 t in 2002 (the highest level since 1979), the catches (landings and discards) of U.S. vessels fishing in the northwest Atlantic (including the Gulf of Mexico) declined precipitously during 2003-2007. The United States did not catch its quota in 2004-2008 with catches of 1,066, 848, 615, 858 and 937 t, respectively. It was noted that not all nations have adopted a calendar year to manage their quota.

The indices of abundance used in last year's assessment were updated through 2008 **(BFTW-Figure 2)**. The catch rates of juvenile bluefin tuna in the U.S. rod and reel fishery fluctuate with little apparent long-term trend, but exhibit a pattern that is consistent with the moderately strong year-classes estimated for 2002 and 2003. The catch rates of older juveniles and adults in the United States rod and reel fishery continue to remain low, increasing only slightly in 2008. The catch rates of the Japanese longline fishery increased markedly in 2007, but decreased in 2008 back to the levels observed in 2005 and 2006. The catch rates from the U.S. Gulf of Mexico longline fishery continue to show a gradual increasing trend, whereas the Gulf of Mexico larval survey continues to fluctuate around the low levels observed since 1980s. The catch rates in the Gulf of St. Lawrence have increased rapidly since 2004 and the catch rates in 2007 and 2008 are the highest in the time series. The catch rates in southwest Nova Scotia have continued to follow a slightly increasing trend since 2000, with catch rates in 2008 being amongst the highest since the early 1990s

BFTW-3. State of the stock

The 2008 assessment was consistent with previous analyses in that spawning stock biomass (SSB) declined steadily between the early 1970s and 1992. Since then, SSB has fluctuated between 18% and 27% of the 1975 level (**BFTW-Figure 3**). The stock has experienced different levels of fishing mortality (F) over time, depending on the size of fish targeted by various fleets (**BFTW-Figure 3**). Fishing mortality on spawners (ages 8 and older) declined markedly between 2002 and 2007. Estimates of recruitment were very high in the early 1970s (**BFTW-Figure 3**), and additional analyses involving longer catch and index series suggested that recruitment was also high during the 1960s. Since 1977, recruitment has varied from year to year without trend. The Committee noted that a key factor in estimating MSY-related benchmarks is the highest level of recruitment that can be achieved in the long term. Assuming that average recruitment cannot reach the high levels from the early 1970s, recent F (2004-2006) is about 30% higher than the MSY level and SSB is about half of the MSY level (**BFTW-Figure 4**). Estimates of stock status are more pessimistic if a high recruitment scenario is considered (F/F_{MSY}=2.1, B/B_{MSY}=0.14).

One important factor in the recent decline of fishing mortality on large bluefin is that the TAC has not been taken during this time period, due primarily to a shortfall by the United States fisheries that target large bluefin. Two plausible explanations for the shortfall were put forward previously by the Committee: (1) that availability of fish to the United States fishery has been abnormally low, and/or (2) the overall size of the population in the Western Atlantic declined substantially from the level of recent years. While there is no overwhelming evidence to favor either explanation over the other, the 2008 base case assessment implicitly favors the first hypothesis (regional changes in availability) because a large recent reduction in SSB is not estimated. Nevertheless, the Committee notes that there remains substantial uncertainty on this issue and more research needs to be done.

The SCRS cautions that the conclusions of the 2008 assessment do not capture the full degree of uncertainty in the assessments and projections. An important factor contributing to uncertainty is mixing between fish of eastern and western origin. Limited analyses were conducted of the two stocks with mixing. Depending on the types of data used to estimate mixing (conventional tagging or isotope signature samples) and modeling assumptions made, the estimates of stock status varied considerably. However, these analyses are preliminary and more research needs to be done before mixing models can be used operationally for management advice. Another important source of uncertainty is recruitment, both in terms of recent levels (which are estimated with low precision in the assessment), and potential future levels (the "low" vs "high" recruitment hypotheses which affect management benchmarks). Finally, the growth curve assumed in the analyses may be revised based on new information that has been collected.

BFTW-4. Outlook

A medium-term (12-year) outlook evaluation of changes in spawning stock size and yield over the remaining rebuilding period under various management options was conducted in 2008. Future recruitment was assumed to fluctuate around two alternative scenarios: (i) average levels observed for 1976-2004 (70,000 recruits, the low recruitment scenario) and (ii) levels that increase as the stock rebuilds (MSY level of 160,000 recruits, the high recruitment scenario). The Committee has no strong evidence to favor either scenario over the other and notes that both are reasonable (but not extreme) lower and upper bounds on rebuilding potential.

The outlook for bluefin tuna in the West Atlantic with the low recruitment scenario (**BFTW-Figure 5**) is similar to that from the 2006 assessment (Anon. 2007a). A total catch of 2,100 t is predicted to have at least a 50% chance of achieving the convention objectives of preventing overfishing and rebuilding the stock to MSY levels by 2019, the target rebuilding time. The outlook under the high recruitment scenario (**BFTW-Figure 5**) is more pessimistic since the rebuilding target would be higher; a total catch of less than 1,500 t is predicted to stop overfishing in 2009, but the stock would not be expected to rebuild by 2019 even with no fishing.

BFTW-Table 1 summarizes the estimated chance that various constant catch policies will allow rebuilding under the high and low recruitment scenarios for the base-case. The low recruitment scenario suggests that catch levels of 2,400 t will have about a 50% chance of rebuilding the stock by 2019 and catches of 2,000 t or lower will have greater than a 75% chance of rebuilding. If the high recruitment scenario is correct, then the western stock will not rebuild by 2019 even with no catch, although catches of 1,500 t or less are expected to immediately end overfishing (50% chance) and initiate rebuilding (**BFTW-Table 2**).

Among the alternative models examined by the Committee in 2008, the option that excluded the Canadian Gulf of St. Lawrence index was examined further, due to the considerations of possible resource re-distribution, and the observation that the recent high values were difficult to reconcile with other available fisheries data, and could reflect the impact of a single or a limited number of strong year-classes. The levels of catch that lead to rebuilding with that alternative model are lower; 1,800 t will have about a 50% chance and 1,500 t will have a 75% chance.

The Committee notes that considerable uncertainties remain for the outlook of the western stock, including the effects of mixing and management measures on the eastern stock.

BFTW-5. Effects of current regulations

Catches of western bluefin have been below the TAC since 2003, although that was not always the case prior to then (**Figure BFTW-1**). The estimated percentage of fish less than 115cm in the catch has been less than 8% of the TAC from 1992 to 2006, although this percentage increased in 2007 to about 11% of TAC.

The Committee previously noted that Recommendation 06-06 was expected to result in a rebuilding of the stock towards the convention objective, but also noted that there has not yet been enough time to detect with confidence the population response to the measure. This statement is also true for recommendation 08-04, which was implemented in 2009. Some of the available fishery indicators (**Figure BFTW-2)** suggest the spawning biomass of western bluefin tuna may be slowly rebuilding, however several more years of data may be required to verify this trend with reasonable statistical certainty.

BFTW-6. Management recommendations

In 1998, the Commission initiated a 20-year rebuilding plan designed to achieve B_{MSY} with at least 50% probability. The 2008 assessment indicated that the stock had not yet rebuilt as projected under the plan initially. The 2007 SSB was estimated to be 7% below the level of the Plan's first year.

In 2008, the Commission recommended a total allowable catch (TAC), inclusive of dead discards, of 1,900 t in 2009 and 1,800 t in 2010 [Rec. 08-04]. These TAC levels were projected to have a 75% chance of meeting the lower rebuilding targets under the "low recruitment" scenario **(BFTW-Table 1)**, but less than a 50% chance of meeting the higher target under the "high recruitment scenario". As noted in 2008, the TAC should be lower if the assessment is positively biased or if there is management implementation error (both of which have occurred in the past). Analyses conducted during the Joint ICCAT-Canada Precautionary workshop as well as two subsequent analyses reviewed by the Committee (SCRS/2008/089, SCRS/2008/175) suggested that the projections made during past assessments were too optimistic. This is reinforced by the observation that, halfway through the rebuilding program, biomass was still below what it was at the beginning. Accordingly, the Committee continues to strongly advise against an increase in TAC.

As noted previously by the Committee, both the productivity of western Atlantic bluefin and western Atlantic bluefin fisheries are linked to the eastern Atlantic and Mediterranean stock. Therefore, management actions taken in the eastern Atlantic and Mediterranean are likely to influence the recovery in the western Atlantic, because even small rates of mixing from East to West can have significant effects on the West due to the fact that Eastern plus Mediterranean resource is much larger than that of the West.

WEST ATLANTIC BLUEFIN TUNA SUMMARY (Catches and Biomass in t)	
Current (2008) Catch (including discards)	2,015 t
Assuming Low Potential Recruitment	
Maximum Sustainable Yield (MSY|R[1])	2,852 (2,680-3,032)[2]
Relative Spawning Stock Biomass:	
$B_{2007}/B_{MSY\|R}$	0.57 (0.46-0.70)[2]
Relative Fishing Mortality[3]:	
$F_{2004\text{-}2006}/F_{MSY\|R}$	1.27 (1.04-1.53)[2]
$F_{2004\text{-}2006}/F_{0.1}$	2.23 (1.82-2.72)[2]
$F_{2004\text{-}2006}/F_{max}$	1.27 (1.04-1.53)[2]
Assuming High Potential Recruitment	
Maximum Sustainable Yield (MSY)	6,201 (4,887-9,142)[2]
Relative Spawning Stock Biomass:	
$B_{2007}/B_{MSY\|R}$	0.14 (0.08-0.21)[2]
Relative Fishing Mortality[3]:	
$F_{2004\text{-}2006}/F_{MSY\|R}$	2.18 (1.74-2.64)[2]
$F_{2004\text{-}2006}/F_{0.1}$	2.23 (1.82-2.72)[2]
$F_{2004\text{-}2006}/F_{max}$	1.27 (1.04-1.53)[2]
Management Measures:	[Rec. 06-06] TAC of 2,100 t which began in 2007, including dead discards [Rec. 08-04] TAC of 1,900 t in 2009 and1,800 t in 2010, including dead discards

[1] MSY calculated conditional that recruitment remains at recent (1976-2004) levels.
[2] Median and approximate 80% confidence interval from bootstrapping from the assessment.
[3] $F_{2004\text{-}2006}$ refers to the geometric mean of the estimates for 2004-2006 (a proxy for recent F levels).

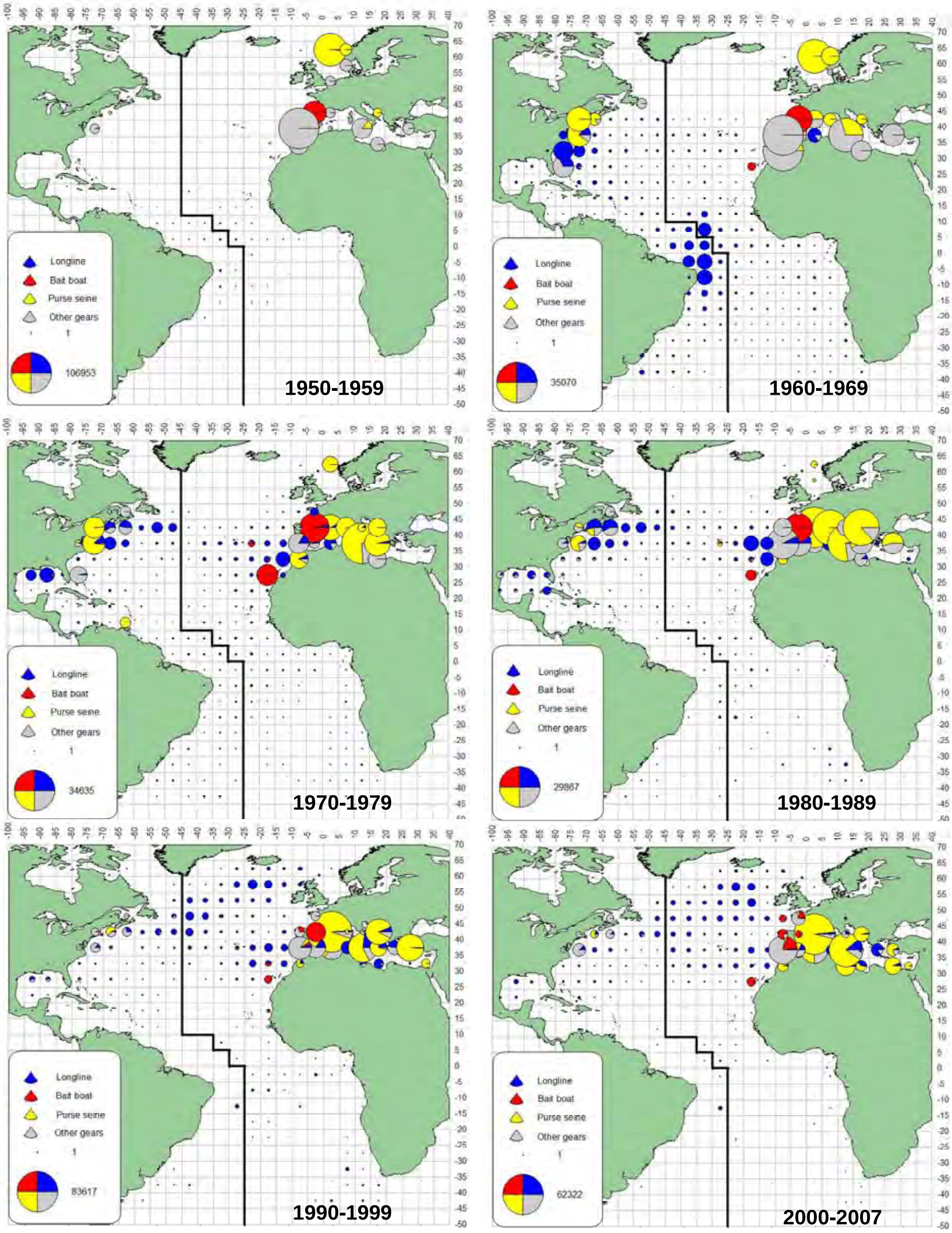
BFT-Table 1. Estimated Catches (t) of Northern bluefin tuna (*Thunnus thynnus*) by major area, gear and flag.

			1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
TOTAL			26716	24695	21570	20723	27016	23819	26027	29350	34131	36636	48853	49714	53320	49489	42375	35228	36541	37390	37089	33469	33505	37602	32459	36151	25944
	ATE+MED		24427	22010	19247	18220	24118	21061	23247	26429	31849	34268	46740	47291	50807	47155	39718	32456	33766	34605	33770	31163	31381	35845	30647	34514	23929
	ATE		7395	4807	4687	4456	6951	5433	6040	6556	7619	9367	6930	9650	12663	13539	11376	9628	10528	10086	10347	7362	7410	9036	7493	8037	7725
	MED		17032	17203	14560	13764	17167	15628	17207	19872	24230	24901	39810	37640	38144	33616	28342	22828	23238	24519	23424	23801	23971	26810	23154	26476	16205
	ATW		2289	2685	2322	2503	2898	2759	2780	2921	2282	2368	2113	2423	2514	2334	2657	2772	2775	2784	3319	2306	2125	1756	1811	1638	2015
Landings	ATE	Bait boat	2262	2004	1414	1821	1936	1971	1693	1445	1141	3447	1980	2601	4985	3521	2550	1492	1822	2275	2567	1371	1790	2018	1116	2032	1794
		Longline	1541	551	967	924	1169	962	1496	3197	3817	2717	2176	4392	4788	4534	4300	4020	3736	3303	2896	2750	2074	2713	2406	1706	2571
		Other surf.	948	536	972	668	1221	1020	562	347	834	1548	932	1047	646	511	621	498	703	712	701	560	402	1014	1047	502	187
		Purse seine	373	86	276	0	0	0	54	46	462	24	213	458	323	828	692	726	1147	150	884	490	1078	871	332	0	
		Sport (HL+RR)	0	1	1	3	1	2	1	0	0	0	0	0	0	162	28	33	126	61	63	109	87	11	4	10	6
		Traps	2271	1630	1057	1040	2624	1478	2234	1522	1365	1631	1630	1152	1921	3982	3185	2859	2996	3585	3235	2082	1978	2408	2588	3788	3166
	MED	Bait boat	1699	278	0	0	0	0	25	148	158	48	0	206	5	4	11	4	0	0	1	9	17	5	0	0	0
		Longline	1196	1228	678	799	1227	1121	1026	2869	2599	2342	7048	8475	8171	5672	2749	2463	3317	3750	2614	2476	2564	3101	2202	2661	2254
		Other surf.	1738	3211	3544	2762	2870	3289	1212	1401	1894	1607	3218	1043	1197	1037	1880	2976	1067	1096	990	2536	1106	480	301	699	1022
		Purse seine	9888	11219	9333	8857	11198	9450	11250	13245	17807	19297	26083	23588	26021	24178	21291	14910	16195	17174	17656	17167	18785	22475	20020	22950	12641
		Sport (HL+RR)	275	507	322	433	838	457	1552	738	951	1237	2257	3556	2149	2340	1336	1622	1921	1321	1647	1392	1340	634	503	72	137
		Traps	2236	760	683	913	1034	1311	2142	1471	821	370	1204	772	601	385	1074	852	739	1177	515	221	159	115	129	95	152
	ATW	Bait boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Longline	832	1245	764	1138	1373	698	739	895	674	696	539	466	547	382	764	914	858	610	730	186	644	425	565	420	606
		Other surf.	377	293	166	156	425	755	536	578	509	406	307	384	433	295	344	281	284	202	108	140	97	89	85	63	82
		Purse seine	401	377	360	367	383	385	384	237	300	295	301	249	245	250	249	248	275	196	208	265	32	178	4	28	
		Sport (HL+RR)	676	750	518	726	601	786	1004	1083	586	854	804	1114	1028	1179	1106	1124	1120	1649	2035	1398	1139	924	1005	1023	1130
		Traps	3	20	0	17	14	1	2	0	1	29	79	72	90	59	68	44	16	16	28	84	32	8	3	4	23
Discards	ATW	Longline	0	0	514	99	102	119	115	128	211	88	83	138	167	155	123	160	222	105	211	232	181	131	149	100	174
		Other surf.	0	0	0	0	0	14	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	
		Sport (HL+RR)	0	0	0	0	0	0	0	0	0	0	0	0	0	14	3	0	0	6	0	0	0	0	0	0	
Landings	ATE	Cape Verde	1	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	85	103	80	68	39	19	41	24	0	72	119
		Chinese Taipei	3	16	197	20	0	109	0	0	0	6	20	8	61	226	350	222	144	304	158	0	0	10	4	0	
		EC.Denmark	0	37	0	0	1	0	0	0	0	37	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
		EC.España	4804	3628	2876	2479	4567	3565	3557	2272	2319	5078	3137	3819	6174	6201	3800	3360	3474	3633	4089	2138	2801	3102	2033	3276	2938
		EC.France	602	490	348	533	724	460	510	565	894	1099	336	725	563	269	613	588	542	629	755	648	561	818	1218	629	253
		EC.Germany	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.Greece	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.Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	14	21	52	22	8	15	3	1	1	2	1	1
		EC.Netherlands	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	0	
		EC.Portugal	34	29	193	163	48	3	27	117	38	25	240	35	199	712	323	411	441	404	186	61	27	79	97	29	36
		EC.Sweden	0	0	0	0	0	0	0	1	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	1	0	1	1	12	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	67	104	118	0	0	0	0	0	0	0	
		Guinée Conakry	0	0	0	0	0	0	0	0	0	0	330	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	2	27	0	0	1	0	0	0	0	0	
		Japan	1514	420	739	900	1169	838	1464	2981	3350	2484	2075	3971	3341	2905	3195	2690	2895	2425	2536	2695	2015	2598	1896	1612	2431
		Korea Rep.	0	77	0	0	0	0	0	0	0	0	4	205	92	203	0	0	6	1	0	0	3	0	1	0	
		Libya	0	0	0	0	0	0	0	0	312	0	0	0	576	477	511	450	487	0	0	0	0	0	47	0	
		Maroc	171	86	288	356	437	451	408	531	562	415	720	678	1035	2068	2341	1591	2228	2497	2565	1797	1961	2405	2196	2418	1947
		NEI (ETRO)	6	3	4	0	5	6	74	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NEI (Flag related)	0	0	0	0	0	0	0	85	144	223	68	189	71	208	66	0	0	0	0	0	0	0	0	0	
		Norway	243	0	31	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
		Panama	17	22	11	4	0	0	0	0	0	0	1	19	550	255	0	13	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	2	0	0	0	0	0	
		Sierra Leone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93	118	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	
	MED	Algerie	254	260	566	420	677	820	782	800	1104	1097	1560	156	156	157	1947	2142	2330	2012	1710	1586	1208	1530	1038	1511	1311
		China P.R.	0	0	0	0	0	0	0	0	0	0	97	137	93	49	0	0	0	0	0	0	0	0	0	0	
		Chinese Taipei	0	0	0	0	0	0	0	0	0	328	709	494	411	278	106	27	169	329	508	445	51	267	5	0	
		Croatia	0	0	0	0	0	0	0	1418	1076	1058	1410	1220	1360	1105	906	970	930	903	977	1139	828	1017	1022	823	834
		EC.Cyprus	10	10	10	10	10	10	10	10	10	14	10	10	10	10	21	31	61	85	91	79	105	149	110	1	132

		EC.España	2743	1460	701	1178	1428	1645	1822	1392	2165	2018	2741	4607	2588	2209	2000	2003	2772	2234	2215	2512	2353	2758	2689	2414	2465
		EC.France	3600	5430	3490	4330	5780	4434	4713	4620	7376	6995	11843	9604	9171	8235	7122	6156	6794	6167	5832	5859	6471	8638	7663	10157	2670
		EC.Greece	0	11	131	156	159	182	201	175	447	439	886	1004	874	1217	286	248	622	361	438	422	389	318	255	285	350
		EC.Italy	7140	7199	7576	4607	4201	4317	4110	3783	5005	5328	6882	7062	10006	9548	4059	3279	3845	4377	4628	4973	4686	4841	4695	4621	2234
		EC.Malta	21	21	41	36	24	29	81	105	80	251	572	587	399	393	407	447	376	219	240	255	264	346	263	334	296
		EC.Portugal	0	0	0	0	0	0	0	278	320	183	428	446	274	37	54	76	61	64	0	2	0	0	11	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	50
		Israel	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	
		Japan	1036	1006	341	280	258	127	172	85	123	793	536	813	765	185	361	381	136	152	390	316	638	378	556	466	80
		Korea Rep.	0	0	0	0	0	0	0	0	0	0	684	458	591	410	66	0	0	0	0	0	700	1145	26	276	335
		Libya	274	300	300	300	300	84	328	370	425	635	1422	1540	812	552	820	745	1063	1941	638	752	1300	1091	1280	1358	1318
		Maroc	4	12	56	116	140	295	1149	925	205	79	1092	1035	586	535	687	636	695	511	421	760	819	92	190	641	531
		NEI (Flag related)	0	0	0	0	0	0	0	0	0	0	427	639	171	1066	825	140	17	0	0	0	0	0	0	0	
		NEI (MED)	19	0	168	183	633	757	360	1799	1398	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NEI (combined)	0	0	0	0	0	0	0	0	0	0	773	211	0	101	1030	1995	109	571	508	610	709	0	0	0	
		Panama	0	0	0	72	67	0	74	287	484	467	1499	1498	2850	236	0	0	0	0	0	0	0	0	0	0	
		Serbia & Montenegro	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	4	0	0	0	0	0	0	0	
		Syria Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	41
		Tunisie	307	369	315	456	624	661	406	1366	1195	2132	2773	1897	2393	2200	1745	2352	2184	2493	2528	791	2376	3249	2545	2622	2679
		Turkey	869	41	69	972	1343	1707	2059	2459	2817	3084	3466	4220	4616	5093	5899	1200	1070	2100	2300	3300	1075	990	806	918	879
		Yugoslavia Fed.	755	1084	796	648	1523	560	940	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ATW	Argentina	0	6	0	2	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Brasil	0	1	0	2	0	2	1	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	
		Canada	264	142	73	83	393	619	438	485	443	459	392	576	597	503	595	576	549	524	604	557	537	600	733	491	575
		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	3	3	4	0	20	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	
		Cuba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	11	19	27	19	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	
		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	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	
		FR.St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	1	10	5	0	4	3
		Japan	696	1092	584	960	1109	468	550	688	512	581	427	387	436	322	691	365	492	506	575	57	470	265	376	277	492
		Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	52	0	
		Mexico	0	0	0	0	0	0	0	0	0	0	4	0	19	2	8	14	29	10	12	22	9	10	14	7	7
		NEI (ETRO)	0	0	0	0	0	30	24	23	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NEI (Flag related)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	429	270	49	0	0	0	0	0	0	
		Norway	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	0	0	
		Sta. Lucia	0	0	0	1	3	2	14	14	14	2	43	9	3	0	0	0	0	0	0	0	0	0	0	0	
		Trinidad and Tobago	0	1	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.	1320	1424	1142	1352	1289	1483	1636	1582	1085	1237	1163	1311	1285	1334	1235	1213	1212	1583	1840	1426	899	717	468	758	764
		UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	1	1	1	0	0	0	0	0	0
		Uruguay	9	16	6	0	2	0	0	1	0	1	0	2	0	0	0	0	0	0	1	0	0	0	0	0	
Discards	ATW	Canada	0	0	0	0	0	14	0	0	0	0	0	0	0	6	16	11	46	13	37	14	15	0	2	0	1
		Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	
		U.S.A.	0	0	514	99	102	119	115	128	211	88	83	138	171	155	110	149	176	98	174	218	167	131	147	100	173

Notes

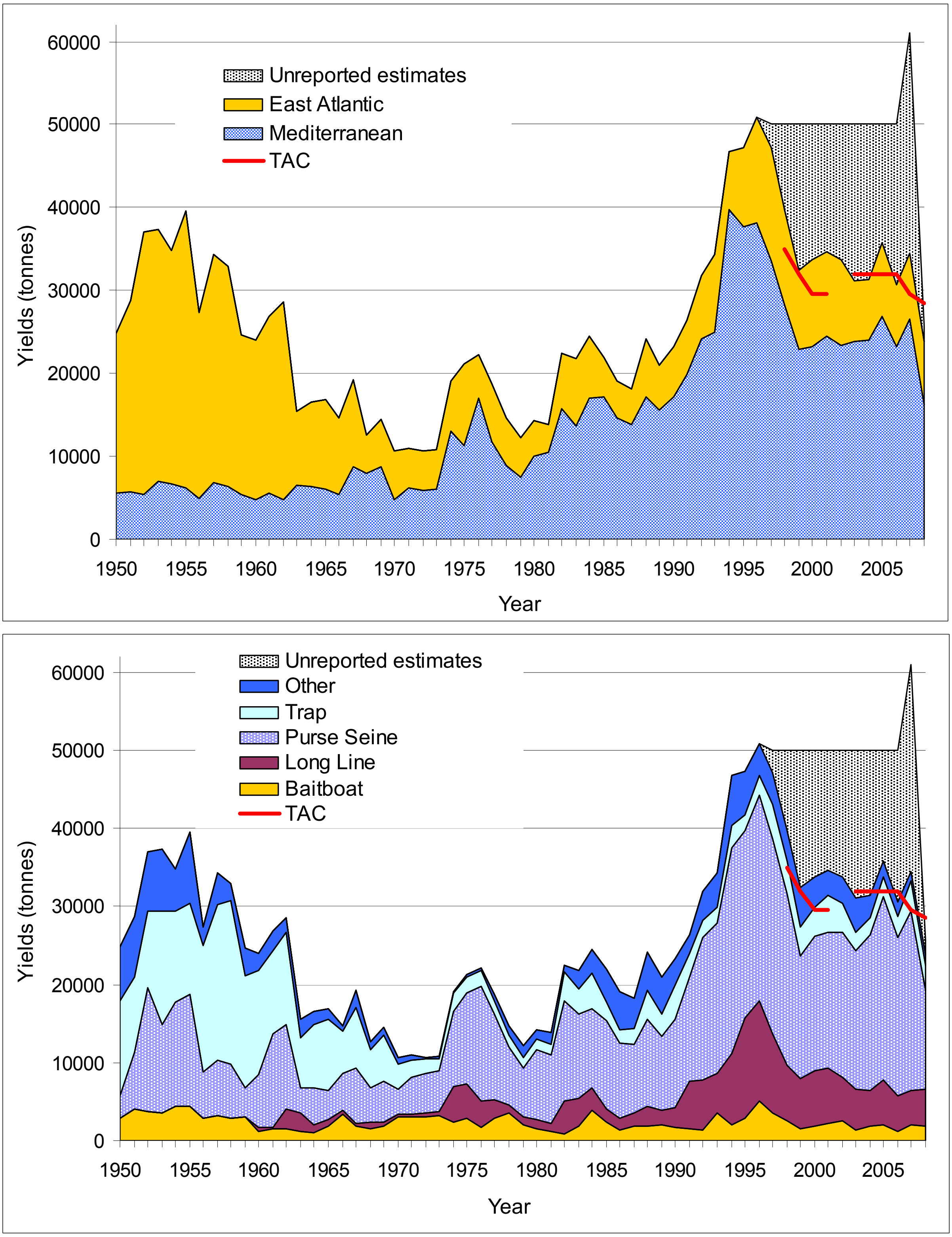
Task-I catches (updated figures) not included in the table: Turkey 2008 MED update (877 t landings; 2 t dead discards), Japan 2008 ATE update (2351 t).



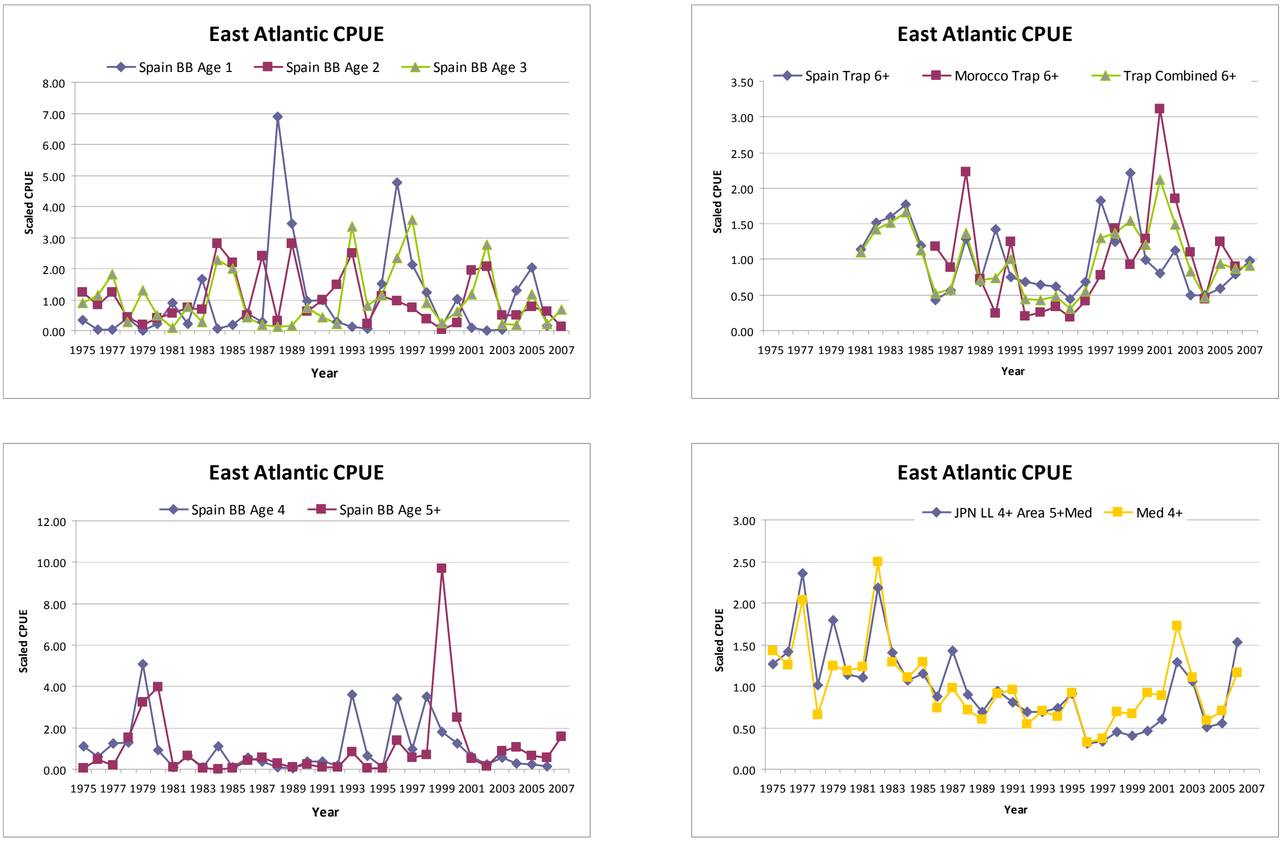
BFT-Figure 1. Geographic distribution of bluefin tuna catches per 5x5 degrees and per main gears.

BFTE-Table 1. **First column**: Fishing vessel categories. **Vessel number Column**: Total number of vessels catching bluefin tuna in the Mediterranean Sea in the East Atlantic and Mediterranean Sea in 2008 (*i.e.* active capacity) estimated on the basis of the list of authorized catching vessels, the weekly catch reports, the VMS data and the expert knowledge. **Best catch rate Column**: Best catch rates estimated by the SCRS Committee on the basis of the same sources of information as Column 2 as well as the summaries of trade information and the caging declarations. **Best Catch Est. Column**: Best SCRS catch estimate for 2008 computed as Column 2 * Column 3. This estimate does not take into account potential IUU. **Pot. Catch Rate Column**: Potential catch rates estimated by the SCRS from the same sources of information as Column 3, but without taking expert knowledge into account. **Pot. Catch Est. Column**: Potential catch estimate for 2008 computed as Column 2 * Column 5. This estimate may be seen as the utilized capacity under [Rec. 08-05] and could give a better indication of the total catch if substantial IUU fishing from registered vessels has occurred. **Past Catch rate Column**: Catch rates used by the SCRS in 2006 and 2008 when the rebuilding plan [Rec. 06-05] and [Rec. 08-05] was not yet implemented. **Past Catch est. Column**: Catch estimate computed as Column 2 * Column 7. This level would be the potential catch that the fleet could have taken in 2008 if the rebuilding plan had not been implemented. This level is given for comparison purposes with past “capacity tables”.

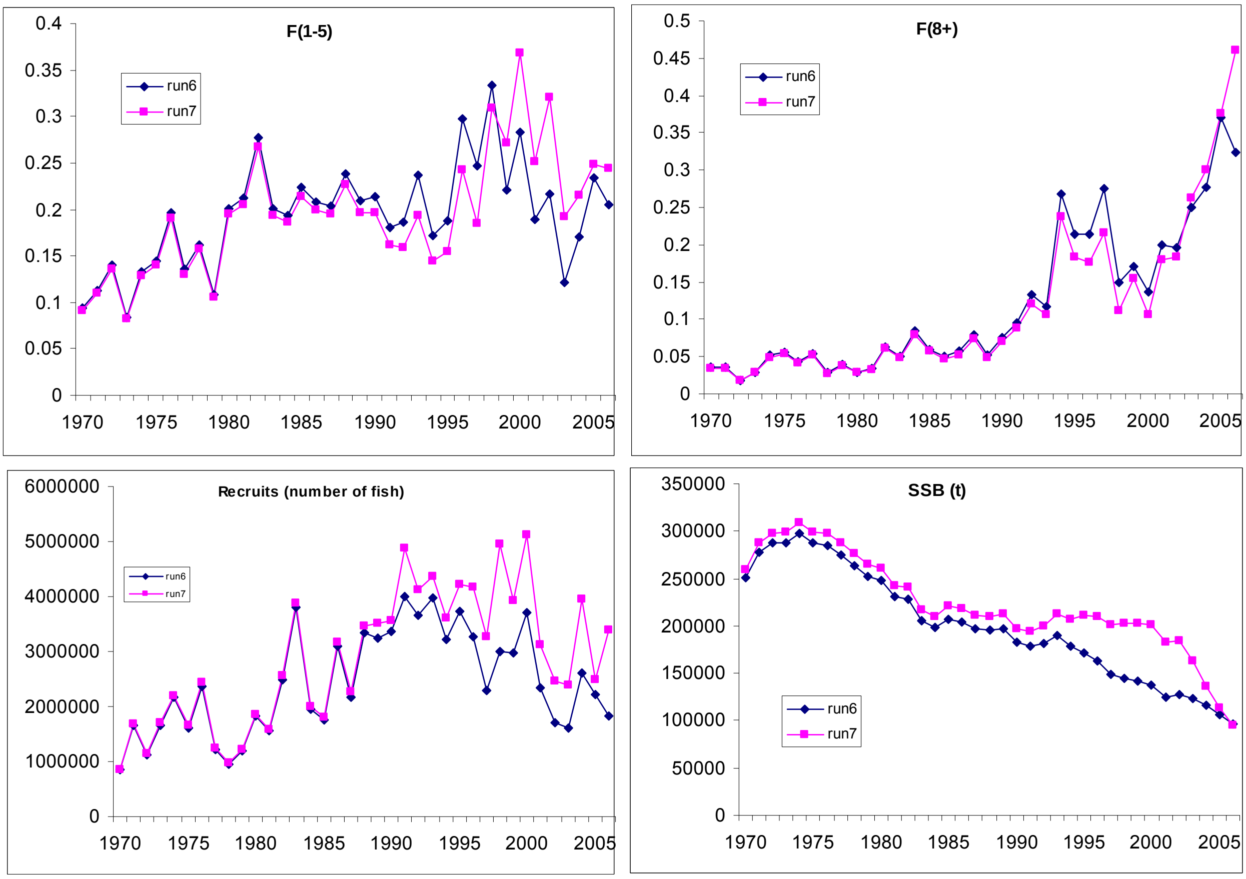
2008 East Atlantic & Mediterranean	Vessel number	Best Catch rate	Best Catch Est.	Pot. catch rate	Pot. catch est.	Past catch rate	Past catch est.
PS large	76	70.66	5370	54.95	4176	300	22800
PS medium	184	49.78	9160	57.29	10542	150	27600
PS small	57	33.68	1920	32.60	1858	40	2280
LL large	52	25	1300	16.54	860	50	2600
LL medium	22	5.68	125	6.59	145	20	440
LL small	217	5	1085	3.25	826	10	2170
Bait Boat	59	19.75	1165	19.75	1165	40	2335
Handline	139	5	695	10	1390	4	556
Trawler	49	10	490	25	1225	15	735
Trap	25	130	3250	300	7500	245	6125
Other artisanal	240	5	1200	19	4560	4	960
Grand Total	**1120**		**25760**		**34247**		**68601**



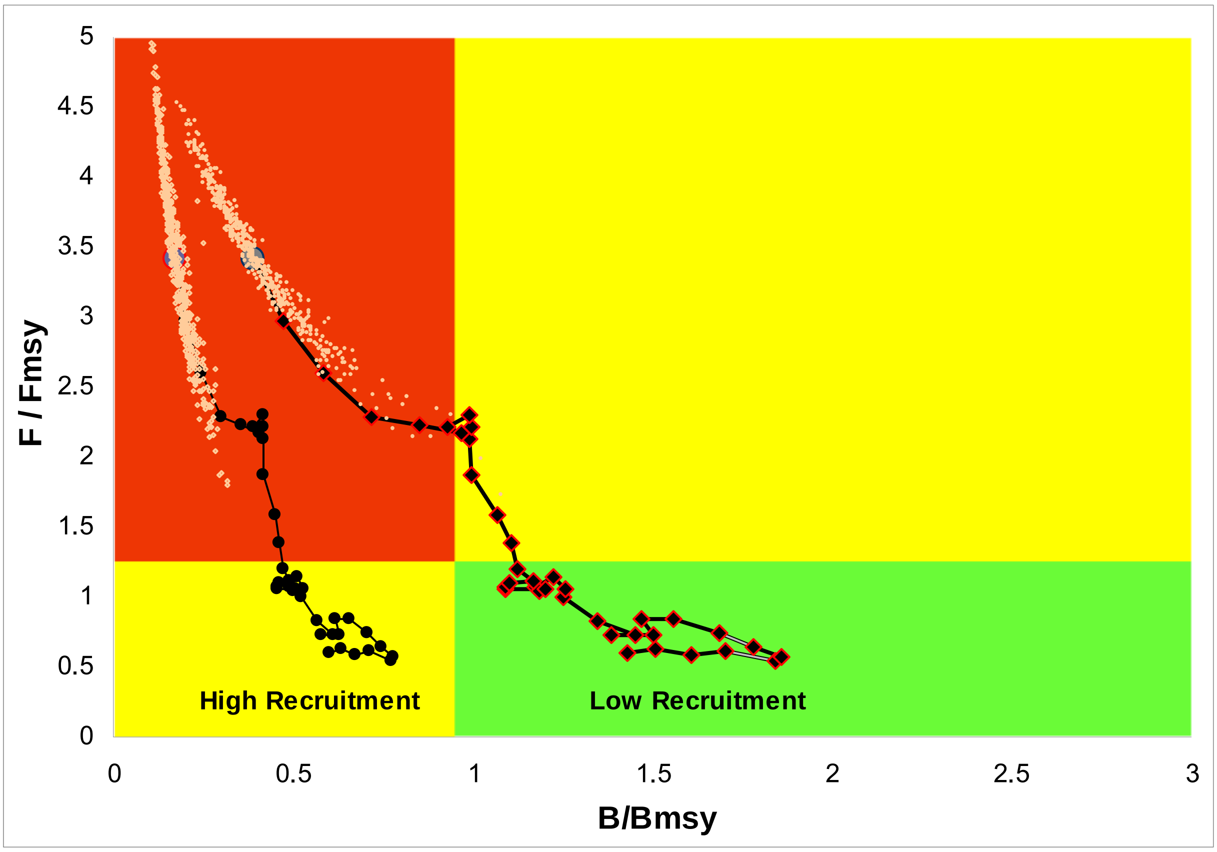
BFTE-Figure 1. Reported catch for the East Atlantic and Mediterranean from Task I data from 1950 to 2008 split by main geographic areas (top panel) and by gears (bottom panel) together with unreported catch estimated by the Committee from fishing capacity and mean catch rates over the last decade (see **BFTE-Table 1**) and TAC levels from 1998 to 2008.



BFTE-Figure 2. Plots of the standardized CPUE time series that have been used in the different VPA runs of the East Atlantic and Mediterranean bluefin tuna stock.



BFTE-Figure 3. Fishing mortality (for ages 1 to 5 and 8+), spawning stock biomass and recruitment estimates from VPA runs 6 (reported catch) and run 7 (adjusted catch).



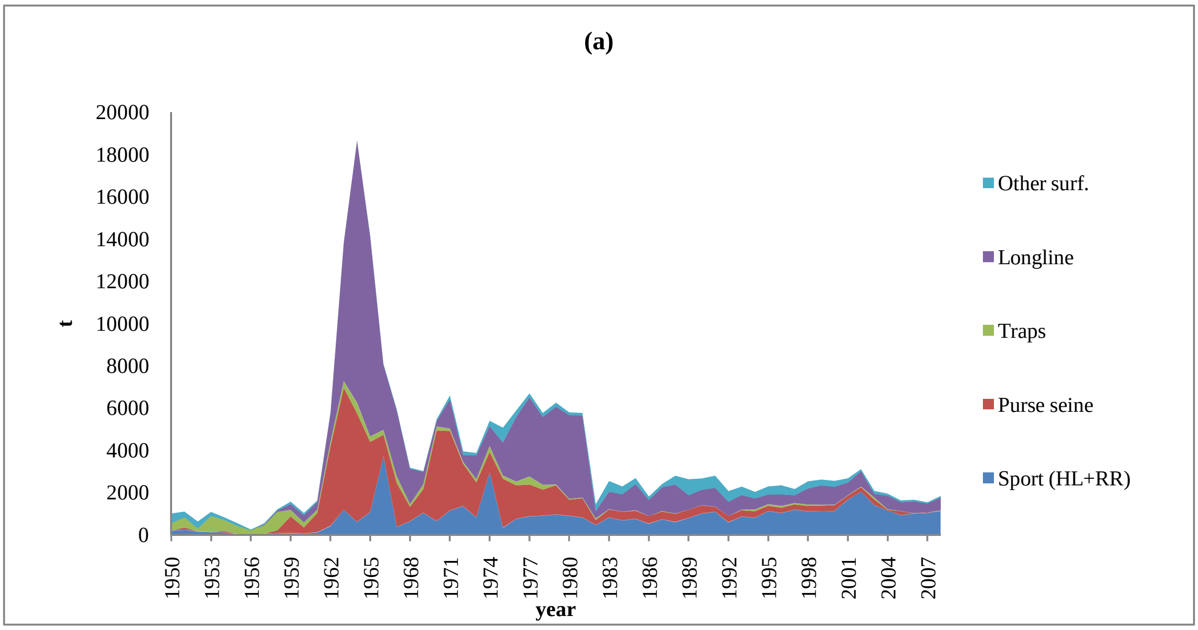
BFTE-Figure 4. Stock status estimated from VPA run 14 (i.e. equivalent to run 7 but for the 1955-2006 period) considering either high recruitment (average from the 1990s) or low recruitment (average from the 1970s) levels. The terminal year (2006) is highlighted by a larger dot. White dots represent the distribution of the terminal year obtained through bootstrapping.

BFTW-Table 1. Estimated chance of recovery under the high and low recruitment scenarios and various levels of future catch. Green shading indicates the chance of recovery by the given year is greater than or equal to the reference probability level (50 or 75 percent). Red shading indicates the chance of recovering by 2019 is less than the reference probability level.

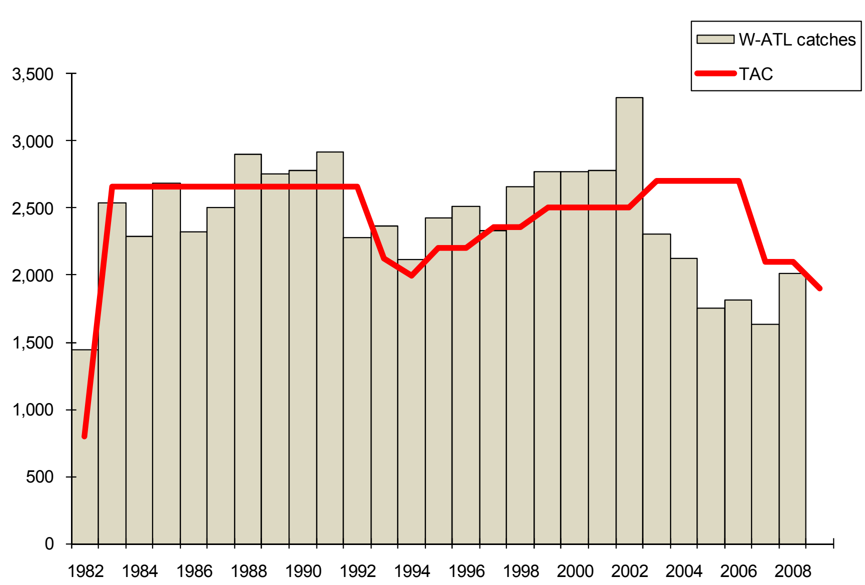
Projected Catch Level (t)	*50% Probability*		*75% Probability*	
	Low	*High*	*Low*	*High*
0	2012	No	2013	No
500	2012	No	2013	No
1,000	2013	No	2014	No
1,500	2014	No	2015	No
1,600	2014	No	2016	No
1,700	2015	No	2016	No
1,800	2015	No	2017	No
1,900	2015	No	2018	No
2,000	2016	No	2019	No
2,100	2017	No	No	No
2,200	2017	No	No	No
2,300	2018	No	No	No
2,400	2019	No	No	No
2,500	No	No	No	No
2,600	No	No	No	No
2,700	No	No	No	No
3,000	No	No	No	No
5,000	No	No	No	No

BFTW-Table 2. Estimated chance of ending overfishing under the high and low recruitment scenarios and various levels of future catch. Entries are year overfishing ends or "no" if overfishing has less than the given probability of success by 2019.

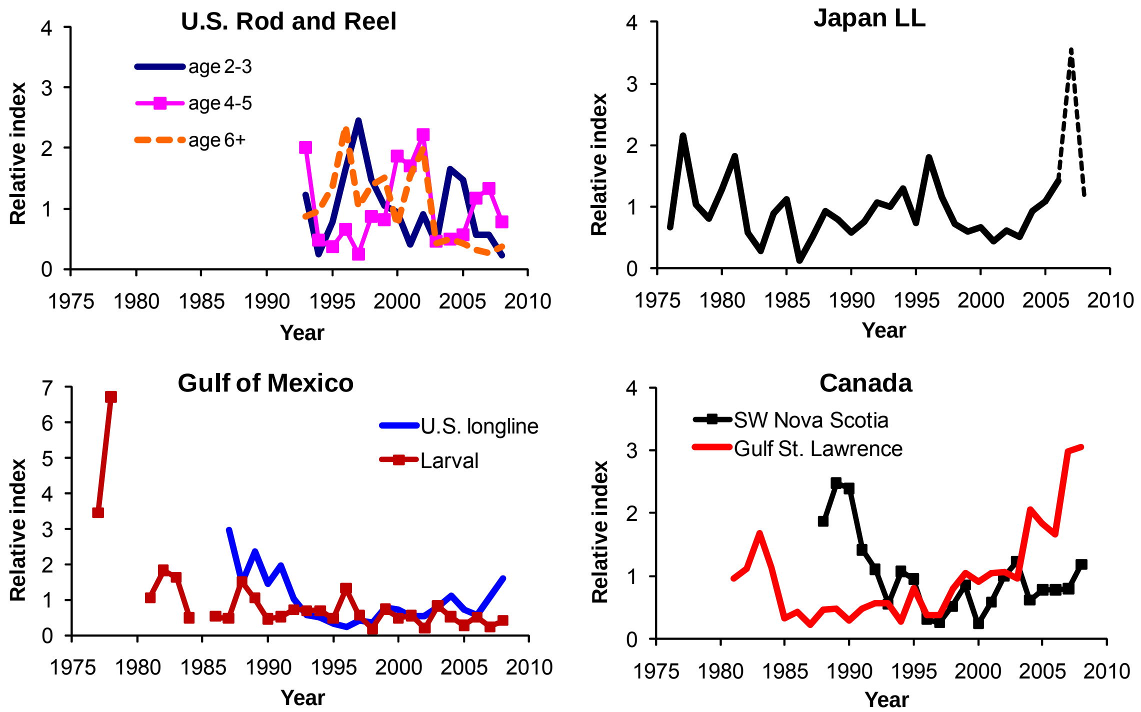
Projected Catch Level (t)	*50% Probability*		*75% Probability*	
	Low	*High*	*Low*	*High*
0	2009	2009	2009	2009
500	2009	2009	2009	2009
1,000	2009	2009	2009	2010
1,500	2009	2009	2009	2015
1,600	2009	2010	2009	2016
1,700	2009	2011	2009	2018
1,800	2009	2012	2011	2019
1,900	2009	2013	2012	No
2,000	2010	2014	2013	No
2,100	2011	2015	2014	No
2,200	2012	2016	2016	No
2,300	2014	2017	2019	No
2,400	2015	2018	No	No
2,500	2017	No	No	No
2,600	No	No	No	No
2,700	No	No	No	No
3,000	No	No	No	No
5,000	No	No	No	No



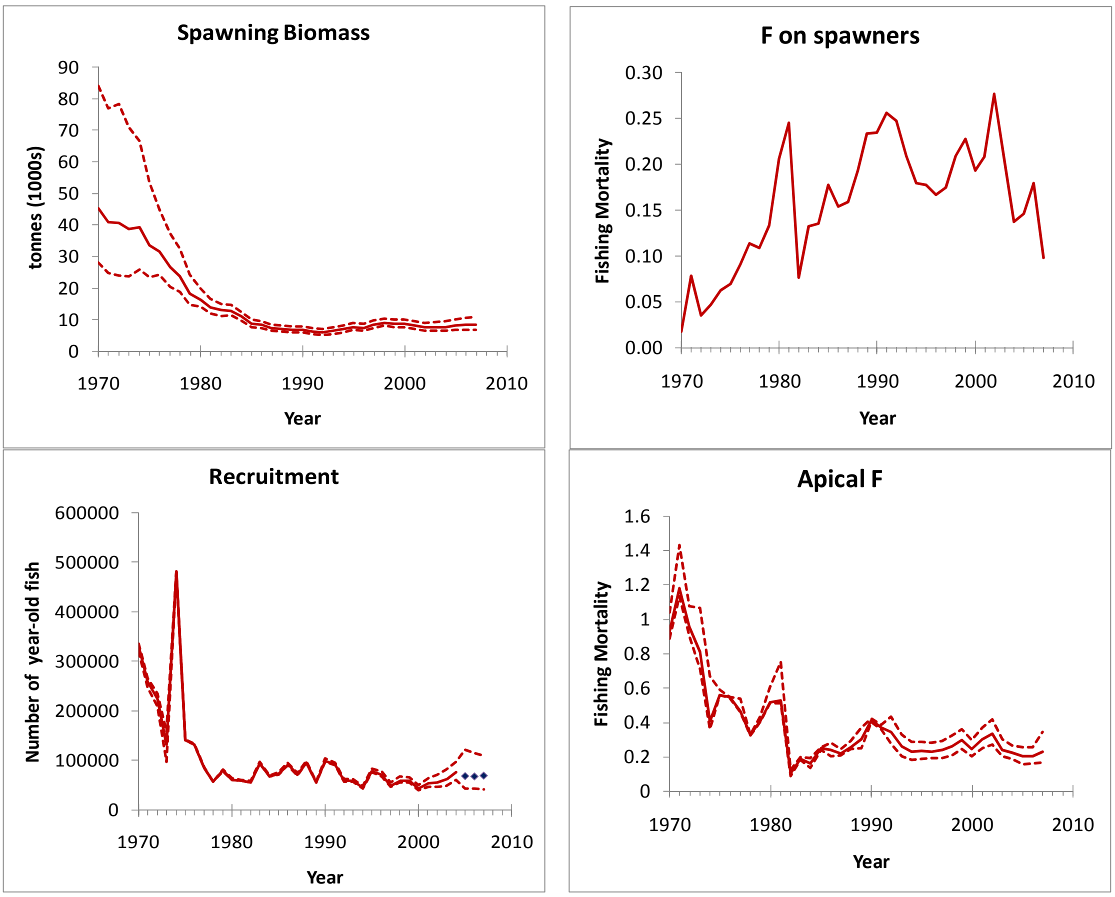
(b)



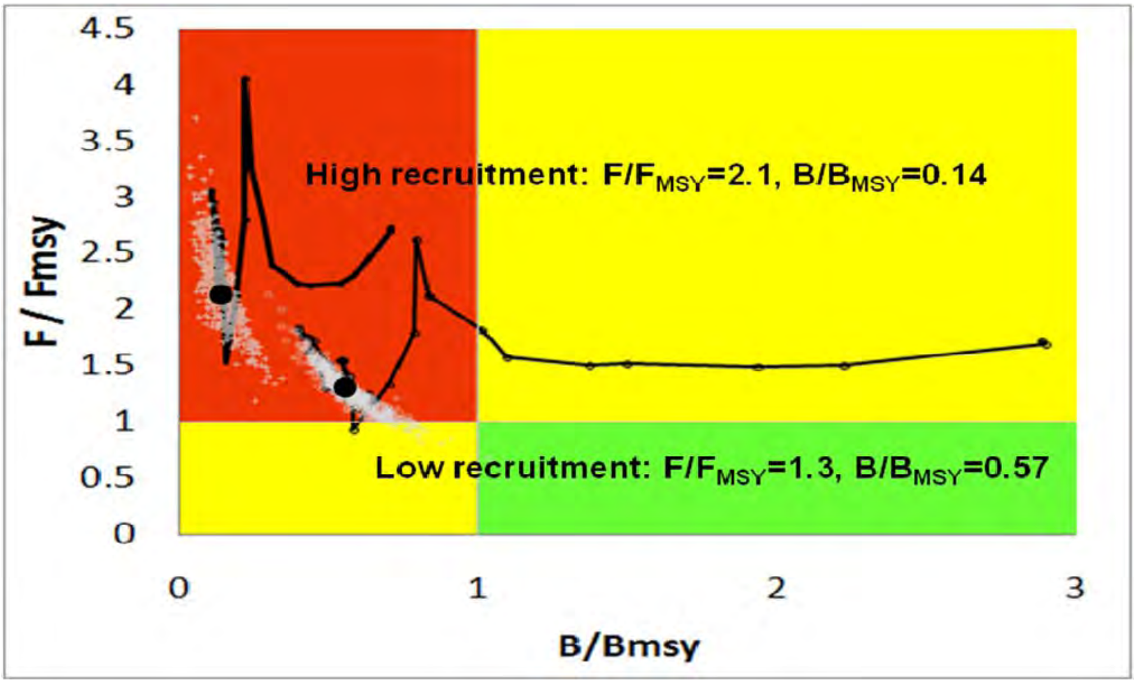
BFTW-Figure 1. Historical catches of western bluefin tuna: (a) by gear type (LL=longline, TP=trap, PS=purse seine, HL/RR= hand line/rod and reel) and (b) in comparison to TAC levels agreed by the Commission.



BFTW-Figure 2. Updated historical indices of abundance for western bluefin tuna. The dashed portion of the Japanese longline series represents the trends estimated after 2006, which were not considered reliable by the 2008 SCRS.

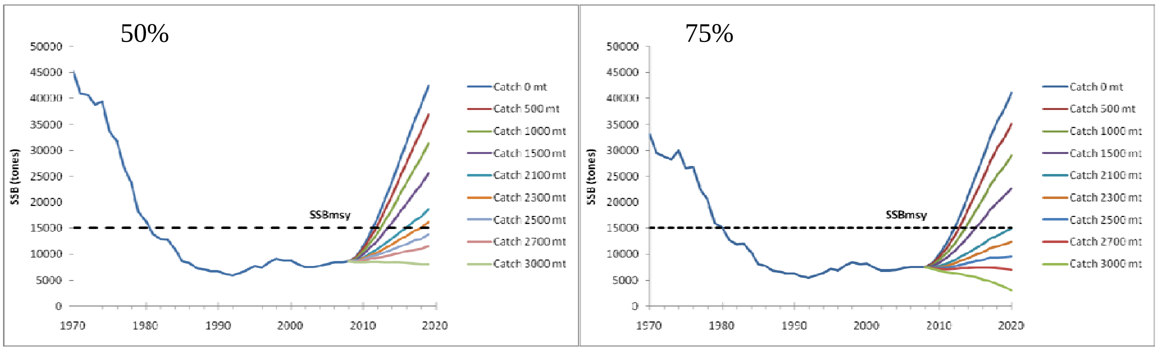


BFTW-Figure 3. Median estimates of spawning biomass (age 8+), fishing mortality on spawners, apical fishing mortality (F on the most vulnerable age class) and recruitment for the base VPA model. The 80% confidence intervals are indicated with dotted lines.

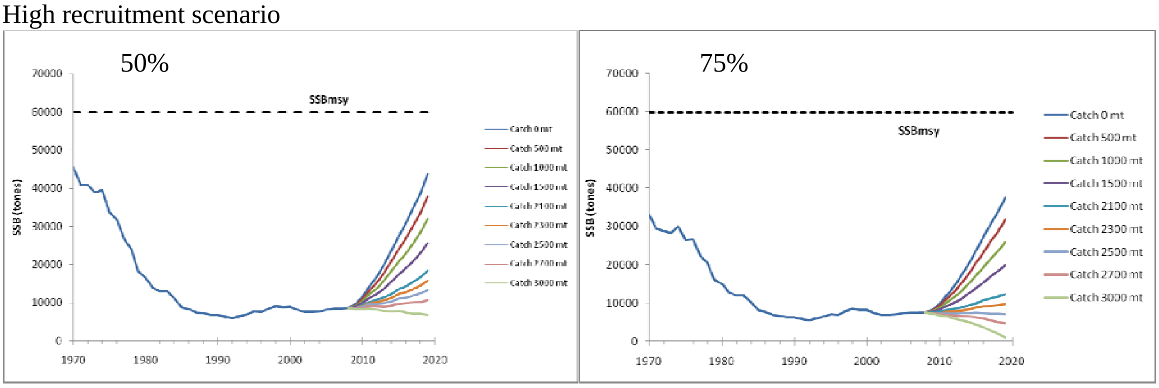


BFTW-Figure 4 Estimated status of stock relative to the Convention objectives (MSY) by year (1970 to 2007). The lines give the time series of point estimates for each recruitment scenario and the clouds of white symbols depict the corresponding bootstrap estimates of uncertainty for the most recent year.

Low recruitment scenario



High recruitment scenario



BFTW-Figure 5 Projections of spawning stock biomass (SSB) for the Base Case assessment under low recruitment (top panels) and high recruitment (bottom panels) and various levels of constant catch. The labels “50%” and “75%” refer to the probability that the SSB will be greater than or equal to the values indicated by each curve. Note that curves are arranged sequentially in the same order as the legends. The dashed horizontal lines represent the median (50%) level of SSB at MSY.

Attachment 11

Doc. No. PA2-604 / 2009

Original: English

Extension of the 2009 SCRS Meeting to Consider the Status of Atlantic Bluefin Tuna Populations with Respect to CITES Biological Listing Criteria

Madrid, Spain, October 21-23, 2009

1. Opening of the meeting and arrangements

The meeting was opened by Mr. Driss Meski, Executive Secretary, who welcomed participants. He thanked them and their organizations for their efforts to participate in this meeting which had been planned on short notice. Mr. Meski highlighted the relevance of the meeting to the work of ICCAT as a whole. Dr. Powers (Chair) also welcomed participants and stressed the need to focus on the terms of reference (Appendix 12 to the 2009 SCRS Report), given the short duration of the meeting.

The Agenda is attached as **Appendix 1** and the List of Participants is attached as **Appendix 2**.

The items in this Report do not necessarily follow the Agenda. The following served as Rapporteurs for various subjects:

Opening and closing: Secretariat
Document summaries: G. Diaz
CITES Criteria: J. Neilson
Analyses and results for the East: J.-M. Fromentin and G. Diaz
Analyses and results for the West: S. Cass-Calay and G. Diaz

2. Documents presented at the meeting

A number of documents were presented to the Committee that included stock projections, estimation of parameters relevant to the CITES criteria (e.g., virgin stock biomass, productivity) and other information relevant to the Terms of Reference for the meeting.

SCRS/2009/193 presented estimates of productivity of Atlantic bluefin tuna, *Thunnus thynnus* (BFT). The author pointed out that for many stocks it is difficult to estimate natural mortality. In the case of BFT, tagging experiments were unsuccessful in estimating natural mortality. For stock assessment purposes, estimates of natural mortality used by the SCRS were obtained from other similar species. Therefore, in the case of BFT, estimating productivity using only natural mortality can lead to wrong conclusions. Another approach to estimate productivity is to use the S-R relationship (shape and slope). However, S-R relationships are uncertain for both bluefin tuna stocks. Given the limitations just explained, the author used potential population growth rate (r’) as a way to estimate productivity. The document concluded that there is a large difference between the productivity of both stocks which is mostly based on the difference in age of maturity and that the productivity of eastern BFT is close to that of North Atlantic swordfish. The authors also compared growth between species. However, The Committee discussed the difficulties in comparing K among species because it is highly correlated with L_∞ and t_0. The conclusion of the document is that eastern BFT can be considered as a medium productivity stock and the western BFT as a low productivity stock. It was pointed out that age of maturity might depend on levels of exploitation, which could explain the differences observed between the stocks. But, in the case of the eastern stock, no change in age of maturity was observed in the last 40 years. If changes in age of maturity occurred due to exploitation then they might have happened at an earlier time. It was also pointed out that the perceived differences in life history between both stocks could be the result of thousands of year of some level of exploitation. The

Committee also discussed that growth was estimated from stocks that that are being heavily exploited and therefore it might not reflect the true growth of the population. It was also noted that calculation of r' were quite different from other estimates that were available to the Committee. However, it was pointed out that the information to estimate r' was obtained from parameter values published in scientific literature. The document concluded that given the differences in productivity between both stock of Atlantic bluefin tuna, a threshold of 15% (upper level of low productivity species and lower level of medium productivity species) therefore seems most appropriate.

Documents SCRS/2009/194,195 and 196 presented VPA results and projections for both BFT stocks. In the case of the eastern stock, projection scenarios included catch levels (reported and 'inflated'), 3 levels of steepness (0.5, 0.75, 0.99), 2 time series of recruitment, and with both perfect implementation and a 20% implementation error of TACs implemented by [Rec. 08-05]and three additional catch levels (i.e., 15,000 t, 8,500 t, and 0 t). For the western stock, projections were run using the TACs implemented by [Rec. 08-04] and additional levels of catch (i.e., 1,500 t, 1,000 t, 500 t, and 0 t). In the case of the eastern stock, the stock will further decline under the [Rec. 08-05] management scenario in most of the cases assuming a steepness of 0.5, but will increase with higher levels of steepness. Catches of 15,000 t or 8,000 t were projected to result in different levels of SSB increases depending on the assume steepness. Projections for the western stock showed catches of 1,800 t (Rec. 08-04) or lower will result in increases of the SSB. The median SSB increase by year 2018 estimated by combining all scenarios was 7.2% for the eastern stock and 10.6% for the western stock. Diagnostic plots showed that for the case of steepness 0.5 the model did not fit the observed data and that the estimated SSB0 values with this steepness were unrealistically high. Therefore, the Committee decided not to include the scenario of steepness=0.5 in future projections. The Committee also discussed if carrying capacity K was taken into consideration in the estimation of SSB0 in the context that ecosystem changes might alter historical values of K. There was a general agreement that K is inherently taken into consideration in the S-R relationship used. The Committee also discussed that, in the case of the Eastern stock, a great number of scenarios were considered and all were given equal weighting and that it might be necessary to reduce the number by excluding the less plausible ones. The Committee also agreed in maintaining both scenarios of full implementation of management regulations and a 20% implementation error as it was not up to this Committee to choose one scenario over the other. Finally, the Committee agreed to perform a detailed review of inputs and methodologies used by the authors of the three documents to verify that the estimated parameters are compatible.

SCRS/2009/197 described how to apply the criteria to marine exploited species. The document used ratios of biomass gain/loss as a proxy for product ivy and it concluded that Atlantic bluefin tuna is a low productivity species. The Committee discussed that mortality in the age range of 30-40 year is most probably higher than for ages 10-30; therefore using the same M=0.1 for all ages 10+ might lead to biased results. However, it was pointed out that the stock has very low numbers of fish in the ages 30+ and therefore they have very little influence in the estimation of overall biomass ratios.

SCRS/2009/198 presented updated CPUE series of BFT in Moroccan Atlantic traps estimated using a GLM approach with a negative binomial error assumption. Results indicated that the factors year and trap were highly statistically significant. Estimated CPUE series showed what the authors hypothesized to be a 13 yr abundance cycle. The average CPUE for the period after the second peak (2002-2009) is 2.4 times higher than the one of the first period (1989-1996). The study also highlights the increasing trend in the abundance (in number) of the bluefin tuna spawners migrating from eastern Atlantic to the Mediterranean since 2004. This upward trend in the CPUEs has been accompanied by an increase in the mean weight (Idrissi and Abid, SCRS/2009/176). The Committee discussed the possibility of abiotic (e.g. temperature) and biotic (e.g. prey availability) factors affecting the availability of fish to the traps. The Committee recognized the importance of the work, but it agreed that the results presented could not be taken into consideration into further consideration without also considering all other BFT CPUE time series.

Although not submitted as a SCRS document, the Committee also discussed the document titled ‘Supplementary information to the draft proposal to CoP15 to include bluefin tuna (*Thunnus thynnus*) on Appendix I of CITES as proposed by Monaco’ authored by A. Silfvergrip. Using an estimated harmonic mean of M, and estimates of age of maturation, generation time, population growth rate and K obtained from scientific literature, and comparing these values with standards established by the FAO and the American Fisheries Society (AFS) the author concluded that that Atlantic bluefin tuna is a low productivity species. The author also recognized that bluefin tuna has a high fecundity, but indicated that low productivity species with high fecundity is not uncommon among marine species.

3. Discussion of CITES Criteria

Mr. David Morgan (representing the CITES Secretariat) gave the Committee an introduction to CITES and the process for amending its Appendices, with special reference to commercially exploited aquatic species (see http://www.cites.org/eng/res/09/09-21R13.shtml). In brief, a species is to be considered for listing under Appendix 1 if at least one of the following criteria is met:

A. The wild population is small, and is characterized by at least one of the following:
   i) an observed, inferred or projected decline in the number of individuals or the area and quality of habitat; or
   ii) each subpopulation being very small; or
   iii) a majority of individuals being concentrated geographically during one or more life-history phases; or
   iv) large short-term fluctuations in population size; or
   v) a high vulnerability to either intrinsic or extrinsic factors

B. The wild population has a restricted area of distribution and is characterized by at least one of the following:
   i) fragmentation or occurrence at very few locations; or
   ii) large fluctuations in the area of distribution or the number of subpopulations; or
   iii) a high vulnerability to either intrinsic or extrinsic factors; or
   iv) an observed, inferred or projected decrease in any one of the following:
      – the area of distribution; or
      – the area of habitat; or
      – the number of subpopulations; or
      – the number of individuals; or
      – the quality of habitat; or
      – the recruitment.

C. A marked decline in the population size in the wild, which has been either:
   i) observed as ongoing or as having occurred in the past (but with a potential to resume); or
   ii) inferred or projected on the basis of any one of the following:
      – a decrease in area of habitat; or
      – a decrease in quality of habitat; or
      – levels or patterns of exploitation; or
      – a high vulnerability to either intrinsic or extrinsic factors; or
      – a decreasing recruitment.

The discussions of The Committee are summarized by criterion below. The majority of the considerations of the Committee focused on the third criterion.

Small Wild Population

The Committee discussed what the meaning of “small population” was in the CITES context. It was noted that while the CITES Annex Five (Resolution Conf. 9.24 (Rev. CoP14)) contains some examples of small populations, those guidelines were not necessarily developed with commercially-exploited aquatic species in mind. During the 2008 stock assessment, the SCRS estimated that the eastern stock included about 5 million individuals in 2007 (among which about 1,000,000 were spawners), while the western stock was about 10 times lower than the eastern one.

The question of effective population size was considered, and it was noted that a recent study of Mediterranean bluefin tuna was completed that compared genetic diversity from 1911 to 1926 to more contemporary (1999– 2007) samples (Riccioni *et al.* 2009, SCRS/2009/186). Those authors concluded that there was no loss of genetic diversity over the period examined. Their estimates of effective genetic population size (Ne) were in the order of 400-700 individuals, which would translate, from a genetic perspective, into subpopulation size estimates (obtained from genetic variation and empirical data for marine species) on the order of 10^6-10^7 (SCRS/2009/186). An estimate of effective population size is not available for the population as a whole. However, the Committee noted that genetic diversity can remain high for a considerable length of time, even when the population is at a low level of abundance.

The Committee concluded that Atlantic bluefin tuna probably could not be characterized as “small”, in an absolute abundance sense.

Restricted Area of Distribution

Although the Atlantic bluefin tuna population is managed as two stocks, separated by the 45°W meridian, its population structure remains poorly understood and needs to be further investigated. Recent genetic and microchemistry studies as well as work based on historical fisheries tend to indicate that the Atlantic bluefin tuna population structure is complex. There have been documented disappearances and re-appearances of population components in both the east and west Atlantic (for a recent review of the spatial structure of Atlantic bluefin tuna, see Fromentin 2009). The Committee agreed that the spatial distribution of Atlantic bluefin tuna can be generally considered to be wide.

Marked Decline in Population Size

A participant asked if the “three generation” time frame would apply to Atlantic bluefin tuna in terms of defining recent declines in the CITES context. Mr. Morgan explained that for Atlantic bluefin tuna, as a commercially-exploited aquatic species in the CITES context, a 10-year period should be used. It was also clarified that both the historical extent of decline and recent rate of decline, as related to the criteria for CITES Appendix I for commercially exploited aquatic species, must be looked at in reference to the baseline population size or biomass.

The Committee then discussed the definition of the historical baseline, and enquired what the interpretation of CITES was. CITES Secretariat responded that there was no single view concerning this, and proponents and interested parties typically make a choice on a case-by-case basis. Some participants recalled that the Terms of Reference were that virgin biomass should be defined using the longest time frame that is possible. It was further noted that the Terms of Reference included both estimated virgin biomass and the highest observed value. The Committee noted the difficulty of defining B_0, and returned to this issue in other discussions.

The CITES Secretariat was asked to expand on the concept that “recent decline” could be observed as ongoing or as having occurred in the past (but with a potential to resume). Under the situation where there was a very low probability of a resumption of a decline, would a historical decline therefore still be of significance? It was clarified that in the CITES criteria, the historical decline is the primary criterion, and remains of key significance, regardless of available information on more recent declines, or the potential for a decline to resume or reverse.

The Committee enquired how CITES dealt with uncertainty in estimates of stock status in commercially exploited marine species. The CITES representative noted that Atlantic bluefin tuna had complete information relative to other species that have been included in the CITES Appendices in the past, and its experience with stock status advice that contained estimates of uncertainty was limited. The meeting Chair noted that the intent of the current meeting was to generate information on stock status that included measures of uncertainty.

4. Evaluation of Decline

4.1 Methods

All of the calculations made by the Committee were based on the results of the 2008 stock assessments of eastern and western Atlantic bluefin. Details of the assessment are contained in ICCAT Col. Vol. Sci. Pap. 64(1): 1-352.

The calculations aimed to estimate "decline" with regards to Annexes 2 and 5 of the CITES listing criteria. This was done:

1. From a historical perspective by comparing current (2009) population size (as measured by SSB) against both (a) unexploited population size, and (b) the maximum historical population size estimated in the stock assessment. (Note: the last year in the assessment was 2007, which means that the 2009 year was estimated from a projection of the assessment results).

2. From a future perspective by comparing future (2019) population size (as measured by SSB) against either (a) unexploited population size or (b) the maximum historical population size estimated in the stock assessment, and (c) by comparing population size in 2019 against that in 2009.

Besides some graphical displays, the results were couched primarily in terms of the probability that SSB was below 10%, 15% or 20% of the baseline (SSB_o or max[SSB_t]). These probabilities were calculated on the basis of the bootstrap results from the stock assessments and projections. In some cases, the probabilities of combined scenarios were calculated with equal weighting.

Stock-specific details about the methods used are given below.

4.1.1 Western stock

The 2008 "base case" stock assessment was used. The Committee considered that the two different methods used in the 2008 assessment for calculating the stock recruitment relationships (SRR) (so-called "high" and "low" recruitment scenarios, **Figure 1**) would be the basis for calculating SSB_o (which would be the SSB resulting from a long-term projection at F=0 using the VPA 2-Box software). The "high recruitment" scenario reflects a hypothesis that potential productivity has shown no trend over the assessment period; the latter reflects the hypothesis that productivity potential has shifted to a lower level after the late 1970s.

In the projections, the 2008 catch was set to 2,015t. Two management scenarios were considered: One following the TACs established in Rec. [08-04], and another one setting the catches in 2010 and after equal to 0. Perfect implementation was assumed for both scenarios.

4.1.2 Eastern stock

The Committee reviewed the approaches explained in SCRS/2009/194 to estimate the stock-recruitment relationship. Both approaches fix the steepness of the SRR and are fitted to the estimated

SSB and R observations (for either a subset of years or for the entire time series). The method requires the calculation of SSB/R at F=0, which can be done in two different ways. The Committee preferred the approach based on equilibrium per-recruit computations.

The BFTE assessment of 2008 considered three different steepness values (0.5, 0.75 and 0.99) and three different sets of SSB-R observations which coincided with periods of "low", "medium" or "high" recruitment: 1970-1980, 1970-2002, and 1990-2002, respectively.

A closer examination of the fitted relationships (**Figure 2**) indicated that the steepness=0.5 scenarios could not be supported by the observations, because the amount of catches that would have had to occur historically for the stock size to be at such low levels would have been huge. However, this does not correspond with our current knowledge about BFTE fisheries in the past 200 years. On the other hand, a steepness of 0.99 would also be difficult to justify on biological grounds, especially because it would imply very strong density dependence among young stages. For these reasons, the Committee decided to present all results, but to focus on the steepness=0.75 as the "base case".

The 2008 stock assessment was conducted using two catch data sets. One used the reported catches, and the other one used catches adjusted to reflect the estimated quantity of unreported and illegal fishing up to 2007 (the last year in the assessment). In terms of projections, for the scenarios that use reported catch, the 2008 catch was set to 23,850 t; for the scenarios that use adjusted catches, the 2008 catch was set to 34,120 t.

Thirty-six projections were made for the following combinations, assuming that catches in 2009 and thereafter would follow the TACs in Rec. [08-05]:

3 steepness levels (0.5, 0.75, 0.99)
2 recent catch levels in the VPA (reported or adjusted)
3 periods of SSB-R observations for the SRR (1970-1980, 1970-2002, and 1990-2002)
2 implementation levels (perfect, and 20% overages, as was assumed in 2008)

In addition, the Committee agreed that it would be useful to provide ICCAT with additional advice that reflects the management recommendations made by SCRS in 2009. For this reason, additional scenarios were considered with 2010-2019 catches of 15,000t (approximating an F_{max} strategy), 8,500t (approximating an $F_{0.1}$ strategy), and zero catches, with the "base case" steepness and the three recruitment levels, and perfect implementation.

4.2 Evaluation for the western stock

The described tables were constructed for the two 2008 western Atlantic bluefin base models, low and high recruitment (**Table 1**). For projection purposes, only two future catch levels were examined, 1) “perfect implementation” of Rec. 08-04 (1,900 t in 2009, 1,800 t in 2010 with 1,800 t carried forward until 2019 and 2) projection of zero catch allowed after 2009.

It is evident that the results of the analysis are dependent on the baseline chosen. If the maximum value of SSB during 1970-2007 is selected, the results suggest that the probability that the stock is at <10%, <15% or <20% of maximum SSB is 8%, 30% and 54%, respectively. Since the estimate of max SSB is not affected by the recruitment assumption, the results are identical for the high and low recruitment scenarios **(Table 1)**. If the SSB at unfished condition (SSB_0) is selected as the baseline, the probability that the stock is at <10%, <15% or <20% of SSB is 30%, 93% and 96% (respectively) for the low recruitment scenario. The high recruitment scenario indicates a near 100% probability that the stock is below 10% of SSB_0 **(Table 1)**. It should be noted that max SSB is a lower threshold (45,000 t) than SSB_0 (80,000 to 221,000 t).

The potential for improvement during the next ten years is also summarized in **Table 1**. Assuming perfect compliance of Rec. 08-04 and subsequent TACs of 1,800 t, the probability that SSB in 2019 will remain below 20% of either baseline is less than 15% for the low recruitment model. For the high recruitment model, the result is strongly dependent on the baseline selected. The probability that SSB in 2019 will remain below 20% of max SSB is 9% and the probability that SSB in 2019 will be below 20% of SSB_0 is 95%. However, in all cases the results indicate it is very unlikely that depletion will continue. In more than 99% of the model realizations SSB in 2019 was predicted to be greater than SSB in 2009. Not surprisingly, the potential to recover to levels above 20% of the baseline is near 100% if no catches are allowed after 2009.

After reviewing the probability tables for the western stock **(Table 1)** the Committee agreed that they only provide a 'snapshot' of the stock status and do not reflect the fact that the western stock has been 'overexploited' but stable for the past 2 decades (i.e., the stock has remained relatively stable at low levels of abundance; **Figure 3**). It was also recognized that although the tables might be difficult to interpret, they reflect the scientific uncertainty associated with the estimated probabilities. It was recognized that the Commission should be precautionary in the interpretation of the projections since past projections of stock status have proven overly optimistic.

The Committee also discussed the merit of producing probability tables that combined results from both recruitment scenarios. Combined advice would imply equal likelihood of both recruitment models. In past, the Committee has been unwilling to assign likelihoods for the recruitment scenarios, therefore implying that both scenarios were considered to be equally plausible. Therefore the Committee agreed not to include combined probabilities.

Both calculations of the baseline (max SSB and SSB0) have limitations. It was noted that maximum SSB was estimated from a time series that started in 1970 while there were periods of large catches in the 1960s. Therefore the short time series could give a false impression of the magnitude of maximum SSB (i.e. underestimated). The Committee also recognized that there is high uncertainty in the estimates of SSB_0 (median = 80,000 t when low recruitment is assumed, 221,000 t with high recruitment) while the estimate of max SSB is independent of our assumptions regarding recruitment scenarios. Therefore, the Committee recognized the need to include both baseline parameters, and interpret them with caution.

4.3 Evaluation for the eastern stock

The Committee reviewed the probability tables that included the results of 54 separate scenarios of different steepness and recruitment assumptions (**Appendix 3**). It was noted that different assumptions of steepness and recruitment levels produce very different estimates of virgin spawning stock biomass (SSB_0), ranging from about 825 thousand t to 2.81 billion t. The Committee emphasized that not all the values in the range are plausible and the wide range is the result of uncertainty in the assumption of steepness.

The probability tables included values for all the scenarios comparing SSB_{2009} and projected SSB_{2019} against three different proportions (benchmarks) of the SSB_0 and maximum SSB (0.1, 0.15, and 0.2), and the probabilities of $SSB_{2019} < SSB_{2009}$, an indication of future SSB decline or increase.

Time series of the ratios SSB_{year}/SSB_0 showed that, in most cases, the SSB of Eastern BFT was low throughout the time series (**Figure 4**). The Committee discussed particular cases where projected probabilities seemed to be inconsistent with the probabilities from the historical time series. However, it was pointed out that such perceived inconsistencies could be explained by the fact that uncertainty increases in projections and by the confidence intervals not being symmetrical around the median values.

The Committee agreed to consider the runs with an assumed steepness of 0.75 as base cases, since the runs with steepness = 0.5 resulted in implausible estimates of SSB_0 and the runs with a steepness value of 0.99 was thought not to reflect the biology of the species well (see **Appendix 3** for results of the last two cases). The Committee agreed, however, to present results for three recruitment scenarios (low, medium, and high) because they are all considered to be equally plausible (**Table 2**). The estimated SSB_0 for the three recruitment regimes under the 0.75 steepness assumption ranged from 1.0 to 11.7 million t. The probability of SSB_{2009} being lower than 0.15 max SSB were about 19% for the case of reported catches and approximately 23% for the adjusted catches. In both cases, these results were the same for the three recruitment scenarios (low, medium, and high). The probabilities with respect to $SSB_{2009} < 0.15SSB_0$ were between approximately 0.88 and 1.0 depending on the recruitment scenario. In the case of projections, the probability of $SSB_{2019} < 0.15$ max SSB ranged from 0.27 to 0.43 while the probability of $SSB_{2019} < 0.15SSB_0$ ranged from 0.67 to 1.0. Combined probabilities for the steepness 0.75 cases are presented in **Table 2**.

A complete set of estimated probabilities for the assumption of steepness of 0.75 are presented in **Table 2.**

Figure 4 illustrates the time series of the ratios of SSB_{year} / SSB_0 or / max SSB, with the three recruitment scenarios. Under the 0.75 and 0.99 steepness assumptions, the population is projected to increase, whereas under the steepness assumption of 0.5, the population declines **(Figure 4a)**. **Figure 4b** depicts the lowest and highest SSB_0 values resulting from assuming a steepness of 0.99 and low recruitment, and a steepness of 0.5 and high recruitment, and are meant to bracket the range of possibilities examined by the Committee.

5. Recommendations

5.1 Western Atlantic Bluefin Tuna

SCRS recommendations relative to ICCAT management objectives:

From the 2009 Executive Summary BFTW:

" In 2008, the Commission recommended a total allowable catch (TAC), inclusive of dead discards, of 1,900 t in 2009 and 1,800 t in 2010 [Rec. 08-04]. These TAC levels were projected to have a 75% chance of meeting the lower rebuilding targets under the "low recruitment" scenario (BFTW-Table 1), but less than a 50% chance of meeting the higher target under the "high recruitment scenario". As noted in 2008, the TAC should be lower if the assessment is positively biased or if there is management implementation error (both of which have occurred in the past). Analyses conducted during the Joint ICCAT - Canada Precautionary workshop as well as two subsequent analyses reviewed by the Committee (SCRS/2008/089, SCRS/2008/175) suggested that the projections made during past assessments were too optimistic. This is reinforced by the observation that, halfway through the rebuilding program, biomass was still below what it was at the beginning. Accordingly, the Committee continues to strongly advise against an increase in TAC."

SCRS summary conclusions relative to CITES criteria:

Small population and restricted area of distribution criteria (Criteria A and B)
The wild population of Western Atlantic Bluefin is not considered small (estimated numbers greater than 170,000 individuals ages 1 and older in 2008), nor is its distribution restricted (distributed throughout the Atlantic).

Marked decline in the population size criteria (Criteria C)
Consistent with the previous assessment and with the above management recommendations spawning biomass was estimated and expressed relative to measures of historical abundance. As noted above, actual observations of long term historical abundance are not available since data are limited to post-1970. Therefore, estimated long term potential spawning stock biomass (referred to as SSB_0 or more

simply B_0) was computed. However, there are two hypotheses about what that long term potential might be, as referenced by the “high recruitment scenario” and the “low recruitment scenario,” above (see Section 4.1). The former reflects a hypothesis that potential productivity has shown no trend over the assessment period; the latter reflects the hypothesis that productivity potential has shifted to a lower level after the late 1970s. Note that uncertainties in the rate of historical decline as measured relative to SSB_0 mostly reflect uncertainties in the estimation of SSB_0 rather than in SSB_{2009}. Therefore, in addition to these hypotheses, the Committee evaluated spawning biomass relative to the maximum estimated during the period 1970-2009 (maximum $SSB_{1970-2007}$). Note that the estimates of long term potential spawning biomass are not estimates of historical biomass *per se*, but what the stock size might be if there were no fishing; conversely the maximum biomass only reflects historical abundance in the context of the post-1970 period and does not reflect higher abundances that probably occurred prior to 1970 in view of the high catches in the 1960s. These were the alternatives used to determine “historical abundance” (baseline) for CITES criteria.

There is a high probability (greater than 90%) that SSB in 2009 is less than 15% of long term potential (i.e. the probability that SSB_{2009} is less than 0.15 times SSB_0 is greater than 90%). The probability that SSB_{2009} is less than 15% of the maximum SSB estimated since 1970 is about 30%; and there is about a 54% chance that it is less than 20% of maximum $SSB_{1970-2007}$ **(Table 1)**.

If there were no catches in the years 2010 through 2019, there is a 63% chance that the SSB in 2019 would be less than 20% of the long term potential as measured by the “high recruitment” hypothesis; but if the “low recruitment” hypothesis were to be true, then the stock in 2019 is almost certain to be above 20% of long term potential. It is also almost certain that the stock in 2019 would be above 20% of maximum $SSB_{1970-2007}$, if there were no catches **(Table 1)**.

If there is perfect implementation of [Rec. 08-04] through the year 2019, projections indicate that it is almost certain that the stock will be higher in 2019 than it is in 2009 for both recruitment scenarios considered **(Table 1)**.

5.2 Eastern Atlantic Bluefin Tuna

SCRS recommendations relative to ICCAT management objectives:

From the 2009 Executive Summary BFTE:

" To address the various sources of uncertainties in the scientific diagnosis, especially regarding the data quality and availability, the Committee has investigated different quantitative approaches and it has considered a variety of scenarios for the projections. On this basis, the best advice of the Committee is currently to follow an $F_{0.1}$ (or another adequate F_{MSY} proxy) strategy to rebuild the stock, because such strategies appear much more robust than [Rec. 06-05] and possibly to [Rec. 08-05] (according to preliminary analyses) to a wide range of uncertainties about the data, the current status and future productivity. These strategies would imply much lower catches during the next few years (on the order of 15,000 t or less), but the long-term gain could lead to catches of about 50,000 t with substantial increases in spawning biomass. For a long lived species such as bluefin tuna, it will take some time (> 10 years) to realize the benefit."

SCRS summary conclusions relative to CITES criteria:

Small population and restricted area of distribution criteria (Criteria A and B)
The wild population of Eastern Atlantic Bluefin is not considered small (estimated numbers greater than 3 million individuals of ages 1 and older in 2008), nor is its distribution restricted (distributed throughout the Atlantic and Mediterranean).

Marked decline in the population size criteria (Criteria C)
As with the Western Atlantic Bluefin, “historical abundance” of Eastern Atlantic Bluefin Tuna was evaluated using both long term potential SSB_0 and the maximum observed over the period 1970-2007. However, long term potential SSB_0 of Eastern Atlantic BFT is even less well defined than that in the West. Therefore, as noted above the assessment incorporated various scenarios of productivity and catch history **(Table 2)**.

Based upon these analyses:

- There is a 96% probability that SSB in 2009 is less than 15% of long term potential (i.e. the probability that SSB_{2009} is less than 0.15 times SSB_0 is greater than 96%). The probability that SSB_{2009} is less than 15% of the maximum SSB estimated since 1970 is about 21% (see **Table 2** which also includes estimated probabilities of the stock being below other thresholds, including 20%).

- Projections indicate that perfect implementation of [Rec. 08-05] through the year 2019 will result in more than a 85% chance that SSB_{2019} will be less than 15% of long term potential, SSB_0. There is a 35% chance that SSB_{2019} will be less than 15% of the maximum $SSB_{1970\text{-}2007}$ **(Table 2)**.

- If there is imperfect implementation of [Rec. 08-05] through the year 2019 (in the order of 20% overages), then there is a 91% chance that SSB_{2019} will be less than 15% of long term potential, SSB_0. There is a 49% chance that SSB_{2019} will be less than 15% of the maximum $SSB_{1970\text{-}2007}$ **(Table 2**).

- If catches were to be kept at 15,000 t annually from 2010 to 2019 then there is a 78% chance that SSB_{2019} will be less than 15% of long term potential, SSB_0. There is a 24% chance that SSB_{2019} will be less than 15% of the maximum $SSB_{1970\text{-}2007}$ **(Table 2)**.

- If catches were to be kept at 8,500 t annually from 2010 to 2019 then there is a 66% chance that SSB_{2019} will be less than 15% of long term potential, SSB_0. There is a 9% chance that SSB_{2019} will be less than 15% of the maximum $SSB_{1970\text{-}2007}$ **(Table 2)**.

- If there were no catch from 2010 to 2019 then there is a 48% chance that SSB_{2019} will be less than 15% of long term potential, SSB0. There is a 0% chance that SSB2019 will be less than 15% of the maximum SSB1970-2007 **(Table 2)**.

- Projections indicate that perfect implementation of [Rec. 08-05] through the year 2019 will result in a 39% chance that the biomass in 2019 will be less than the biomass in 2009 **(Table 2)**.

- If there is imperfect implementation of [Rec. 08-05] through the year 2019 (in the order of 20% overages), then there is a 58% chance that the biomass in 2019 will be less than the biomass in 2009 **(Table 2)**.

- If catches were to be kept at 15,000 t annually from 2010 to 2019 then there is a 26% chance that SSB2019 will be less than SSB2009 **(Table 2)**.

- If catches were to be kept at 8,500 t annually from 2010 to 2019 then there is a 7% chance that SSB_{2019} will be less than SSB_{2009} **(Table 2)**.

5.3 Combined Eastern and Western Bluefin Tuna

The Committee has long used a stock definition in which management boundaries separate the Western Atlantic Bluefin from the Eastern Atlantic and Mediterranean. The Commission is familiar with this approach for both management and assessments. Additionally, this approach is consistent with precautionary management when stock identification is uncertain. Because of this, the Committee did not evaluate Eastern and Western BFT combined.

However, it has also been long noted that some BFT move across the management boundary between East and West and that because of that movement and the difference in size of the stocks (East being much larger than the West), then fisheries in the East might impact the population of BFT in the West.

6. Other matters

The delegate of Japan mentioned that his delegation would seek clarification during the 2009 Commission meeting about the rules of procedure to follow with respect to reports that have not been yet discussed by the Commission. The Secretariat noted that it has been common practice in recent years to post reports of inter-sessional meetings on the ICCAT Web Site once they are adopted by the Committee, unless instructed not to do so. Because of the controversial and politically-charged nature of the issues discussed at this meeting, the Chairman asked participants to consider refraining from distributing this report outside ICCAT before the Commission had an opportunity to read and discuss it.

7. Report adoption and closure

The report was adopted during the meeting. It will be annexed to the 2009 SCRS Report for consideration by the Commission. The Chair thanked all participants for their hard work. The meeting was closed.

This formally concluded the 2009 SCRS sessions.

References

Fromentin, J.-M. 2009. Lessons from the past: investigating historical data from bluefin tuna fisheries. Fish and Fisheries 10: 197–216.

Table 1. Probability of BFTW spawning stock biomass (SSB) being less than 10%, 15% or 20% of the baseline in 2009 and 2019. In A), the baseline is estimated by the maximum SSB in the time series, and in B) it is estimated by SSB_0. Projections are made with perfect compliance of Rec. [08-04] as well as with zero catch in 2010 and thereafter. Also tabulated, the probability of further decline (SSB 2019 < SSB 2009) and the median estimate of maximum SSB, or the median SSB_0, (from the 500 model realizations).

A)	**Historical Decline-probability of SSB_{2009}**			**10-Year projection (probability of SSB_{2019})**					
Recruitment	**<0.10 max SSB**	**<0.15 max SSB**	**<0.20 max SSB**	**TAC**	**<0.10 max SSB**	**<0.15 max SSB**	**<0.20 max SSB**	**<SSB_{2009}**	**Median Max SSB**
Low	0.088	0.298	0.542	[08-04]	0.004	0.016	0.056	0.000	45,390
High	0.088	0.300	0.542	[08-04]	0.012	0.038	0.090	0.014	45,390
Low	NA	NA	NA	0 t	0.000	0.000	0.000	0.000	45,390
High	NA	NA	NA	0 t	0.000	0.000	0.000	0.000	45,390

B)	**Historical Decline-probability of SSB_{2009}**			**10-Year projection (probability of SSB_{2019})**					
Recruitment	**<0.10 SSB_0**	**<0.15 SSB_0**	**<0.20 SSB_0**	**TAC**	**<0.10 SSB_0**	**<0.15 SSB_0**	**<0.20 SSB_0**	**<SSB_{2009}**	**Median SSB_0**
Low	0.302	0.926	0.996	[08-04]	0.006	0.036	0.152	0.000	79,969
High	0.996	1.000	1.000	[08-04]	0.544	0.848	0.952	0.014	220,948
Low	NA	NA	NA	0 t	0.000	0.000	0.000	0.000	79,969
High	NA	NA	NA	0 t	0.096	0.298	0.626	0.000	220,948

Table 2. Probability (base case) of BFTE spawning stock biomass (SSB, referred to as simply B, below) being less than 10%, 15% or 20% of the baseline in 2009 and 2019. In A), the baseline is estimated by SSB_0, and in B) it is estimated by the maximum SSB in the time series. Projections are made for different scenarios as explained in Section 4.1. Also tabulated, the probability of further decline (SSB 2019 < SSB 2009).

A)

				Historical Decline (probability)					10-Year projection (probability)				
Run	Steep	Rmax	Catch	$B_{2009}<0.10B_o$	$B_{2009}<0.15B_o$	$B_{2009}<0.20B_o$	Implem.	TAC	$B_{2019}<0.10B_o$	$B_{2019}<0.15B_o$	$B_{2019}<0.20B_o$	$B_{2019}<B_{2009}$	deterministic virgin SSB (million t)
4	0.75	low	report.	0.64	0.89	0.97	perfect	[08-05]	0.58	0.72	0.83	0.53	1.00
5	0.75	med	report.	0.99	1.00	1.00	perfect	[08-05]	0.69	0.87	0.95	0.37	2.19
6	0.75	high	report.	1.00	1.00	1.00	perfect	[08-05]	0.99	1.00	1.00	0.29	11.70
13	0.75	low	adjust	0.66	0.88	0.96	perfect	[08-05]	0.54	0.67	0.76	0.48	1.00
14	0.75	med	adjust	0.99	1.00	1.00	perfect	[08-05]	0.68	0.84	0.93	0.36	2.46
15	0.75	high	adjust	1.00	1.00	1.00	perfect	[08-05]	0.99	1.00	1.00	0.32	6.15
22	0.75	low	report.	0.65	0.90	0.97	20% err	[08-05]	0.76	0.85	0.91	0.80	1.00
23	0.75	med	report.	0.99	1.00	1.00	20% err	[08-05]	0.81	0.93	0.98	0.58	2.19
24	0.75	high	report.	1.00	1.00	1.00	20% err	[08-05]	0.99	1.00	1.00	0.44	11.70
31	0.75	low	adjust	0.67	0.88	0.96	20% err	[08-05]	0.69	0.77	0.86	0.71	1.00
32	0.75	med	adjust	0.99	1.00	1.00	20% err	[08-05]	0.77	0.88	0.95	0.52	2.46
33	0.75	high	adjust	1.00	1.00	1.00	20% err	[08-05]	0.99	1.00	1.00	0.45	6.15
37	0.75	low	report.				perfect	15,000	0.44	0.59	0.74	0.34	1.00
38	0.75	med	report.				perfect	15,000	0.58	0.80	0.93	0.24	2.19
39	0.75	high	report.				perfect	15,000	0.99	1.00	1.00	0.18	11.70
40	0.75	low	adjust				perfect	15,000	0.42	0.55	0.68	0.35	1.00
41	0.75	med	adjust				perfect	15,000	0.58	0.77	0.89	0.24	2.46
42	0.75	high	adjust				perfect	15,000	0.99	1.00	1.00	0.20	6.15
43	0.75	low	report.				perfect	8,500	0.21	0.34	0.50	0.09	1.00
44	0.75	med	report.				perfect	8,500	0.37	0.63	0.86	0.07	2.19
45	0.75	high	report.				perfect	8,500	0.97	1.00	1.00	0.06	11.70
46	0.75	low	adjust				perfect	8,500	0.23	0.34	0.45	0.09	1.00
47	0.75	med	adjust				perfect	8,500	0.40	0.67	0.83	0.06	2.46
48	0.75	high	adjust				perfect	8,500	0.98	1.00	1.00	0.05	6.15
49	0.75	low	report.				perfect	0	0.03	0.09	0.17	0.00	1.00
50	0.75	med	report.				perfect	0	0.13	0.34	0.63	0.00	2.19
51	0.75	high	report.				perfect	0	0.93	0.99	1.00	0.00	11.70
52	0.75	low	adjust				perfect	0	0.03	0.08	0.18	0.00	1.00
53	0.75	med	adjust				perfect	0	0.16	0.41	0.68	0.00	2.46
54	0.75	high	adjust				perfect	0	0.97	0.99	1.00	0.00	6.15
Steepness 0.75 [08-05] all runs				0.88	0.96	0.99			0.79	0.88	0.93	0.49	
Steepness 0.75[08-05] perfect impl.: Runs 4-6 & 13-15				0.88	0.96	0.99			0.75	0.85	0.91	0.39	
Steepness 0.75 [08-05] 20% error: Runs 22-24 & 31-33				0.88	0.96	0.99			0.84	0.91	0.95	0.58	
15,000 perfect impl.: Runs 37-42									0.67	0.78	0.87	0.26	
8,500 perfect impl.: Runs 43-48									0.53	0.66	0.77	0.07	
0 perfect impl.: Runs 49-54									0.37	0.48	0.61	0.00	

B)

				Historical Decline (probability)					10-Year projection (probability)				
Run	Steep	Rmax	Catch	B_{2009}<0.1 maxB	B_{2009}<0.15 maxB	B_{2009}<0.20 maxB	Implem.	TAC	B_{2019}<0.10 maxB	B_{2019}<0.15 maxB	B_{2019}<0.20 maxB	$B_{2019}<B_{2009}$	VPA maximum SSB (t)
4	0.75	low	report.	0.09	0.19	0.32	perfect	[08-05]	0.40	0.43	0.48	0.53	296,944
5	0.75	med	report.	0.09	0.19	0.32	perfect	[08-05]	0.31	0.33	0.36	0.37	296,944
6	0.75	high	report.	0.09	0.19	0.32	perfect	[08-05]	0.25	0.27	0.29	0.29	296,944
13	0.75	low	adjust	0.09	0.23	0.35	perfect	[08-05]	0.39	0.41	0.45	0.48	308,609
14	0.75	med	adjust	0.09	0.23	0.35	perfect	[08-05]	0.33	0.34	0.36	0.36	308,609
15	0.75	high	adjust	0.09	0.23	0.35	perfect	[08-05]	0.28	0.31	0.33	0.32	308,609
22	0.75	low	report.	0.10	0.20	0.33	20% err	[08-05]	0.58	0.61	0.65	0.80	296,944
23	0.75	med	report.	0.09	0.20	0.32	20% err	[08-05]	0.48	0.50	0.52	0.58	296,944
24	0.75	high	report.	0.09	0.20	0.32	20% err	[08-05]	0.39	0.41	0.43	0.44	296,944
31	0.75	low	adjust	0.10	0.24	0.36	20% err	[08-05]	0.54	0.58	0.62	0.71	308,609
32	0.75	med	adjust	0.10	0.23	0.35	20% err	[08-05]	0.44	0.46	0.48	0.52	308,609
33	0.75	high	adjust	0.10	0.23	0.35	20% err	[08-05]	0.39	0.41	0.43	0.45	308,609
37	0.75	low	report.				perfect	15,000	0.27	0.29	0.33	0.34	296,944
38	0.75	med	report.				perfect	15,000	0.20	0.22	0.26	0.24	296,944
39	0.75	high	report.				perfect	15,000	0.17	0.18	0.19	0.18	296,944
40	0.75	low	adjust				perfect	15,000	0.28	0.32	0.35	0.35	308,609
41	0.75	med	adjust				perfect	15,000	0.22	0.24	0.26	0.24	308,609
42	0.75	high	adjust				perfect	15,000	0.18	0.21	0.23	0.20	308,609
43	0.75	low	report.				perfect	8,500	0.10	0.11	0.13	0.09	296,944
44	0.75	med	report.				perfect	8,500	0.08	0.09	0.10	0.07	296,944
45	0.75	high	report.				perfect	8,500	0.06	0.07	0.09	0.06	296,944
46	0.75	low	adjust				perfect	8,500	0.09	0.11	0.13	0.09	308,609
47	0.75	med	adjust				perfect	8,500	0.07	0.09	0.11	0.06	308,609
48	0.75	high	adjust				perfect	8,500	0.06	0.08	0.09	0.05	308,609
49	0.75	low	report.				perfect	0	0.00	0.01	0.02	0.00	296,944
50	0.75	med	report.				perfect	0	0.00	0.01	0.01	0.00	296,944
51	0.75	high	report.				perfect	0	0.00	0.01	0.01	0.00	296,944
52	0.75	low	adjust				perfect	0	0.00	0.00	0.01	0.00	308,609
53	0.75	med	adjust				perfect	0	0.00	0.00	0.01	0.00	308,609
54	0.75	high	adjust				perfect	0	0.00	0.00	0.01	0.00	308,609
Steepness 0.75 [08-05] all runs				0.10	0.21	0.33			0.40	0.42	0.45	0.49	
Steepness 0.75[08-05] perfect impl.: Runs 4-6 & 13-15				0.09	0.21	0.33			0.32	0.35	0.38	0.39	
Steepness 0.75 [08-05] 20% error: Runs 22-24 & 31-33				0.10	0.22	0.34			0.47	0.49	0.52	0.58	
15,000 perfect impl.: Runs 37-42									0.22	0.24	0.27	0.26	
8,500 perfect impl.: Runs 43-48									0.08	0.09	0.11	0.07	
0 perfect impl.: Runs 49-54									0.00	0.00	0.01	0.00	

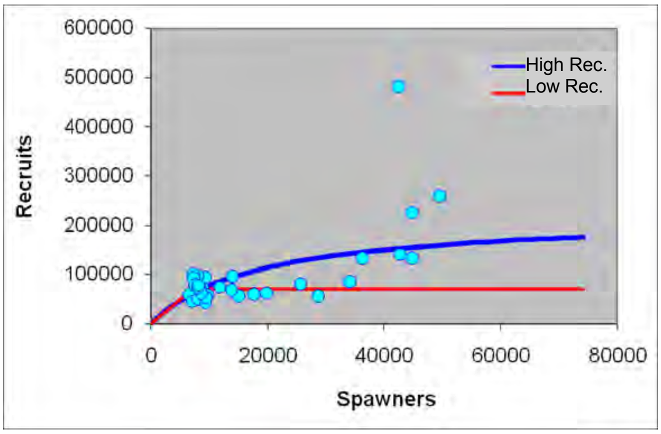


Figure 1. The spawner-recruit relationships assumed for western Atlantic bluefin: The two-line ("low recruitment") and Beverton and Holt ("high recruitment").

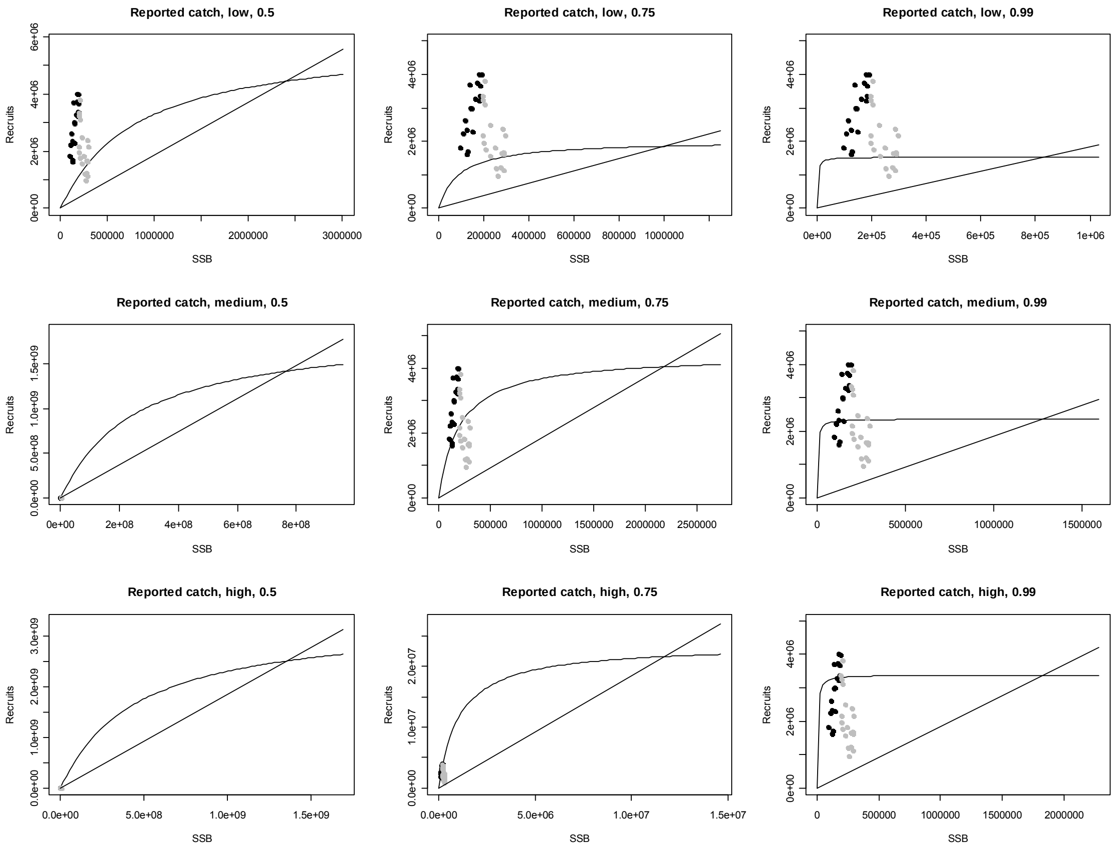


Figure 2. Assumed stock-recruitment relationships for BFT-E. Top row: fitted using 1970-1980 data ("low recruitment"); middle row: using 1970-2002 data ("medium recruitment"); bottom row: using 1990-2002 data ("high recruitment"). The left, center and right-hand-side columns correspond to steepness values of 0.5, 0.75 and 0.99, respectively. The data points are the estimated SSB-R data (gray=1970-1989; dark=1990-2002). The straight line is the replacement line at F=0, i.e., a line with slope equal to the inverse of $[SSB/R]_{F=0}$. Its intersection with the stock-recruitment relationship defines SSB_0 and R_0, the theoretical equilibrium biomass and recruitment under unfished conditions.

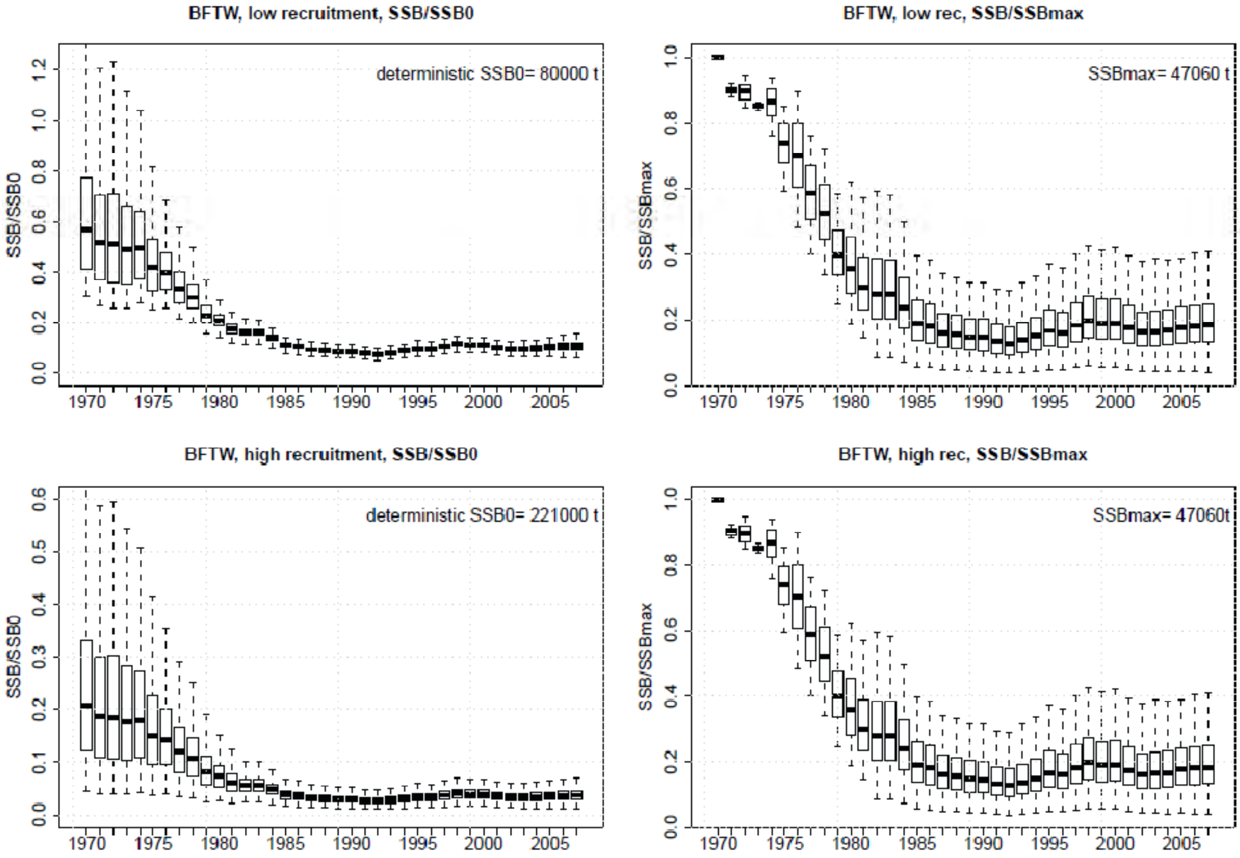


Figure 3. Trends in SSB relative to different baselines for BFTW. Top row: low recruitment scenario; bottom row: high recruitment scenario. Left hand side: baseline calculated by SSB_0, depending on the assumed stock-recruitment relationship. Right hand side: baseline calculated as maximum observed SSB in the time series. The boxes contain the central 50% of the observations and the whiskers 95%.

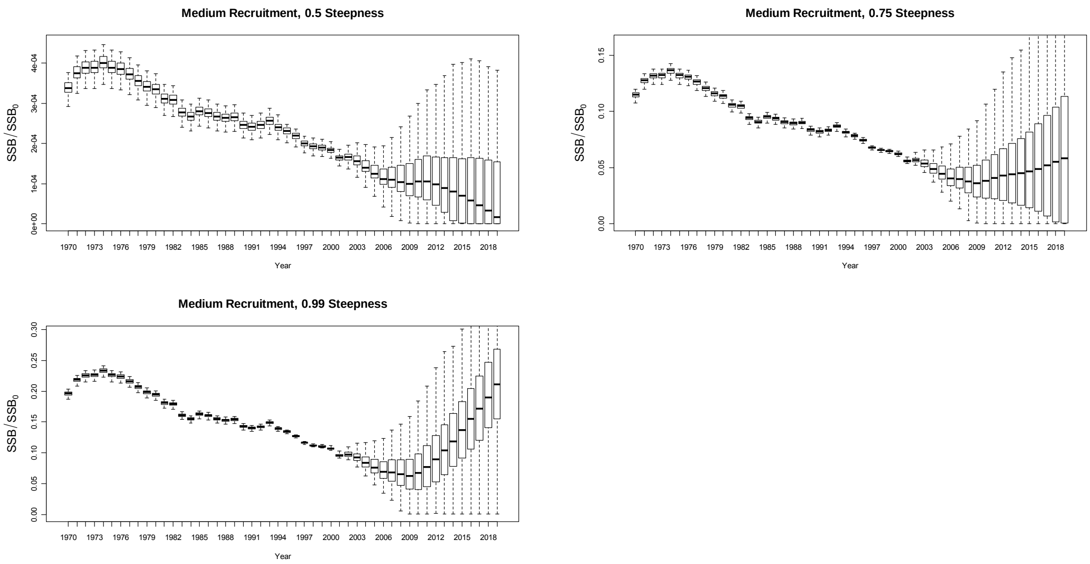


Figure 4a. Trends in spawning biomass for BFT-E relative to the baseline biomass estimated with different assumptions (note that the Y-axis scale differs between the various panels). The baseline is SSB_0 estimated with assumed steepness values of 0.5, 0.75 and 0.99, and using all of the SSB-R observations. The boxes contain the central 50% of the observations and the whiskers 95%.

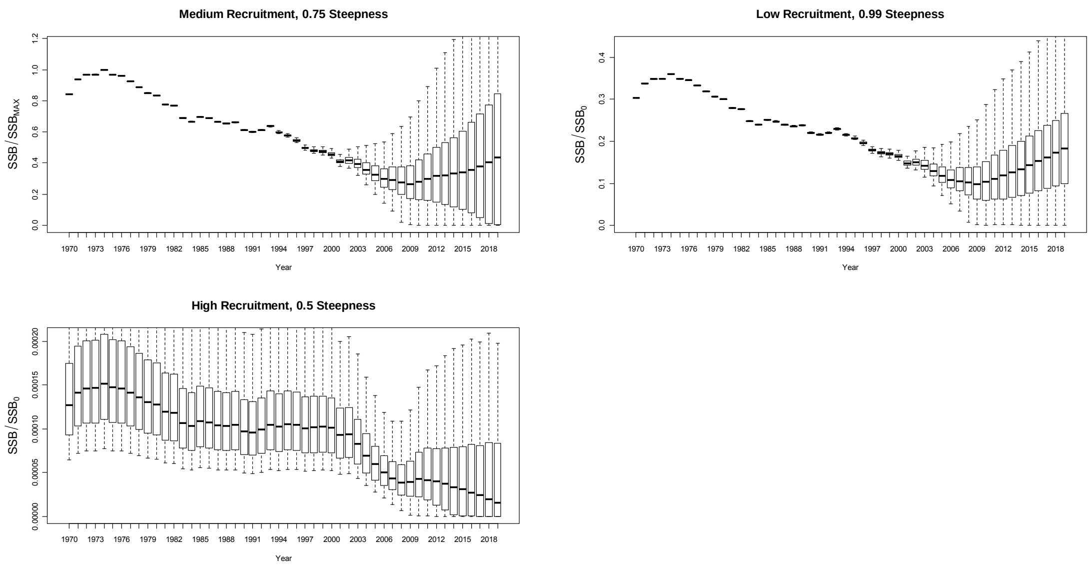


Figure 4b. Trends in spawning biomass relative to the baseline. The upper left panel uses the maximum SSB in the historical time series as the baseline. The two other panels correspond to the lowest and highest SSB_0 values resulting from assuming a steepness of 0.99 and low recruitment, and a steepness of 0.5 and high recruitment. The boxes contain the central 50% of the observations and the whiskers 95%.

Appendix 1

Agenda

1. Opening of the meeting and arrangements
2. Discussion of CITES Criteria
    2.1 Concepts
    2.2 Examples
3. Evaluation of the status of bluefin with regards to CITES Appendix I
    3.1 Eastern Bluefin
    3.2 Western Bluefin
4. Evaluation of the status of bluefin with regards to CITES Appendix II
    4.1 Eastern Bluefin
    4.2 Western Bluefin
5. Recommendations
6. Other matters
7. Report adoption and closure

Appendix 2

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Appendix 3

Complete calculations for BFTE

The tables show the estimated probability of BFTE spawning stock biomass (SSB, referred to as simply B, below) being less than 10%, 15% or 20% of the baseline in 2009 and 2019. In A), the baseline is estimated by SSB_0, and in B) it is estimated by the maximum SSB in the time series. Projections are made for different scenarios as explained in Section 4.1. Also tabulated, the probability of further decline (SSB 2019 < SSB 2009). The last column provides the baseline.

A)

				Historical Decline (probability)					10-Year projection (probability)				
Run	**Steep**	**Rmax**	**Catch**	$B_{2009}<0.10B_o$	$B_{2009}<0.15B_o$	$B_{2009}<0.20B_o$	**Implem.**	**TAC**	$B_{2019}<0.10B_o$	$B_{2019}<0.15B_o$	$B_{2019}<0.20B_o$	$B_{2019}<B_{2009}$	**deterministic virgin SSB (million t)**
1	0.5	low	report.	0.99	1.00	1.00	perfect	[08-05]	0.93	0.98	1.00	0.78	2.40
2	0.5	med	report.	1.00	1.00	1.00	perfect	[08-05]	1.00	1.00	1.00	0.73	766.00
3	0.5	high	report.	1.00	1.00	1.00	perfect	[08-05]	1.00	1.00	1.00	0.73	1352.67
4	0.75	low	report.	0.64	0.89	0.97	perfect	[08-05]	0.58	0.72	0.83	0.53	1.00
5	0.75	med	report.	0.99	1.00	1.00	perfect	[08-05]	0.69	0.87	0.95	0.37	2.19
6	0.75	high	report.	1.00	1.00	1.00	perfect	[08-05]	0.99	1.00	1.00	0.29	11.70
7	0.99	low	report.	0.51	0.79	0.92	perfect	[08-05]	0.25	0.40	0.56	0.16	0.83
8	0.99	med	report.	0.82	0.95	0.98	perfect	[08-05]	0.09	0.23	0.45	0.03	1.28
9	0.99	high	report.	0.94	0.99	0.99	perfect	[08-05]	0.03	0.09	0.26	0.01	1.83
10	0.5	low	adjust	0.98	1.00	1.00	perfect	[08-05]	0.87	0.95	0.98	0.70	2.35
11	0.5	med	adjust	1.00	1.00	1.00	perfect	[08-05]	1.00	1.00	1.00	0.67	971.34
12	0.5	high	adjust	1.00	1.00	1.00	perfect	[08-05]	1.00	1.00	1.00	0.67	2810.90
13	0.75	low	adjust	0.66	0.88	0.96	perfect	[08-05]	0.54	0.67	0.76	0.48	1.00
14	0.75	med	adjust	0.99	1.00	1.00	perfect	[08-05]	0.68	0.84	0.93	0.36	2.46
15	0.75	high	adjust	1.00	1.00	1.00	perfect	[08-05]	0.99	1.00	1.00	0.32	6.15
16	0.99	low	adjust	0.53	0.76	0.91	perfect	[08-05]	0.27	0.38	0.50	0.14	0.84
17	0.99	med	adjust	0.86	0.97	1.00	perfect	[08-05]	0.07	0.21	0.41	0.02	1.43
18	0.99	high	adjust	0.98	1.00	1.00	perfect	[08-05]	0.02	0.09	0.32	0.00	2.18
19	0.5	low	report.	0.99	1.00	1.00	20% err	[08-05]	0.96	0.99	1.00	0.92	2.40
20	0.5	med	report.	1.00	1.00	1.00	20% err	[08-05]	1.00	1.00	1.00	0.87	766.00
21	0.5	high	report.	1.00	1.00	1.00	20% err	[08-05]	1.00	1.00	1.00	0.87	1352.67
22	0.75	low	report.	0.65	0.90	0.97	20% err	[08-05]	0.76	0.85	0.91	0.80	1.00
23	0.75	med	report.	0.99	1.00	1.00	20% err	[08-05]	0.81	0.93	0.98	0.58	2.19
24	0.75	high	report.	1.00	1.00	1.00	20% err	[08-05]	0.99	1.00	1.00	0.44	11.70
25	0.99	low	report.	0.52	0.80	0.92	20% err	[08-05]	0.50	0.64	0.77	0.50	0.83
26	0.99	med	report.	0.82	0.95	0.98	20% err	[08-05]	0.28	0.48	0.69	0.12	1.28
27	0.99	high	report.	0.94	0.99	0.99	20% err	[08-05]	0.10	0.26	0.54	0.03	1.83
28	0.5	low	adjust	0.98	1.00	1.00	20% err	[08-05]	0.92	0.96	0.99	0.84	2.35
29	0.5	med	adjust	1.00	1.00	1.00	20% err	[08-05]	1.00	1.00	1.00	0.79	971.34
30	0.5	high	adjust	1.00	1.00	1.00	20% err	[08-05]	1.00	1.00	1.00	0.79	2810.90
31	0.75	low	adjust	0.67	0.88	0.96	20% err	[08-05]	0.69	0.77	0.86	0.71	1.00
32	0.75	med	adjust	0.99	1.00	1.00	20% err	[08-05]	0.77	0.88	0.95	0.52	2.46
33	0.75	high	adjust	1.00	1.00	1.00	20% err	[08-05]	0.99	1.00	1.00	0.45	6.15
34	0.99	low	adjust	0.53	0.77	0.91	20% err	[08-05]	0.46	0.59	0.69	0.44	0.84
35	0.99	med	adjust	0.86	0.97	1.00	20% err	[08-05]	0.27	0.42	0.61	0.07	1.43
36	0.99	high	adjust	0.98	1.00	1.00	20% err	[08-05]	0.08	0.27	0.50	0.01	2.18
37	0.75	low	report.				perfect	15,000	0.44	0.59	0.74	0.34	1.00
38	0.75	med	report.				perfect	15,000	0.58	0.80	0.93	0.24	2.19
39	0.75	high	report.				perfect	15,000	0.99	1.00	1.00	0.18	11.70
40	0.75	low	adjust				perfect	15,000	0.42	0.55	0.68	0.35	1.00
41	0.75	med	adjust				perfect	15,000	0.58	0.77	0.89	0.24	2.46
42	0.75	high	adjust				perfect	15,000	0.99	1.00	1.00	0.20	6.15
43	0.75	low	report.				perfect	8,500	0.21	0.34	0.50	0.09	1.00
44	0.75	med	report.				perfect	8,500	0.37	0.63	0.86	0.07	2.19
45	0.75	high	report.				perfect	8,500	0.97	1.00	1.00	0.06	11.70
46	0.75	low	adjust				perfect	8,500	0.23	0.34	0.45	0.09	1.00
47	0.75	med	adjust				perfect	8,500	0.40	0.67	0.83	0.06	2.46
48	0.75	high	adjust				perfect	8,500	0.98	1.00	1.00	0.05	6.15
49	0.75	low	report.				perfect	0	0.03	0.09	0.17	0.00	1.00
50	0.75	med	report.				perfect	0	0.13	0.34	0.63	0.00	2.19
51	0.75	high	report.				perfect	0	0.93	0.99	1.00	0.00	11.70
52	0.75	low	adjust				perfect	0	0.03	0.08	0.18	0.00	1.00
53	0.75	med	adjust				perfect	0	0.16	0.41	0.68	0.00	2.46
54	0.75	high	adjust				perfect	0	0.97	0.99	1.00	0.00	6.15
All runs [08-05] perfect impl.: Runs 1-18				0.88	0.96	0.98			0.61	0.69	0.77	0.39	
All runs [08-05] 20% error: Runs 19-36				0.88	0.96	0.98			0.70	0.78	0.86	0.54	
Base case [08-05] perfect impl.: Runs 4-6 & 13-15				0.88	0.96	0.99			0.75	0.85	0.91	0.39	
Base case [08-05] 20% error: Runs 22-24 & 31-33				0.88	0.96	0.99			0.84	0.91	0.95	0.58	
15,000 perfect impl.: Runs 37-42									0.67	0.78	0.87	0.26	
8,500 perfect impl.: Runs 43-48									0.53	0.66	0.77	0.07	
0 perfect impl.: Runs 49-54									0.37	0.48	0.61	0.00	

B)

				Historical Decline (probability)					10-Year projection (probability)				
Run	Steep	Rmax	Catch	B_{2009}<0.1 maxB	B_{2009}<0.15maxB	B_{2009}<0.20 maxB	Implem.	TAC	B_{2019}<0.10 maxB	B_{2019}<0.15 maxB	B_{2019}<0.20 maxB	B_{2019}<B_{2009}	VPA maximum SSB (t)
1	0.5	low	report.	0.09	0.19	0.32	perfect	[08-05]	0.56	0.59	0.64	0.78	296,944
2	0.5	med	report.	0.09	0.19	0.32	perfect	[08-05]	0.53	0.58	0.60	0.73	296,944
3	0.5	high	report.	0.09	0.19	0.32	perfect	[08-05]	0.53	0.58	0.60	0.73	296,944
4	0.75	low	report.	0.09	0.19	0.32	perfect	[08-05]	0.40	0.43	0.48	0.53	296,944
5	0.75	med	report.	0.09	0.19	0.32	perfect	[08-05]	0.31	0.33	0.36	0.37	296,944
6	0.75	high	report.	0.09	0.19	0.32	perfect	[08-05]	0.25	0.27	0.29	0.29	296,944
7	0.99	low	report.	0.09	0.19	0.32	perfect	[08-05]	0.13	0.16	0.19	0.16	296,944
8	0.99	med	report.	0.09	0.19	0.32	perfect	[08-05]	0.03	0.04	0.05	0.03	296,944
9	0.99	high	report.	0.09	0.18	0.32	perfect	[08-05]	0.01	0.01	0.01	0.01	296,944
10	0.5	low	adjust	0.10	0.23	0.35	perfect	[08-05]	0.53	0.57	0.61	0.70	308,609
11	0.5	med	adjust	0.10	0.23	0.35	perfect	[08-05]	0.50	0.55	0.58	0.67	308,609
12	0.5	high	adjust	0.10	0.23	0.35	perfect	[08-05]	0.50	0.55	0.58	0.67	308,609
13	0.75	low	adjust	0.09	0.23	0.35	perfect	[08-05]	0.39	0.41	0.45	0.48	308,609
14	0.75	med	adjust	0.09	0.23	0.35	perfect	[08-05]	0.33	0.34	0.36	0.36	308,609
15	0.75	high	adjust	0.09	0.23	0.35	perfect	[08-05]	0.28	0.31	0.33	0.32	308,609
16	0.99	low	adjust	0.09	0.23	0.35	perfect	[08-05]	0.13	0.15	0.20	0.14	308,609
17	0.99	med	adjust	0.09	0.22	0.34	perfect	[08-05]	0.02	0.02	0.03	0.02	308,609
18	0.99	high	adjust	0.09	0.22	0.34	perfect	[08-05]	0.01	0.01	0.01	0.00	308,609
19	0.5	low	report.	0.10	0.20	0.33	20% err	[08-05]	0.73	0.76	0.80	0.92	296,944
20	0.5	med	report.	0.10	0.20	0.33	20% err	[08-05]	0.69	0.73	0.76	0.87	296,944
21	0.5	high	report.	0.10	0.20	0.33	20% err	[08-05]	0.69	0.73	0.76	0.87	296,944
22	0.75	low	report.	0.10	0.20	0.33	20% err	[08-05]	0.58	0.61	0.65	0.80	296,944
23	0.75	med	report.	0.09	0.20	0.32	20% err	[08-05]	0.48	0.50	0.52	0.58	296,944
24	0.75	high	report.	0.09	0.20	0.32	20% err	[08-05]	0.39	0.41	0.43	0.44	296,944
25	0.99	low	report.	0.09	0.19	0.32	20% err	[08-05]	0.33	0.37	0.43	0.50	296,944
26	0.99	med	report.	0.09	0.19	0.31	20% err	[08-05]	0.11	0.14	0.15	0.12	296,944
27	0.99	high	report.	0.08	0.18	0.31	20% err	[08-05]	0.03	0.04	0.04	0.03	296,944
28	0.5	low	adjust	0.10	0.24	0.36	20% err	[08-05]	0.69	0.70	0.71	0.84	308,609
29	0.5	med	adjust	0.10	0.24	0.36	20% err	[08-05]	0.67	0.69	0.70	0.79	308,609
30	0.5	high	adjust	0.10	0.24	0.36	20% err	[08-05]	0.67	0.69	0.70	0.79	308,609
31	0.75	low	adjust	0.10	0.24	0.36	20% err	[08-05]	0.54	0.58	0.62	0.71	308,609
32	0.75	med	adjust	0.10	0.23	0.35	20% err	[08-05]	0.44	0.46	0.48	0.52	308,609
33	0.75	high	adjust	0.10	0.23	0.35	20% err	[08-05]	0.39	0.41	0.43	0.45	308,609
34	0.99	low	adjust	0.09	0.23	0.35	20% err	[08-05]	0.34	0.37	0.40	0.44	308,609
35	0.99	med	adjust	0.09	0.22	0.35	20% err	[08-05]	0.08	0.09	0.11	0.07	308,609
36	0.99	high	adjust	0.08	0.20	0.33	20% err	[08-05]	0.01	0.01	0.02	0.01	308,609
37	0.75	low	report.				perfect	15,000	0.27	0.29	0.33	0.34	296,944
38	0.75	med	report.				perfect	15,000	0.20	0.22	0.26	0.24	296,944
39	0.75	high	report.				perfect	15,000	0.17	0.18	0.19	0.18	296,944
40	0.75	low	adjust				perfect	15,000	0.28	0.32	0.35	0.35	308,609
41	0.75	med	adjust				perfect	15,000	0.22	0.24	0.26	0.24	308,609
42	0.75	high	adjust				perfect	15,000	0.18	0.21	0.23	0.20	308,609
43	0.75	low	report.				perfect	8,500	0.10	0.11	0.13	0.09	296,944
44	0.75	med	report.				perfect	8,500	0.08	0.09	0.10	0.07	296,944
45	0.75	high	report.				perfect	8,500	0.06	0.07	0.09	0.06	296,944
46	0.75	low	adjust				perfect	8,500	0.09	0.11	0.13	0.09	308,609
47	0.75	med	adjust				perfect	8,500	0.07	0.09	0.11	0.06	308,609
48	0.75	high	adjust				perfect	8,500	0.06	0.08	0.09	0.05	308,609
49	0.75	low	report.				perfect	0	0.00	0.01	0.02	0.00	296,944
50	0.75	med	report.				perfect	0	0.00	0.01	0.01	0.00	296,944
51	0.75	high	report.				perfect	0	0.00	0.01	0.01	0.00	296,944
52	0.75	low	adjust				perfect	0	0.00	0.00	0.01	0.00	308,609
53	0.75	med	adjust				perfect	0	0.00	0.00	0.01	0.00	308,609
54	0.75	high	adjust				perfect	0	0.00	0.00	0.01	0.00	308,609
All runs [08-05] perfect impl.: Runs 1-18				0.09	0.21	0.33			0.30	0.33	0.35	0.39	
All runs [08-05] 20% error: Runs 19-36				0.10	0.21	0.34			0.44	0.46	0.48	0.54	
Base case [08-05] perfect impl.: Runs 4-6 & 13-15				0.09	0.21	0.33			0.32	0.35	0.38	0.39	
Base case [08-05] 20% error: Runs 22-24 & 31-33				0.10	0.22	0.34			0.47	0.49	0.52	0.58	
15,000 perfect impl.: Runs 37-42									0.22	0.24	0.27	0.26	
8,500 perfect impl.: Runs 43-48									0.08	0.09	0.11	0.07	
0 perfect impl.: Runs 49-54									0.00	0.00	0.01	0	