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REPORT OF THE FIRST MEETING OF THE SUBGROUP ON MANAGEMENT OF STOCKS. (SGMOS-05-01) OF THE SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

LONG-TERM MANAGEMENT STRATEGIES FOR BAY OF BISCAY SOLE, CELTIC SEA COD AND ANGLERFISH VIIIC-IXA

Lisbon, 26-30 September 2005

This report has been evaluated and endorsed by the Scientific, Technical and Economic Committee for Fisheries (STECF) in its plenary session of 7-11 November 2005

This report does not necessarily reflect the view of the European Commission and in no way anticipates the Commission's future policy in this area.

Contents

STECF evaluation and endorsement. SUSTAINABLE EXPLOITATION RULES FOR BAY OF BISCAY SOLE, CELTIC SEA COD AND ANGLERFISH IN ICES DIVISIONS VIIIC AND IXA

STECF was asked the following:

To deliver an opinion on the work done by a Subgroup on management of stocks (SGMOS-05-01) which met in Lisbon, 26-30 September 2005 to evaluate "Long-term Management strategies for Bay of Biscay sole, Celtic Sea cod and anglerfish in VIIc-IXa.

Background and target reference points for long-term management

In the absence of agreed long term management strategies that lead to safe biological levels, the study group considered F_{max} as a proxy for a long term target conservation reference point for Celtic Sea cod and Bay of Biscay sole and F_{msy} in the case of anglerfish in VIIc and IXa.

The Group carried out 3 standard projections, to be used as references: (i) projection at F_{sq}, (ii) projection at constant catch, (iii) projection with a 10% reduction every year until F reaches F_{max}/F_{msy}.

STECF Comments and Recommendations

Celtic Sea cod

STECF notes that the 2005 cod VIIe-k assessment was not accepted by ICES due to a recent deterioration in data quality. The main issues were un-quantified high-grading of catches since late 2002, unreported catch, the absence of a time-series of discards estimates, and specific concerns over the commercial and research vessel CPUE data.

As a result projections were carried forward using population numbers in 2003 with fishing mortalities in 2004 and 2005 predicted from trends in fishing effort of the main fleets.

Council Regulation (EC) No 27/2005, Annex III, part A 12 (b) prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during January-March 2005 was assumed to have resulted in an approximately 10% reduction in F on cod in 2005, based on the analysis by Ifremer (Biseau, 2005).

STECF notes that these procedures may give an over-optimistic estimate of the number of years it will take to reach F_{max}.

The projections indicate that a constant-catch strategy with catches below 6,000t gives a high probability of SSB falling below B_{lim} and is not an appropriate strategy.

Progressively reducing fishing mortality by 10% annually until F_{max} is reached would result in a gradual increase in median landings until 2010 at around 11,600t with a high probability of SSB remaining above B_{lim}. However STECF notes that results are very sensitive to assumptions regarding the starting populations and initial assumptions about fishing mortality. A combination of smaller initial stock size and reduced future recruitment results in declining landings for the first 5 years and a large risk of SSB falling below B_{lim}.

Although a 15% variation in TAC constraint was not explored in combination with a progressive reduction in F, the simulations that were undertaken indicate that TAC variations were within the range of year-to-year variations that occurred in the past.

STECF further notes that although progressively reducing fishing mortality by 10% annually until F_{max} is reached is conditional on the correctness of the assumptions for the early years of the projection and the lack of any implementation error.

Therefore STECF advises that in reality, progressive annual reductions in F well in excess of 10% will probably be required to reach F_{max}.

Bay of Biscay sole

STECF notes that F_{max} for this stock is well defined at 0.20 with acceptable variability between years (0.02 for the last 5 years). In the absence of any specific management objective, STECF proposes F_{max} as a target reference point for a long-term management strategy.

SSB for Bay of Biscay sole in 2004 is estimated to be lower then B_{pa} and fishing mortality in 2004 is estimated to be at about F_{pa}. However, status quo fishing mortality (average over 2000-2004) is above F_{lim}. Therefore measures to reduce fishing mortality and increase biomass in the short term are desirable.

Maintaining fishing at status quo fishing mortality would bring SSB further down to a level where the population dynamics are unknown. STECF notes that this is a high-risk strategy and does not recommend it.

Simulations suggest that the stock can sustain landings at a level, similar to the 2005 TAC. Since median SSB is predicted to maintain SSB below Bpa, this strategy is not compatible with the precautionary approach.

STECF **recommends** that taking into account the precautionary approach, in order to ensure that SSB reaches B_{pa} in the short term; a significant reduction in F is required. In the longer-term subsequent gradual but less severe F reductions towards Fmax might be more acceptable.

STECF notes that there are no options presented with realistic implementation error that result in achieving F_{max} within 10 years. STECF considers that it cannot recommend an appropriate minimum annual reduction in F as part of a sustainable HCR.

Anglerfish in Divisions VIIIc and IXa.

As anglerfish are caught in a mixed fishery with Hake, Megrim, Norway Lobster and other species, Recovery Plans of Southern Hake and Iberian Norway lobster stocks is expected to have some impact on the anglerfish catches.

A non-equilibrium production model (ASPIC) is used as assessment tool. It is apparent that fishing mortality has been over F_{msy} for the whole data series and SSB shows a decrease since the beginning of the time series with recent values at about 50% of B_{msy}. The assessment indicates that a 57% reduction in fishing mortality is required to bring F at F_{msy}. The ASPIC model is not a good estimator of short-term changes in F and SSB, hence STECF is uncertain that the implied recent changes in F have been reliably estimated.

Several evaluations were undertaken, changing fishing mortality and varying the input parameters for projections covering a 50-year period.

Maintaining fishing at status quo fishing mortality SSB is predicted to continue to decline further below B_{msy} and would bring SSB further down into unknown population dynamics and therefore **not recommended** by STECF as an appropriate management strategy.

Simulations indicate that in a "most optimistic" reducing F-scenario, there is a 50% probability that the decline in SSB will be reversed only in the next 2-7 years and that SSB is not expected to reach B_{msy} within three decades.

With no fishing after 2005, biomass will increase at around 10%, 20% or 30% depending on the assumed input parameter and will reach B_{msy} level in 2013-2012-2011 respectively.

Given the uncertainties in input parameters used for simulation and the current status of anglerfish in VIIIc-IXa, STECF strongly **recommends** that a substantial reduction in fishing mortality is needed as soon as possible. STECF notes that even with zero catches of anglerfish in VIIc-IXa after 2005, there is less than a 50% probability of achieving B_{msy} by 2011.

Given the current state of the stock and the absence of clear objectives relating to the desired rate of stock recovery, STECF is unable to advise on an appropriate long-term management strategy.

STECF notes that regulating F with days at sea for static gears is unlikely to be an effective instrument. Anglerfish in VIIIc-IXa are taken in about equal amounts by static gears and trawl fisheries.

References

ICES, 2006a. Report of the Working Group on the Assessment of Hake, Monk and Megrim. ICES CM 2006/ACFM:01.

ICES. 2006b. Report of the Working Group on the Assessment of Southern Shelf Demersal Stocks. ICES CM 2006/ACFM: 03.

BISEAU, 2005 Working document to the 2005 Working Group on the Assessment of Southern Shelf Demersal Stocks - Effect of the Cod closure (ICES rectangles 30E4, 31E4, 32E3) in the Celtic Sea on the fishing behaviour.

1 INTRODUCTION

The definition of long term management strategies (LTMS) that lead stocks to safe biological levels were considered for Celtic Sea cod, Bay of Biscay sole and Iberian anglerfish. This level is commonly accepted to be Bmsy, the biomass that will produce the highest yield on the long term. During the World Summit on Sustainable Development on Johannesburg (2nd to 4th September 2002) an international commitment was achieved to drive stocks to this level. Fishing mortality that keeps stocks at Bmsy level, Fmsy, can be estimated by Fmax (the fishing mortality rate that would produce the highest yield per recruit if adequate recruitment is maintained) or by F0.1 (a fishing mortality close to Fmax but at which the risks of depleting the stock are lower). At this fishing mortality levels yield will be stable, fishing costs will be lower and the risks of bringing the stock to levels were its dynamics are unknown will be lower.

The long term target conservation reference point considered for Celtic Sea cod and Bay of Biscay sole was Fmax. In the case of anglerfish Fmsy was used as a long term target.

The stocks studied during this meeting are caught in mixed fisheries. The effect on the other stocks of the LTMS proposed were not considered due to lack of time and data. The possible effect of the recovery plans for Southern hake on Iberian anglers LTMS was explored.

These stocks are caught by different fleets, mainly trawlers and netters, but also small scale fleets, like it is the case of Bay of Biscay sole and Iberian anglerfish. For each stock a table was included with the partition of the landings by fleet and country that should help to address the impact of each LTMS by fleet.

During this meeting it was considered that implementation options would be difficult to address due to the lack of information and time. On the other hand implementation issues would probably be better addressed in a wider audience including the administration and stake holders. However some general statements are important to take into consideration:

- TAC regulation does not accomplish the objective of fishing mortality management due to discards practices and misreporting. A TAC reduction can simply have the effect of increasing these practices.
- It was considered that a reduction in effort will reduce fishing mortality accordingly, which may not be correct if changes in fishing strategies or catchability occur.
- Management of effort for netters must assure that the length and time at sea of the fishing nets can be limited during usual fishing periods. Regarding this need, a limited number of fishing days may not be sufficient to reduce fishing mortality if the vessels stay in the harbour when the catchability of fixed nets is low, else if the length of nets used by a fishing boat can be increased during fishing periods or if the nets continue to fish during the periods vessels stay at the harbour.

Taking these into account, the group considered that an effort control system should be used to effectively reduce fishing mortality, which can be implemented through several actions including: direct control of fishing effort (e.g. reduce fishing activity by x days per month), decomissioning, technical measures like closed areas and/or periods, changes in gear selectivity, etc.

The work carried out during the meeting was developed using some recommendations from SGMAS(2004) in particular on the construction of the information base, the projection definitions (Sec 2.5.1, 3.5.1 and 4.5.1) and the conditions of the LTMS (sections 5.1.1, 5.2.1 and 5.3.1).

The group agreed on using the 2005 ICES assessments as a basis for the projections studies. Celtic Sea cod and Bay of Biscay sole are assessed on the Working Group on the Assessment of Southern Shelf Demersal Stocks (WGSSDS) (ICES 2006b) and Iberian anglerfish are assessed on the Working Group on the Assessment of Hake, Monk and Megrims (WGHMM) (ICES 2006a).

It was agreed that 3 standard projections should be carried out to be used as references: (i) project at F statu quo, (ii) project at constant catch, (iii) project with a 10% reduction every year until F reaches Fmax. These results are presented in the Annexes. A set of exploratory runs was performed until an acceptable LTMS was identified. Using these LTMS the most critical parameters were identified and sensitivity analyses of the LTMS to these parameters were performed.

The LTMS developed are composed of an HCR and technical measures. The HCR defines an operational procedure to take fishing mortality to long term target conservation reference point and must be considered under the conditions stated.

In Sections 2-4 a small description of the fishery, assessment and actual management together with the settings and results of the projection studies for each stock are presented.

Advice is given in section 5. For each stock the LTMS proposed was defined by an HCR and technical measures which have to be considered within the set of conditions stated.

The software available was CS5, F-PRESS and CP (v0.5) (code in Annex). These have some constraints that are documented in each section but did not constitute a major constraint for projections studies.

1.1 TERMS OF REFERENCE

The meeting was held at IPIMAR in Lisbon (26-30 September 2005). The terms of reference, supplied by the STECF, were as follows:

Background

1. Advice is requested concerning targets for sustainable exploitation, and harvesting rules for catch and/or fishing effort limits for Bay of Biscay Sole, Celtic Sea Cod and Anglerfish in ICES Divisions VIIIc and IXa.

2. Such targets and harvest rules should be commensurate with conservation status of the stocks. The rules should also be based on the precautionary principle (in that the absence of adequate scientific information should not be used as a reason for postponing or failing to take management measures to conserve the stocks concerned).

The detailed request

(1) STECF is requested to evaluate a range of harvest rules for the stocks named in paragraph 1. with respect to medium and long term yield, stability of yield and effort and stock status with respect to safe biological limits. Evaluations shall in the first instance be made on a single species basis but the experts shall, to the extent possible, quantify mutual compatibility of the rules for the target species with the conservation needs of other species caught in the same fisheries.

The types of harvest rule to be considered shall include:

(a) Target conservation reference points, and (where appropriate) limit reference points.

(b) Harvest rules where TACs and/or fishing effort are derived according to a target fishing mortality, supplemented with a rule for reducing the mortality if the spawning biomass is below a trigger level, to ensure avoiding a limit value for the spawning biomass.

(c) Harvest rules as in (a) but including an additional constraint on the year -to-year variation of the TAC including a 15% limit on TAC variation.

(d) Evaluate alternative approaches to limit the year-to-year changes in TAC as considered appropriate.

(e) Where available data are not adequate to estimate stock size and fishing mortality by conventional techniques, identify adaptive harvest rules (such as those directly based on survey data) that are appropriate to reaching the conservation objectives.

(2) STECF is requested to advise whether effort management is necessary to achieve the effective implementation of the harvest rule and the attainment of conservation targets.

(3) The rules shall be evaluated through simulations that take into account the variability and uncertainties considered appropriate by the scientists following the guidance provided in the ICES SGMAS study group report. (Ref)

(4) The performance of the rules shall be evaluated both with respect to the perceived state of the stock and to the state of the underlying operating model population. The performance criteria shall include:

- Compatibility with the precautionary approach and relevant international standards and agreements.
- Probability distributions of yield, TACs, spawning stock biomass and fishing mortality and (where relevant) fishing effort.
- Year to year variation in TACs, yield, spawning stock biomass and fishing mortality.
- The risk of entering rebuilding situations in simulations without the year-to-year limitations in TAC change.

(5) Evaluations shall show the robustness of the harvest rules in assuring stock recovery and maintaining stocks inside safe biological limits, considering a plausible range of scenarios.

1.2 PARTICIPANTS

The participants are listed below:

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2 CELTIC SEA COD

2.1 THE FISHERY

Cod in Divisions VIIe-k are taken as components of catches in mixed demersal fisheries. The reported landings since 2000 have been made principally by France, UK, Ireland and Belgium (Table 2.1). The bulk of the catch is taken by France (~75%).

Table 2.1. Percentage composition of official records of VIIe-k cod landings for the years 2000-2004, by country and gear type, as supplied to the STECF 2005 meeting on cod recovery.

COUNTRY	GearReg	%
BEL	Beam >=80mm	2.2
BEL	Other	0.3
UK	Beam >=80mm	2.0
UK	DemTrawl >=100mm	0.73
UK	DemTrawl 70-99mm	1.92
UK	Static	2.1
FRA	Other	76.7
FRA	Static	0.7
IRL	Other	11.5
IRL	Static	1.8

The French fleets consist of French gadoid and French Nephrops trawlers operating in VIIf,g,h. Prior to 1980, the French gadoid trawlers also fished for hake in the Celtic Sea. Fishing effort by French gadoid trawlers has decreased since 2000. This fleet has contributed 40% on average (1983-2004) to the international landings. Most cod landed by Irish vessels are taken by trawlers (~90%) and gillnets (~10%). The UK cod landings are distributed fairly evenly across demersal trawlers, beam trawlers and static gears. Most of the Belgian landings are made by beam trawlers.
Landings compiled by WGSSDS (ICES 2006a) by country and gear are presented on Table 2.2.

Table 2.2. Nominal landings of Cod in Divisions VII e-k used by the Working Group.

Year	Belgium	France	Ireland	UK	Others	Total
1971						**5782**
1972						**4737**
1973						**4015**
1974						**2898**
1975						**3993**
1976						**4818**
1977						**3058**
1978						**3647**
1979						**4650**
1980						**7243**
1981						**10596**
1982						**8766**
1983						**9641**
1984						**6631**
1985						**8317**
1986						**10475**
1987						**10228**
1988	554	13863	1480	1292	2	17191

1989	910	15801	1860	1223	15	19809
1990	621	9383	1241	1346	158	12749
1991	303	6260	1659	1094	20	9336
1992	195	7120	1212	1207	13	9747
1993	391	8317	766	945	6	10425
1994	398	7692	1616	906	8	10620
1995	400	8321	1946	1034	8	11709
1996	552	8981	1982	1166	0	12681
1997	694	8662	1513	1166	0	12035
1998	528	8096	1718	1089	0	11431
1999	326	6820	1883	897	0	9926
2000	208	4690	1302	744	0	6944
2001	347	5914	1091	838	0	8190
2002	555	6897	694	618	0	8764
2003	136	5018	517	346	0	6017
2004*	153	2299	647	282	0	3381

*** provisional**

Scaled landings 1971-1987 (SSDS WG 1999)

2.2 THE ASSESSMENT

The XSA assessment of this stock is based on estimates of landings at age and trends in abundance given by commercial CPUE data and two series of French and UK trawl survey data (ICES 2006). Data on discards are presently inadequate for inclusion in the assessment. The French gadoid fleet has a strong influence on the assessment both in terms of catch numbers and CPUE.

The early part of the assessment time series (1970s) is characterised by relatively low estimates of landings, recruitment and SSB (Fig. 2.1). A 20-year period of elevated recruitment, with some very strong year classes (particularly in 1986) resulted in an increase in SSB and landings, but also a progressive increase in fishing mortality which exceeded F_{pa} continuously from the late 1980s. More recently, the 2001 to 2003 year classes are estimated to be well below average.

In 2005, the working group assessment was rejected by the Review Group of ACFM due to a recent deterioration in data quality. The main issues were un-quantified high-grading of catches by French vessels since late 2002, under-reporting that may be suspected when TACs become more restrictive, absence of a time-series of discards estimates, and specific concerns over the commercial and research vessel CPUE data used for XSA tuning.

As the 2005 ICES assessment for this stock was rejected, an alternative procedure for estimating starting populations in 2005 for the simulations was developed, avoiding the problems caused by high-grading of catches in 2003 and 2004 (Annex 1.1). This involved a forward projection from population numbers in 2003 given by an XSA run terminating in 2002, with fishing mortalities predicted from trends in fishing effort of the main fleets. This analysis showed a decline in F from an average of 0.85 for 2000-2002 to 0.68 in 2003 and 0.61 in 2004. SSB in 2005 is estimated to be above B_{pa}, whilst F is at or slightly below F_{pa} in 2003&2004. To examine the sensitivity of the LTMS simulations to this forecast, an alternative "pessimistic" XSA forecast was carried out assuming status quo F (0.85) in 2003 and 2004. This forecast gives SSB in 2005 between B_{lim} and B_{pa}, and F in 2003&2004 above F_{pa}.

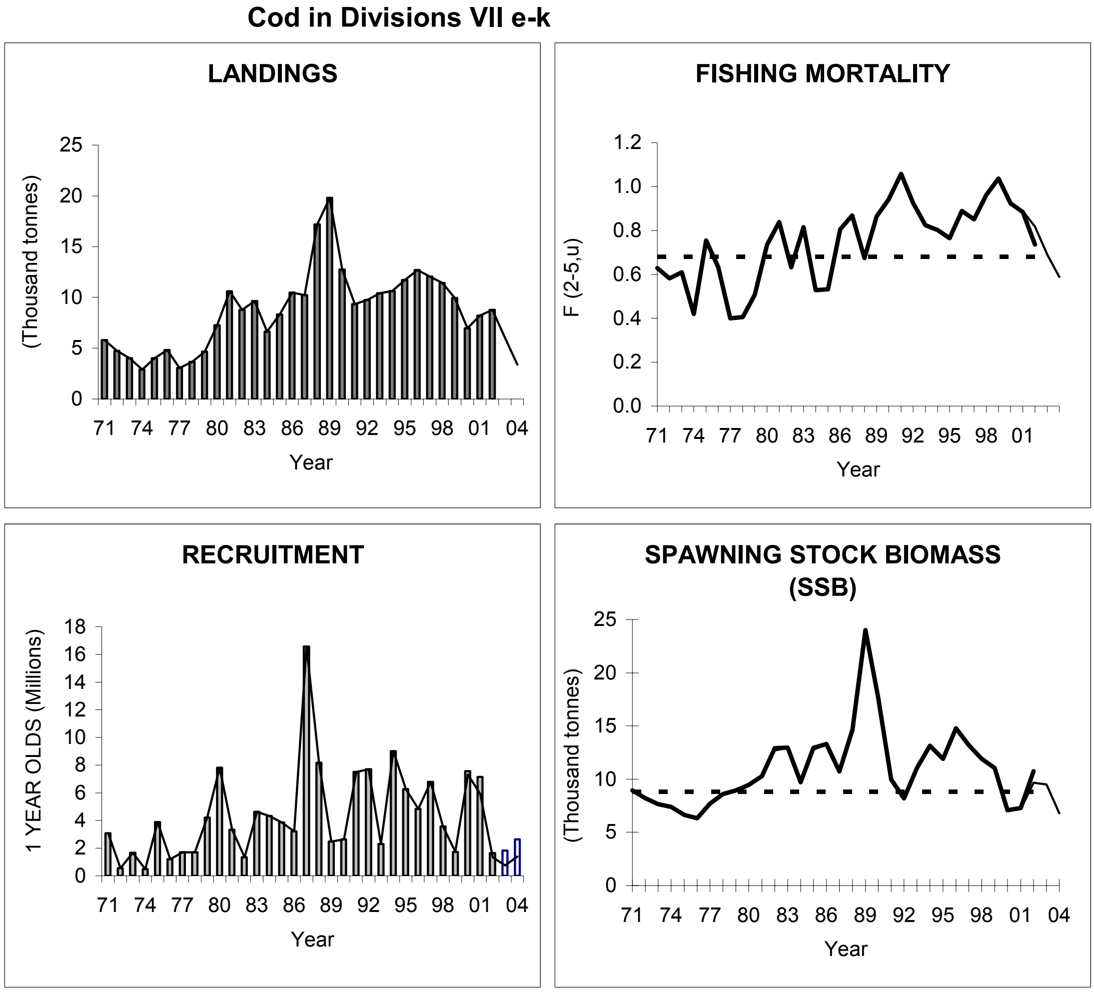

Fig. 2.1. Cod in VIIe-k: Summary plots for the XSA assessment used to generate starting values for management strategy simulations. Bars and bold lines give the XSA results for data to 2002; the thin lines indicate the results of the 2005 WG assessment which was rejected by the ACFM Review Group. Open bars for recruitment in 2003 and 2004 are from RCT3.

2.3 THE MANAGEMENT

A TAC is in place for ICES areas VIIb-k, VIII, IX, X, and CECAF 34.1.1(1), which does not correspond to the stock area (VIIe-k). In 2004 and 2005 TACs were set at 5 700 and 6 200 t. Technical measures applied to this stock are a minimum mesh size for beam and otter trawlers in Sub-area VII and a minimum landing size (MLS) of 35 cm. The MLS for Belgian trawlers is 40 cm.

Council Regulation (EC) No 27/2005, Annex III, part A 12 (b) prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during January-March 2005. This prohibition did not apply to beam trawlers during March. Council Regulation (EC) No 1954/2003 established measures for the management of fishing effort in a 'biologically sensitive area' in areas of VIIb, VIIj, VIIg and VIIh. Effort exerted within the 'biologically sensitive area' by the vessels of each EU Member State may not exceed their average annual effort (calculated over the period 1998-2002).

From the beginning of 2003, French trawlers were subject to trip landing restrictions. Penalties were imposed when landings from a trip were above the level of limitation. The restriction was suspended from May 2005 due to reduced catch rates. French vessels were also prohibited from landing the smallest size categories of cod from 2003. These two management controls were responsible for an increase in discarding due to high-grading of catches.

2.4 MANAGEMENT STRATEGY SIMULATIONS

Limit and precautionary reference points

Precautionary reference points for this stock are as follows (ICES, 2006):

B_{lim} = 6,300 t B_{pa} = 8,800 t
F_{lim} = 0.90 year^{-1} F_{pa} = 0.68 year^{-1}

Target conservation reference points

The target reference point used for the simulations was F_{max} = 0.33, as given by WGSSDS 2005 (ICES 2006b; Table 2.3). The increase in the F_{max} value in recent years may be explained by apparent changes in the exploitation pattern.

Table 2.3 Fmax Estimates

Assessment year	F_{max}
2002	0.28
2003	0.29
2004	0.31
2005	0.33
Average	**0.30±0.04**

LTMS options examined

The fishery closure in Quarter 1 is assumed to have resulted in an approximately 10% reduction in F on cod in 2005, based on the analysis by Ifremer (Biseau, Working Document 1).

Given the uncertainties in the assessment of this stock, it was decided not to examine HCRs that rely upon having an accurate assessment each year. Hence, the cod recovery plan objective for other European cod stocks of achieving a 30% year-on-year SSB increase with +/- 15% constraint on annual TAC changes was not examined. The options examined were:

A: 10% annual reduction in F until F_{max} of 0.33 is reached, then F=0.33 thereafter
B: F reduced in equal annual increments to reach F_{max} by 2015.
C: Continuation of status-quo F (for purposes of comparison)
D: Constant catch from 2005 onwards (options examined: 5,000t, 6,000t…….9,000t).

Five sensitivity tests were carried out for selected LTMS options using the following scenarios:

S1 Future recruitment lower than expected from historical estimates (e.g. due to climate change)
S2 Fishing mortality in 2003 and 2004 did not reduce in response to the decline in fishing effort – i.e. population numbers are lower in 2005, and F_{sq} correspondingly higher.
S3. Combination of above
S4 +15% bias assumed in estimates of population numbers
S5 No reduction in F due to Quarter 1 fishery closure.

Runs are identified by their codes: e.g. run A_S1 is option A with sensitivity test S1.

An additional run was carried out following implementation of sensitivity test S3, to examine the mitigating effect of a more rapid reduction in F towards F_{max} than given by scenario A_S3. This is referred to as E_S3.

2.5 PROJECTIONS

Simulations were carried out using the CS5 model. Several of the simulations were also carried out using the software package F-PRESS for comparison (Codling and Kelly, in press), as this makes a number of different assumptions to CS5 in regard to how uncertainty is modelled.

2.5.1 Settings

Assumptions in the CS5 and supporting F-PRESS simulations are summarised in Table 2.4.

Inputs to the management strategy simulations using CS5 are given below (alternative values used for sensitivity tests are given in italics).

- Population numbers at ages 2 – 7+ in 2005 taken from the short-term forecast to 2005 using effort-predicted F in 2003 and 2004 (*reduced numbers from prediction using F_{sq} in 2003 and 2004*)
- CV of population numbers representative of recent ICES XSA results, rounded up to allow for probable under-estimation of error variance in XSA.
- Recruits at age 1 from 2006 onwards calculated from "hockey stick" SRR with SSB breakpoint 13,300t and recruitment asymptote 4,600m fish, with log SE 0.79. The breakpoint was defined from inspection of the LOESS smoother fitted to historic S-R data by WGSSDS (ICES 2006). Log-normal random recruit values were generated from the SRR after adjustment of the SRR by $\exp(-\sigma^2/2)$ where $\sigma = 0.79$. Recruits at age 1 in 2005 = long term GM recruitment. (*Recruits from SRR fitted after excluding historic strong year classes >6,000m fish; SSB breakpoint 12,000t;* R *asymptote 3,000m, log SE 0.56. Recruits in 2005 = GM of reduced data set*)
- Catch and stock weights at age = 1990-2004 average over a period of stable weights, allowing a better estimate of variance for these values than a 3 year recent average.
- Exploitation pattern = mean F-at-age for 2000-2002 from SGMOS XSA run to 2002, scaled to F_{2-5} in 2004 (=F_{sq} for simulations) rather than to 1.0.
- Natural mortality and maturity values as given by WGSSDS (ICES 2006b).
- Reduction in fishing mortality of ~10% from 2005 onwards which is expected due to the fishery closure in first quarter, based on analysis of effort displacement and spatial LPUE, and direct observations of effect of closure.

The options and settings for the CS5 simulations are summarised in Table 2.5.

The F-PRESS runs used the same inputs. This model differed from CS5 in assuming normal error distributions, and in applying random variability to fishing mortality rather than population numbers after the first year of the simulation. Population numbers in year 1 are drawn from the same probability distributions in both models.

Table 2.4. Simulation assumptions for Celtic Sea cod, as in conceptual framework given by ICES SGMAS report (ICES CM 2005/ACFM:09).

	Parameter	model	bias	uncertainty	error dist	source	comments
Biological model	maturity	Historical age-based pattern; fixed		CV = 0.1 (assumed)	normal	survey	treated as exact in CS5; error incl. In F-PRESS
	stock wts	1990-2004 mean; fixed		SD of observations	normal	assessment data	treated as exact in CS5; error incl. In F-PRESS
	M	Fixed M = 0.2		CV = 0.1 (assumed)	normal	assumed	treated as exact in CS5; error incl. In F-PRESS
	S-R model	Ockham		Log SD = 0.73	lognormal	XSA	Normal error in F-PRESS
	Dynamics	Standard age-structured					
Fishery model	catch wts	1990-2004 mean; fixed		SD of observations	normal	Assessment data	treated as exact in CS5; error incl. In F-PRESS
	selectivity	2000-2002 mean; fixed				XSA	treated as exact in CS5 and F-PRESS
	spatial structure	not modelled					
Observation model	landings			Treated as exact			
	discards	not modelled					Not included
	abundance						Errors subsumed in assessment model
Assessment model	population nos.	Random error applied to CS5 operating model as proxy for assessment error	0 or 15%	Typical CV's from XSA	normal	XSA	CVs applied annually in CS5; 1st yr in F-PRESS. 15% bias applied as sensitivity test
	F	Target F specified annually					
Implementation error	non-compliance						not explicitly modelled
	closure effectiveness	Variable F	0 or 10% redn in F				varied as sensitivity test
	discarding	Not modelled					
	F	Random error		CV = 0.15	normal	Residuals from effort-F relationships	CV applied annually in F-PRESS only. Assessment error in CS5 generates implementation error in F.

Table 2.5. Celtic Sea cod: summary table for a number of different management strategy simulations

Scenario	S/R[1]	Starting population in 2005 & F_{sq}	F 2005	F 2006 onwards	Target	Error	Simulation type
A	Ockham 13300t/4600/0.79	XSA forecast with F in 2003/04 from F-effort regression; F_{sq} = 0.61	0.9F_{sq}	F -10% p.a. to F_{max}	F_{max}	CV on population nos.	HCR
A-S1	Reduced Ockham 12000/3000/0.56	as in A	0.9F_{sq}	F -10% p.a. to F_{max}	F_{max}	CV on population nos.	sensitivity
A-S2	Ockham as in option A	Pessimistic forecast with F in 2003/04 = 2000-02 mean (F_{sq}= 0.85)	0.9F_{sq}	F -10% p.a. to F_{max}	F_{max}	CV on population nos.	sensitivity
A-S3	Reduced Ockham as A_S1	Pessimistic forecast as in A-S2	0.9F_{sq}	F -10% p.a. to F_{max}	F_{max}	CV on population nos.	sensitivity
A-S4	Ockham as in option A	as in A	0.9F_{sq}	F -10% p.a. to F_{max}	F_{max}	CV on population nos. with +15% bias	sensitivity
A-S5	Ockham as in option A	as in A	1.0 F_{sq}	F -10% p.a. to F_{max}	F_{max}	CV on population nos.	sensitivity
B	Ockham as in option A	as in A	0.9F_{sq}	F reduced to F_{max} in equal steps until 2015	F_{max}	CV on population nos.	HCR
C	Ockham as in option A	as in A	0.9F_{sq}	0.9*F_{sq}	0.9F_{sq}	CV on population nos.	HCR
D	Ockham as in option A	as in A	0.9F_{sq}	Constant catch (5kt, 6kt…9kt)	Const TAC	CV on population nos.	HCR
E-S3	Reduced Ockham as A_S1	Pessimistic forecast as in A-S2	0.9F_{sq}	F -30% every year until F_{max}	F_{max}	CV on population nos.	sensitivity

[1] Ockham 13300t/4600/0.79 = SSB breakpoint 13,300 t ; recruitment asymptote 4600 m fish ; residual error log SD = 0.79

2.5.2 Results

Results of the simulation options A, C and D and sensitivity tests A_S1 to A_S4 listed in Table 2.4 are given in detail in Annex 1 Figures 1-9. Summary plots comparing the trends in mean landings, median SSB and probability of SSB<B_{lim} are given in Annex 1 Figs 10-11, including results of options B and A_S5 (note that the "probability of recovery by year" plot in the CS5 output is probability of SSB>B_{lim} for two successive years whilst the "probability SSB > B_{lim}" plot in Annex 1 Figs 10-11 is the probability in any one year).

Strategy of maintaining F_{sq} (Run C)

Maintaining F_{sq} at the 2004 value of 0.61 adjusted for the 10% reduction due to the fishery closure (F=0.55) results in landings increasing progressively from around 6,000t in 2005 to 10,000t with a very high probability of SSB > B_{lim} (run C: Annex 1 Fig.1). If the Q1 closure is assumed to have no significant effect on F (i.e. F_{sq} =0.61), the landings increase to 8,000 t in the medium term, but with a probability of SSB > B_{lim} declining to 80% (run C_S5: Annex 1 Fig 10).

For scenarios where the stock size in 2005 is derived from the "pessimistic" forecast, or where future average recruitment is lower than observed historically (F-PRESS run C_S1: Annex 1 Fig 15), the Fsq strategy results in static or declining SSB and landings over time. Hence, given the uncertainty in the state of the stock and future recruitment patterns,, an Fsq strategy may be considered inappropriate for this stock at the present time.

Constant catch strategies (Run D)

A constant catch strategy leads to an increase in the median SSB if the amount of allowable catches does not excess 8,000 t. However, even with lower constant-catch strategies down to 6,000 t the probability of SSB falling below B_{lim} can be high (Annex 1 Figs 4 and 10) since in some occurrences with low SSB, a very high F is required (by the model) to achieve the fixed catches, leading to a further depletion. Even with a very high F, the catches would sometimes not reach the TAC due to stock collapse. This explains why, in Annex 1 Fig. 10, the mean landings resulting from the constant TAC scenario of 7,000t could be much lower than the fixed TAC.

Reducing F progressively to F_{max} (Runs A & B and sensitivity tests)

Reducing F by 10% each year until F_{max} of 0.33 is reached, then F=0.33 thereafter, results in average landings increasing gradually until 2010 when F_{max} is reached (Annex 1 Figs 2&10). Maintaining F at F_{max} in subsequent years would lead to a further increase in landings, which are expected to stabilise in the late 2010's at around 11,600 t. The median SSB increases to over 30,000t, with very high probability of SSB > B_{lim}.

A smaller rate of reduction in F by equal annual increments to reach F_{max} in 2015, would obviously lead to the same long-term result, while the short-term landings would be slightly higher (Annex 1 Fig. 10). However, the Group felt that the more rapidly the fishing mortality is reduced, the safer the stock will be, and decided that the scenario assuming a 10% reduction in F each year until F_{max} shoud be considered as the most appropriate scenario, and is called the 'base case' in the following. Table 2.6 and Figure 2.2 show the input parameters and the results of this scenario, respectively.

Table 2.6. Input values for base-case CS5 run on Celtic Sea cod. Expl(F) is the status quo F , not scaled to Fbar = 1.0, hence F-multipliers are applied to give 10% reduction in F to F_{max} (=0.33). "Box" refers to Q1 cod closure imposed since 2005.

Starting year, Last year, first age, last age
2005, 2025, 1, 7
N, se log(N hat), Bias(N hat), M, Mat, Expl(F), WEST, WECA

3300	0.80	1.0	0.2	0	0.147	0.584	0.842
1868	0.40	1.0	0.2	0.39	0.559	1.469	2.058
598	0.25	1.0	0.2	0.87	0.645	4.337	4.622
221	0.20	1.0	0.2	0.93	0.620	6.885	7.169
416	0.20	1.0	0.2	1	0.616	9.068	9.421
106	0.20	1.0	0.2	1	0.540	10.956	11.245
20	0.20	1.0	0.2	1	0.540	13.109	13.455

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
4630 13300 0.0 0.0 0.729 -1
HCR % change (up, down), Fpa, SSBincr%
15,15, 0.68, -1000
Spawning Time as fraction of year
0.0
Catch in StartingYear-1
6450
Catch in the starting year, or (if negative) F (multiplier) constraint (F sq = 0.61)
-0.9
Ages for calculating reference F
2 5
Reference Biomass to calculate probabilities
6300
SSB in StartingYear-1
11000
Method For each year after starting year Rule, Target (1 - apply harvest rule, 2 - fixed F, 3 - Fixed TAC)

2	0.90
2	0.81
2	0.73
2	0.66
2	0.59
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53
2	0.53

COMMENTS
Blim = 6300; Bpa = 8800; Flim = 0.90, Fpa = 0.68
RUN id : cod7fg_run2
Stock : VIIe-k cod
Starting Point : Forecasted populations in 2005 from retrospective XSA with 2002 as last data year
Constraint : Status quo F -10% (Box) from 2005 - 10% reduction each year to Fmax.

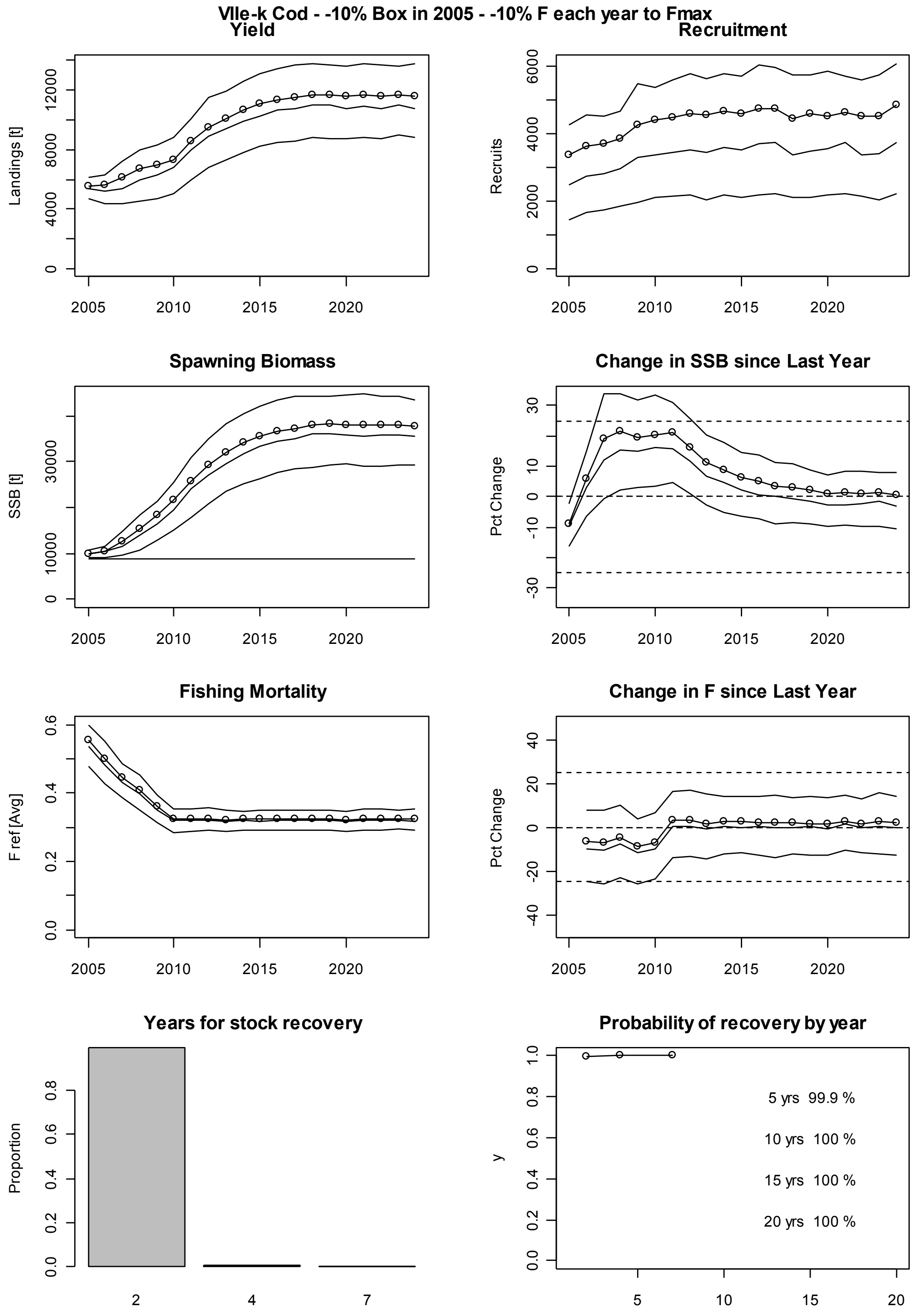

Figure 2.2. Celtic Sea cod: CS5 Run A (see text for explanation of run combinations)

Sensitivity analysis for base case (Runs A_S1 to A_S5)

The results of the sensitivity analyses for the base case scenario (F reducing to F_{max} by 10% per year) are compared in Annex 1 Fig. 11.

For the "pessimistic" forecast for 2005 starting populations (F_{sq} = 0.85 compared with 0.61 for "base case"), landings remain stable for several years until the F is sufficiently low to allow a more rapid increase in stock size (Run A_S2; Annex 1 Figs 5&11). Median SSB remains below Bpa until 2010, and probability of being above B_{lim} for two consecutive years is 60-70% initially but rises to over 90% after about 7 years as F is reduced.

A more pessimistic regime for future recruitment (Run A_S1; Annex 1 Figs 6&11) mainly impacts the level of SSB and landings attained. Landings remain low until F reaches F_{max}, then begin to increase. Probability of SSB > B_{lim} remains high.

A combination of smaller initial stock size in 2005 and reduced future recruitment results in declining landings for the first 5 years and a large risk of SSB < B_{lim} (Run A_S3; Annex 1 Figs 7&11). Median SSB remains below B_{pa} until 2013 and landings do not start to recover until 2014. In this case, a stronger reduction in F (by 30% each year) would decrease the risk in the short term, and would bring SSB above B_{pa} in 2008 (Run E_S3; Annex 1, Fig. 8&11).

Including a +15% over-estimate of stock size estimates each year in the base-case model results in a higher F than intended. This causes a small reduction in long-term landings compared with the equivalent run with un-biased stock estimates, but a larger reduction in median SSB (Run A_S4; Annex 1 Figs 9&11). However, probability of SSB > B_{lim} remains high.

2.5.3 Comments

The simulations are carried out within the Precautionary Approach framework by evaluating SSB and F in relation to PA reference points proposed by ICES (ICES, 2006b).

There is currently no accepted assessment for Celtic Sea cod due to recent deterioration in data quality, and an ad-hoc method has been adopted by SGMOS to infer starting populations and status quo F for the simulations. The simulation results are very sensitive to assumptions regarding the starting populations in 2005 and the recent level of F associated with this.

The strategy of a 10% reduction in F to F_{max} was robust to assumptions regarding future recruitment, which affected mainly the landings and SSB achieved in the medium to long term.

A 15% variation in TAC constraint could not be explored together with a progressive reduction in F when using the CS5 software. Examination of the simulation results for the years where the F reduction is applied shows that the proportion of occurrences for which the absolute variation from one year to the next is greater than 15% is around 61%. This is similar to the historical year-to-year variations observed in the past landings for which 67% were above 15%.

An analysis carried out by Ifremer showed that in 2005, the closure of three ICES rectangles during Quarter 1 resulted in French gadoid trawlers switching from cod fishing to fishing for benthic species such as anglerfish, megrim and rays, where cod by-catch was low (Biseau, Working Document 1). A 10% reduction in F due to this measure was included in the simulations. If the measure were to result in a smaller reduction in F, this would effectively delay the attainment of F_{max} by up to 1 year under a strategy of 10% annual reduction in F.

3 BAY OF BISCAY SOLE

3.1 THE FISHERY

The French fleet is the major participant in the Bay of Biscay sole fishery with landings of about 90% of the total official international landings. The remaining part is usually landed by the Belgian beam trawl fleet.

The French fishery is mainly a fixed net sole fishery. This fishery developed in the eighties expanded in the nineties and now accounts for 65-75% of the French landings. About half of the catch is taken in the first quarter when this fishery operates on the spawning grounds.

There is also a French mixed demersal fishery (sole, cuttlefish, squid, hake, pout, whiting, etc.) by otter trawlers. A major part of this fleet comprises coastal boats of less than 12 m. Although sole is taken throughout the year by trawlers, sole catches of the coastal trawlers are less important in winter.

The Belgian beam trawl fishery is directed to sole, with an important bycatch of anglerfish. This fishery operates generally from June to August.

Table 3.1: The percentage of the landings for the different fleets. Numbers are calculated from the average landings over the period 2002-04.

French fixed net fleet	63%
French otter trawlers	30%
Belgian beam trawlers	7%

Landings have increased continuously since the beginning of the 1980s, until a maximum was reached in 1994 (7400 t). They decreased afterwards to about 4000 t recently. Discards estimates are available for most of the fleets and are generally low (Table 3.2).

3.2 THE ASSESSMENT

The ICES Working Group on the Assessment of Southern Shelf Demersal Stocks (WGSSDS) caries out the assessment of Bay of Biscay sole and currently uses XSA to assess the stock (ICES 2006b). The catch at age matrix is mainly composed of the French fixed net fleet, and the assessment is tuned with three commercial trawler fleets and two surveys. The surveys were discontinued in 2002. The lack of survey data is a deficiency in the assessment, especially for estimating incoming recruitment.

The assessment summary is presented in Figure 3.1.

Retrospective analysis shows that F is underestimated in the terminal year (on average 20%) and therefore SSB is overestimated.

3.3 THE MANAGEMENT

Management of Bay of Biscay sole is by TAC and technical measures. The 2004 TAC was set at 3600 t. The 2005 TAC is set at 4140 t. The minimum landing size is 24 cm and the minimum mesh size is 70 mm for trawls and 100 mm for fixed nets, when directed to sole. Since 2002, the minimum mesh size was increased to 100 mm for trawlers operating in those areas of the Bay of Biscay that fall under the hake recovery plan.

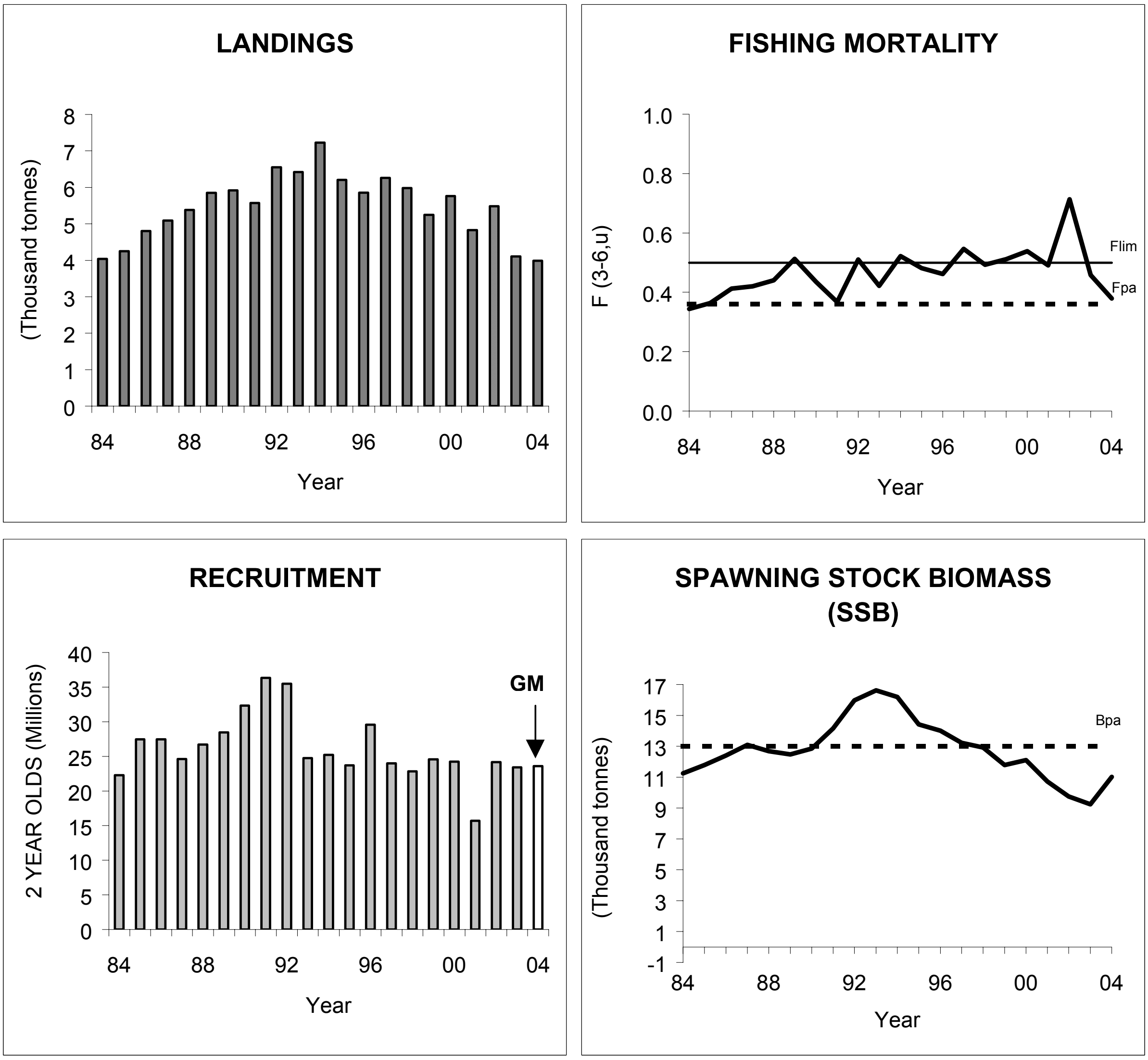

Figure 3.1 : Bay of Biscay sole summary plots for the XSA assessment used to generate starting values for management strategy simulations (ICES, 2006b).

Table 3.2: Bay of Biscay sole (Division VIIIa,b). Internationnal landings and catches used by the Working Group (in tonnes).

	Official landings						Unallocated	WG	Discards[1]	WG
Years	Belgium	France	Nether.	Spain	Others	Total	landings	landings		catches
1979	5*	2376		62*		2443	176	2619	-	-
1980	33*	2549		107*		2689	297	2986	-	-
1981	4*	2581*	13*	96*		2694	242	2936	-	-
1982	19*	1618*	52*	57*		1746	2067	3813	-	-
1983	9*	2590	32*	38*		2669	959	3628	-	-
1984		2968	175*	40*		3183	855	4038	99	4137
1985	25*	3423	169*	308*		3925	326	4251	64	4315
1986	52*	4227	213*	75*		4567	238	4805	27	4832
1987	124*	4009	145*	101*		4379	707	5086	198	5284
1988	135*	4308				4443	939	5382	254	5636
1989	311*	5471*				5782	63	5845	356	6201
1990	301*	5231				5532	384	5916	303	6219
1991	389*	4315		3		4707	862	5569	198	5767
1992	440*	5919				6359	191	6550	123	6673
1993	400*	6083		13		6496	-76	6420	104	6524
1994	466*	6620		17***		7103	123	7226	184	7410
1995	546*	5325		6***		5877	328	6205	130	6335
1996	460*	3843		13***		4316	1537	5853	142	5995
1997	435*	4526		23***	1	4985	1274	6259	118	6377
1998	469*	3821	44	40***	1	4375	1607	5982	127	6109
1999	504*	3280		41***		3825	1424	5249	110	5359
2000	451*	5293		95***	1	5840	-81	5759	51	5810
2001	361*	4361	201	224***	1	5148	-320	4828	39	4867
2002	303*	3679		27***	1	4010	1457	5467	21	5488
2003	296*	3445				3741	365	4106	20	4126
2004	323	N/A			1	323	3667	3990	-	-

* reported in VIII — *** reported as Solea spp (*Solea lascaris* and *solea solea*) in VIII

** Preliminary — [1] Discards = Partial estimates for the French offshore trawlers fleet

N/A — Non available

3.4 LONG TERM MANAGEMENT STRATEGIES

Limit and precautionary reference points

There is no biomass limit reference point set for Bay of Biscay sole. The F limit reference point and the precautionary reference points for this stock are indicated below. $F_{lim} = 0.50$ year^{-1}

$F_{pa} = 0.36$ year^{-1}

$B_{pa} = 13000$ t

Bpa is based on the historical development of the stock and was set equal to Bloss (= 13000 t) as estimated in the 2001 WGSSDS. However, successive assessments have revised this estimate and the estimate in the most recent assessment is 11200 t. Given this uncertainty, the value of Bpa has been kept at 13000 t and is used as a trigger value in some long term management scenarios (see section 3.5).

In 2001 Flim was set at Floss, based on the historical development of the stock. Floss is statistically well determined but not sound biologically since there is no stock-recruitment relationship. Consequently the current basis to set Flim and Fpa is weak. Furthermore the estimates of Floss vary between years. Using the same rational as in 2001, Flim can now be estimated at 0.59, and Fpa at 0.42. Therefore Fpa was not considered as a reference point for setting possible HCR.

Target conservation reference points

In 2005 the Fmax was estimated to be 0.21 (Table 3.3) and this value was used as a target conservation reference point in the simulations. Fmax is well defined for this stock, with an acceptable variability between years.

Table 3.3: Estimated Fmax for Bay of Biscay Sole.

Assessment year	F_{max}
2001	0.18
2002	0.19
2003	0.20
2004	0.24
2005	0.21
Average	**0.20 ± 0.02**

The simulations for Bay of Biscay sole did focus on F based scenarios, reducing F towards the target conservation reference point of 0.21. Section 3.5 outlines the different F-based scenarios selected for this stock and explains in more detail why these scenarios were chosen.

3.5 PROJECTIONS

The programs that were used for the simulation are CS5 and CP.

3.5.1 Settings

The simulation assumptions are summarized in Table 3.4.

Table 3.4: Simulation assumptions for Bay of Biscay Sole.

Model	Parameter	model	bias	uncertainty	error dist	source	Comments
Biological	Mo					sampling	
	Wbars					sampling	
	M					assumption	
	R	Ockham		0.3		historical S-R	
Fishery	Wbarc					sampling	
	selectivity						Not considered
	spatial structure						Not considered
Observation	C					sampling	
	Discards						Low impact
	abundance						Not available
Assessment	N	XSA	+25%	0.15	lognormal	WGSSDS 05	
	F	XSA	-20%			WGSSDS 05	bias estimated from retrospective analysis
Implementation Error	F multiplier					assumption	

General settings

All simulations start in 2006. There is one TAC based scenario, the others are F based. Natural mortality and maturity were considered constant. Population numbers in the beginning of 2006 and their log standard errors were taken from the assessment and predictions carried out by the 2005 WGSSDS (ICES 2006b). Similarly the catch estimate for 2005 was taken from the short term prediction. The exploitation pattern was the average over the period 2000-05. Catch and stock weights were the average over the period 2002-04.

There were no scenarios carried out with a 15% constraint on annual TAC changes. The results of such scenarios would not have differed from the ones carried out since the yearly TAC change for all simulations was less than 15%.

The stock-recruitment curve is not well defined for this stock. Therefore the Ockham model was used for estimating recruitment. The breakpoint for the curve was set at (11200;23602) corresponding to the lowest observed biomass in the converged part of the assessment and the GM recruitment calculated over the period 1993-2003.

Scenarios

The settings for the different scenarios are briefly described below. Scenarios 1-6 are HCR scenarios, while scenarios 7-9 look at the sensitivity to a possible bias in the estimates of the population numbers and the robustness of the HCR to implementation errors. The different scenarios settings are summarized in Table 3.5.

Table 3.5: Settings for the different scenarios used for Bay of Biscay Sole.

Scenario	S/R	Constraint TAC change	F 2006	F 2007 onwards	Target	Error	Type
1	Ockham	/	F_{sq}	F_{sq}	F_{sq}	/	HCR
2	Ockham	/	TAC_{05}	TAC_{05}	Constant TAC	/	HCR
3	Ockham	/	$0.9F_{sq}$	F -10% every year	F_{max}	/	HCR
4	Ockham	/	$0.9F_{sq}$	F -10% every 3 years	F_{max}	/	HCR
5	**Ockham**	**/**	**$0.9F_{sq}$**	**If SSB < B_{pa}: F -10% every year else if SSB > B_{pa}: F -3% every year**	**F_{max}**	**/**	**HCR**
6	Ockham	/	$0.9F_{sq}$	If SSB < B_{pa}: F -10% every year else if SSB > B_{pa}: F -10% every 3 years	F_{max}	/	HCR
7	Ockham	/	$0.9F_{sq}$	If SSB < B_{pa}: F -10% every year else if SSB > B_{pa}: F -3% every year	F_{max}	25% bias in N	Sensitivity
8	Ockham	/	$0.9F_{sq}$	F -10% every year	F_{max}	5% implementation error	Robustness
9	Ockham	/	$0.9F_{sq}$	If SSB < B_{pa}: F -10% every year else if SSB > B_{pa}: F -3% every year	F_{max}	5% implementation error	Robustness

The inputs and the output figures for scenarios 3 are presented in this section, those for the other scenarios can be found in the Annex

Scenario 1 assumes a status quo fishing mortality from 2006 onwards. Fsq = 0.52 is the average over the period 2000-04 (same as in WGSSDS 2005). Scenario 2 simulates what happens when landings are kept at a constant level that is the same as the TAC of 2005. Scenarios 3-6 simulate different HCRs. Fishing mortality in 2006 is set at 0.9 x Fsq for all these scenarios. This is an arbitrary choice but since the TAC for 2006 will probably be set at a level corresponding to a fishing mortality equal to or lower than Fpa (= 0.36), F in 2006 will be lower than Fsq (= 0.52). The simulation settings are for:

- **Scenario 3** a 10% reduction in F every year until the target reference point Fmax (= 0.21) is reached;
- **Scenario 4** a 10% reduction in F every three years until Fmax is reached;
- **Scenario 5** a 10% reduction in F every year if SSB is below Bpa, and a 3% reduction in F every year if SSB is above Bpa. F is reduced until Fmax is reached (input and results in Table 3.6 and Figure 3.2), and;
- **Scenario 6** a 10% reduction in F every year if SSB is below Bpa, and a 10% reduction in F every three years if SSB is above Bpa. F is reduced until Fmax is reached.

Note that the CS5 program has no predefined options for scenarios 5 and 6. Hence the different F values corresponding to the preset conditions were calculated manually. Scenario 7 looks at the sensitivity to the estimates of the population numbers. After all, given the underestimation of F in the assessment of Bay of Biscay sole, the estimates of the population numbers in the beginning of 2006 might be biased. The underestimation of F in the final year is on average 20%. Taking into account this underestimation, the population numbers might be overestimated on average by 25%. The 25% bias is simulated in this scenario 7. The HCRs were the same as scenario 5. Scenarios 8 and 9 are similar to scenarios 3 and 5 respectively, but with an assumed implementation error of 5%.

3.5.2 Results

The scenario input data and output results that are not presented under this section can be found in Annex 2.

Fishing at status quo fishing mortality (Scenario 1) would bring SSB further down into unknown population dynamics. Scenario 2 suggests that the stock can sustain landings at a level that is similar to the 2005 TAC. As catch rates increase over time, effort should decrease accordingly in order to keep the landings at the same level. Scenarios 3-6 simulate different HCR with Fmax as long term target. Scenario 5 (Table 3.6 and Figure 3.2) might be the best option that finds a balance between biological and socio-economic priorities under the condition that the F reductions corresponding to the HCR are actually realised. If a yearly reduction of 10% in F is realised, the stock will be above Bpa within 2-3 years from now. From then onwards less severe yearly reductions bring F to the target in ~20 years. Equilibrium SSB is around 30000 t. Note that the highest SSB values observed so far are around 20000 t. Although this scenario results in short term losses in yield compared to fishing at status quo, estimated yields would remain above the TAC05 of 4140 t. Long term yields are estimated to be around 5000 t. If an implementation error of 5% is assumed (Scenario 9), then there is a low probability that F will reach the Fmax target, and that the stock will increase into known population dynamics.

With a yearly 10% reduction, F reaches Fmax by 2015 (Scenario 3). This scenario is in agreement with the commitments made on the World Summit of Johannesburg. Applying an implementation error of 5% (Scenario 8) fishing mortality is unlikely to reach the Fmax target.

The sensitivity of the HCR to a bias in the population numbers is simulated in Scenario 7. A bias in population numbers of 25% corresponding to an underestimation in F of on average 20% results in a delay in achieving the targets of ~10 years.

3.5.3 Comments

Although the current status of Bay of Biscay sole is not in such a way that the stock is at a high risk of collapsing, current SSB is estimated to be at a lower level and current fishing mortality is too high. Therefore measures to reduce fishing mortality and increase biomass in the short term are required. These should be complemented with long term management goals. Such a long term target point for this stock is Fmax. To get to Fmax different HCRs can be developed, hence the different scenarios to get to Fmax that are presented here are not exclusive. It is clear that the more severe the reductions in F are, the quicker Fmax is reached and vice versa. For Bay of Biscay sole stringent measures need to be taken in the short term to bring the stock back as quickly as possible into known population dynamics while in the longer term gradual but less severe F reductions towards Fmax might be more acceptable. Scenario 5 (10% F reduction if SSB < Bpa, 3% F reduction if SSB > Bpa, target Fmax) might be a possible HCR that fits to these conditions. It is obvious that scenario 5 considers that the F reductions are actually realised. Simulating an implementation error of 5% on this scenario shows that the Fmax target may not be reached. A re-evaluation of the HCR is therefore necessary within 3 years. If the presupposed goals are not met, new HCRs should be developed including stronger reductions in F.

Beside implementation errors, the HCR is also sensitive to the bias in population number estimates. A bias in population numbers of 25% results in a delay in achieving the targets of ~10 years.

The scenarios consider that fishing mortality can be reduced with according effort reductions. In the case of Bay of Biscay sole, the fixed net fleet is the major fishery. Conversely to the trawler fleets, regulating fishing mortality by direct effort limitations (e.g. by limiting the number of fishing days), is not as straightforward for the fixed net fleet. Other possibilities to regulate effort are regulating the number of vessels, adjusting mesh sizes, temporal and/or spatial closures, etc..

Table 3.6. Input to scenario 5 (F06 = 0.9 Fsq; If SSB < Bpa: F -10% every year, else if SSB > Bpa: F -10% every year; Target = Fmax). Note that the CS5 program has no predefined options for scenarios 5 and 6. Hence the different F values corresponding to the preset conditions were calculated manually.

Starting year, Last year, first age, last age
2006, 2030, 1, 7
N, se log(N hat), Bias(N hat), M, Mat, Expl, WEST, WECA

23602	0.18	1.0	0.1	0.32	0.468	0.179	0.179
17316	0.18	1.0	0.1	0.83	0.957	0.22	0.22
9642	0.14	1.0	0.1	0.97	1.259	0.286	0.286
5674	0.13	1.0	0.1	1	1.191	0.356	0.356
3062	0.09	1.0	0.1	1	1.125	0.479	0.479
1004	0.09	1.0	0.1	1	0.995	0.629	0.629
1276	0.09	1.0	0.1	1	0.995	0.712	0.712

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
23602 11200 0.0 0.0 0.3 -1
HCR % change (up, down), Fpa, SSBincr%
15, 15, .36, -1000
Spawning Time as fraction of year
0.0
Catch in StartingYear-1
4722
Catch in the starting year, or (if negative) F constraint (F pa in 2006 = 0.36)
-0.468
Ages for calculating reference F
1 5
Reference Biomass to calculate probabilities
13000
SSB in StartingYear-1
11610
Method For each year after starting year Rule, Target (1 - apply harvest rule, 2 - fixed F, 3 - Fixed TAC)
2 1. 2006
2 0.421
2 0.409
2 0.396
2 0.384
2 0.373
2 0.362
2 0.351
2 0.340
2 0.330
2 0.320
2 0.311
2 0.301
2 0.292
2 0.283
2 0.275
2 0.267
2 0.259
2 0.251
2 0.243
2 0.236
2 0.229
2 0.222
2 0.216
2 0.21
COMMENTS

RUN id : sole BB run 5 : 10% F decrease if SSB<Bpa else -3% to Fmax
Stock : Bay of Biscay sole
Starting Point : N in 2006 = SSDSWG 05
Constraint : Fixed F

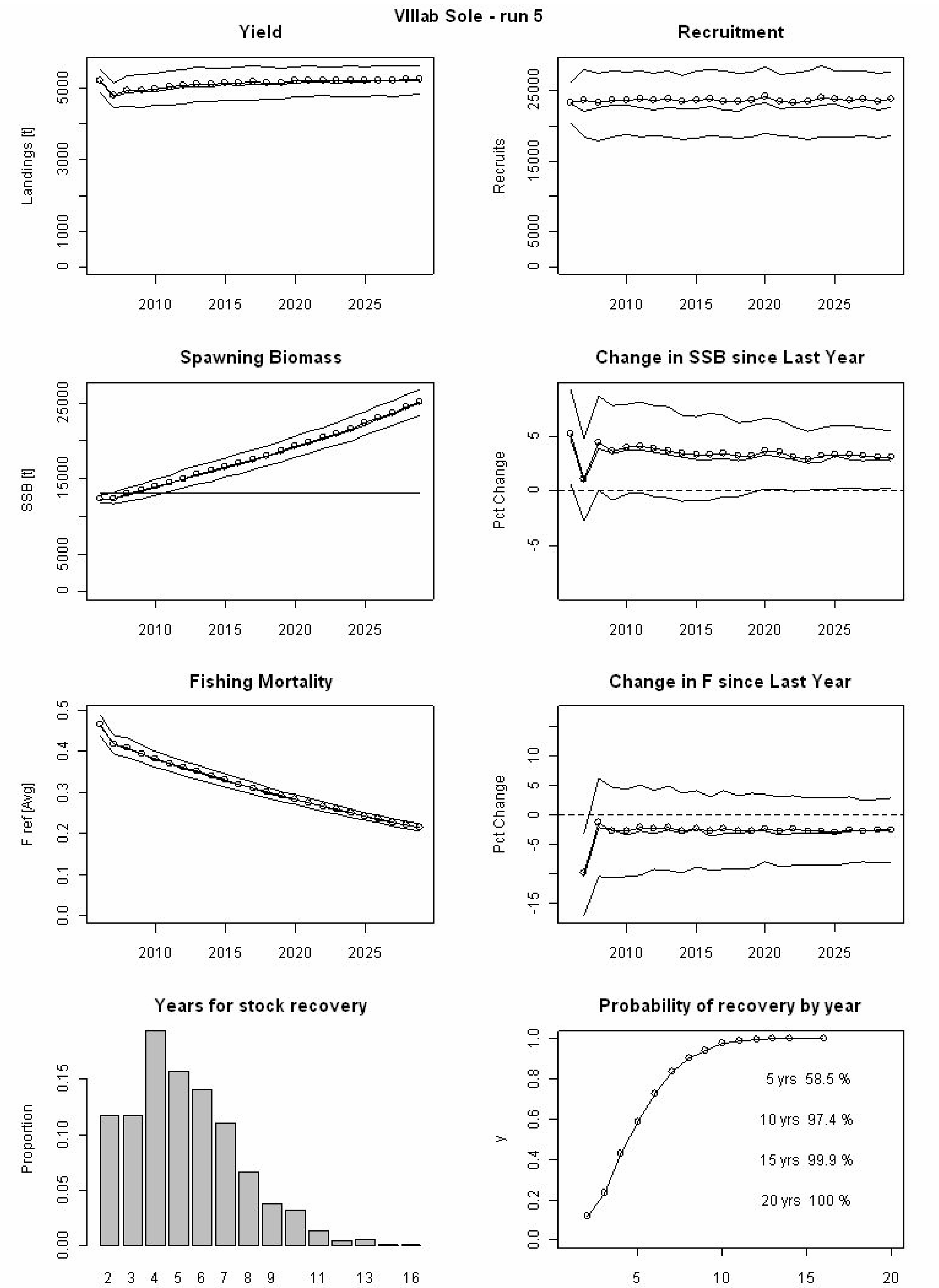

Figure 3.2. Scenario 5 results (F06 = 0.9 Fsq; If SSB < Bpa: F -10% every year, else if SSB > Bpa: F -10% every year; Target = Fmax).

4 IBERIAN ANGLERFISH

4.1 THE FISHERY

In the Atlantic Iberian Peninsula two anglerfish species are caught by Spanish and Portuguese fleets, the white anglerfish (Lophius piscatorius) and the black anglerfish (L. budegassa). The proportion of both species in the 2004 landings is shown in Table 4.1 by country. White anglerfish represented 77% of the total landings, with Spain landing 70%. In the Portuguese landings both species were equally present.

Table 4.1. Landings of each Iberian Anglerfish species by country in 2004.

	L.piscatorius			*L.budegassa*			Total
	Spain	Portugal	Total	Spain	Portugal	Total	Total
Landings (t)	2795	281	3076	656	268	924	4000
Landings (%)	70	7	77	16	7	23	100

The landings of anglerfish Stock (combined species) estimated by the WGHMM (ICES 2006a) (Table 4.2) show total landings of 4000 t in 2004, which are 25% higher than the landings in 2003. Landings show a decreasing trend since the mid eighties to recent years. Table 4.3 shows the proportion of anglerfish landings from fleet and country in 2004. Both fleets contributed approximately with the same landings (trawl fleet 51 %, and the static gears 49%). The importance of the anglerfish landings in the total fleet landings are different (Table 4.4). Anglerfish are by-catch species mainly for the trawl fleets being only target species for static gears (gillnets in Spain and for a component of the trammel nets in Portugal). Annex 3 shows a more detailed description of the fleets.

Table 4.2 Iberian Anglerfish landings (t) by country, ICES Division and fleet 1978-2004 as determined by the WGHMM.

	Div. VIIIc			Div. IXa				Div. VIIIc+IXa
	SPAIN			SPAIN	PORTUGAL			
Year	Trawl	Gillnet	TOTAL	Trawl	Trawl	Artisanal	TOTAL	TOTAL
1978	n/a	n/a	n/a	506		222	728	
1979	n/a	n/a	n/a	625		435	1060	
1980	4008	1477	5485	786		654	1440	6926
1981	3909	2240	6149	1040		679	1719	7867
1982	2742	3095	5837	1716		598	2314	8151
1983	4269	1911	6180	1426		888	2314	8494
1984	3600	1866	5466	1136	409	950	2495	7961
1985	2679	2495	5174	977	466	1355	2798	7972
1986	3052	3209	6261	1049	367	1757	3172	9433
1987	3174	2571	5745	1133	426	1668	3227	8973
1988	3583	3263	6846	1254	344	1577	3175	10021
1989	2291	2498	4789	1111	531	1142	2785	7574
1990	1930	1127	3057	1124	713	1231	3068	6125
1991	1993	854	2847	878	533	1545	2956	5803
1992	1668	1068	2736	786	363	1610	2758	5494
1993	1360	959	2319	699	306	1231	2237	4556
1994	1232	1028	2260	629	149	549	1327	3587
1995	1743	677	2420	814	134	297	1245	3665
1996	2146	850	2995	749	265	574	1589	4584
1997	2249	1389	3638	838	191	860	1889	5527
1998	1660	1507	3167	865	209	829	1903	5070
1999	1116	1140	2256	750	119	692	1561	3817
2000	710	612	1322	485	146	675	1306	2628
2001	614	364	978	247	117	459	823	1801
2002	559	415	974	344	104	380	828	1802
2003	1190	771	1961	617	96	529	1242	3203
2004	1513	1389	2901	549	70	479	1098	4000

n/a: not available

Table 4.3. Proportion of the Iberian Anglerfish landings by fleet in 2004

Gear	Country		
	Spain	Portugal	Total
Bottom otter trawl	43	2	45
Pair bottom trawl	6		6
Gillnet "rasco"	28		28
Artisanal	9	12	21
Total Trawl	49	2	51
Total Static gears	37	12	49
Total	86	14	100

Table 4.4. Proportions of total landings representing Iberian Anglerfish for each fleet in 2004

Gear	Country	
	Spain	Portugal
Bottom otter trawl	4	
Pair bottom trawl	1	
Total Trawl	3	<1
Gillnet "rasco"	90	
Artisanal	<1	2

Both anglerfish species are caught by Spanish bottom trawlers and static gears fleet in Div. VIIIc. In Div. IXa anglerfish are captured by the Spanish and Portuguese bottom trawlers and by the Portuguese static gears fleet. The captures do not present any clear seasonality but they show a overall decreasing trend along the year in Div. IXa. In Div. VIIIc a similar trend between the two fleets is observed during the first three quarters, with higher yields during the second quarter.

Pérez et al. (1996) showed that the Spanish discards rates of anglerfish in the trawl fleet were low (2% in weigth of the total anglerfish caught in Div. VIIIc, and lower than 1% in Subdiv. IXa-north). However, the discard rate of anglerfish in the gillnet fleet in Div.VIIIc was high: 29% in weight (31% in L.piscatorius and 18 % in L.budegassa). Anglerfish discarded were large individuals, basically due to fish in poor condition when drawing up the nets (Pérez et al.,1996).

4.1.1 Mixed fisheries

Anglerfish are caught in a mixed fishery with Hake, Megrins, Norway Lobster and other species. The proposal of Recovery Plans of Southern Hake and Iberian Norway lobster stocks established by STECF/SGMOS (2004) is expected to have impact on strategies for Anglerfish. The referred RP had the following elements:

- An overall effort reduction scheme applied to all vessels which land hake and Norway lobster in these areas. This should achieve an annual reduction in effort of 10% relative to the previous year.
- The closure of selected Norway lobster fishing grounds to all fishing.

The annual reduction in effort of 10% has a direct implication in the present anglerfish long term management, because the three fleets that catch hake and Norway lobster (Spanish trawl VIIIc-IXa-North, Portuguese trawl and Portuguese artisanal) also catch anglerfish. The trawl fleets catch around 50% of the Iberian anglerfish. They target a wide range of species and the anglerfish catches are very low, being mainly a by-catch.

The interactions between Iberian fisheries were analysed in the WGHMM (ICES, 2006a) and were considered high between Iberian Anglerfish and the fleets included in the Iberian Hake and Norway lobster recovery plan.

4.2 THE ASSESSMENT

The assessment of the Iberian Anglerfish is carried out in the WGHMM and has been based since 1998 on a non-equilibrium production model, ASPIC (Prager, 1994 and Prager, 2004) with combined species. Two commercial fleets are used in the assessment (anglerfish as by-catch), the Spanish A Coruna trawl fleet and the Portuguese trawl fleet. No survey data are used in the assessment due to the low anglerfish catches of the surveys carried out in the Iberian coast.

Assessment results (Figure 4.1) show that fishing mortality has been over FMSY along the time series, reaching lower values only in 2001 and 2002. The biomass shows a decreasing trend since the beginning of the time series being relatively stable at low levels through the last 10-15 years. During the last 5 years the biomass is estimated to be around 50% of BMSY.

Age structured models (XSA) have been used to make exploratory assessments. Results were poor due to high log catchability residuals with year effects in the tuning fleets, showing inconsistencies with model assumptions.

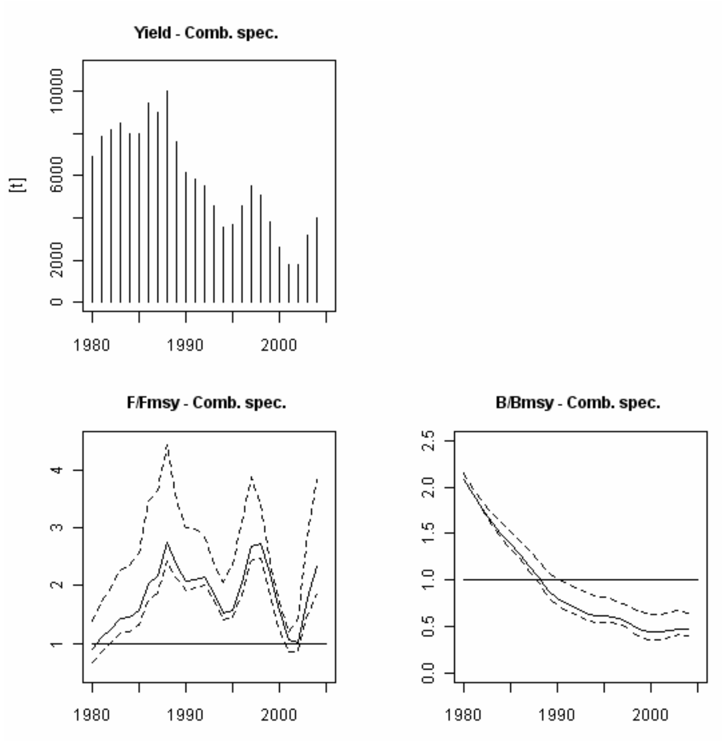

Figure 4.1. Yield, F/FMSY and B/BMSY trends as estimated from WGHMM 2005.

4.3 THE MANAGEMENT

4.3.1 TACs

TAC2005=1955 t is set for both species combined. For most of years the agreed TAC has been set well above the landings for the stock. Since 1998 a decrease of the TAC took place and in 2004 the landings will be higher than TAC.

4.3.2 Relevant gear regulations and minimum landing sizes

EU regulations:

Minimum landing size not yet fixed but there is a minimum commercial weight of 500 g.
Minimum mesh size: Trawl gears: 70 mm (55 mm for Gulf of Cadiz). 55 mm in some situations.
Static gears: 100 mm. 220 mm when anglerfish catches >30% of total catch.

National regulations:

Spain

North:

- Trawl: Min.mesh size: 55 mm. Fishing time: <18 hours per day. Min. fishing depth: 100 m.
- Static gears: <5 fishing days per week. "Rasco gillnet": Min. mesh size: 280 mm. Max. length gear: 11 km per boat. Max. stretched net height: 3.5 m. Min. fishing depth: 50 m. Some special conditions in Vizcaya and Guipuzcoa.

South (Gulf of Cadiz):

- Trawl: Min. fishing depth: 50 m or forbidden inside the 6 miles limit from coastline.

Portugal

- Trawl: forbidden inside the 6 miles limit from coastline.

- Static gears: restrictions based on the min. distance to the coastline and the max. length of the fleets. Nets cannot be set for more than 24 hours (72 hour, if mesh size is equal or higher than 100 mm, or the fishing is carried out at depths higher than 300 metres). Trammels: minimum inner mesh size: 100 mm, with exceptions depending of the area.

4.3.3 Closed areas and seasons

Spain
Trawl: Six closed areas established and closure season of different duration (from 4 to 12 months depending of the closed area).

Portugal
One closed area during 3 months.

4.4 LONG TERM MANAGEMENT STRATEGIES

The results from the ASPIC model should be used as a relative measure of the stock status and the estimates of stock biomass and fishing mortality should be analysed relative to their respective maximum sustainable yield (MSY) values.

BMSY and FMSY points can be used as a lower boundary for the biomass and an upper boundary for F. BMSY and FMSY, defined in the context of a production model, correspond to lower exploitation levels than adopted for stocks with similar population dynamics for which PA points are based on an analytical assessment.

The actual biomass is under BMSY and the fishing mortality is above FMSY. A reduction of 57% in the actual F is necessary to reach FMSY.

4.5 PROJECTIONS

An R (R Development Core Team 2005)) function was written to make stochastic projections of biomass and yield, given the following parameters:

- annual vector of fishing mortalities (F),
- initial biomass (B1),
- r parameter
- K parameter
- CV's for stochastic simulations

The CV's from the ASPIC Bootstrap analysis were used for each parameter.

Simulations with the ASPICP (projection program) were also performed giving the same results (relative to the R function) for the deterministic projection and similar confidence intervals.

For the simulations, the R function was adopted due to it's flexibility to explore different scenarios with different levels of CV's, what is not possible with the ASPICP program.

4.5.1 Settings

Parameter estimates from the WGHMM 2005 (ICES 2006a) assessment were adopted for projections. The bootstrap confidence intervals of these parameters show that there are important uncertainties in some parameters. The 80% confidence intervals are indicated in Table 4.5.

In spite of these uncertainties, it is clear that actual biomass is at low levels (B/BMSY < 1) and that the actual fishing mortality is above FMSY (F/FMSY > 1) (Table 4.5).

Table 4.5. WGHMM 2005 parameter estimates for Iberian anglerfish. Deterministic estimates and bootstrap 80% confidence intervals.

Parameter	Value	-80%	+80%	
R	0.172	0.09	0.39	Msy/Bmsy*4
K (t)	88500	64980	198200	
B1 (2005) (t)	19270	12920	38670	
Fsq (2005) (y-1)	0.2	0.1	0.3	
B_{MSY} (t)	44250	32490	99110	
MSY (t)	3815	2111	4614	
F_{MSY} (year-1)	0.08	0.03	0.14	
B/B_{MSY}	0.44	0.36	0.61	
F/F_{MSY}	2.33	1.85	3.83	

The uncertainties in the parameter estimates do not have an influence in the perception of the stock status but may have an effect in the biomass and yield projections and may affect the level of fishing mortality reduction and the time that is needed for biomass to reach BMSY level.

Therefore, projections with several scenarios were performed: 1) by changing the level of fishing mortality and 2) by varying the model parameters to values that would correspond to a faster biomass growth (higher r value). Since all parameters (B1, K, F and r) are highly correlated, all parameters were changed accordingly. The objective was to analysis until what extend the biomass recovery would be faster with a higher r value.

All simulations were performed starting in 2005 with F status quo and for a period of 50 years in order to allow biomass recovery for some of the scenarios. The adopted parameters are given in Table 4.6.

Table 4.6. Simulation settings for the three r parameters.

	r - parameter		
Parameter	r = 0.17 (WG2005)	r = 0.25	r = 0.35
k	88500	79548	66408
B1 (2005)	19270	14787	11207
Cvf	0.2	0.2	0.2
cvb	0.04	0.04	0.04
cvr	0.3	0.3	0.3
cvk	0.03	0.03	0.03
MSY	3815	4995	5781
F_{MSY}	0.086	0.126	0.174
B_{MSY}	44250	39774	33204
Fsq	0.20	0.27	0.36
B1(2005)/BMSY	0.44	0.37	0.34
Fsq/FMSY	2.3	2.1	2.1
seed	12	12	12

Parameters for r value of 0.17 are WGHMM estimates. For r values of 0.25 and 0.35 the parameters were obtained within the 80% bootstrap confidence interval. CV's for the stochastic simulations were obtained from the bootstrap results of the working group.

Scenarios

For each r parameter value, 5 fishing mortality scenarios were adopted as seen in Table 4.7. Annex 3 shows the inputs and outputs for each scenario.

- **Scenario 1** assumes a status quo fishing mortality from 2006 onwards.
- **Scenario 2** a 10% reduction in F every year until the target reference point Fmsy is reached.
- **Scenario 3** a 20% reduction in F every year until the target reference point Fmsy is reached.
- **Scenario 4** a 30% reduction in F every year until the target reference point Fmsy is reached.
- **Scenario 5** assumes a zero fishing mortality value (F = 0) from 2006 until B = BMSY, followed by F = FMSY.

Table 4.7. Summary table for the different scenario settings.

Scenario	S/R	Constraint TAC change	F 2006	F 2007 onwards	Target	Error	Type
1	/	/	F_{sq}	F_{sq}	F_{sq}	/	HCR
2	/	/	$0.9F_{sq}$	F -10% every year	F_{msy}	/	HCR
3	/	/	$0.8F_{sq}$	F -20% every year	F_{msy}	/	HCR
4	/	/	$0.7F_{sq}$	F -30% every year	F_{msy}	/	HCR
5	/	/	0	F=0, until B=B_{MSY}	F_{msy}	/	HCR

4.5.2 Results

For any r parameter, actual biomass is considered under BMSY as can be seen from the WGHMM results in Table 4.6. The projection results show that maintaining fishing mortality at the actual level (scenario 1), total biomass will progressively reduce. In the next 50 years the biomass will not invert it's decreasing tendency (Table 4.8) and will be maintained below BMSY (Table 4.9).

Table 4.8. Number of years necessary for biomass to invert actual decreasing tendency, with a probability of 50% and 75%.

Prob.	*r*	Fsq	F10	F20	F30	F00
	0.17	+50	5	3	3	2
50%	0.25	+50	3	3	2	2
	0.35	+50	3	3	2	2
	0.17	+50	+50	5	4	2
75%	0.25	+50	7	4	3	2
	0.35	+50	5	4	3	2

Table 4.9. Biomass ratio to BMSY for each r parameter value and F scenario.

	r = 0.17					r = 0.25					r = 0.35				
	Scen. 1 Fsq	Scen. 2 F10	Scen. 3 F20	Scen. 4 F30	Scen. 5 F00	Scen. 1 Fsq	Scen. 2 F10	Scen. 3 F20	Scen. 4 F30	Scen. 5 F00	Scen. 1 Fsq	Scen. 2 F10	Scen. 3 F20	Scen. 4 F30	Scen. 5 F00
2005	0.43	0.43	0.43	0.43	0.44	0.37	0.37	0.37	0.37	0.37	0.34	0.34	0.34	0.34	0.34
2006	0.41	0.41	0.41	0.41	0.42	0.35	0.35	0.35	0.35	0.36	0.32	0.32	0.32	0.32	0.32
2007	0.39	0.40	0.41	0.42	0.48	0.33	0.34	0.35	0.36	0.44	0.30	0.31	0.32	0.33	0.43
2008	0.38	0.40	0.42	0.44	0.55	0.32	0.35	0.37	0.40	0.53	0.29	0.32	0.35	0.38	0.56
2009	0.37	0.41	0.44	0.48	0.63	0.31	0.36	0.41	0.44	0.64	0.28	0.33	0.39	0.43	0.71
2010	0.36	0.42	0.48	0.51	0.72	0.30	0.38	0.45	0.48	0.76	0.27	0.36	0.44	0.48	0.88
2011	0.34	0.43	0.50	0.54	0.81	0.29	0.40	0.48	0.51	0.89	0.25	0.39	0.49	0.53	1.05
2012	0.33	0.45	0.53	0.57	0.90	0.28	0.43	0.52	0.55	1.02	0.24	0.43	0.54	0.58	1.04
2013	0.31	0.47	0.56	0.59	1.00	0.27	0.46	0.55	0.58	1.01	0.23	0.47	0.58	0.62	1.03
2014	0.30	0.50	0.59	0.62	1.09	0.26	0.49	0.59	0.62	1.01	0.22	0.52	0.63	0.66	1.02
2015	0.29	0.53	0.61	0.65	1.07	0.25	0.53	0.62	0.65	1.00	0.22	0.57	0.67	0.70	1.00
2016	0.28	0.56	0.64	0.68	1.07	0.24	0.57	0.65	0.68	1.00	0.21	0.61	0.70	0.73	1.00
2017	0.28	0.59	0.67	0.71	1.08	0.23	0.61	0.69	0.72	1.01	0.20	0.66	0.75	0.77	1.01
2018	0.27	0.62	0.70	0.73	1.07	0.23	0.64	0.72	0.75	1.00	0.20	0.70	0.78	0.80	0.99
2019	0.26	0.64	0.72	0.75	1.07	0.22	0.67	0.75	0.77	1.00	0.19	0.74	0.81	0.83	0.98
2020	0.25	0.67	0.75	0.78	1.06	0.21	0.71	0.78	0.80	1.00	0.19	0.77	0.84	0.86	0.99
2021	0.25	0.70	0.77	0.80	1.06	0.21	0.74	0.80	0.82	1.00	0.18	0.80	0.86	0.88	0.99
2022	0.24	0.73	0.80	0.83	1.06	0.20	0.77	0.83	0.85	1.00	0.18	0.84	0.89	0.90	1.00
2023	0.23	0.75	0.82	0.84	1.07	0.20	0.79	0.85	0.86	1.00	0.17	0.85	0.90	0.91	0.99
2024	0.23	0.77	0.83	0.86	1.07	0.19	0.82	0.87	0.88	1.01	0.17	0.88	0.92	0.93	1.00
2025	0.22	0.79	0.85	0.87	1.05	0.19	0.83	0.88	0.89	0.99	0.16	0.89	0.93	0.93	0.97
2026	0.21	0.81	0.86	0.89	1.05	0.18	0.85	0.89	0.90	1.00	0.16	0.91	0.93	0.94	0.99
2027	0.21	0.83	0.88	0.91	1.05	0.18	0.87	0.90	0.91	1.00	0.15	0.91	0.94	0.94	0.99
2028	0.20	0.84	0.89	0.91	1.06	0.17	0.88	0.91	0.92	1.01	0.15	0.92	0.94	0.94	1.00
2029	0.20	0.86	0.91	0.93	1.05	0.17	0.90	0.93	0.94	0.99	0.15	0.94	0.95	0.96	0.99
2030	0.19	0.87	0.92	0.94	1.05	0.16	0.90	0.93	0.94	1.00	0.14	0.94	0.96	0.96	0.99
2031	0.19	0.88	0.92	0.94	1.06	0.16	0.91	0.93	0.94	1.01	0.14	0.94	0.95	0.96	1.00
2032	0.19	0.91	0.94	0.96	1.06	0.16	0.93	0.95	0.96	1.01	0.14	0.96	0.97	0.97	0.99
2033	0.18	0.91	0.94	0.96	1.06	0.16	0.93	0.95	0.96	1.01	0.14	0.96	0.96	0.97	0.99
2034	0.18	0.93	0.96	0.98	1.06	0.15	0.95	0.97	0.97	1.01	0.13	0.97	0.98	0.98	1.00
2035	0.17	0.94	0.96	0.98	1.06	0.15	0.96	0.97	0.97	1.01	0.13	0.97	0.98	0.98	1.00
2036	0.17	0.95	0.97	0.99	1.05	0.15	0.96	0.97	0.97	1.01	0.13	0.97	0.97	0.98	0.99
2037	0.17	0.95	0.97	0.99	1.04	0.14	0.96	0.97	0.98	0.99	0.13	0.97	0.98	0.98	0.98
2038	0.16	0.96	0.98	1.00	1.04	0.14	0.97	0.98	0.98	0.98	0.12	0.97	0.98	0.98	0.98
2039	0.16	0.98	1.00	1.01	1.05	0.14	0.98	0.99	0.99	0.99	0.12	0.98	0.98	0.98	0.98
2040	0.16	0.97	0.98	1.00	1.04	0.13	0.96	0.97	0.97	1.00	0.12	0.96	0.97	0.97	0.98
2041	0.15	0.97	0.98	0.99	1.05	0.13	0.96	0.97	0.97	1.00	0.12	0.97	0.97	0.97	0.99
2042	0.15	0.96	0.98	0.99	1.06	0.13	0.96	0.96	0.97	1.01	0.11	0.96	0.96	0.96	1.00
2043	0.15	0.97	0.99	1.00	1.07	0.13	0.97	0.97	0.97	1.01	0.11	0.97	0.97	0.97	0.99
2044	0.15	0.98	1.00	1.01	1.06	0.13	0.97	0.98	0.98	1.01	0.11	0.97	0.97	0.97	0.99
2045	0.14	0.99	1.00	1.01	1.06	0.12	0.97	0.98	0.98	1.01	0.11	0.97	0.97	0.97	1.00
2046	0.14	1.00	1.00	1.02	1.06	0.12	0.98	0.98	0.98	1.01	0.11	0.97	0.98	0.98	1.01
2047	0.14	1.01	1.02	1.03	1.06	0.12	1.00	1.00	1.00	1.02	0.11	0.99	0.99	0.99	1.01
2048	0.13	1.01	1.01	1.03	1.08	0.12	0.99	1.00	1.00	1.04	0.10	0.99	0.99	0.99	1.03
2049	0.13	1.01	1.02	1.03	1.08	0.12	0.99	1.00	1.00	1.03	0.10	0.99	0.99	0.99	1.02
2050	0.13	1.03	1.04	1.05	1.08	0.11	1.01	1.01	1.01	1.03	0.10	1.00	1.00	1.00	1.02
2051	0.13	1.03	1.03	1.05	1.07	0.11	1.01	1.01	1.01	1.03	0.10	1.00	1.00	1.00	1.02
2052	0.12	1.02	1.03	1.04	1.08	0.11	1.00	1.00	1.00	1.03	0.10	0.99	0.99	0.99	1.02
2053	0.12	1.03	1.04	1.05	1.08	0.11	1.01	1.01	1.01	1.04	0.10	1.00	1.00	1.00	1.02
2054	0.12	1.03	1.04	1.05	1.08	0.11	1.01	1.01	1.01	1.04	0.10	1.00	1.00	1.00	1.01

By reducing fishing mortality to FMSY levels by a constant yearly decrease (scenarios 2-4: 10%, 20% or 30% a year), biomass trend will invert it's decrease in the next 2 to 7 years (depending on the F reduction and the r parameter) with a probability of 50%. Biomass will reach BMSY level only after 2030 for any r value (Figure 4.2 and Table 4.9).

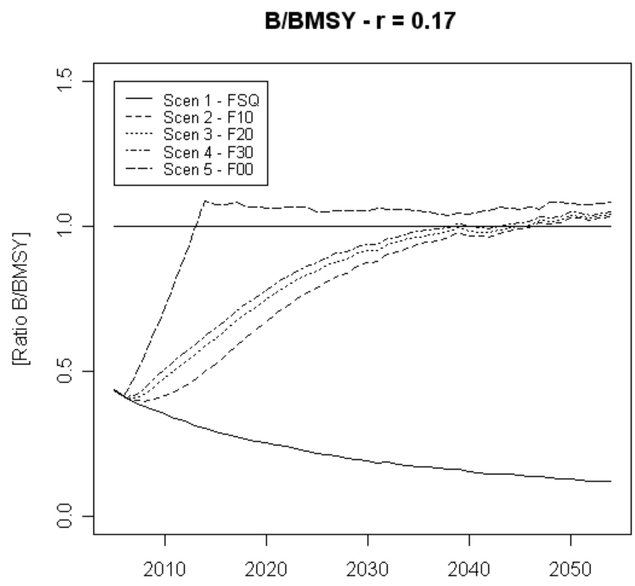

Figure 4.2. Biomass ratio (B/BMSY) for the 5 scenarios with r parameter of 0.17.

With no fishing mortality after 2005 (scenario 5), biomass will increase at around 10% (r = 0.17), 20% (r = 0.25) or 30% (r = 0.35) a year (annex 3) and will reach BMSY level in 2014, 2012 or 2011 (Table 4.9).

Differences between r values

The biomass recovery is sensitive to the adopted r value, with higher r's showing slightly faster biomass increases. On the other hand, the actual state of the stock is also r dependent as can be seen from the input parameters (Table 4.6), since with higher r values the biomass is at lower levels (lower B/BMSY ratio). It can also be seen that fishing mortality is about the same level relative to FMSY.

In Annex 3 are the plots with biomass, fishing mortality and yield trends and the differences between consecutive years.

4.5.3 Comments

In spite of the uncertainties inherent to the estimated model parameters it is clear that a recovery of the stock to biological safe levels is only achieved with a high reduction of fishing mortality. Even with no fishing mortality (scenario 5) biomass will not reach BMSY level before 2010.

It is therefore important to invert the decreasing trend in biomass to avoid driving the stock to unsustainable levels and low stock productivity.

The Iberian hake and Nephrops recovery plan may affect at least 50% of the anglerfish fishing mortality (it affects directly the trawl fleet that accounts for 50% of the anglerfish landings and may affect part of the artisanal fleet). Scenario 2 was performed to analyse the possible effect of this plan (10% annual F reduction), assuming that the implementation would include the total artisanal fleet. It is seen that total biomass would not reach BMSY level in the short-medium term.

Regarding to the use of an effort control scheme, it is important to note that a significant part of the anglerfish landings were taken by static gears (gillnets "rasco" in Spain and some components of the trammel nets in Portugal). The effort control of these static gears is difficult and may not be effective, as the gears can be left fishing while the vessels are in port. When gillnets are left fishing a long period, an important part of the catches is discarded due to the deteriorated state of the fish (Pérez et al., 1996). Also, the real number and total length of the gillnets that each vessel has left fishing, is difficult to determinate. It should also be noted that the `fishing power` of vessels using static gears is more closely related to vessel size than to engine power, and this may need to be considered in implementing an effort control scheme.

TACs were considered unlikely to be an effective conservation measure for Iberian anglerfish stocks since part of the landings are from mixed-species fishery. TACs have the problem that if the quota for one species is exhausted, boats will continue fishing to target other species in the fishery. As a result, fish of the first species will continue to be caught and either discarded or landed illegally.

Annex 3 contains a detailed description of anglerfish distribution and abundance in the Iberian coast, information that could be useful for management.

5 ADVICE

5.1 CELTIC SEA COD

5.1.1 Conditions

The special conditions that apply to this stock include the suspected high but as of yet unquantifed discarding that has occurred in the French fleet in response to restrictions placed by industry since 2003 on quantities and size-grades landed. High discard rates of young cod have also been observed in some other fleets at certain times and localities. A further condition is the closure of three ICES rectangles with typically high catch-rates of cod during Quarter 1 2005. Any future closure should be evaluated and, if implemented, its effectiveness included in the long-term management plan.

This long-term management strategy is sensitive to a number of input parameters, initial population numbers [6-35% variation], fishing mortality [Fbar: 0.61-0.85] and recruitment in 2005 [2240-3300] and onwards [Ockham model with break points of (4630, 13300)-(3000, 12000)].

There is not a clear stock recruitment relationship, and whilst the Ockham model was fitted, it should be noted that any changes that invalidate the assumptions of this model could necessitate a change in the management plan. Furthermore, it has been shown that the management plan is sensitive to initial population numbers and in the event of an accepted and robust assessment for this stock the management strategy will have to be revaluated, especially if the input parameters are changed substantially.

Given the uncertainties in input parameters used for simulation, the management plan should be re-evaluated every 3 years. This revision should prevent any deviation in the realisation of the plan due to exceptional events such as a change in the recruitment regime.

This evaluation of the effectiveness of the management plan will be based on an accurate assessment of the stock. This implies accurate discards estimates. In the absence of discards estimate and thus of a reliable assessment, the management plan should be revised to a stronger reduction (by 30%) in fishing mortality.

5.1.2 Management plan

5.1.2.1 HCR

1) The fishing mortality is decreased by 10 % each year until it reaches Fmax

2) Assuming fishing mortality is proportional to fishing effort, the change in fishing effort must be defined according to the previous rule.

3) In addition, the TAC is set in accordance.

5.1.2.2 Technical measures

The management strategy of a step-wise reduction in F to Fmax should be implemented in addition to the current fishery closure in Quarter 1. The present agreed technical measures should be maintained (minimum mesh and landing size).

5.2 BAY OF BISCAY SOLE

5.2.1 Conditions

Bias in N is estimated to can be 25% : its occurrence must be consider for fishing mortality reduction conditional to an SSB level.

Recruitment simulated by an Ockham model. Parameter are a reduced time series geometric mean because an apparent change in recruitment regime since 1993 (CV set at .3) and the lowest observed SSB. If new observations invalidate these choices, the consequences in the management plan must be investigated.

The environmental conditions (swell periods) may cause a large increase in gillnets catchability (as observed in 2002 winter, see ICES, 2005) and generate a temporal difficulty for the implementation of the HCR.

Given bias, uncertainties in input parameters, possible implementation error in a predicted scenario for this stock, a 3 years control of its realisation is considered to be necessary. The HCR should be re-evaluated taking into account all these sources of uncertainty.

5.2.2 Management plan

5.2.2.1. HCR

1) The fishing mortality is decrease until it reaches Fmax by:
   10 % if SSB is below Bpa,
   3 % if SSB is over Bpa
2) Assuming fishing mortality is proportional to fishing effort, the change in fishing effort must be defined according to the previous rule.

3) In addition, the TAC is set in accordance.

5.2.2.2. Technical measures

The implementation of the proposed HCR for sole in Bay of Biscay should imply that the present agreed technical measures should be maintained (minimum mesh and landing size) and likely strengthened.

5.3 IBERIAN ANGLERS

5.3.1 Conditions

The performed simulations were based on a stock production model that does not account for recruitment. Since there are some evidences of higher recruitments in recent years (information from surveys and landings length frequencies, ICES 2006a) the present simulations should be revised if these evidences are confirmed.

When an assessment based on age structured model should be available, the present simulations should be revised.

The actual assessment is totally based on commercial CPUE series.

Simulations for sensitivity analysis covered parameter ranges for a 80% confidence intervals: r between 0.09 and 0.39, k between 64980 and 198200 t, B1 (2005) between 12920 and 38670 t, and F (2005) between 0.10 and 0.30 year-1.

Given the uncertainties in input parameters used for simulation, the management plan should be re-evaluated every 3 years.

5.3.2 Management plan

5.3.2.1 HCR

Due to the low stock status and the strong F reduction needed to bring the biomass to safe biological levels, the Group decided not to formulate any HCR. The Group considered that F should be reduced in order to:

1) Revert decreasing trend of biomass in short term (next 2/3 years) with an high probability,

2) Reduce F towards FMSY, so that there will be a high probability that B > BMSY in the medium term.

5.3.2.2 Technical measures

The long term management plan proposes that the present agreed technical measures should be maintained.

6 REFERENCES

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7 ANNEX 1 - CELTIC SEA COD

7.1 ESTIMATION OF STARTING POPULATION NUMBERS FOR CELTIC SEA COD IN 2005

As the WGSSDS 2005 (ICES, 2006) assessment was rejected by ACFM due to problems with catch data in 2003 and 2004, it was necessary to find an alternative method to estimate population numbers in 2005 to initiate management strategy simulations from 2005. The procedure adopted was to run a retrospective XSA with 2002 as the terminal year (using the same settings as in WGSSDS 2005), and to use this as a basis for a short-term forecast to 2005 using a number of assumptions concerning F and recruitment in 2003 and 2004.

Surveys and commercial CPUE data indicate below-average 2002 and 2003 year-classes. Hence, these were estimated using RCT3 (not including French CPUE data) for inclusion in the forecast.

There is evidence for a reduction in fishing effort by French vessels in recent years. The relationship between partial fishing mortality and recorded fishing effort was examined for each of the main national fleets catching cod, and used for predicting F in 2003 and 2004 for the forecast to 2005. The method is described below.

Landings and effort data are available since 1983, for five main fleets (see Table 4.1.2. of WGSSDS 2005 report):

- French gadoids fleet in VIIgfh
- French Nephrops fleet in VIIfgh
- Other French Otter Trawlers in VIIe-k
- UK Beam trawlers in VIIe-k
- UK Otter trawlers in VIIe-k

Partial F was calculated based on the proportion of the total international landings taken by each fleet, and the XSA estimates of F(2-5). A linear regression was performed for each fleet between partial F and effort of the fleet. Finally, given the reported fishing effort in 2003 and 2004, predicted values for partial F were computed for those years. For the 'residual' component representing fleets other than the five ones with effort data, the partial F's in 2003 and 2004 were calculated from the historical relationship between partial F and landings.

Results of the linear regression for each fleet are given in Annex 1 Table 1. All regression slopes were positive, and there was a reduction in fishing effort for most of the French fleets and especially the gadoid trawlers which are the highest contributor to cod landings. This resulted in a predicted decline in mean F from 0.74 in 2002 to 0.66 in 2003 and to 0.61 in 2004.

The predicted F values for 2003 and 2004 were incorporated into the short-term stock forecast. Annex 1 Table 2 compares the F, SSB and landings values for recent years from the forecast with the estimates given by the 2005 ICES WGSSDS. Results of a forecast carried out assuming status quo F in 2003 and 2004, instead of values predicted from fishing effort, are also given (these are used in a sensitivity test for the management strategy simulations). Although the effort-predicted F values for 2003 and 2004 are in fact similar to the estimates given by WGSSDS in 2005, the values for SSB and landings are larger than given by WGSSDS. This reflects the larger population numbers in 2003 given by the XSA run to 2002, compared with the XSA run to 2005 given by WGSSDS, and the smaller recruitment values for recent year classes given by the XSA run to 2005 (see Fig. 2.1).

The result of assuming a status quo F in 2003 and 2004 in the short term forecast to 2005 (Annex 1 Table 2) is a smaller population size in 2005 for initiating the management strategy simulations, and a correspondingly larger F_{sq} for the long-term forecasts.

7.2 DETAILED RESULTS OF CS5 SIMULATIONS

Inputs for the "base case" CS5 simulation (10% annual reduction in F to F_{max}) are given in Annex 1, Table 3. The outputs of the scenarios described in Section 2.4 and simulated using the CS5 software are plotted in Annex 1 Figures 1 – 9. Comparative trends in mean landings, median SSB and probability of SSB < Blim are shown in Annex 1 Figs. 10-11.

7.3 F-PRESS SIMULATIONS

F-PRESS is a stochastic stock projection simulation based on the exponential decay model with noise added each year to system parameters to represent uncertainty and variability in the operating model. A number of runs were carried out to support the results from CS5 runs. Equivalent projections for CS5 runs A-C, A_S1, B_S1 and C_S1 runs were carried out in F-PRESS. The input parameters are the same as those used in the CS5 simulations for the comparable runs taking into consideration the assumed reduction in F associated with the closure in 2005. Recruitment in F-Press was determined using the Ockham model with normally distributed error. Other settings are outlined in the simulation assumptions table (Table 2.2). All runs were projected for 10 years and the final year of the projection is 2014.

Annex 1 Figure 12 shows Run C with Fsq. Under these conditions there is increasing yield and SSB to the final year of the projection. Recruitment is stable but with high variability. In the second scenario (Run A) there was an annual 10% decline in F to Fmax in 2010. There is a slightly steeper increase in SSB with a higher final SSB (around 30,000 t) and an increase in yield to around 10,000 t for the final year of the projection (Figure 13). The next simulation carried out (Run B) was with a decline in F to Fmax by 2015 (2014 in the case of F-Press) (Figure 14). SSB increases from around 10,000 t to above 20,000 t, with a progressive yield increase from 5,000 t to 10,000 t. Figures 15-17 show the same runs but with reduced recruitment. Again the input parameters are the same as those for the CS5. Both models produce similar projections under the 3 comparable scenarios for reduced recruitment.

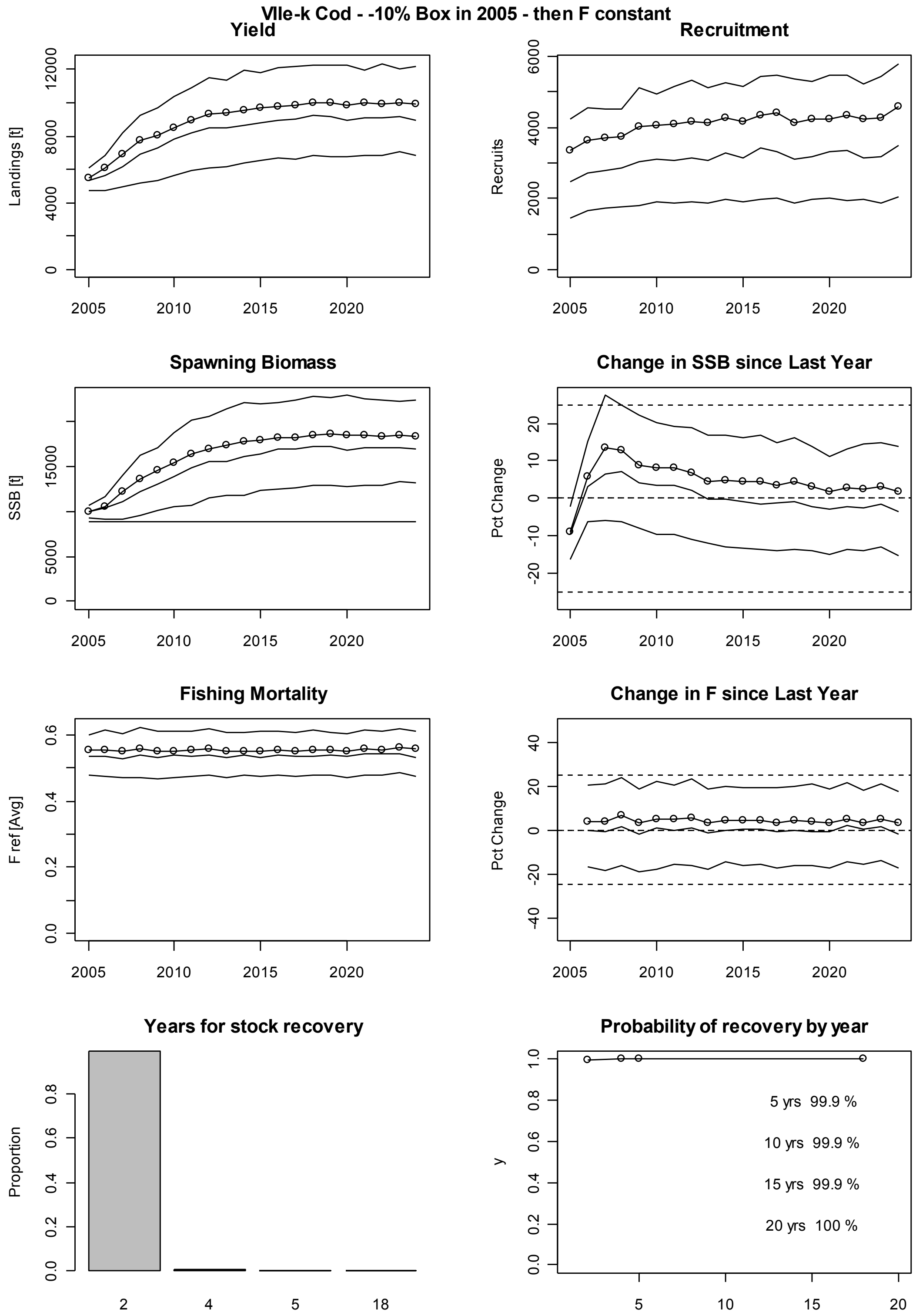
Annex 1 Table 1. Parameters of linear regressions between partial F and fishing effort for fleets fishing cod in the Celtic Sea, with predictions of F for 2003 and 2004, and XSA estimates for 2002 for comparison.

	intercept	slope	R^2	F2002 est	F2003 pred	F2004 pred
FR gadoids VIIfgh	0.1448	0.0011	0.42	0.3592	0.2857	0.2535
FR Nephrops VIIfgh	0.0267	3.36 E-04	0.40	0.0899	0.0848	0.0706
FR Other VIIe-k	0.0435	1.81 E-04	0.25	0.1221	0.1748	0.1558
UK Otter Trawlers VIIe-k	3.29 E-04	1.69 E-04	0.18	0.0067	0.0126	0.0131
UK Beam Trawlers VIIe-k	-1.36 E-03	9.11 E-05	0.36	0.0109	0.0244	0.0236
Residual fleets VIIe-k ,	8.13 E-03	7.80 E-05	0.59	0.1472	0.0804	0.0925
Total F				**0.7360**	**0.6626**	**0.6091**

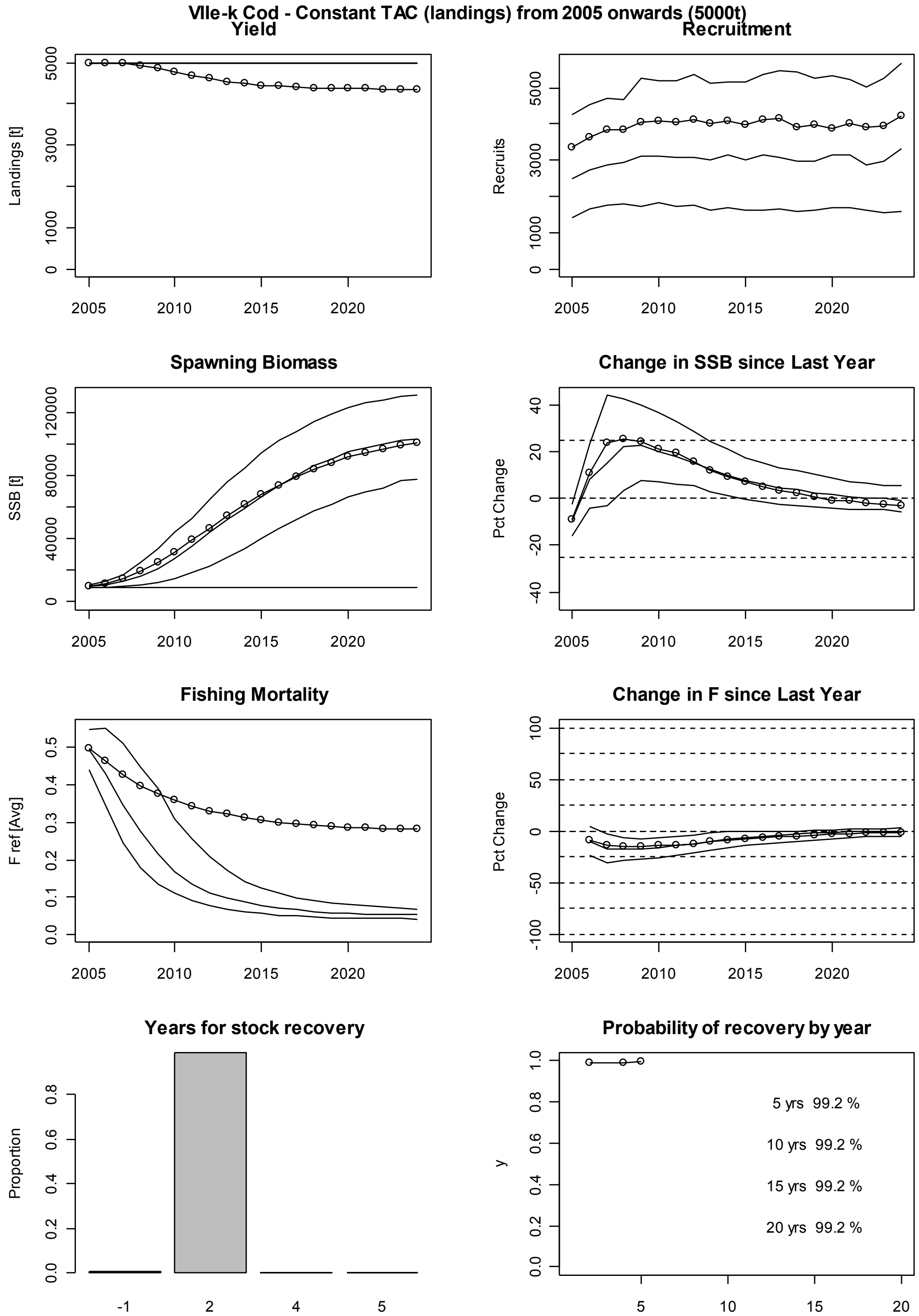
Annex 1 Table 2. Comparison of F, SSB and landings in 2002 – 2005 given by the (rejected) ICES assessment in 2005, and the values obtained from a short-term forecast to 2005 based on an XSA assessment run with 2002 as the terminal year. Two scenarios for F in 2003 and 2004 in the forecast are given. SSB and landings are in kt.

	2005 WG results			SGMOS: F in 2003-2004 predicted from effort			SGMOS: F in 2003-2004 = XSA mean for 2000-2002		
Year	F(2-5)	SSB	landings	F(2-5)	SSB	landings	F(2-5)	SSB	landings
2002	0.82	9.7	8.8	0.74[1]	10.7	8.8	0.74[1]	10.7	8.8
2003	0.69	9.5	6.0	0.66[2]	14.4	8.6	0.85[3]	14.4	10.2
2004	0.59	6.8	3.4	0.61[2]	11.4	6.5	0.85[3]	9.5	7.0
2005		5.7			10.0			7.1	

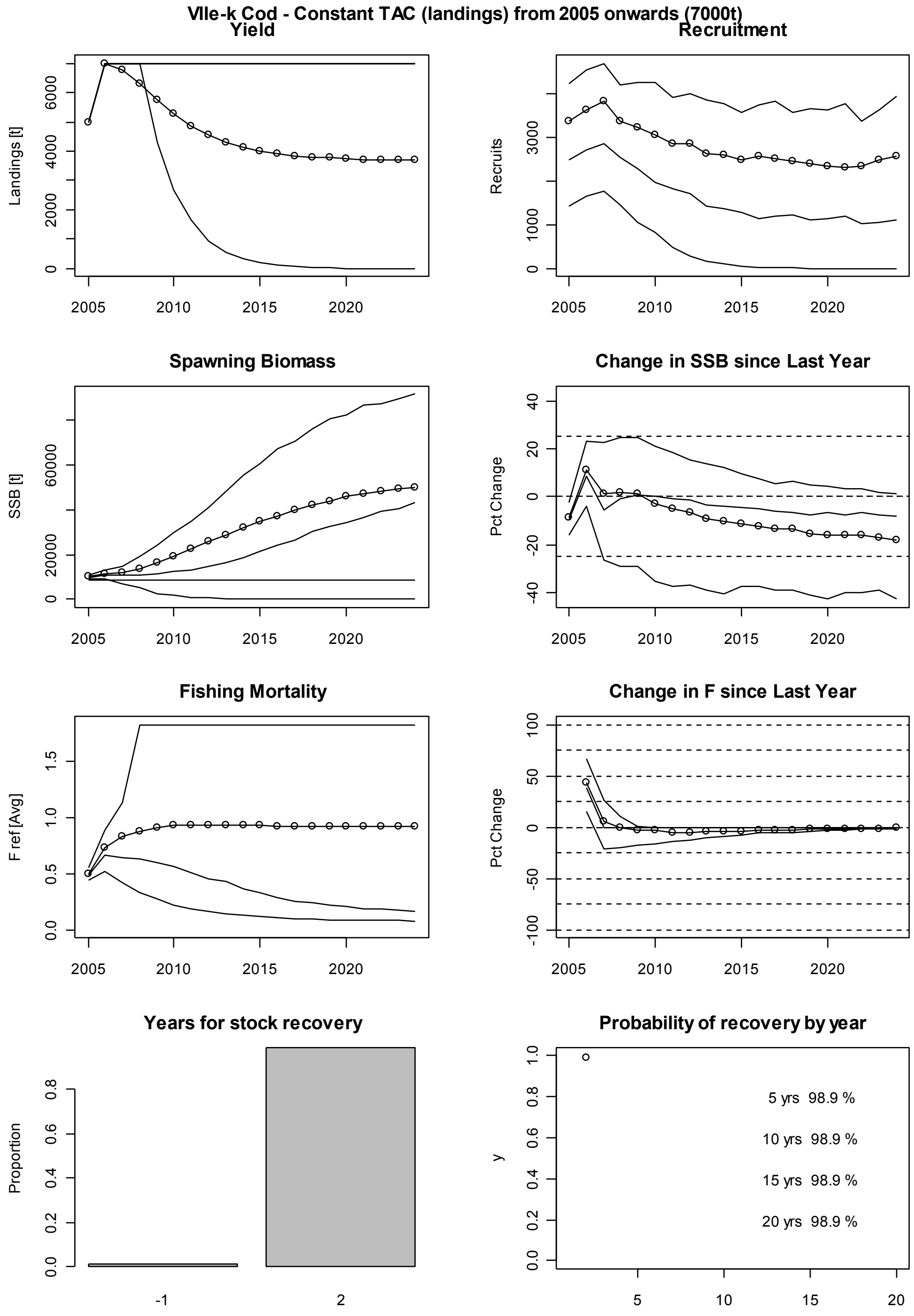
[1] XSA estimate from run to 2002. [2] F predicted from effort. [3]Mean for 2000-2002 from XSA run to 2002



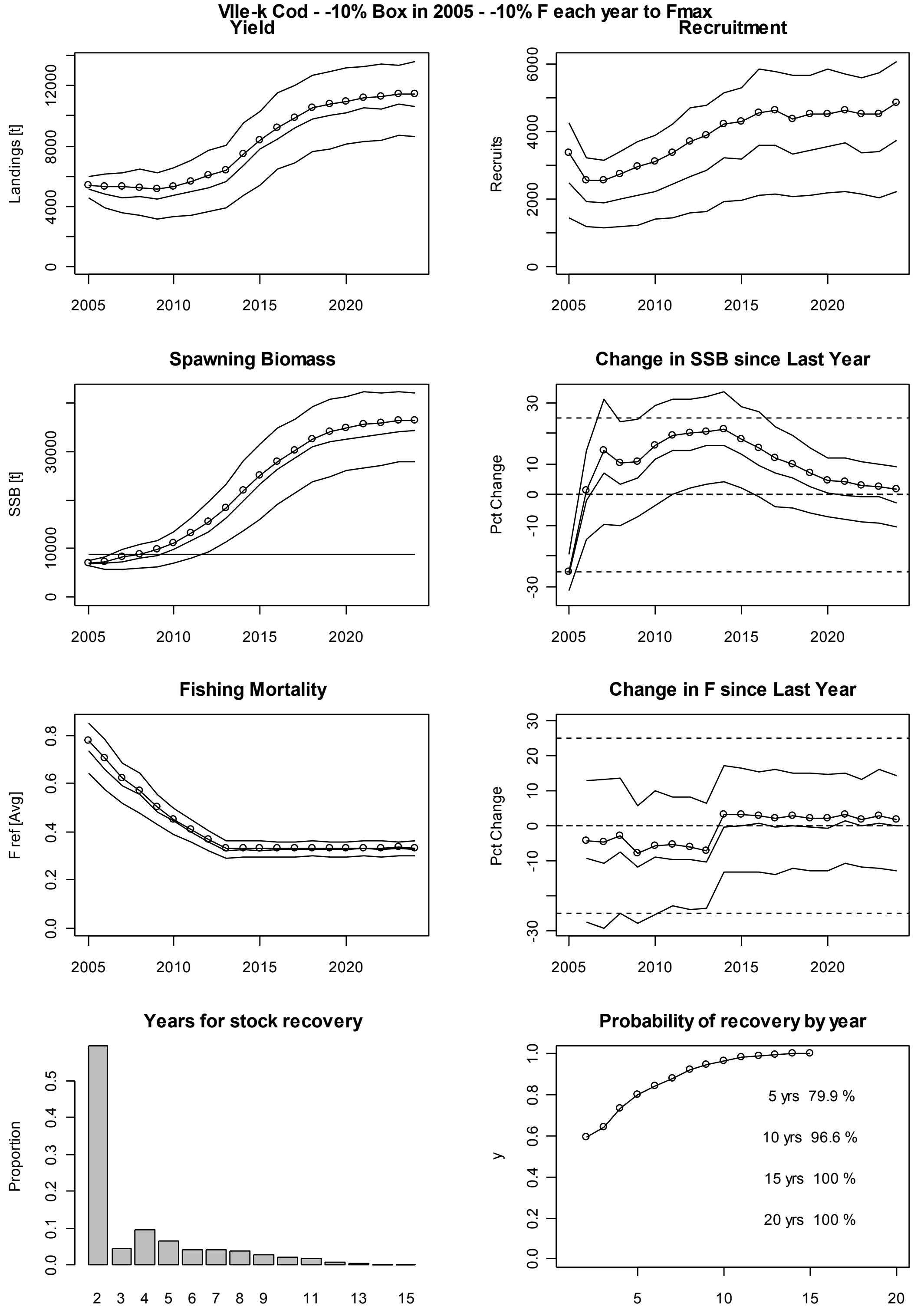
Annex 1, Figure 1. Celtic Sea cod: CS5 Run C (see text for explanation of run combinations)



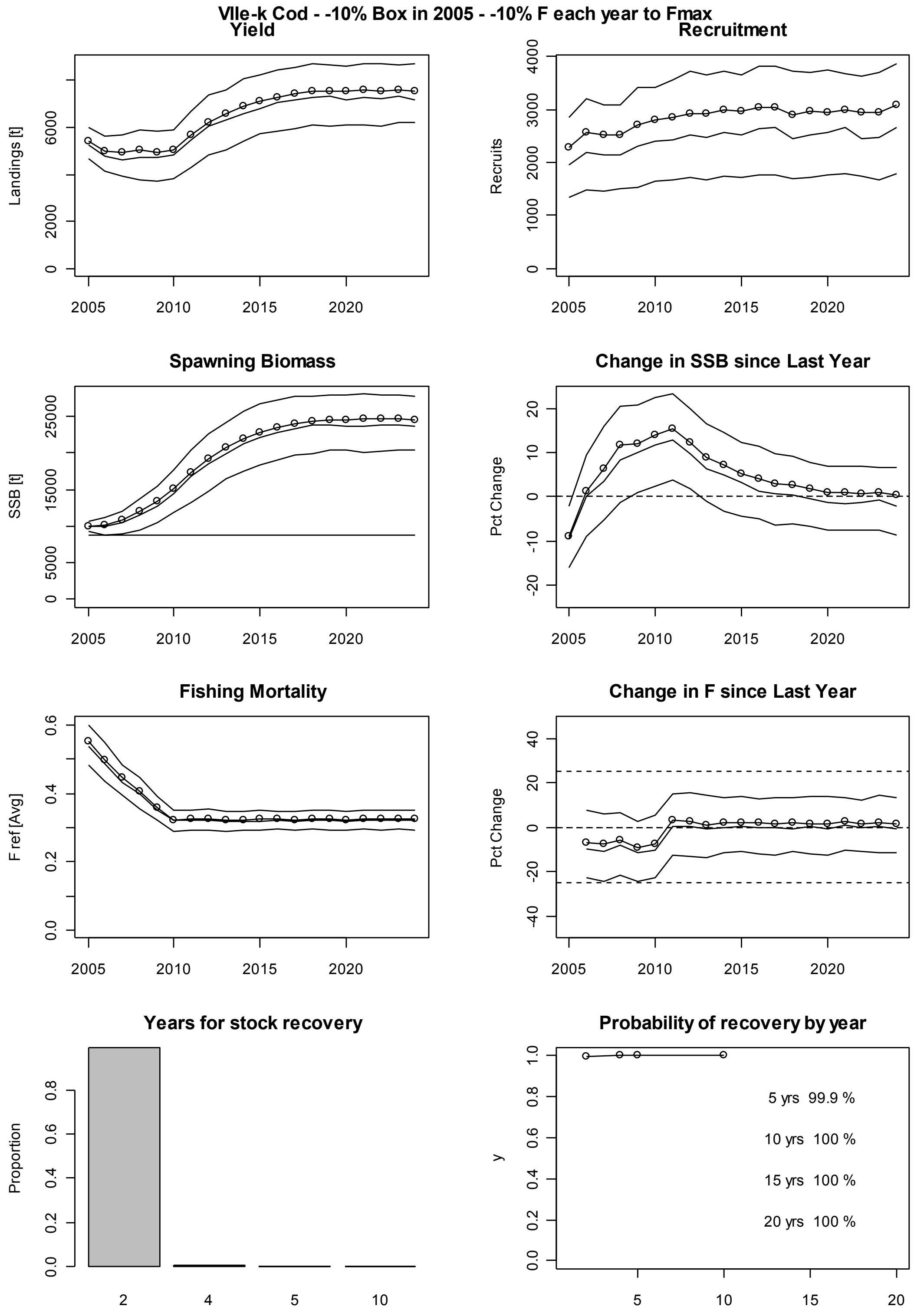
Annex 1, Figure 3 Celtic Sea cod: CS5 Run D (see text for explanation of run combinations)- Constant TAC of 5000 t



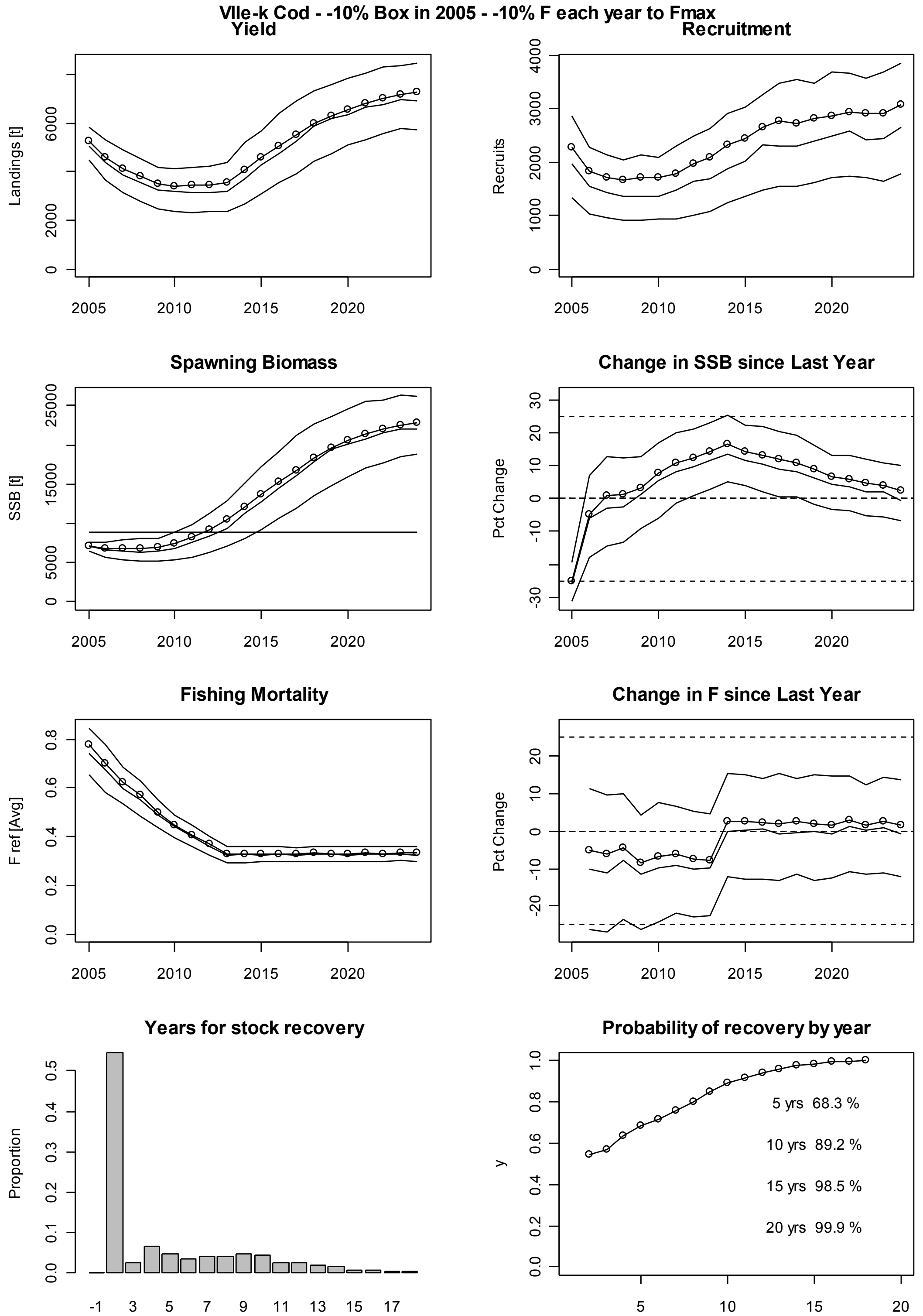
Annex 1, Figure 4 Celtic Sea cod: CS5 Run D (see text for explanation of run combinations) Constant TAC of 7,000 t



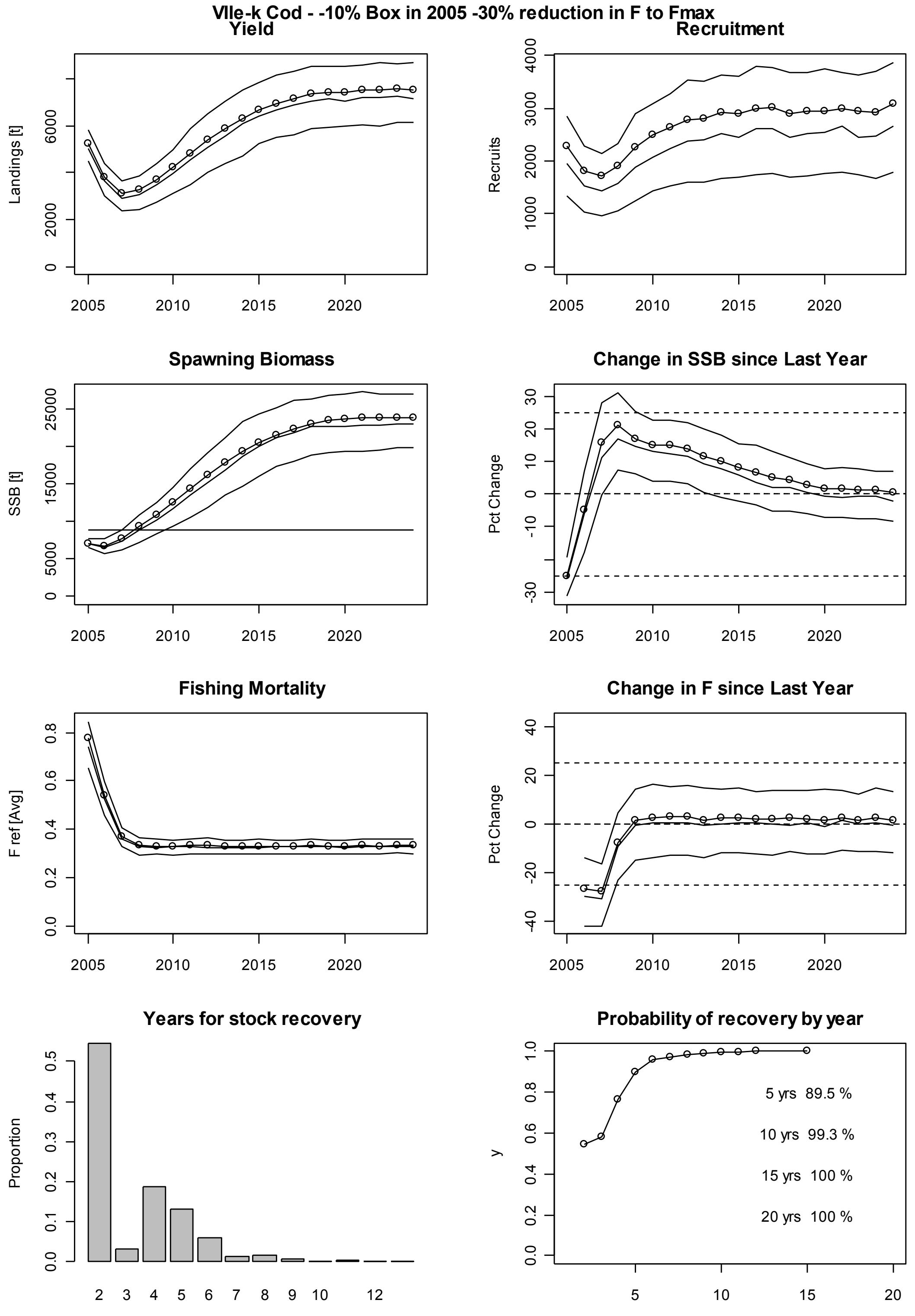
Annex 1, Figure 5 Celtic Sea cod: CS5 Run A_S2 (see text for explanation of run combinations)



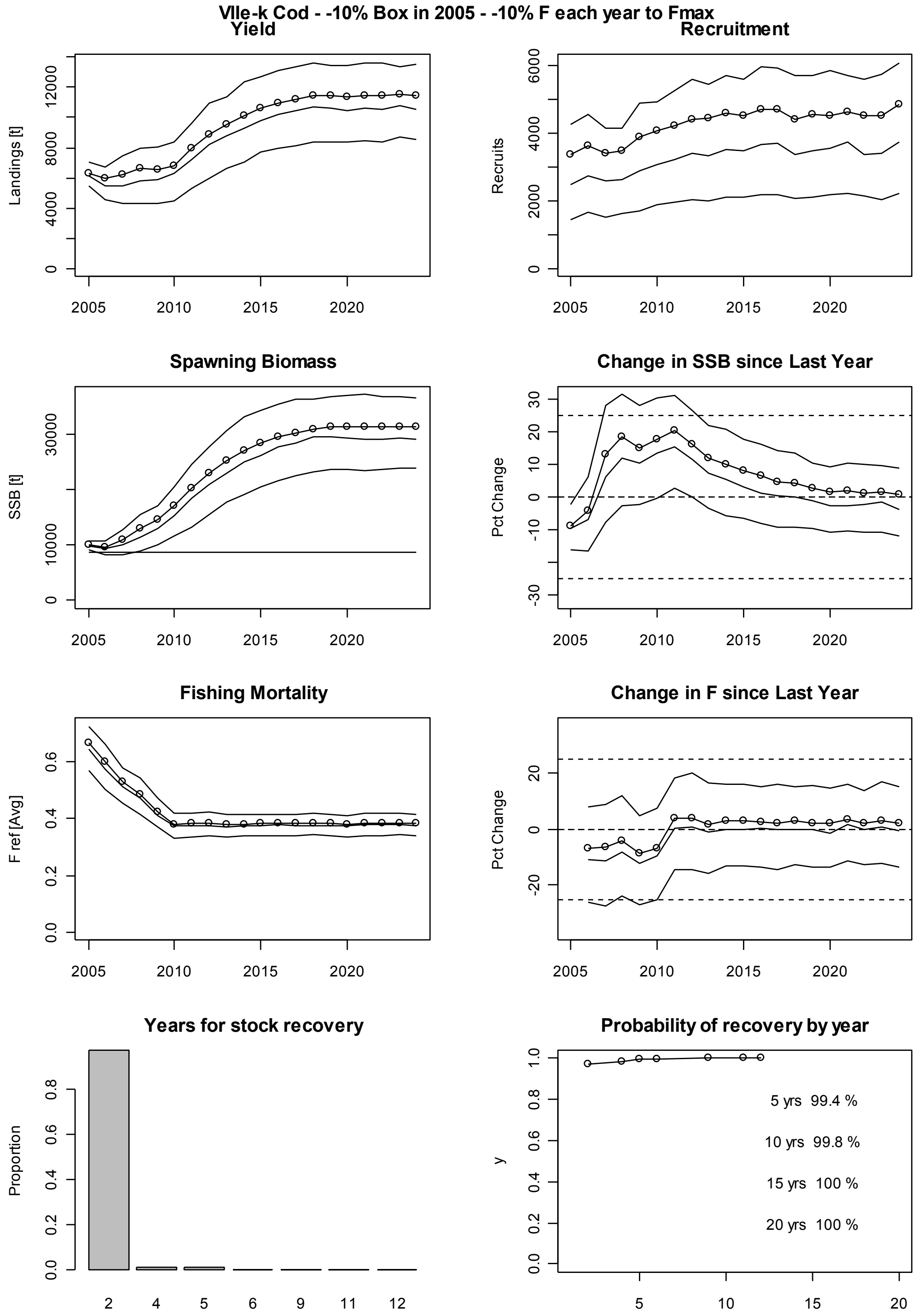
Annex 1, Figure 6 Celtic Sea cod: CS5 Run A_S1 (see text for explanation of run combinations)



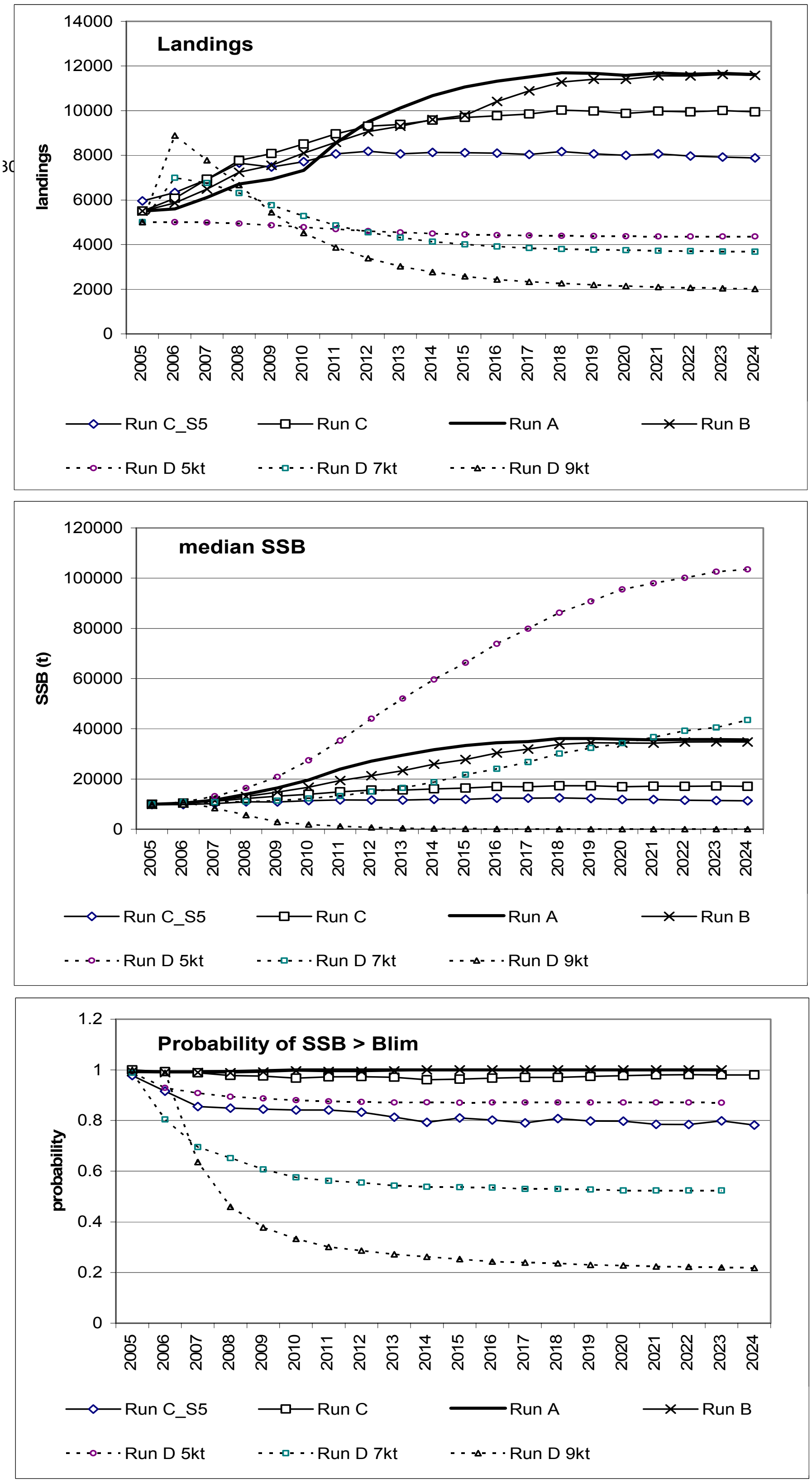
Annex 1, Figure 7 Celtic Sea cod: CS5 Run A_S3 (see text for explanation of run combinations)



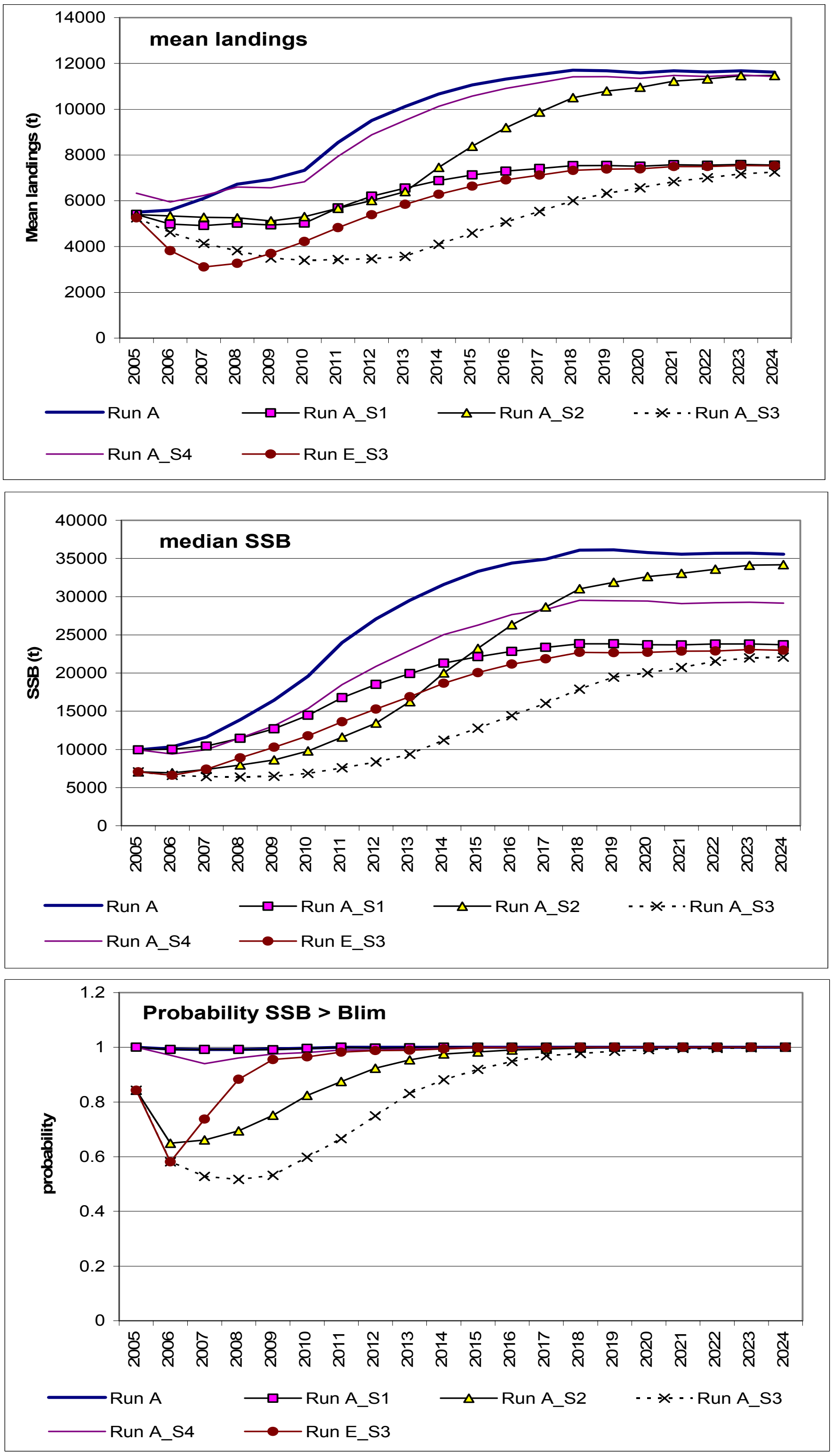
Annex 1, Figure 8 Celtic Sea cod: CS5 Run E_S3 (see text for explanation of run combinations)



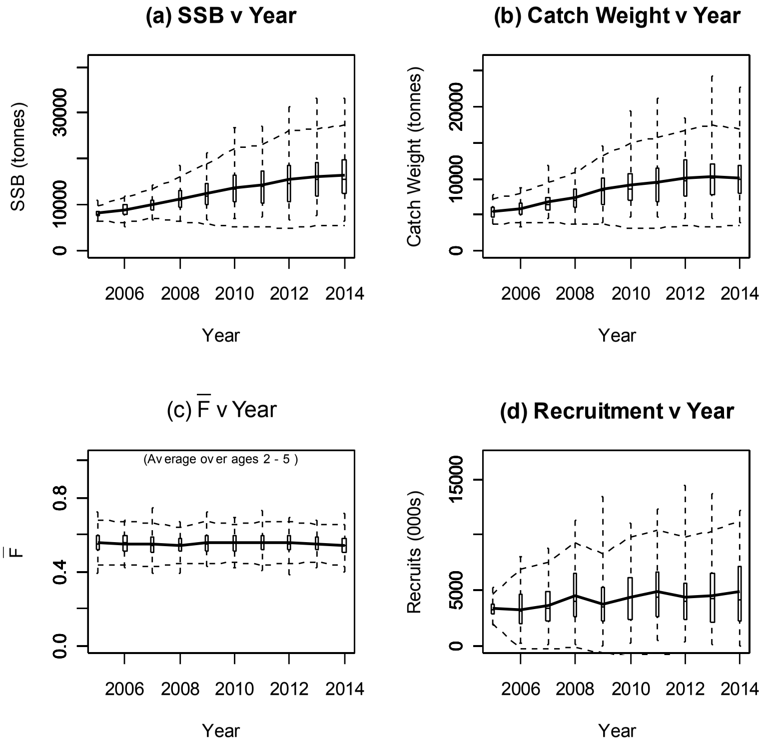
Annex 1, Figure 9 Celtic Sea cod: CS5 Run A_S4 (see text for explanation of run combinations)



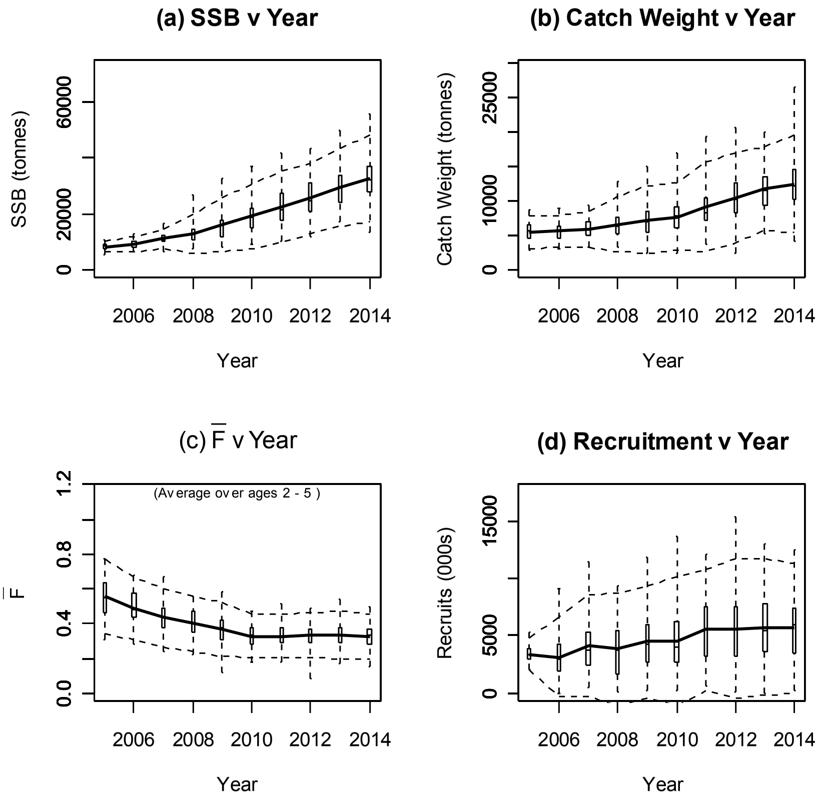
Annex 1 Fig. 10. Celtic sea cod: Summary of results of CS5 simulations based on starting populations in 2005 from XSA to 2002, and forecast to 2005 using F's predicted from fishing effort. (See text for explanation of run combinations)



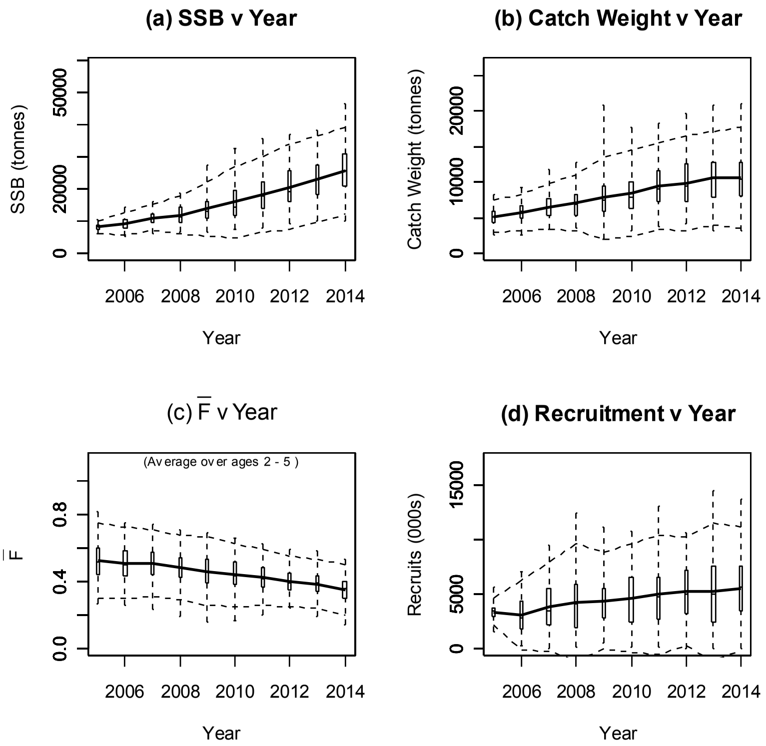
Annex 1. Fig. 11 Celtic Sea cod: Summary of results of CS5 simulations examining sensitivity of "base-case" model to uncertainties in starting populations, future recruitment, and assessment bias. (See text for explanation of run combinations)



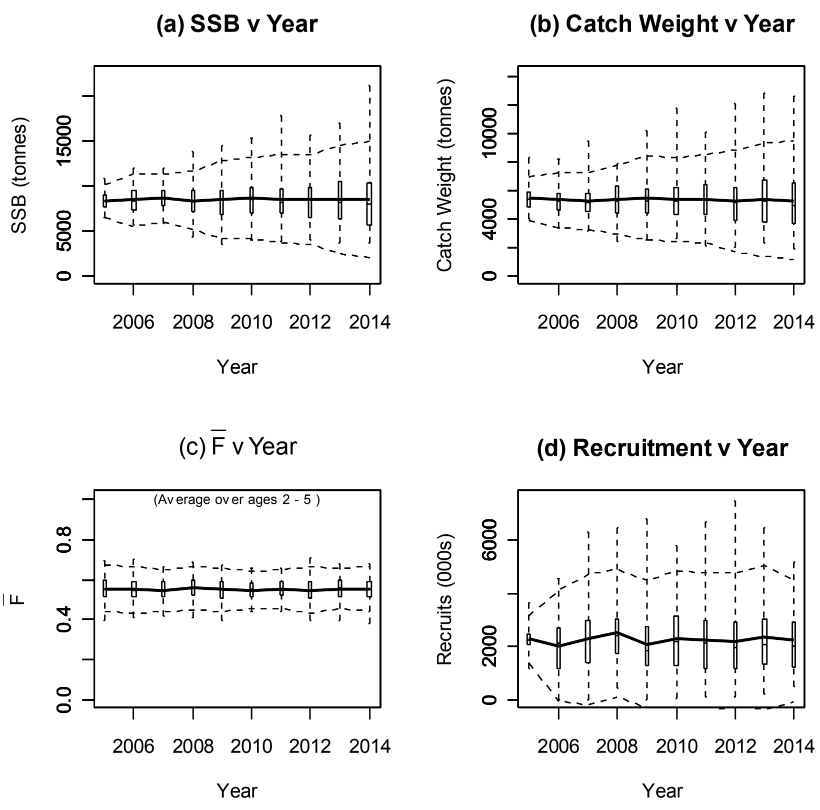
Annex 1, Figure 12- Celtic Sea cod: F-PRESS Run C - scenario with Fsq



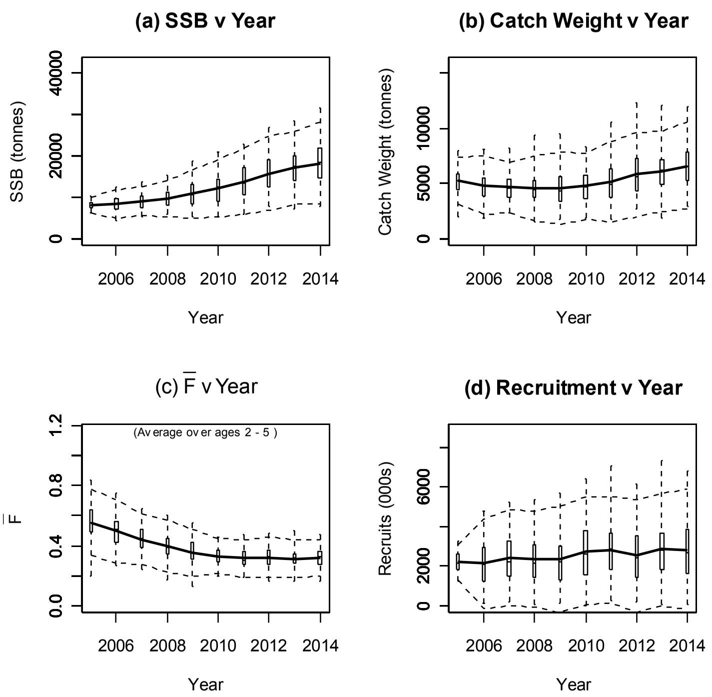
Annex 1, Figure 13. Celtic Sea cod: F-PRESS Run A - F reduced by 10% to F max in 2010



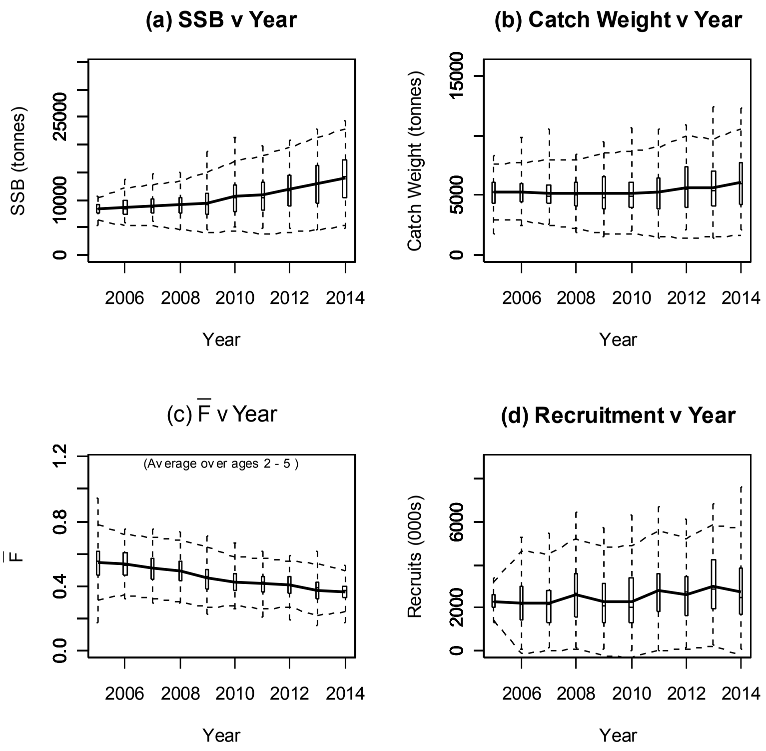
Annex 1, Figure 14 Celtic Sea cod: F-PRESS Run B- Scenario with decreasing F to F max until 2015



Annex 1, Figure 15 Celtic Sea cod: F-PRESS Run C_S1- Reduced Recruitment- scenario with Fsq



Annex 1, Figure 16 Celtic Sea cod: F-PRESS Run B_S1 Reduced Recruitment Scenario- F reduced by 10% to F max in 2010



Annex 1, Figure 17 Celtic Sea cod: F-PRESS Run A_S1 Reduced recruitment Scenario with decreasing F to F max until 2015

8 ANNEX 2 – BAY OF BISKAY SOLE

Annex 2, Table 1. Input to scenario 1 (F = Fsq).

Starting year, Last year, first age, last age
2006, 2030, 1, 7
N, se log(N hat), Bias(N hat), M, Mat, Expl, WEST, WECA

23602	0.18	1.0	0.1	0.32	0.468	0.179	0.179
17316	0.18	1.0	0.1	0.83	0.957	0.22	0.22
9642	0.14	1.0	0.1	0.97	1.259	0.286	0.286
5674	0.13	1.0	0.1	1	1.191	0.356	0.356
3062	0.09	1.0	0.1	1	1.125	0.479	0.479
1004	0.09	1.0	0.1	1	0.995	0.629	0.629
1276	0.09	1.0	0.1	1	0.995	0.712	0.712

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
23602 11200 0.0 0.0 0.3 -1
HCR % change (up, down), Fpa, SSBincr%
15, 15, .36, -1000
Spawning Time as fraction of year
0.0
Catch in StartingYear-1
4722
Catch in the starting year, or (if negative) F constraint (F pa in 2006 = 0.36)
-0.52
Ages for calculating reference F
1 5
Reference Biomass to calculate probabilities
13000
SSB in StartingYear-1
11610
Method For each year after starting year Rule, Target (1 - apply harvest rule, 2 - fixed F, 3 - Fixed TAC)
2 1. 2006
2 0.52
2 0.52
2 0.52
2 0.52
2 0.52
2 0.52
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COMMENTS

RUN id : sole BB run 1 : Fsq
Stock : Bay of Biscay sole
Starting Point : N in 2006 = SSDSWG 05
Constraint : Fixed F

Annex 2 Table 2. Input to scenario 2 (Constant TAC).

Starting year, Last year, first age, last age
2006, 2030, 1, 7
N, se log(N hat), Bias(N hat), M, Mat, Expl, WEST, WECA

23602	0.18	1.0	0.1	0.32	0.468	0.179	0.179
17316	0.18	1.0	0.1	0.83	0.957	0.22	0.22
9642	0.14	1.0	0.1	0.97	1.259	0.286	0.286
5674	0.13	1.0	0.1	1	1.191	0.356	0.356
3062	0.09	1.0	0.1	1	1.125	0.479	0.479
1004	0.09	1.0	0.1	1	0.995	0.629	0.629
1276	0.09	1.0	0.1	1	0.995	0.712	0.712

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
23602 11200 0.0 0.0 0.3 -1
HCR % change (up, down), Fpa, SSBincr%
15, 15, .36, -1000
Spawning Time as fraction of year
0.0
Catch in StartingYear-1
4722
Catch in the starting year, or (if negative) F constraint (F pa in 2006 = 0.36)
4140
Ages for calculating reference F
1 5
Reference Biomass to calculate probabilities
13000
SSB in StartingYear-1
11610
Method For each year after starting year Rule, Target (1 - apply harvest rule, 2 - fixed F, 3 - Fixed TAC)
3 4140 2006
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
3 4140
COMMENTS

RUN id : sole BB run 2 : constant TAC
Stock : Bay of Biscay sole

Starting Point : N in 2006 = SSDSWG 05
Constraint : Constant TAC

Annex 2 Table 3. Input to scenario 3 (F06 = 0.9 Fsq; F 2007 onwards: -10% every year; Target = Fmax).

Starting year, Last year, first age, last age
2006, 2030, 1, 7
N, se log(N hat), Bias(N hat), M, Mat, Expl, WEST, WECA

23602	0.18	1.0	0.1	0.32	0.468	0.179	0.179
17316	0.18	1.0	0.1	0.83	0.957	0.22	0.22
9642	0.14	1.0	0.1	0.97	1.259	0.286	0.286
5674	0.13	1.0	0.1	1	1.191	0.356	0.356
3062	0.09	1.0	0.1	1	1.125	0.479	0.479
1004	0.09	1.0	0.1	1	0.995	0.629	0.629
1276	0.09	1.0	0.1	1	0.995	0.712	0.712

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
23602 11200 0.0 0.0 0.3 -1
HCR % change (up, down), Fpa, SSBincr%
15, 15, .36, -1000
Spawning Time as fraction of year
0.0
Catch in StartingYear-1
4722
Catch in the starting year, or (if negative) F constraint (F pa in 2006 = 0.36)
-0.468
Ages for calculating reference F
1 5
Reference Biomass to calculate probabilities
13000
SSB in StartingYear-1
11610
Method For each year after starting year Rule, Target (1 - apply harvest rule, 2 - fixed F, 3 - Fixed TAC)
2 1. 2006
2 0.421
2 0.379
2 0.341
2 0.307
2 0.276
2 0.249
2 0.224
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
COMMENTS

RUN id : sole BB run 3 : 10% F decrease to Fmax

Stock : Bay of Biscay sole
Starting Point : N in 2006 = SSDSWG 05
Constraint : Fixed F

Annex 2 Table 4. Input to scenario 4 (F06 = 0.9 Fsq; F 2007 onwards: -10% every three years; Target = Fmax).

Starting year, Last year, first age, last age
2006, 2030, 1, 7
N, se log(N hat), Bias(N hat), M, Mat, Expl, WEST, WECA

23602	0.18	1.0	0.1	0.32	0.468	0.179	0.179
17316	0.18	1.0	0.1	0.83	0.957	0.22	0.22
9642	0.14	1.0	0.1	0.97	1.259	0.286	0.286
5674	0.13	1.0	0.1	1	1.191	0.356	0.356
3062	0.09	1.0	0.1	1	1.125	0.479	0.479
1004	0.09	1.0	0.1	1	0.995	0.629	0.629
1276	0.09	1.0	0.1	1	0.995	0.712	0.712

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
23602 11200 0.0 0.0 0.3 -1
HCR % change (up, down), Fpa, SSBincr%
15, 15, .36, -1000
Spawning Time as fraction of year
0.0
Catch in StartingYear-1
4722
Catch in the starting year, or (if negative) F constraint (F pa in 2006 = 0.36)
-0.468
Ages for calculating reference F
1 5
Reference Biomass to calculate probabilities
13000
SSB in StartingYear-1
11610
Method For each year after starting year Rule, Target (1 - apply harvest rule, 2 - fixed F, 3 - Fixed TAC)
2 1. 2006
2 0.468
2 0.468
2 0.421
2 0.421
2 0.421
2 0.379
2 0.379
2 0.379
2 0.341
2 0.341
2 0.341
2 0.307
2 0.307
2 0.307
2 0.276
2 0.276
2 0.276
2 0.249
2 0.249
2 0.249
2 0.224
2 0.224
2 0.224
2 0.21
COMMENTS

RUN id : sole BB run 4 : 10% F decrease /3years to Fmax
Stock : Bay of Biscay sole
Starting Point : N in 2006 = SSDSWG 05
Constraint : Fixed F

Annex 2 Table 5. Input to scenario 6 (F06 = 0.9 Fsq; If SSB < Bpa: F -10% every year, else if SSB > Bpa: F -10% every three years; Target = Fmax). Note that the CS5 program has no predefined options for scenarios 5 and 6. Hence the different F values corresponding to the preset conditions were calculated manually.

Starting year, Last year, first age, last age
2006, 2030, 1, 7
N, se log(N hat), Bias(N hat), M, Mat, Expl, WEST, WECA

23602	0.18	1.0	0.1	0.32	0.468	0.179	0.179
17316	0.18	1.0	0.1	0.83	0.957	0.22	0.22
9642	0.14	1.0	0.1	0.97	1.259	0.286	0.286
5674	0.13	1.0	0.1	1	1.191	0.356	0.356
3062	0.09	1.0	0.1	1	1.125	0.479	0.479
1004	0.09	1.0	0.1	1	0.995	0.629	0.629
1276	0.09	1.0	0.1	1	0.995	0.712	0.712

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
23602 11200 0.0 0.0 0.3 -1
HCR % change (up, down), Fpa, SSBincr%
15, 15, .36, -1000
Spawning Time as fraction of year
0.0
Catch in StartingYear-1
4722
Catch in the starting year, or (if negative) F constraint (F pa in 2006 = 0.36)
-0.468
Ages for calculating reference F
1 5
Reference Biomass to calculate probabilities
13000
SSB in StartingYear-1
11610
Method For each year after starting year Rule, Target (1 - apply harvest rule, 2 - fixed F, 3 - Fixed TAC)
2 1. 2006
2 0.421
2 0.379
2 0.341
2 0.307
2 0.307
2 0.307
2 0.276
2 0.276
2 0.276
2 0.249
2 0.249
2 0.249
2 0.224
2 0.224
2 0.224
2 0.221
2 0.221
2 0.221
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
2 0.21
COMMENTS

RUN id : sole BB run 6 : 10% F decrease if SSB<Bpa else -10%/3years to Fmax
Stock : Bay of Biscay sole
Starting Point : N in 2006 = SSDSWG 05
Constraint : Fixed F

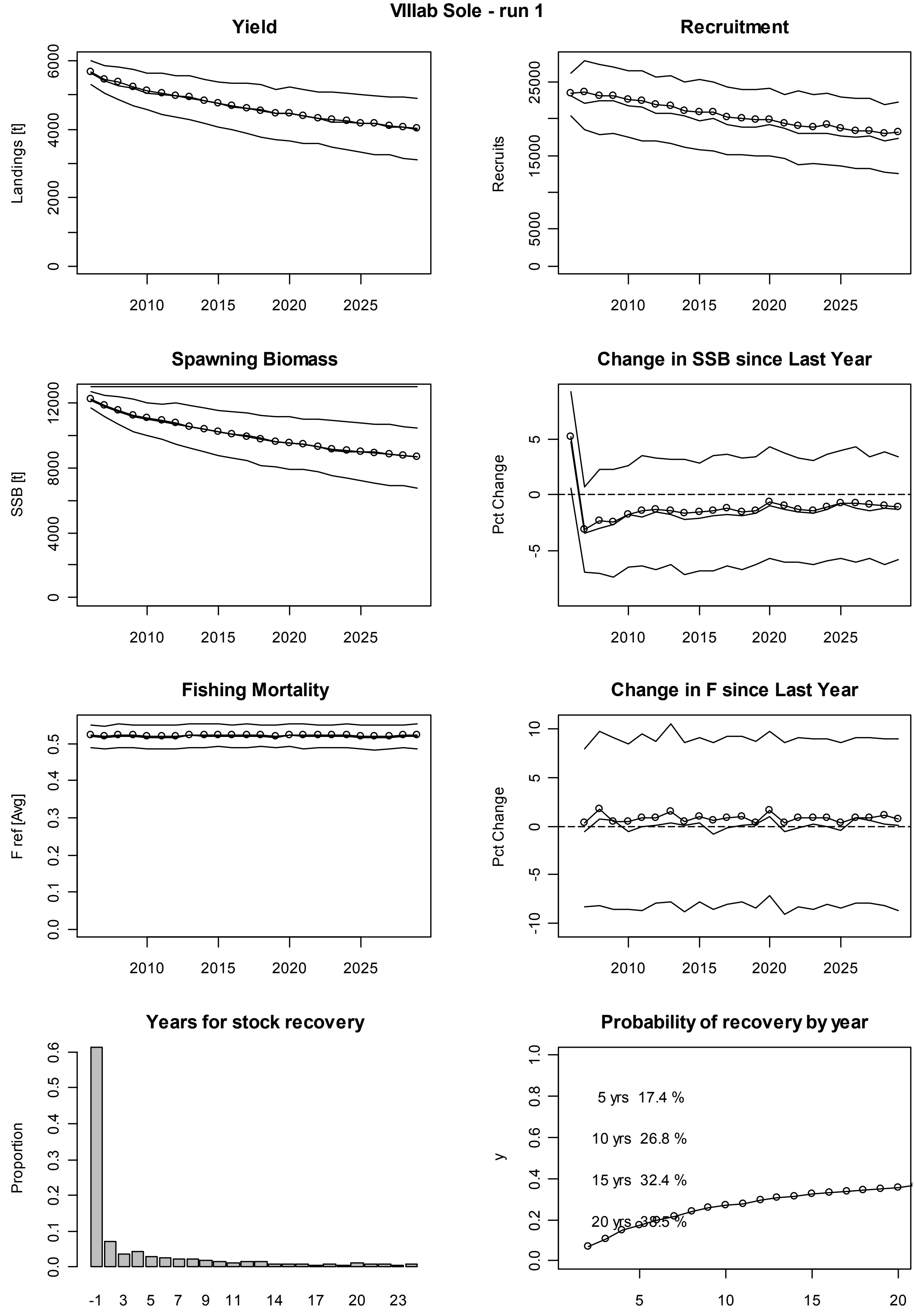
Annex 2 Table 6. Input to scenario 7 (F06 = 0.9 Fsq; If SSB < Bpa: F -10% every year, else if SSB > Bpa: F -10% every year; Target = Fmax; 25% bias in N). Note that the CS5 program has no predefined options for scenarios 5 and 6. Hence the different F values corresponding to the preset conditions were calculated manually.

Starting year, Last year, first age, last age
2006, 2030, 1, 7
N, se log(N hat), Bias(N hat), M, Mat, Expl, WEST, WECA

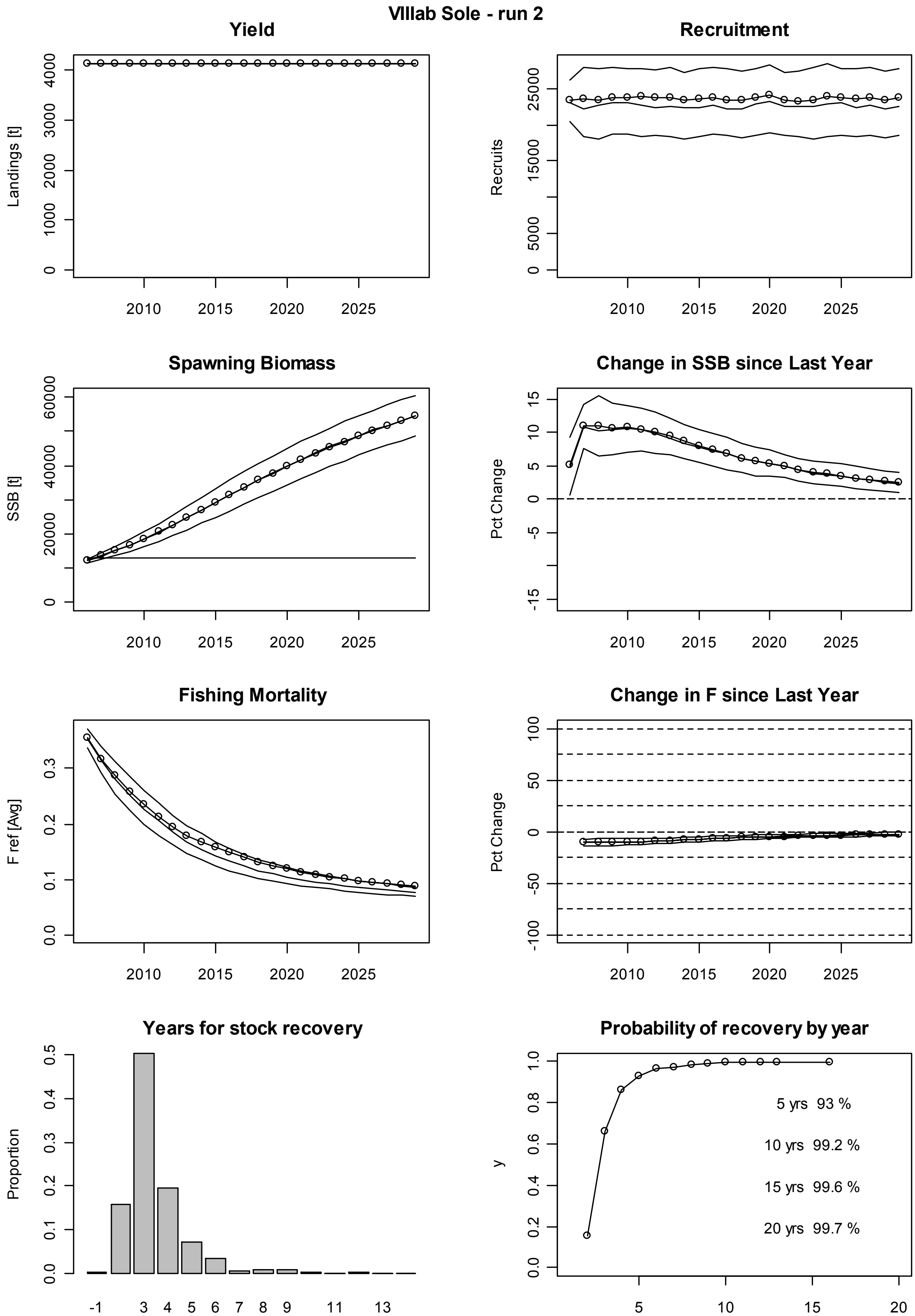
23602	0.18	1.25	0.1	0.32	0.468	0.179	0.179
17316	0.18	1.25	0.1	0.83	0.957	0.22	0.22
9642	0.14	1.25	0.1	0.97	1.259	0.286	0.286
5674	0.13	1.25	0.1	1	1.191	0.356	0.356
3062	0.09	1.25	0.1	1	1.125	0.479	0.479
1004	0.09	1.25	0.1	1	0.995	0.629	0.629
1276	0.09	1.25	0.1	1	0.995	0.712	0.712

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
23602 11200 0.0 0.0 0.3 -1
HCR % change (up, down), Fpa, SSBincr%
15, 15, .36, -1000
Spawning Time as fraction of year
0.0
Catch in StartingYear-1
4722
Catch in the starting year, or (if negative) F constraint (F pa in 2006 = 0.36)
-0.468
Ages for calculating reference F
1 5
Reference Biomass to calculate probabilities
13000
SSB in StartingYear-1
11610
Method For each year after starting year Rule, Target (1 - apply harvest rule, 2 - fixed F, 3 - Fixed TAC)
2 1. 2006
2 0.421
2 0.409
2 0.396
2 0.384
2 0.373
2 0.362
2 0.351
2 0.340
2 0.330
2 0.320
2 0.311
2 0.301
2 0.292
2 0.283
2 0.275
2 0.267
2 0.259
2 0.251
2 0.243
2 0.236
2 0.229
2 0.222
2 0.216
2 0.21
COMMENTS

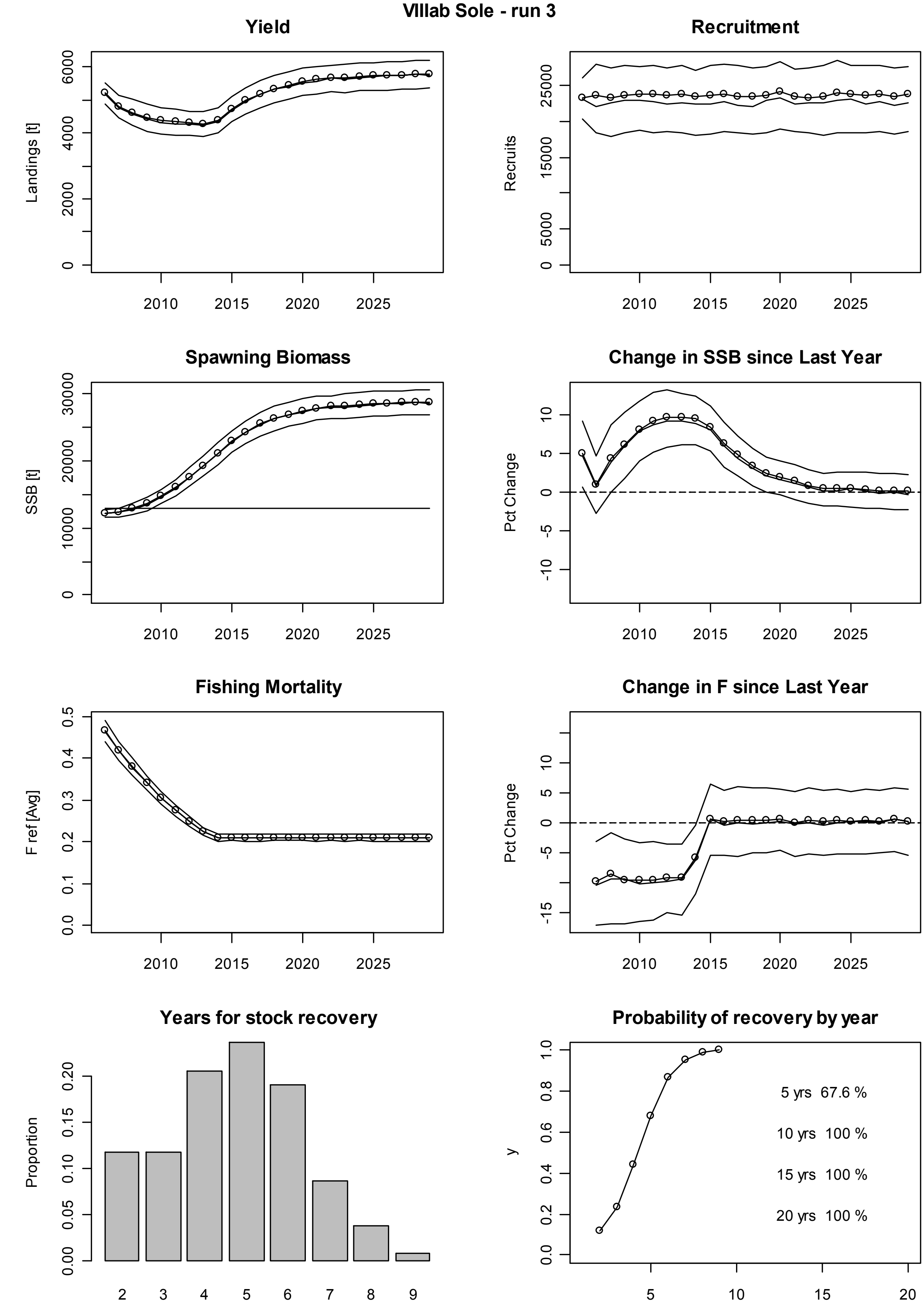
RUN id : sole BB run 7 : 10% F decrease if SSB<Bpa else -3% to Fmax
Stock : Bay of Biscay sole
Starting Point : N in 2006 = SSDSWG 05 + Bias
Constraint : Fixed F



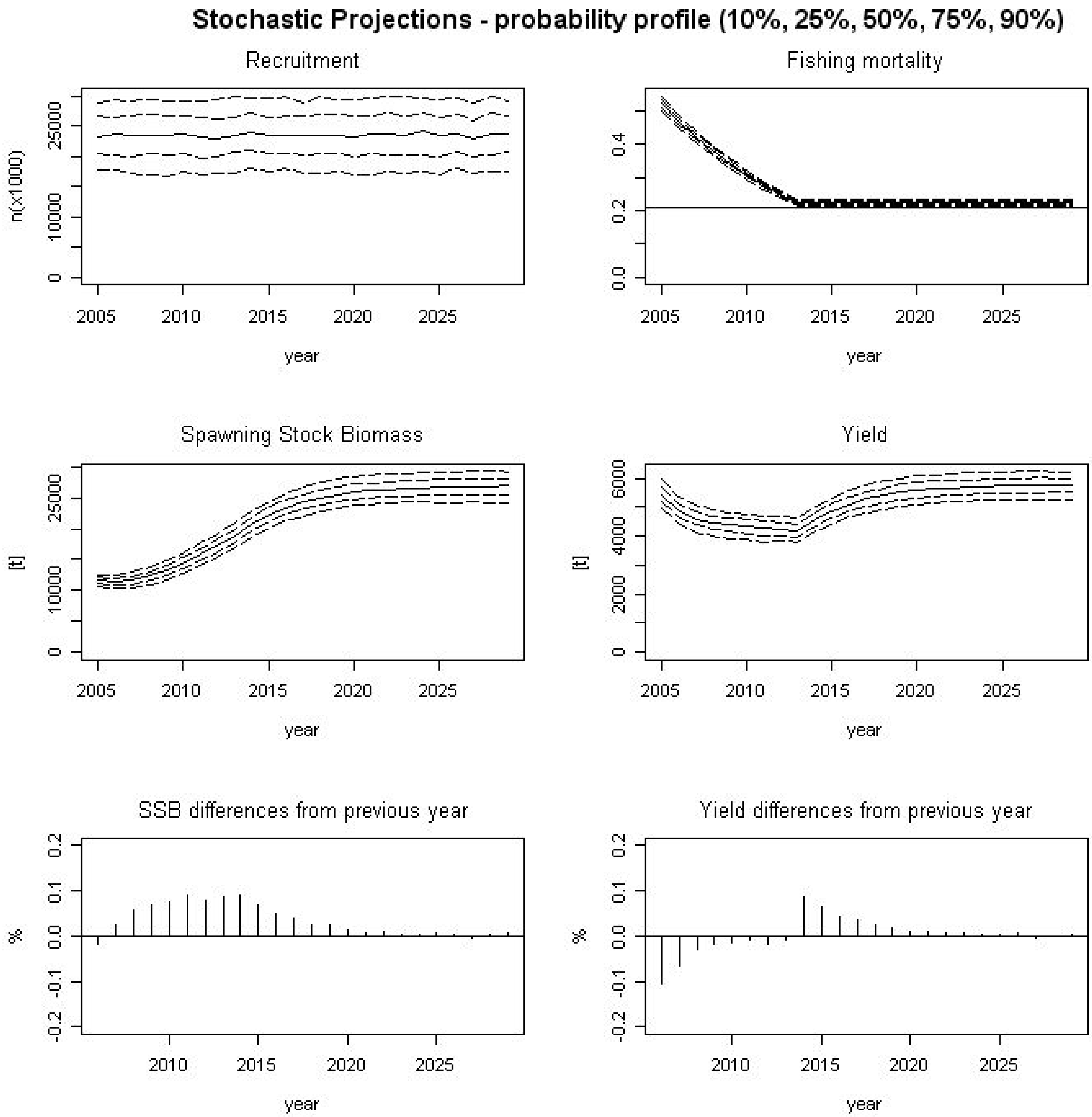
Annex 2 Figure 1. Scenario 1 results (F = Fsq).



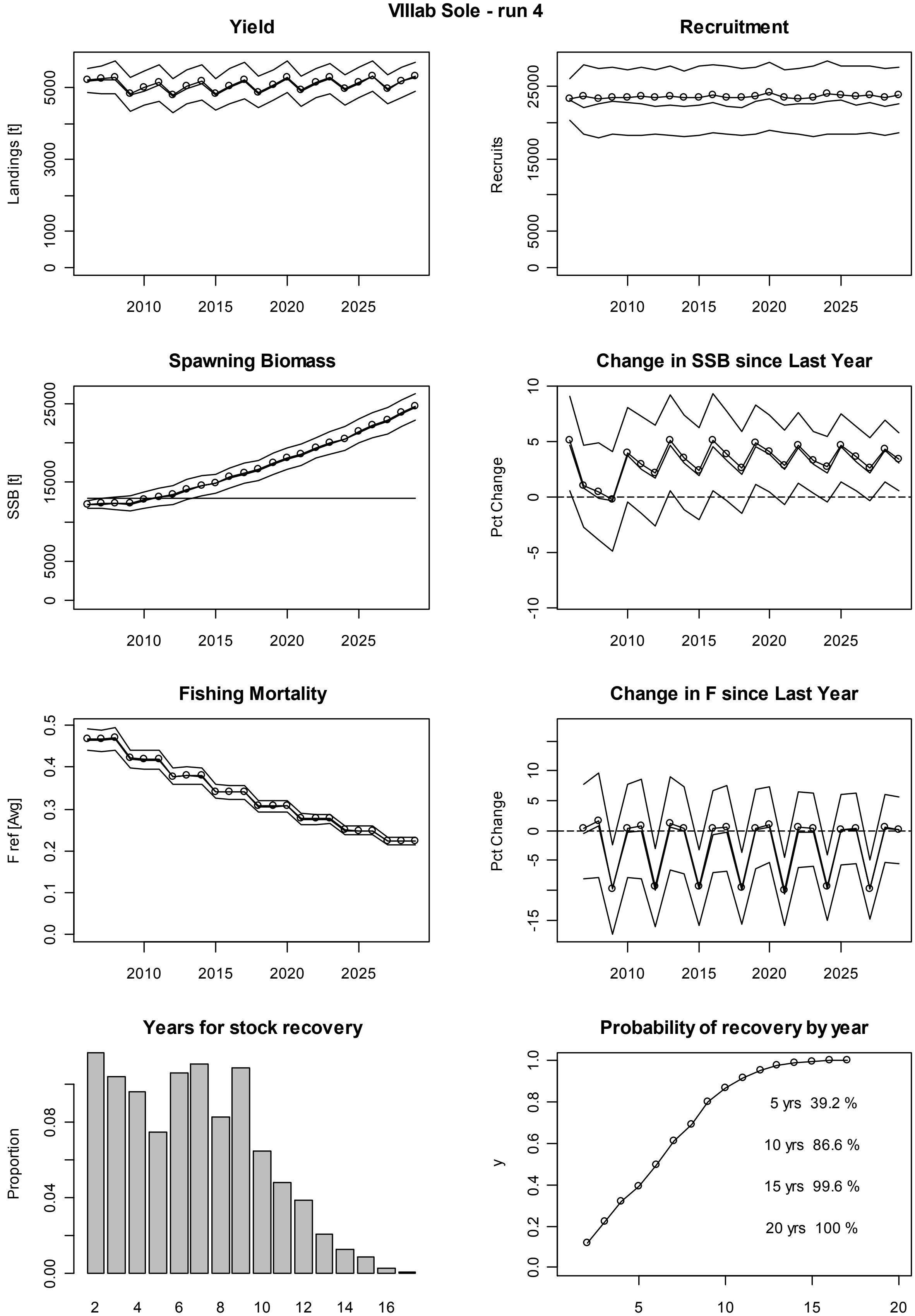
Annex 2 Figure 2. Scenario 2 results (Constant TAC)



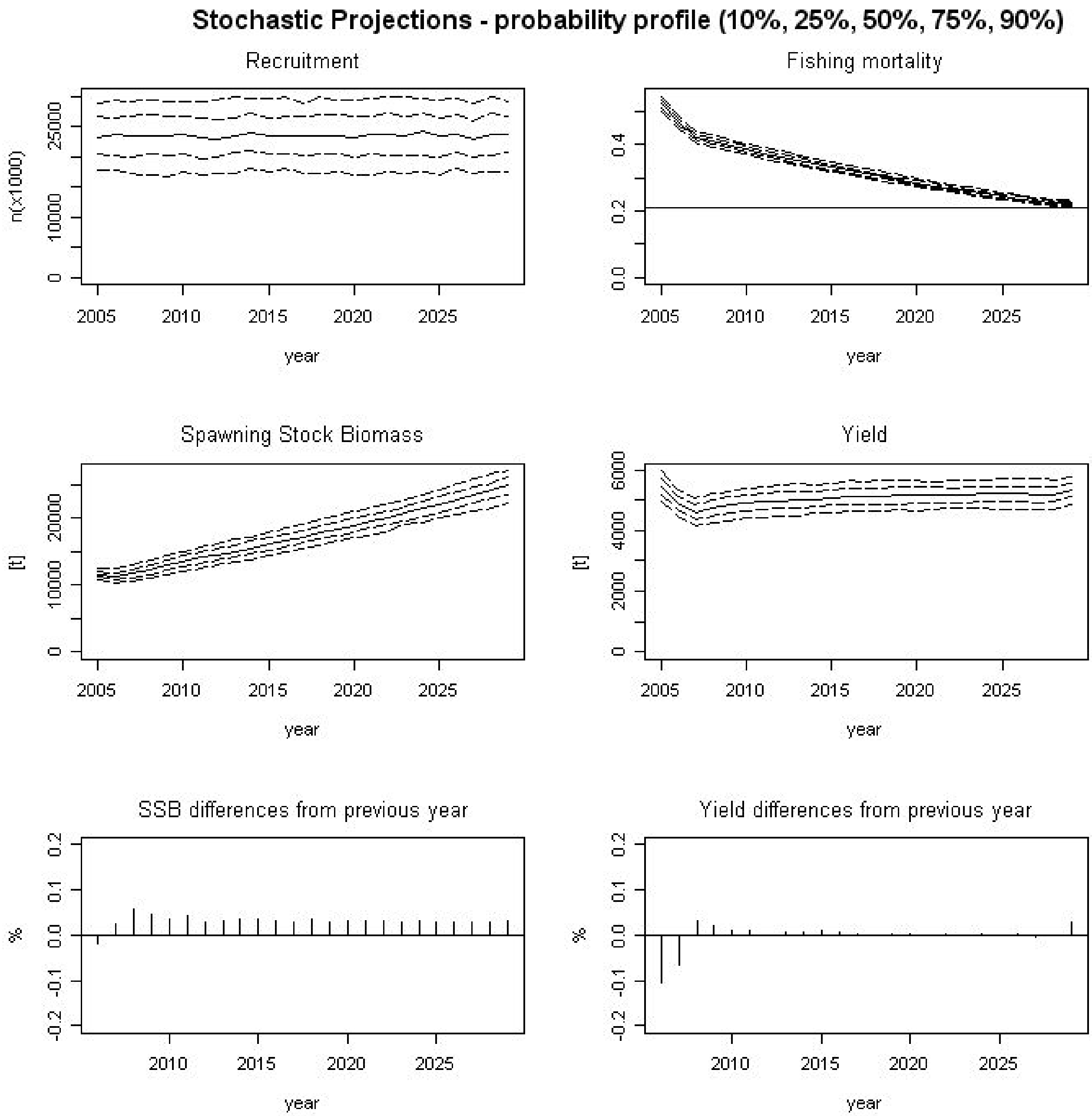
Annex 2 Figure 3. Scenario 3 results (F06 = 0.9 Fsq; F 2007 onwards: -10% every year; Target = Fmax).



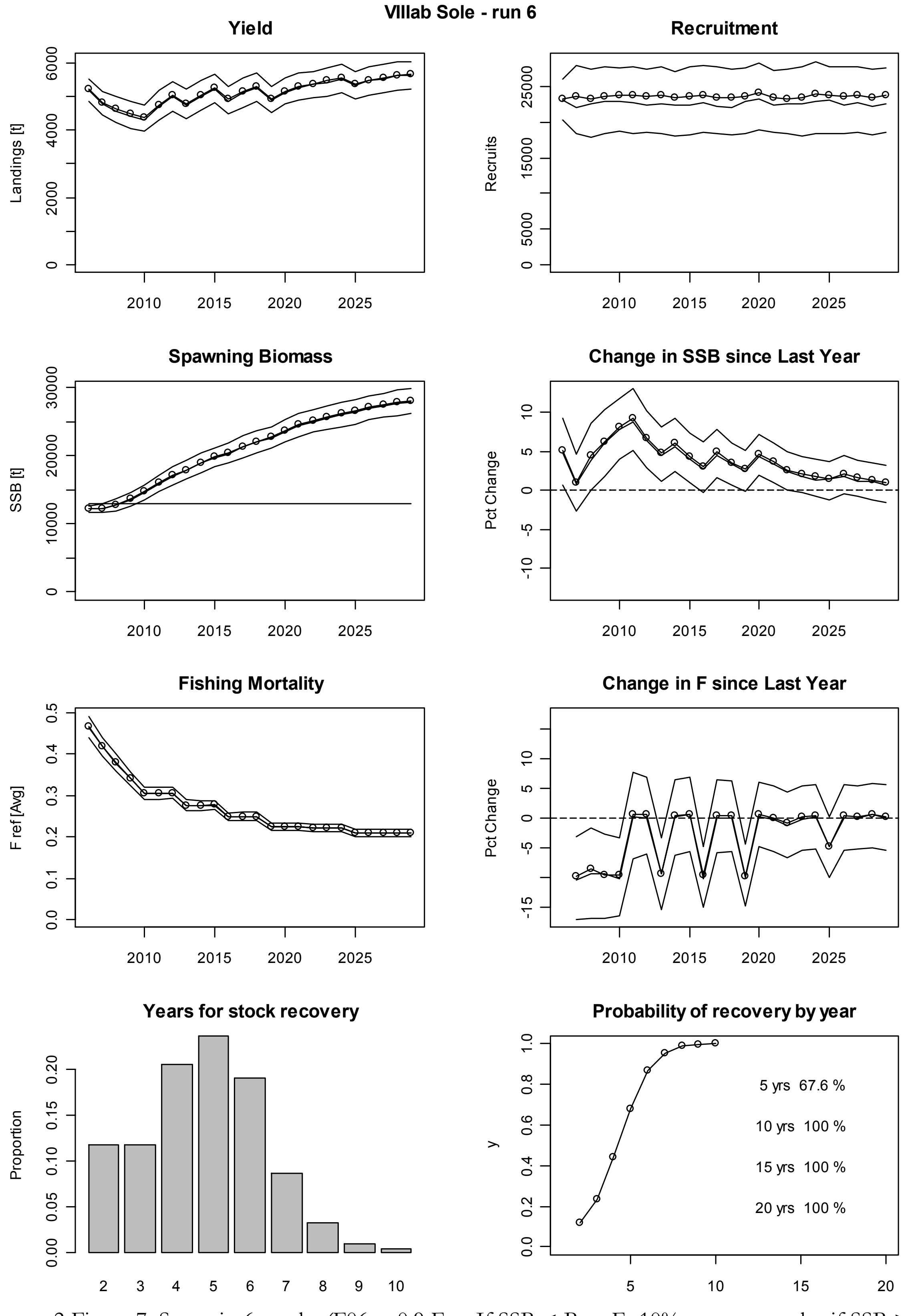
Annex 2 Figure 4. Scenario 3 results – CP program (F06 = 0.9 Fsq; F 2007 onwards: -10% every year; Target = Fmax).



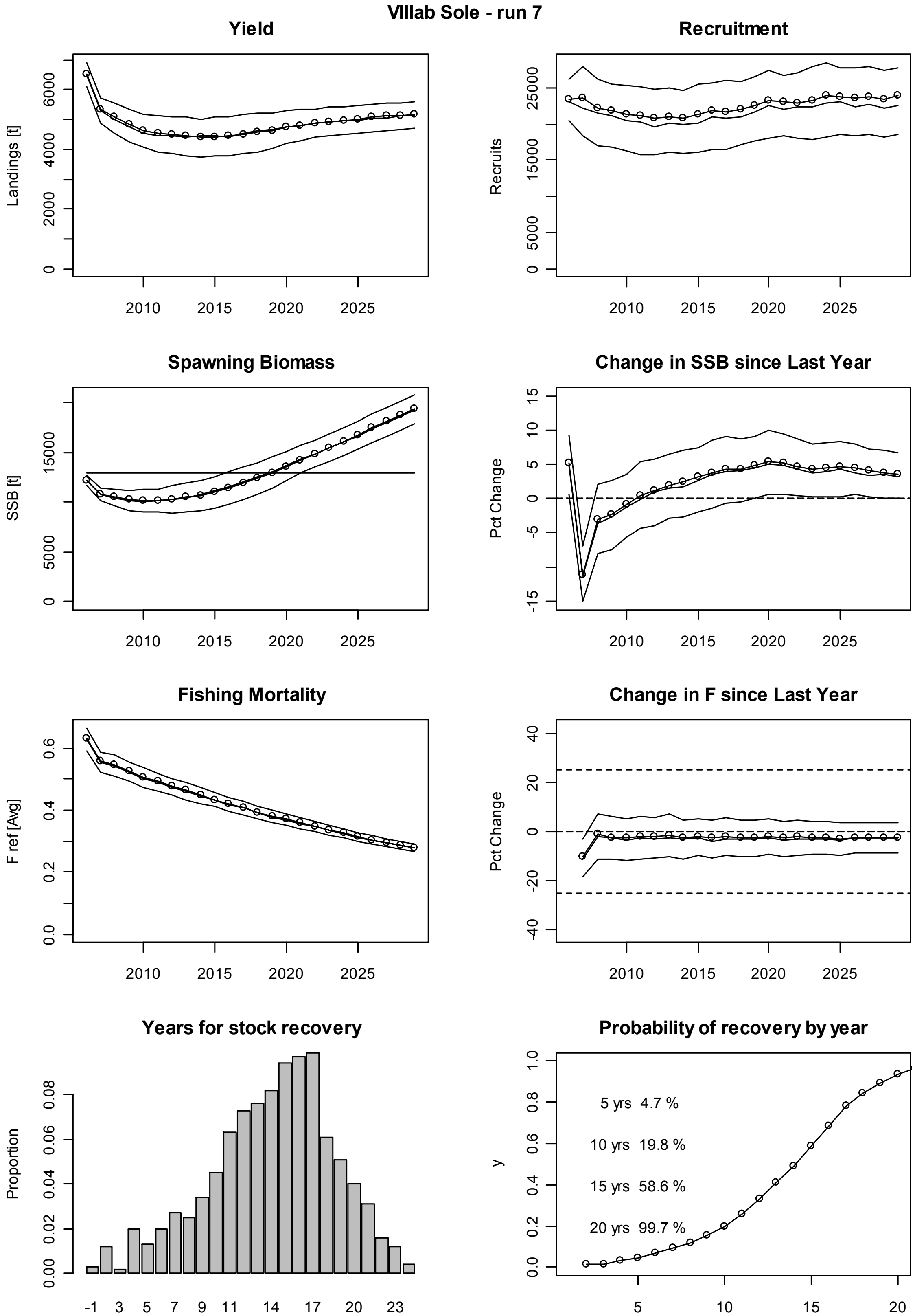
Annex 2 Figure 5. Scenario 4 results (F06 = 0.9 Fsq; F 2007 onwards: -10% every three years; Target = Fmax).



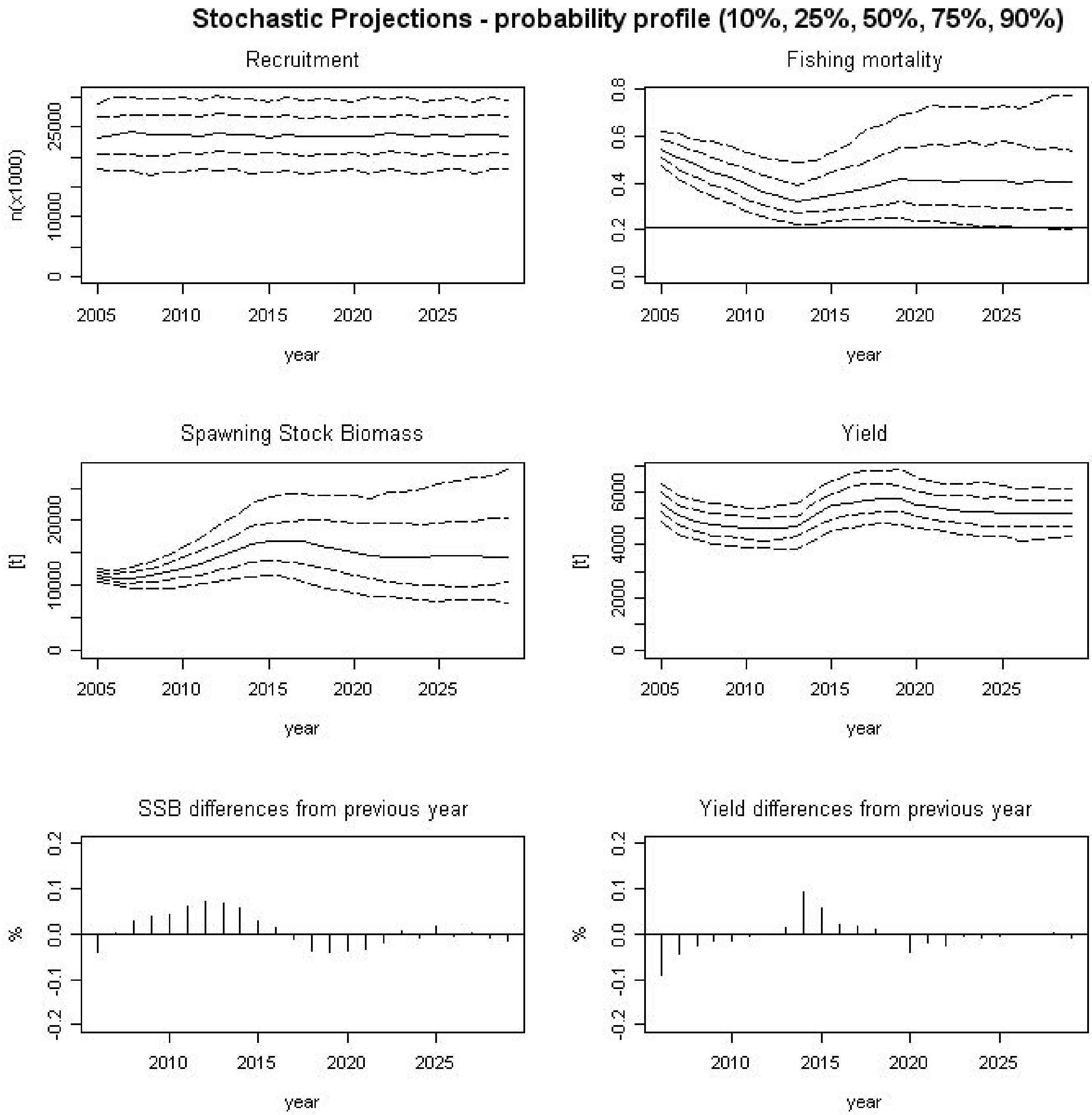
Annex 2 Figure 6. Scenario 5 results – CP program (F06 = 0.9 Fsq; If SSB < Bpa: F -10% every year, else if SSB > Bpa: F -3% every year; Target = Fmax).



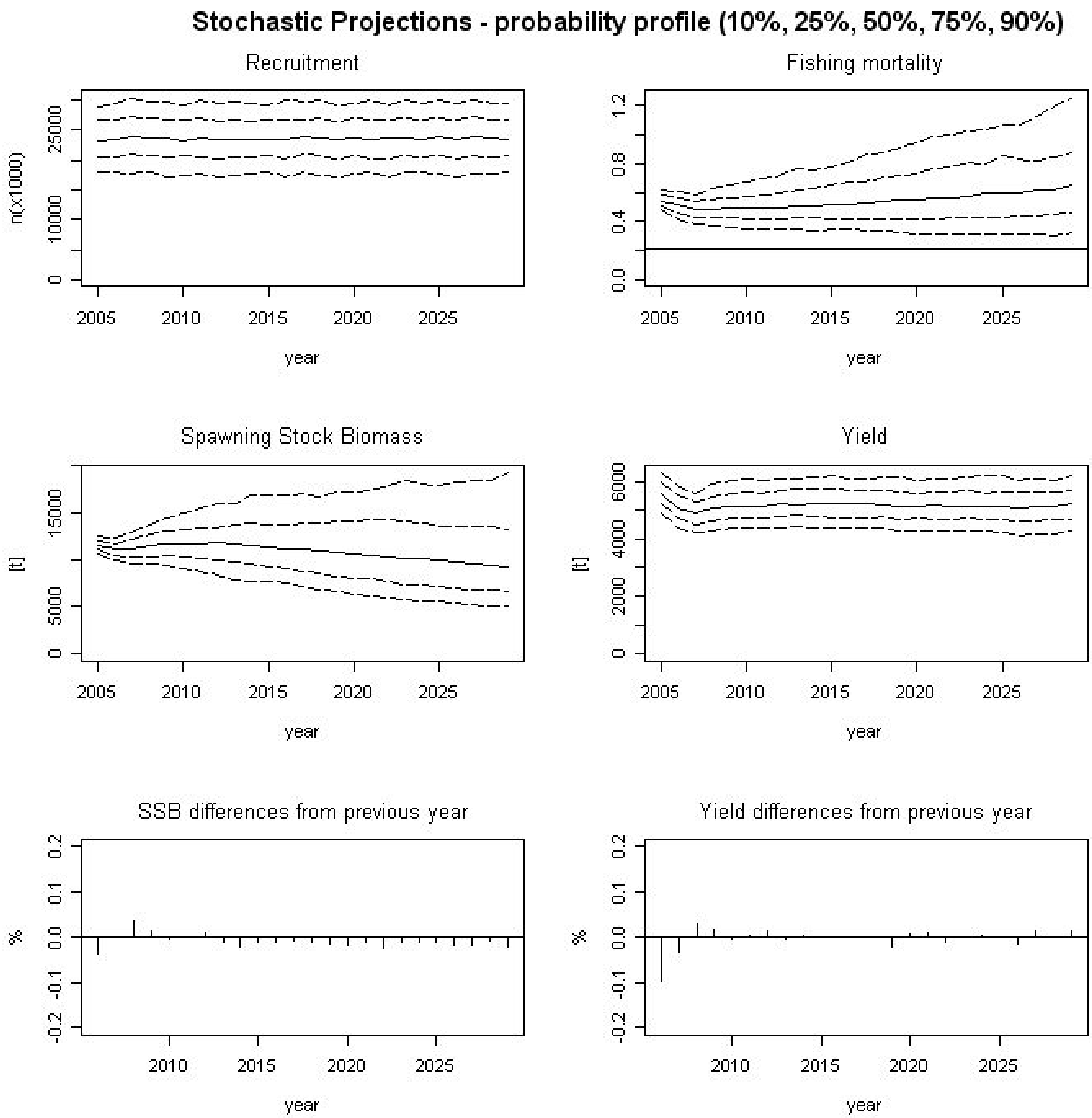
Annex 2 Figure 7. Scenario 6 results (F06 = 0.9 Fsq; If SSB < Bpa: F -10% every year, else if SSB > Bpa: F -10% every three years; Target = Fmax). Note that the CS5 program has no predefined options for scenarios 5 and 6. Hence the different F values corresponding to the preset conditions were calculated manually.



Annex 2 Figure 8. Scenario 7 results (F06 = 0.9 Fsq; If SSB < Bpa: F -10% every year, else if SSB > Bpa: F -10% every year; Target = Fmax; 25% bias in N). Note that the CS5 program has no predefined options for scenarios 5 and 6. Hence the different F values corresponding to the preset conditions were calculated manually.



Annex 2 Figure 9. Scenario 8 results (F06 = 0.9 Fsq; F 2007 onwards: -10% every year; Target = Fmax; 5% implementation error).



Annex 2 Figure A 10. Scenario 9 results (F06 = 0.9 Fsq; If SSB < Bpa: F -10% every year, else if SSB > Bpa: F -10% every year; Target = Fmax; 5% implementation error). Note that the CS5 program has no predefined options for scenarios 5 and 6. Hence the different F values corresponding to the preset conditions were calculated manually.

9 ANNEX 3 – IBERIAN ANGLERFISH

9.1 FLEETS

SPAIN

Anglerfish captures represented a low proportion (3%) of the total catch in the Spanish demersal fisheries in 2004. Different fleets are distinguished depending on the area: the North Spanish fleets (Div. VIIIc and IXa-north) that captured 98% of the anglerfish in 2004, and the Spanish fleets in the Gulf of Cadiz (Div. IXa-south) that captured 2% of the anglerfish in 2004.

North Spanish fleets (Cantabrian Sea and NW Spain)
A description of North Spanish fleets (Div. VIIIc and IXa-north) operating in the Atlantic Iberian Peninsula shelf was compiled in 2002 (STECF, 2002) updating the information of the period 1986-1993 (STECF, 1994) using the results of recent studies (Lart *et al.*, 2002)

Trawl fleet: Anglerfish represent 3% of landings of this fleet in 2004. It is composed of different units:

• Bottom otter trawl (OTB). Around 235 vessels. It caught 88% of the anglerfish captured by trawl in 2004. It targets a wide range of species including horse mackerel, blue whiting, mackerel, hake, anglerfish, megrims, and Nephrops. Anglerfish: 6% of landings of this fleet in 2004. Five trip types obtained in the OTB (Castro and Punzón, 2005):

- "OTB-HM" (VHVO): Bottom otter trawl trips targeting horse mackerel (> 70% in landings). Anglerfish: 4% of landings in 2004.
- "OTB-M": Bottom otter trawl trips targeting mackerel (> 73% in landings). Anglerfish: 3% of landings in 2004.
- "OTB-BW": Bottom otter trawl trips targeting blue whiting (> 40% in landings). Anglerfish: 8% of landings in 2004.
- "OTB-demersal": Bottom otter trawl trips targeting anglerfish, megrims, hake, Nephrops and "other" species. Anglerfish: 40% of landings in 2004.
- "OTB-mixed": Bottom otter trawl trips with mixed catch, mainly "other" species and megrims, anglerfish, hake and *Nephrops*. Anglerfish: 10% of landings in 2004.

• Bottom pair trawl (PTB): Around 68 pairs (136 vessels). This fleet caught 12% of the anglerfish captured by trawl in 2004. It catches mainly blue whiting (above 80%) and other pelagic species. Anglerfish: 1% of landings of this fleet in 2004. Two trip types obtained in the PTB:

- "PTB-BW": Bottom pair trawl trips targeting blue whiting (> 87% in landings). Anglerfish: 1% of landings in 2004.
- "PTB-H": Bottom pair trawl trips targeting mainly hake (but also pelagic species as blue whiting, mackerel and horse mackerel). Anglerfish: 5% of landings in 2004.

Static gears fleet: Around 230 vessels (40 "rasco" vessels). There are three kinds of fixed nets depending on mesh size. "Rasco" (280 mm on mesh size) is directed to anglerfish on the shelf edge and these species are around 90% of total landings by "rasco" in 2004.

Artisanal fleet: Around 8300 vessels. Anglerfish: 1% of landings in 2004.

Spanish fleets in the Gulf of Cadiz.
The Spanish fleets in the Gulf of Cadiz (Div. IXa-south) were described compiling new information available in Velasco *et al.* (2003).

Trawl fleet: Around 231 vessels. It targets a wide range of species including blue whiting, pink shrimp, hake, horse mackerel, cephalopods, *Nephrops* and wedge sole. Anglerfish: 1% of landings in 2004. .

Artisanal fleet: Around 642 vessels. Its main species are sparids (mainly red seabream), cephalopods, wedge sole, and prawn. Anglerfish lower than 0.1% of landings in 2004.

PORTUGALl

Anglerfish are caught by the Portuguese fleet in the trawl and artisanal mixed fishery. The Portuguese landings of anglerfish were 83% from the artisanal fishery and 17% from the trawl fleet, during last three years (2002-2004).

Artisanal fleet: Around 8500 vessels. There is a component of the trammelnets fleet that target anglerfish and it is the main gear with the most of the landings.

Trawl fleet: Anglerfish are a by-catch for these fleets y represent a low % of their landings. The trawl fleet comprises two components e.g., trawl fleet catching demersal fish (65 mm mesh size) and trawl fleet directed to crustaceans (55 mm mesh size). Anglerfish is more important for the trawl fleet directed to crustaceans.

9.2 DISTRIBUTION AND ABUNDANCE

SPAIN
The abundance indices of both anglerfish from the Spanish Bottom Trawl Survey that took place in October in northern Spain (Div. VIIIc and IXa-north), and in November in the Gulf of Cadiz (Subdiv. IXa-south) during last three years (2002-2004) were analysed.

In northern Spain, both anglerfish appear in the area as euribathial, occupying in a wide depth range, from 30 to 700 m (Sánchez, 1993). At the beginning of the historical series of surveys (1983-1986), the data showed a higher abundance index of *L. piscatorius*, located in shallower bottoms (50-300 m), and *L.budegassa* preferring deeper waters (75-400 m) (Sánchez, 1993). This abundance and distribution pattern has varied with the years, being the abundance of *L budegassa* more reduced in the last years, and *L.piscatorius* occupying a wider area of distribution, with higher abundance indices.

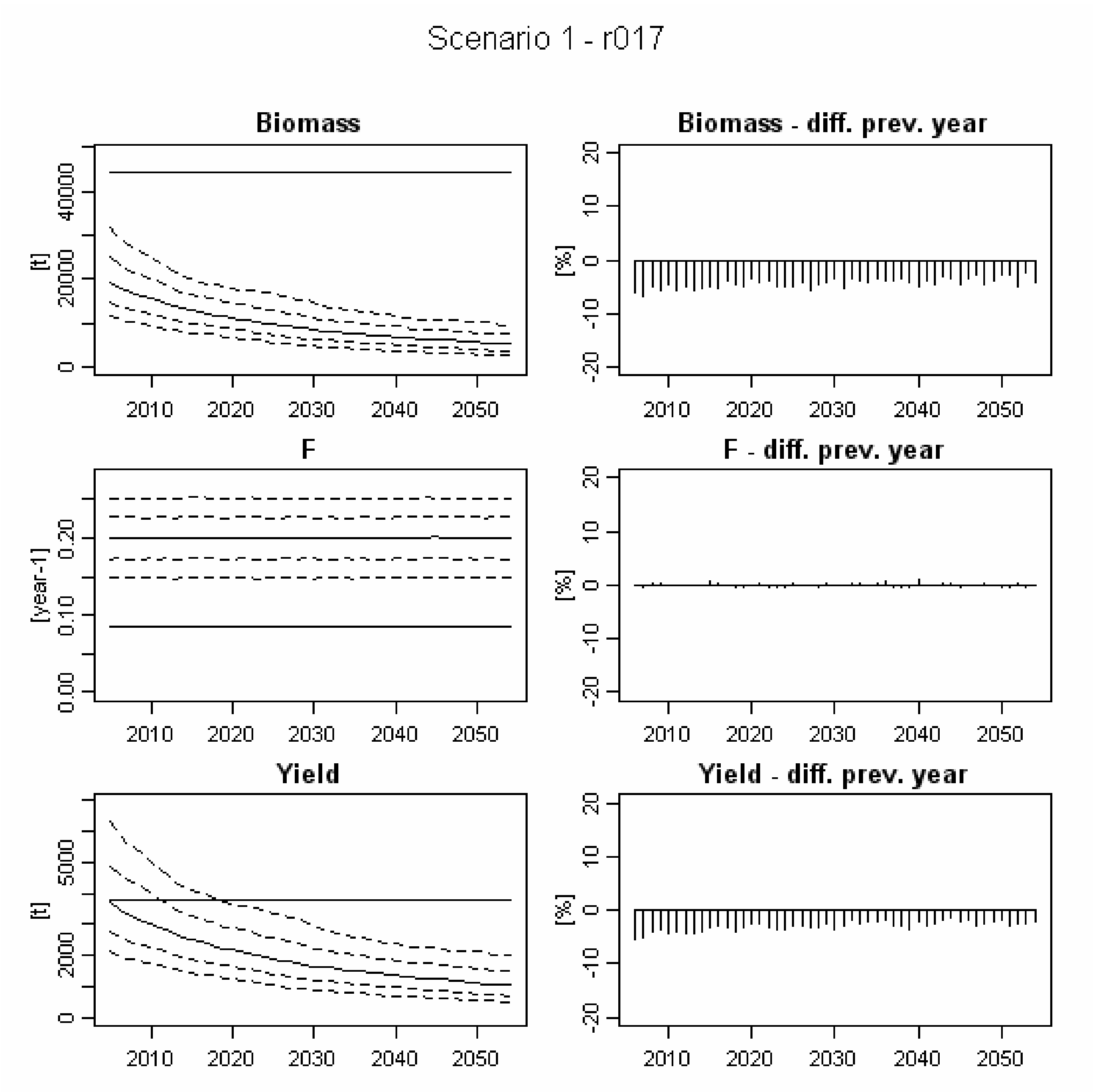
L.piscatorius specimens smaller than 25 cm show a northerly distribution (Div. VIIIc), with greater concentration in their central and western areas. The spatial distribution of the specimens larger than 25 cm is more uniform throughout all the North zone (Div. VIIIc), with scarcity of specimens in the south-western zone (Subdiv. IXa-north). This distribution, with greater indices mainly in the north (Div. VIIIc), also has been observed in the surveys during years 1991-1993 (Sanchez *et al.*, 1995) and 1997-1999 (Sanchez *et al.,* 2002) although then they only occupied the Cantabrian Sea (Subdiv. VIIIc-east). The abundance of *L.piscatorius* in the Gulf of Cadiz (Subdiv. IXa-south) was very low.

The low recruitments of *L.budegassa* during the last years show a concentration of them in the north of Galicia (Subdiv. VIIIc-west) and eastern Cantabrian Sea (Subdiv. VIIIc-east). The spatial distribution of the specimens larger than 25 cm show a low abundance with higher concentrations in eastern Cantabrian Sea (Subdiv. VIIIc-east). This species shows a very clear decrease of the abundance indices during the last years (2002-2004) compared with the results of the surveys of 1991-1993 (Sanchez *et al.,* 1995) and 1997-1999 (Sanchez *et al.*, 2002) where they were also more uniformly distributed throughout all the area. *L. budegassa* in the Gulf of Cadiz (Subdiv. IXa-south) showed low abundance values and most of the specimens were concentrated in the southern of the Gulf.

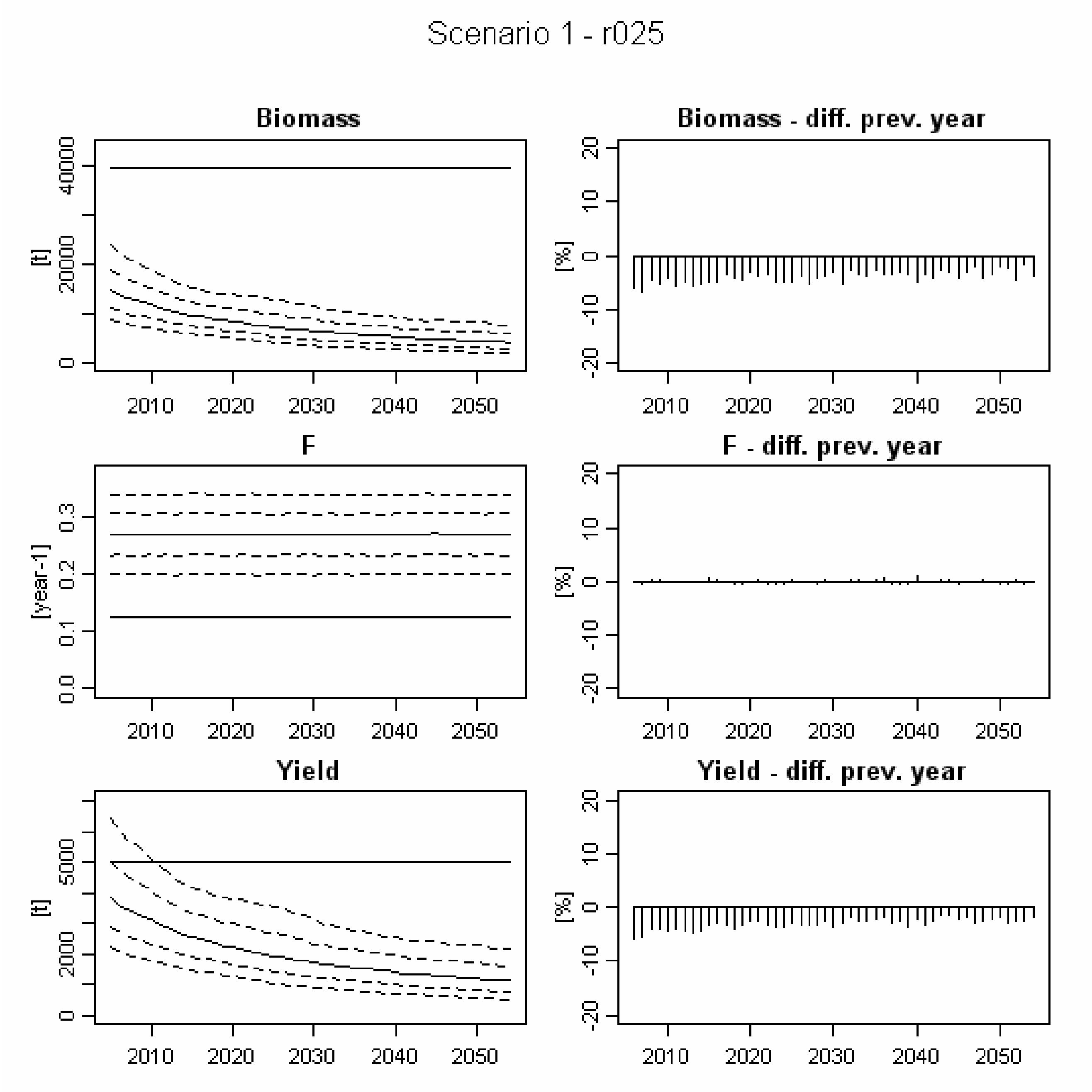
PORTUGAL

The Portuguese Bottom Trawl Survey that took place in Portuguese continental shelf (Subdiv. IXa-south) during last three years (2002-2004) showed low abundance values for both species. Most of the specimens were concentrated in the southern and south-western area of the Subdiv. IXa-south.

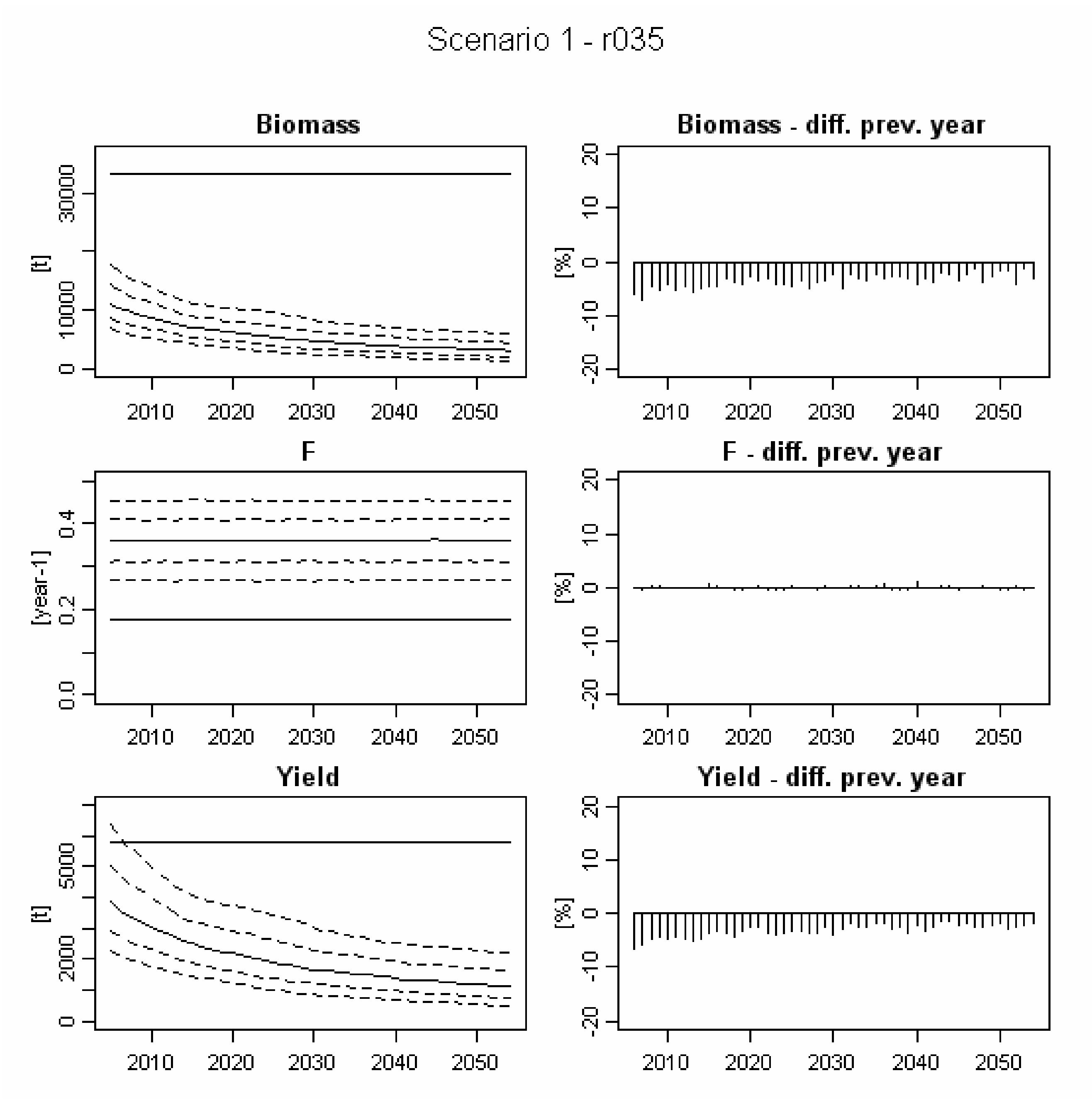
9.3 SIMULATIONS



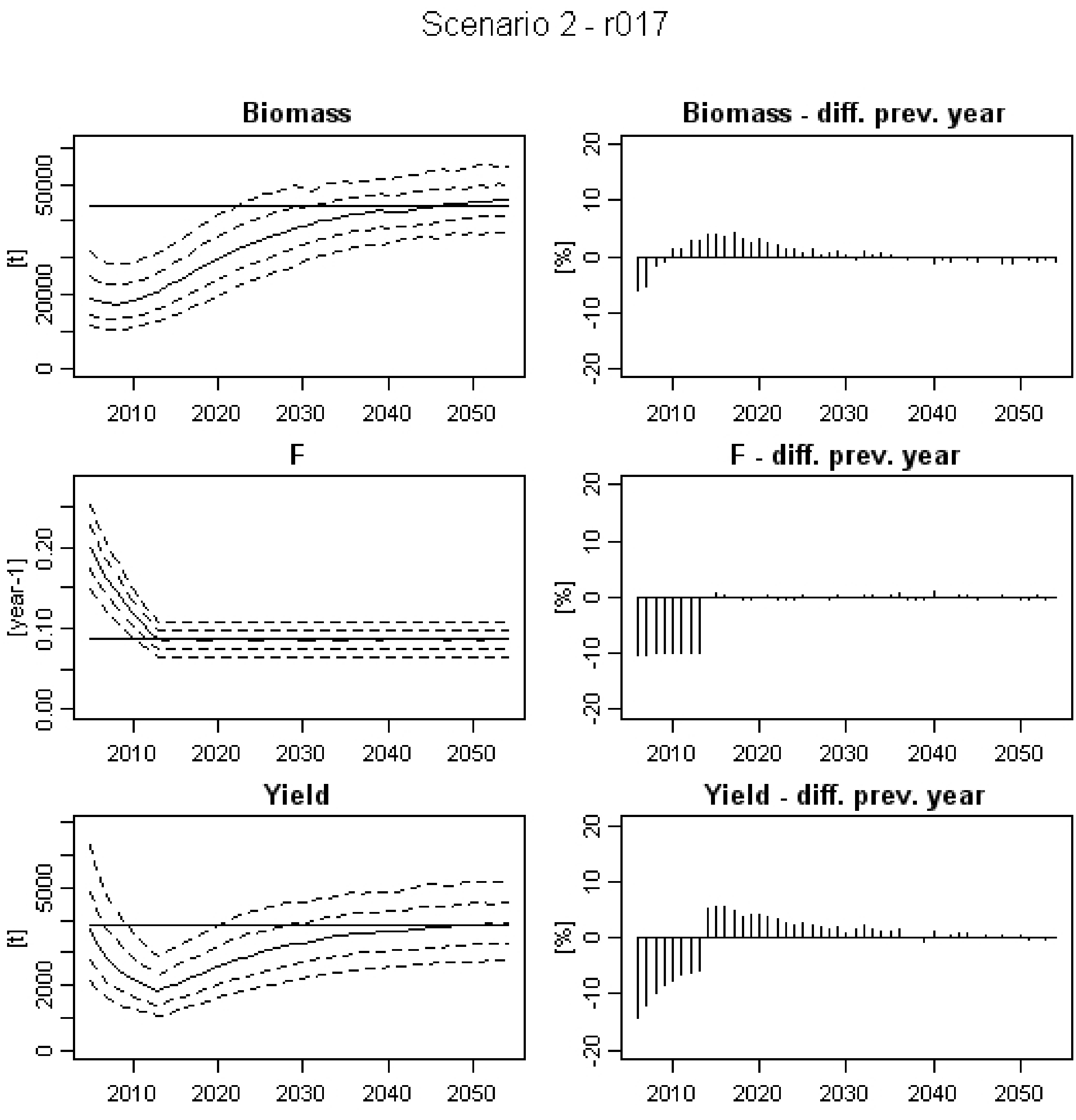
Annex 3, Figure 1. Scenario 1 results (F2006 = F_{sq}; F2007 onwards = F_{sq}; Target = F_{sq}; r = 0.17).



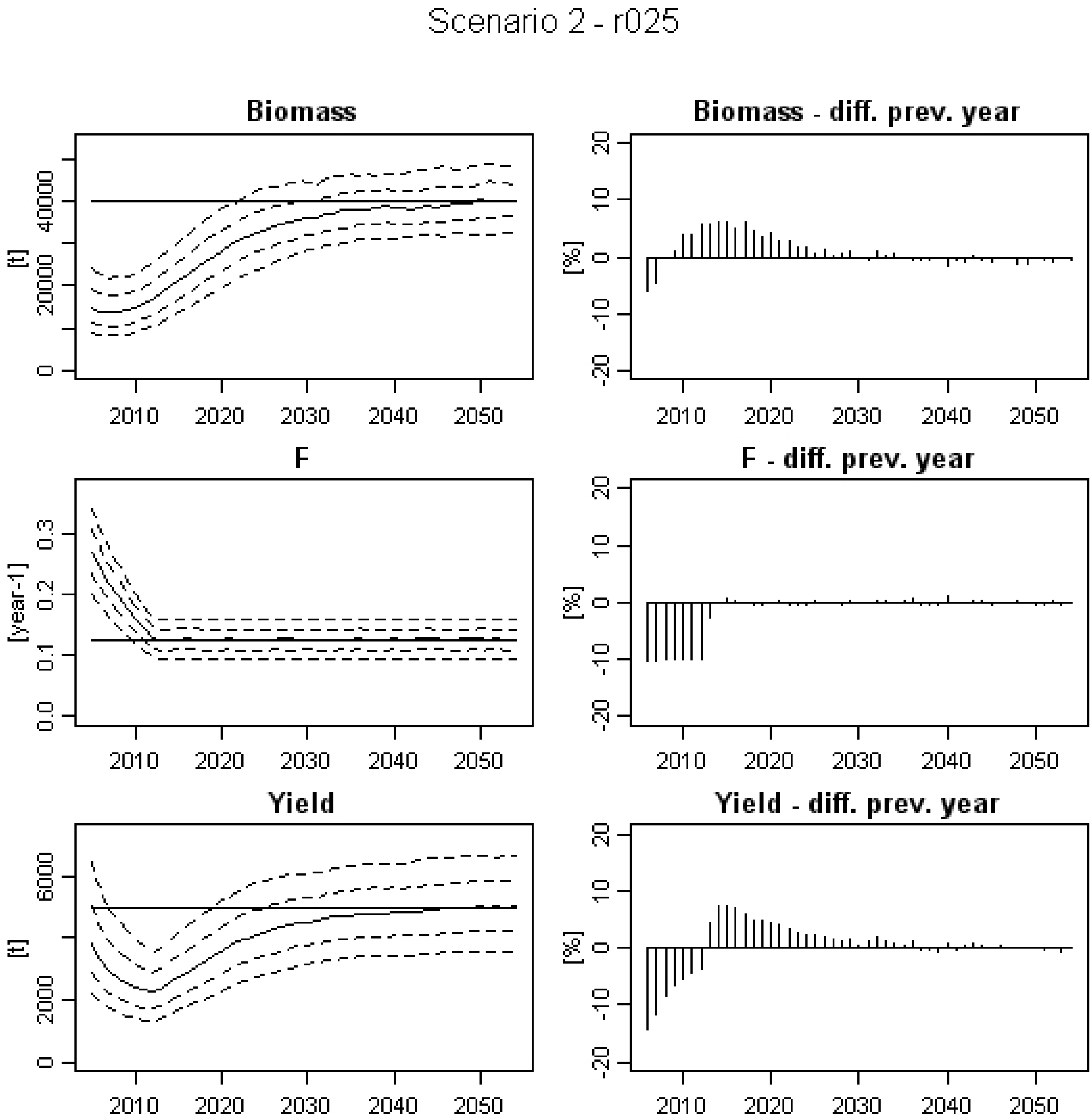
Annex 3, Figure 2. Scenario 1 results (F2006 = F_{sq}; F2007 onwards = F_{sq}; Target = F_{sq}; r = 0.25).



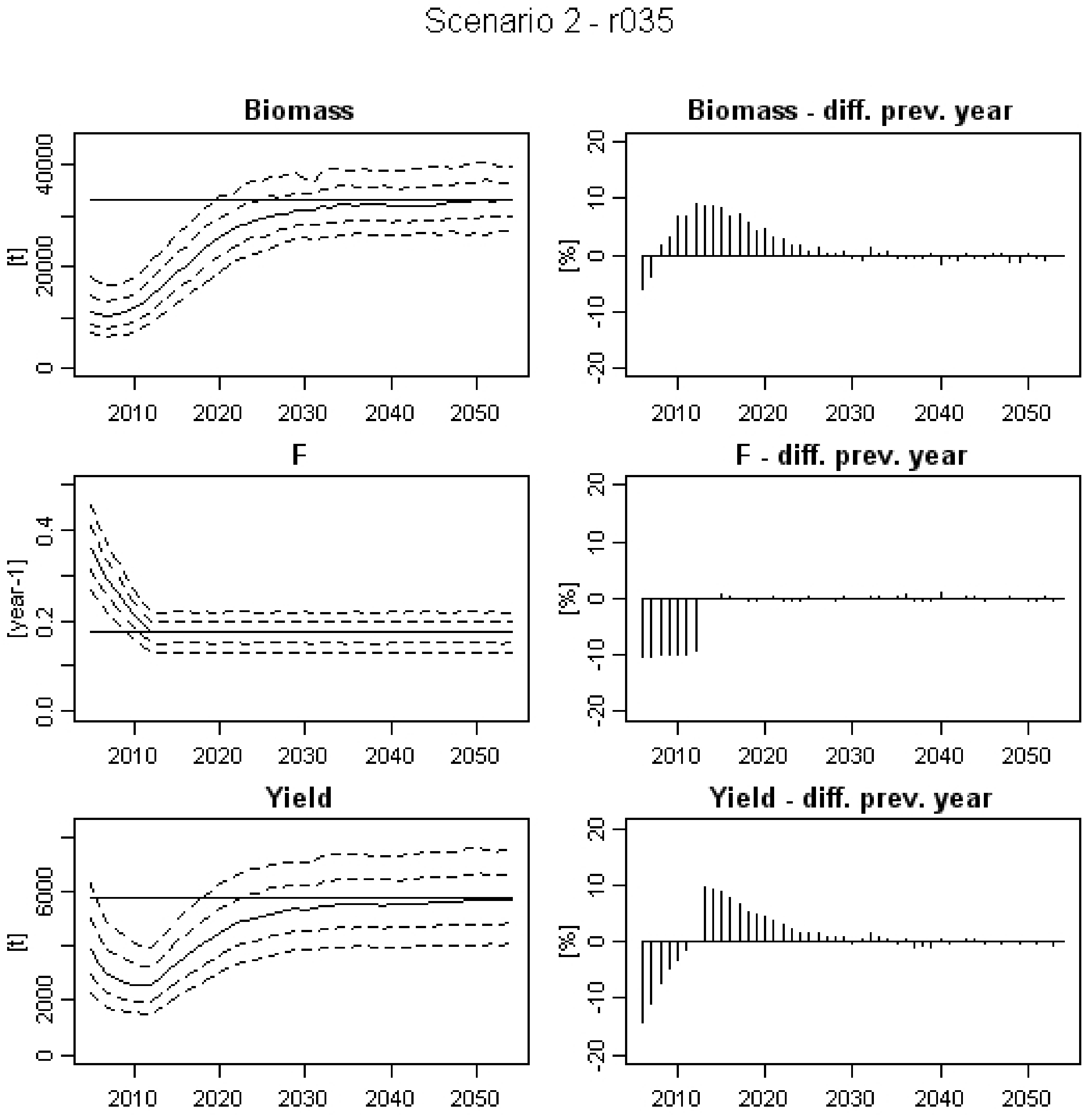
Annex 3, Figure 3. Scenario 1 results (F2006 = F_{sq}; F2007 onwards = F_{sq}; Target = F_{sq}; r = 0.35).



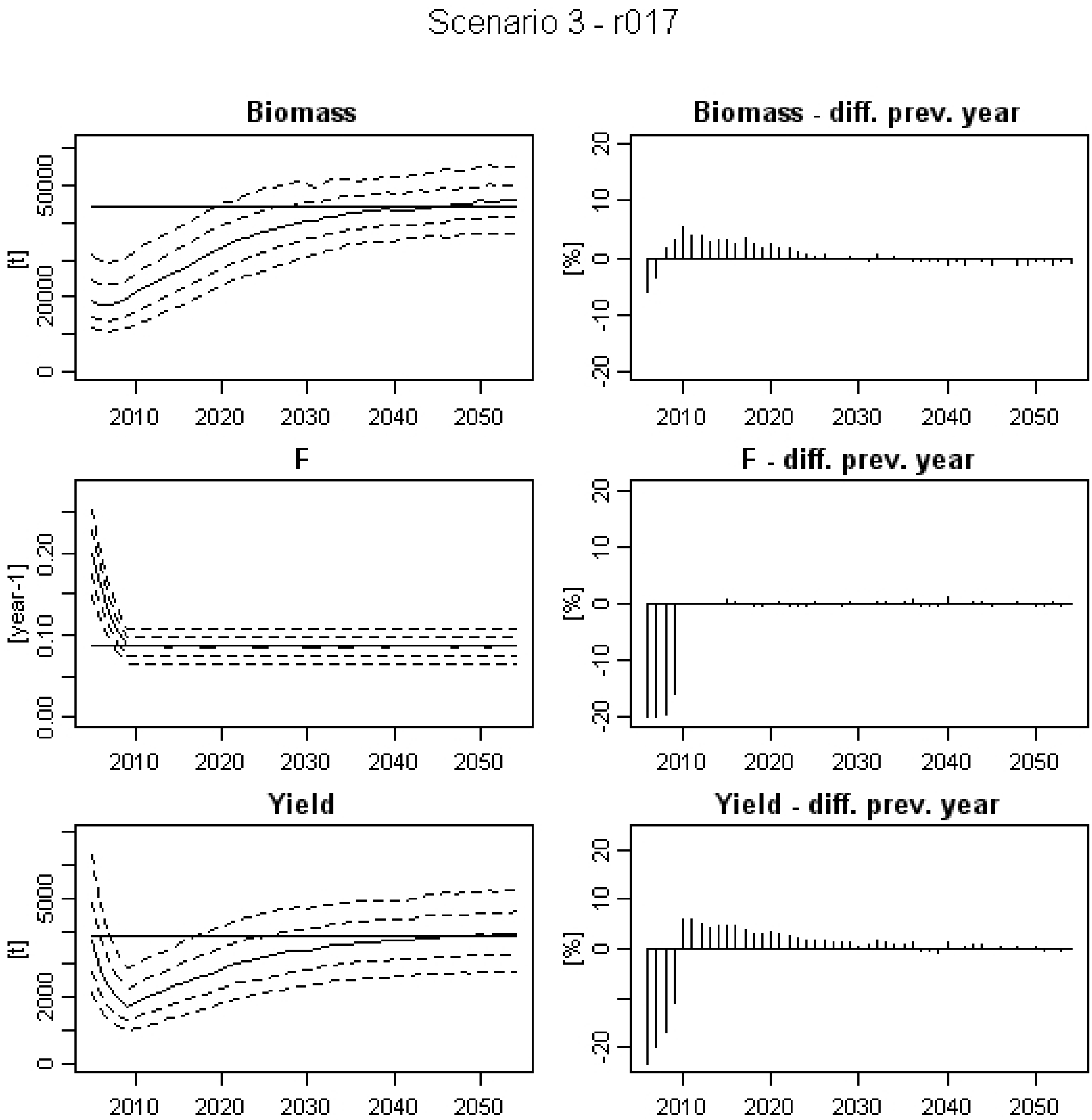
Annex 3, Figure 4. Scenario 2 results (F2006 = 0.9F_{sq}; F2007 onwards: -10% every year; Target = F_{msy}; r = 0.17).



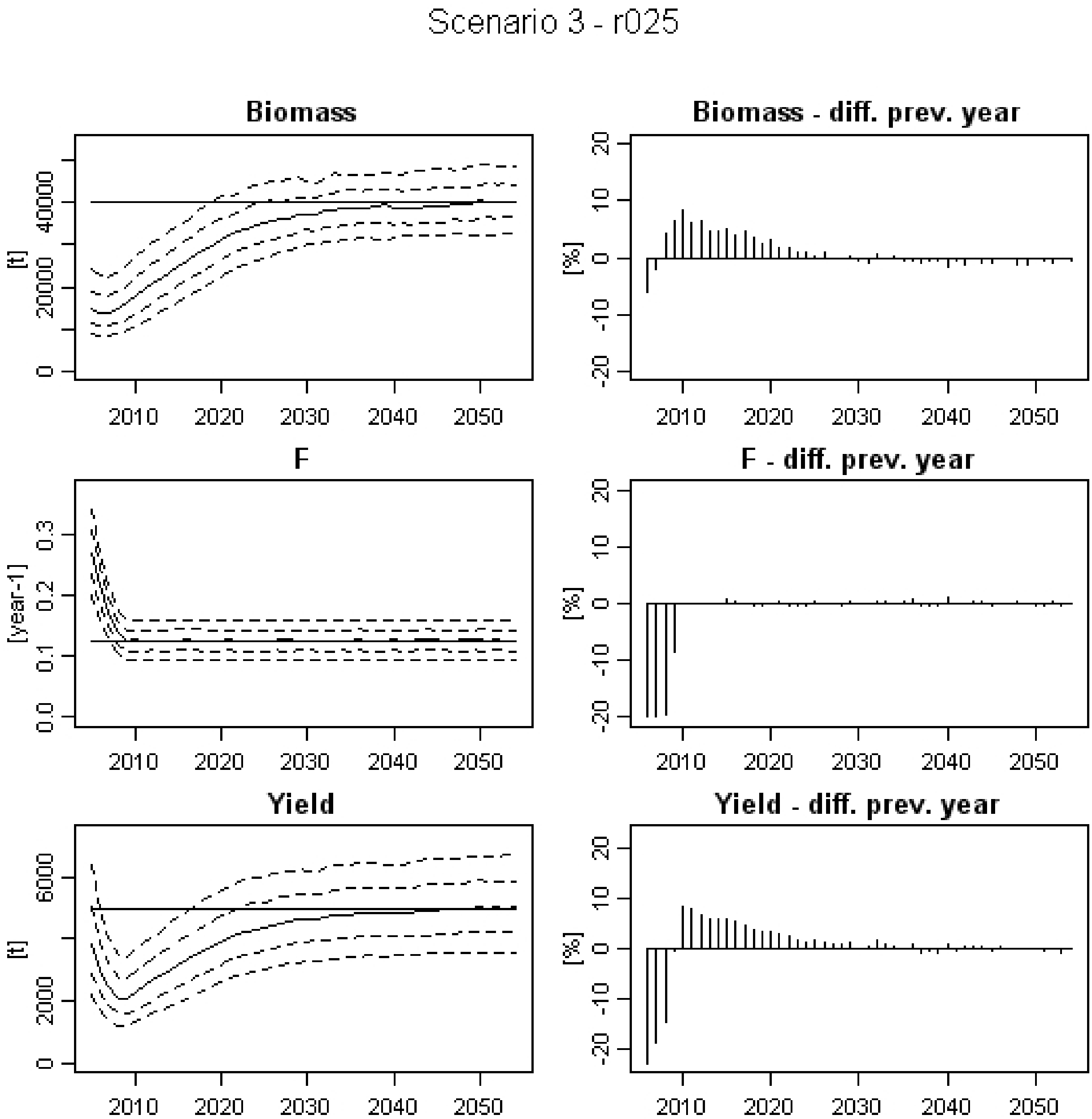
Annex 3, Figure 5. Scenario 2 results (F2006 = 0.9F_{sq}; F2007 onwards: -10% every year; Target = F_{msy}; r = 0.25).



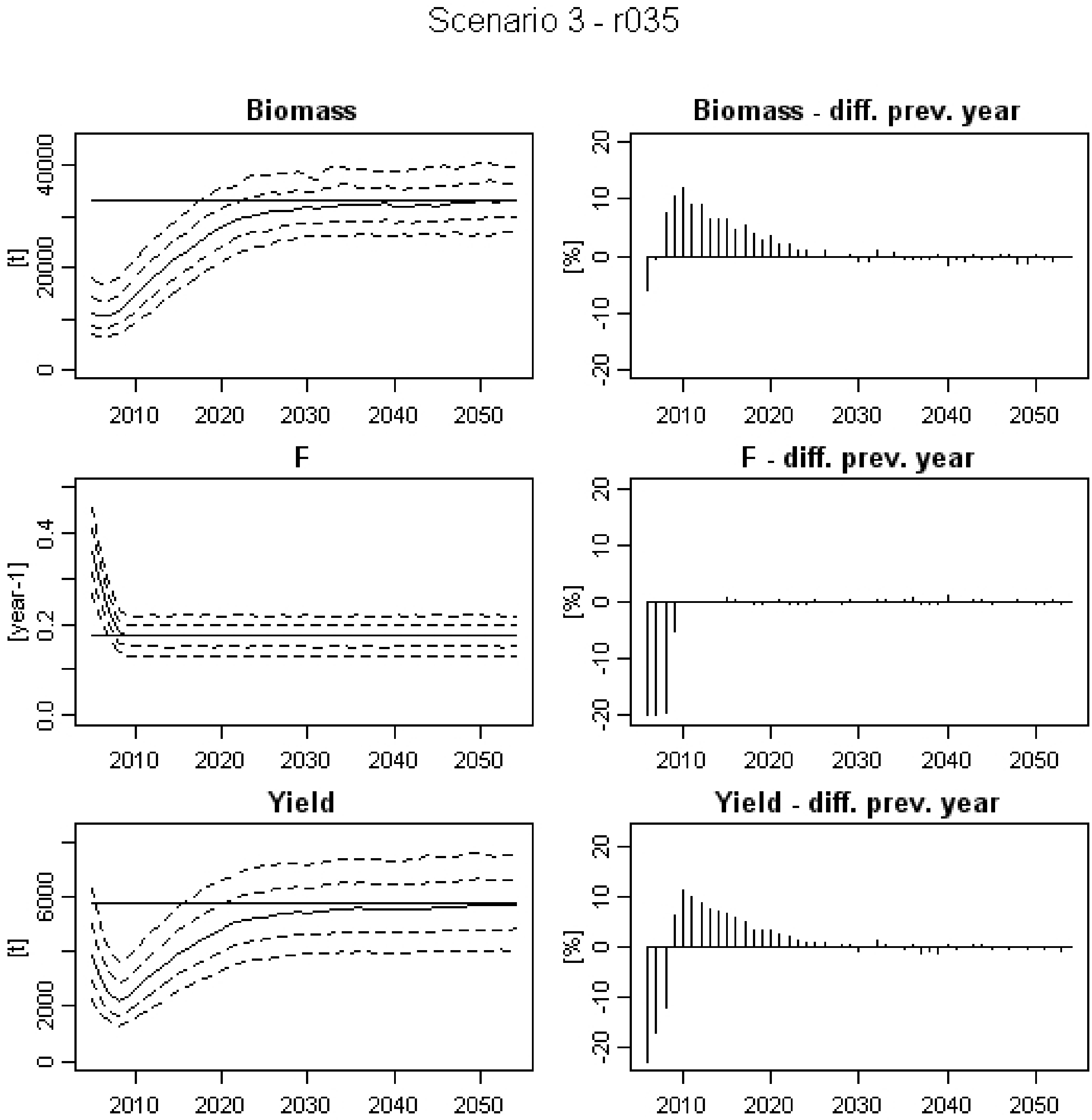
Annex 3, Figure 6. Scenario 2 results (F2006 = $0.9F_{sq}$; F2007 onwards: -10% every year; Target = F_{msy}; r = 0.35).



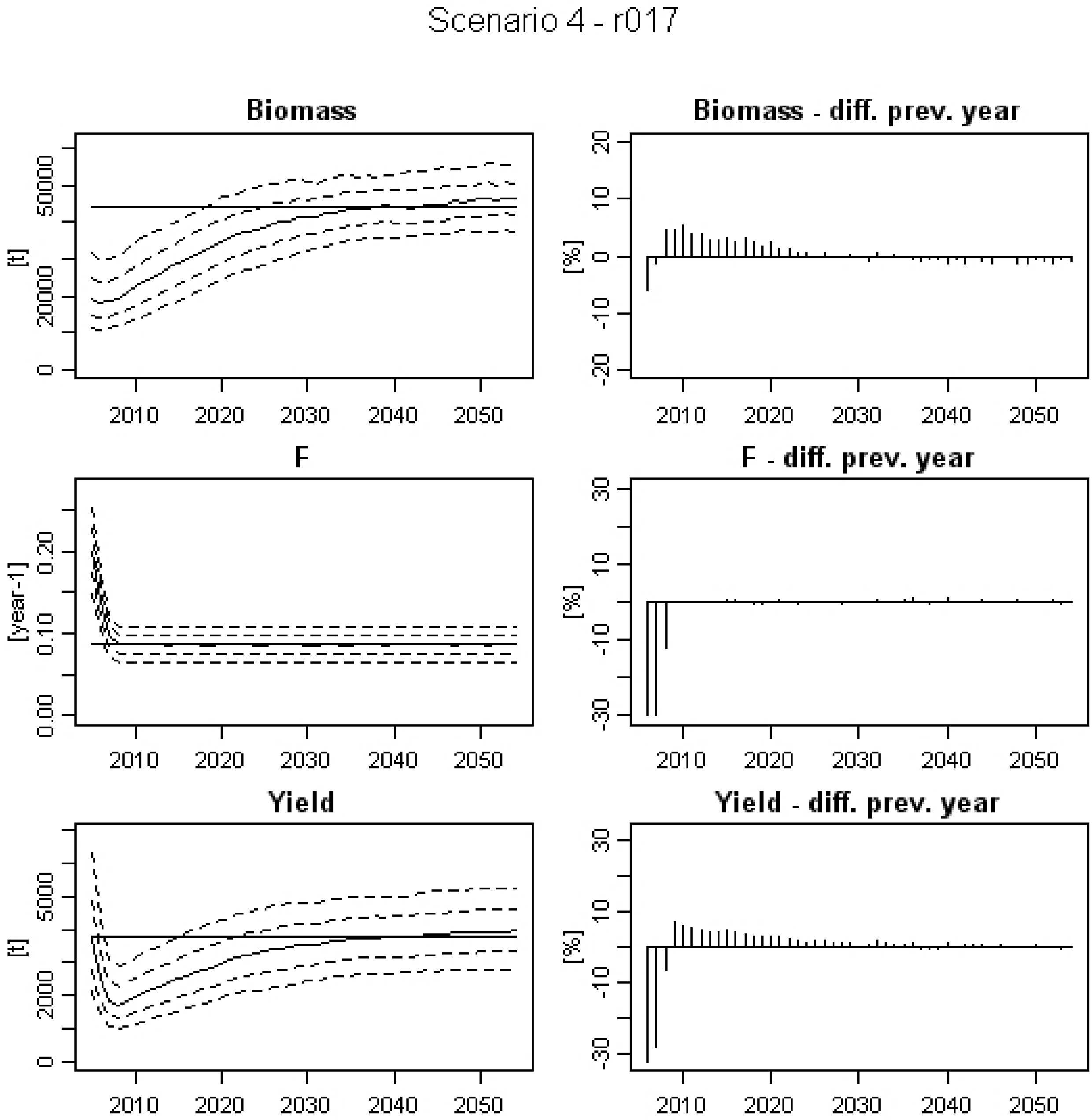
Annex 3, Figure 7. Scenario 3 results (F2006 = $0.8F_{sq}$; F2007 onwards: -20% every year; Target = F_{msy}; r = 0.17).



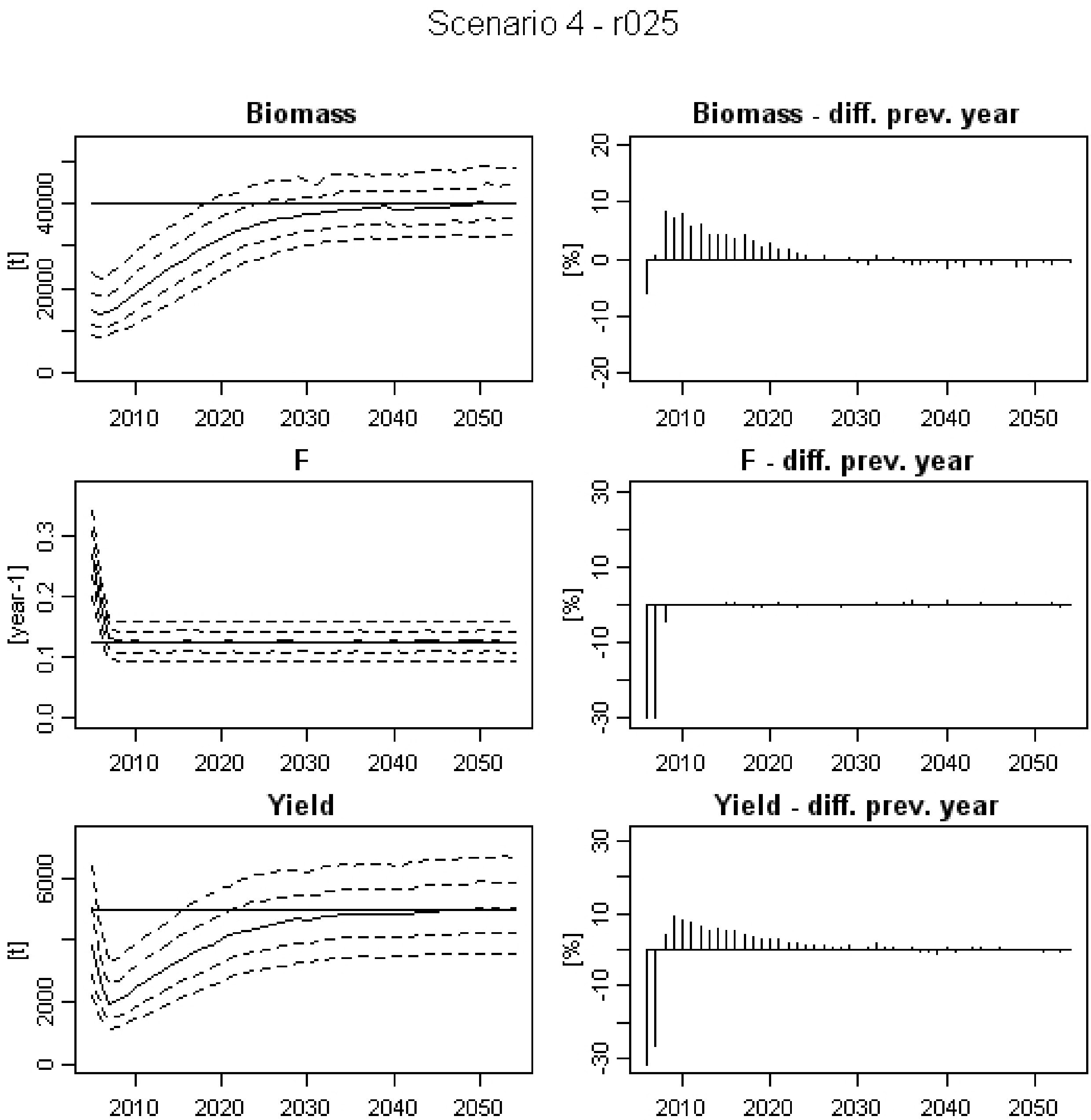
Annex 3, Figure 8. Scenario 3 results (F2006 = $0.8F_{sq}$; F2007 onwards: -20% every year; Target = F_{msy}; r = 0.25).



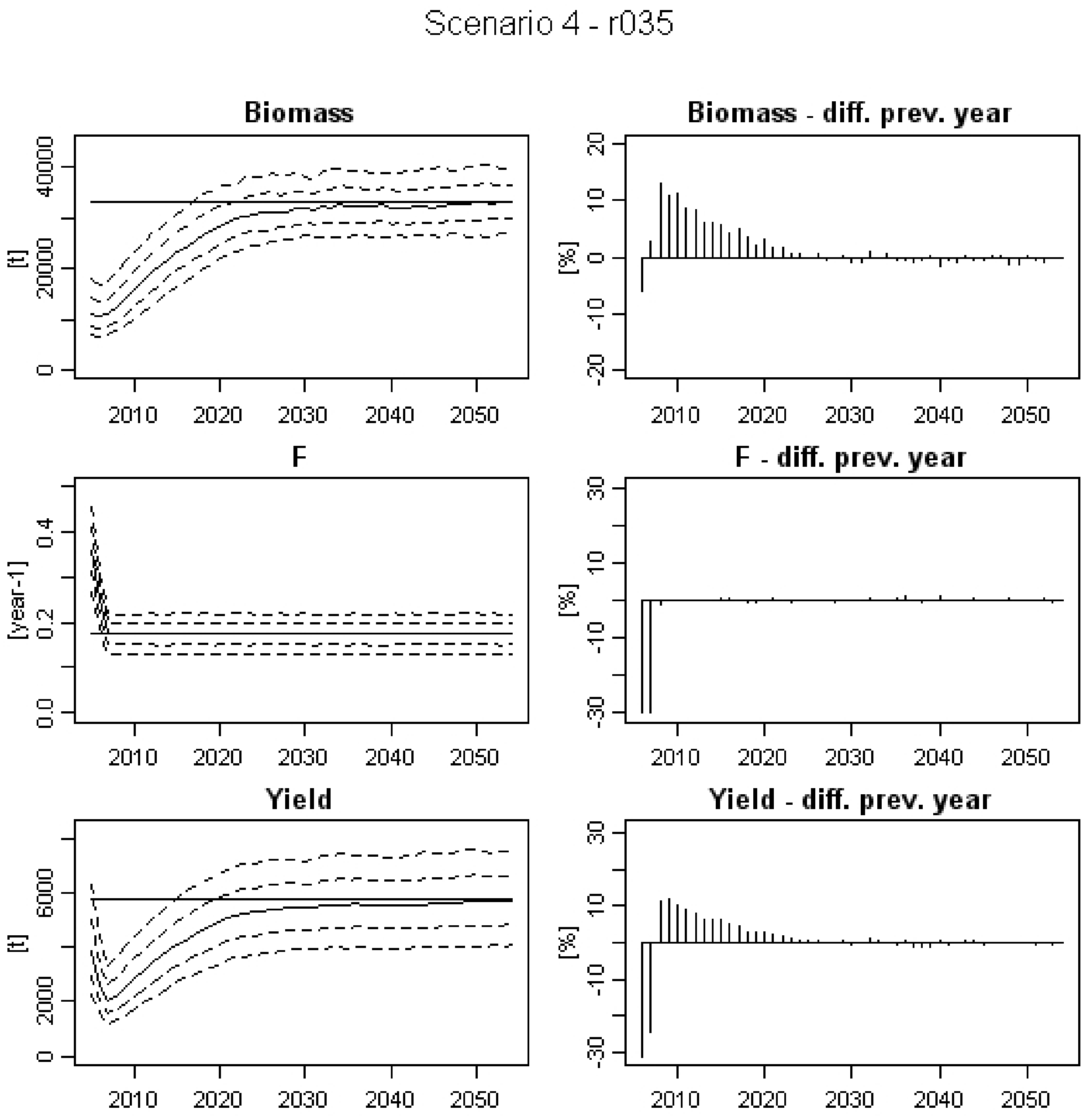
Annex 3, Figure 9. Scenario 3 results (F2006 = 0.8F_{sq}; F2007 onwards: -20% every year; Target = F_{msy}; r = 0.35).



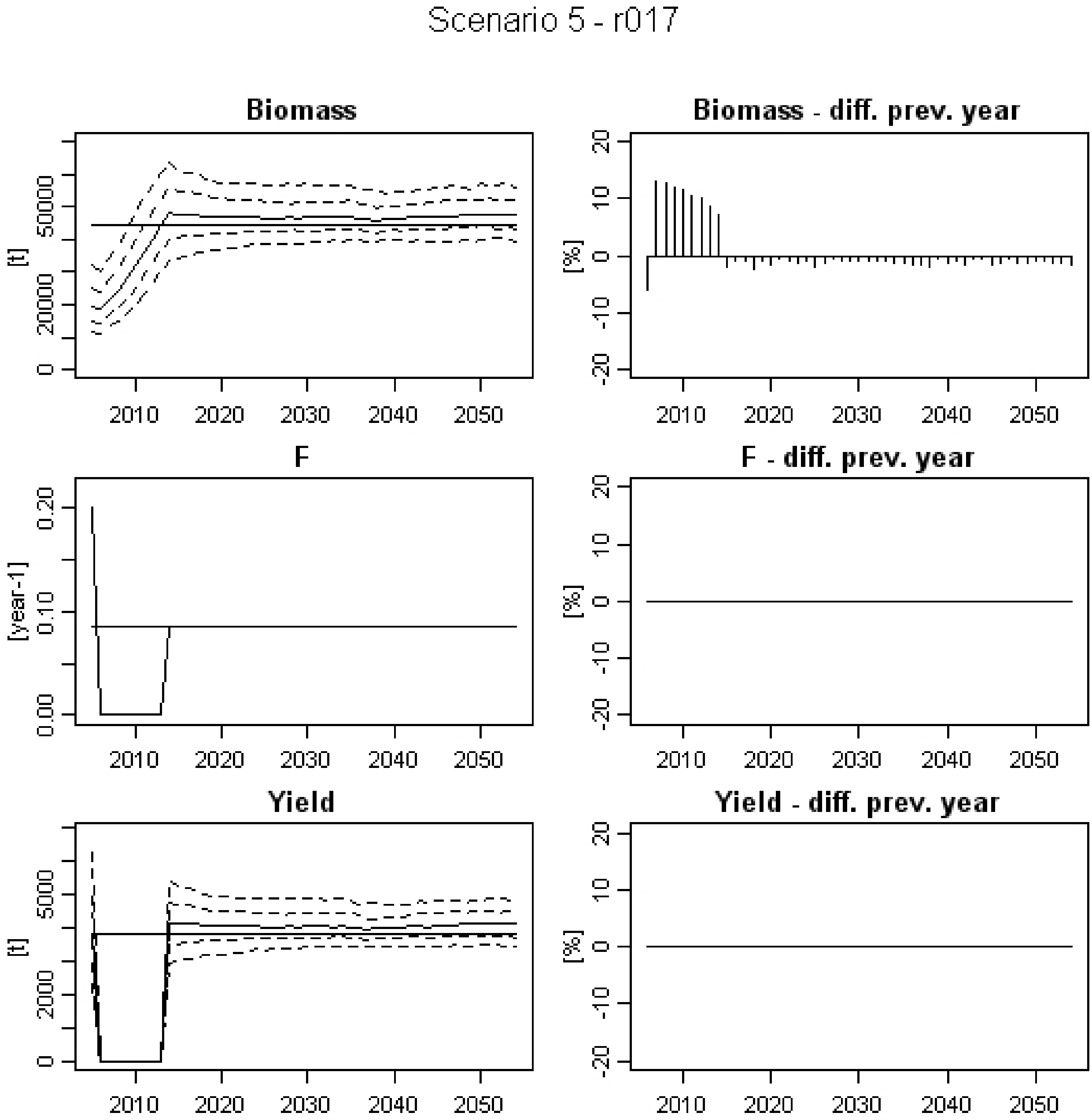
Annex 3, Figure 10. Scenario 4 results (F2006 = $0.7F_{sq}$; F2007 onwards: -30% every year; Target = F_{msy}; r = 0.17).



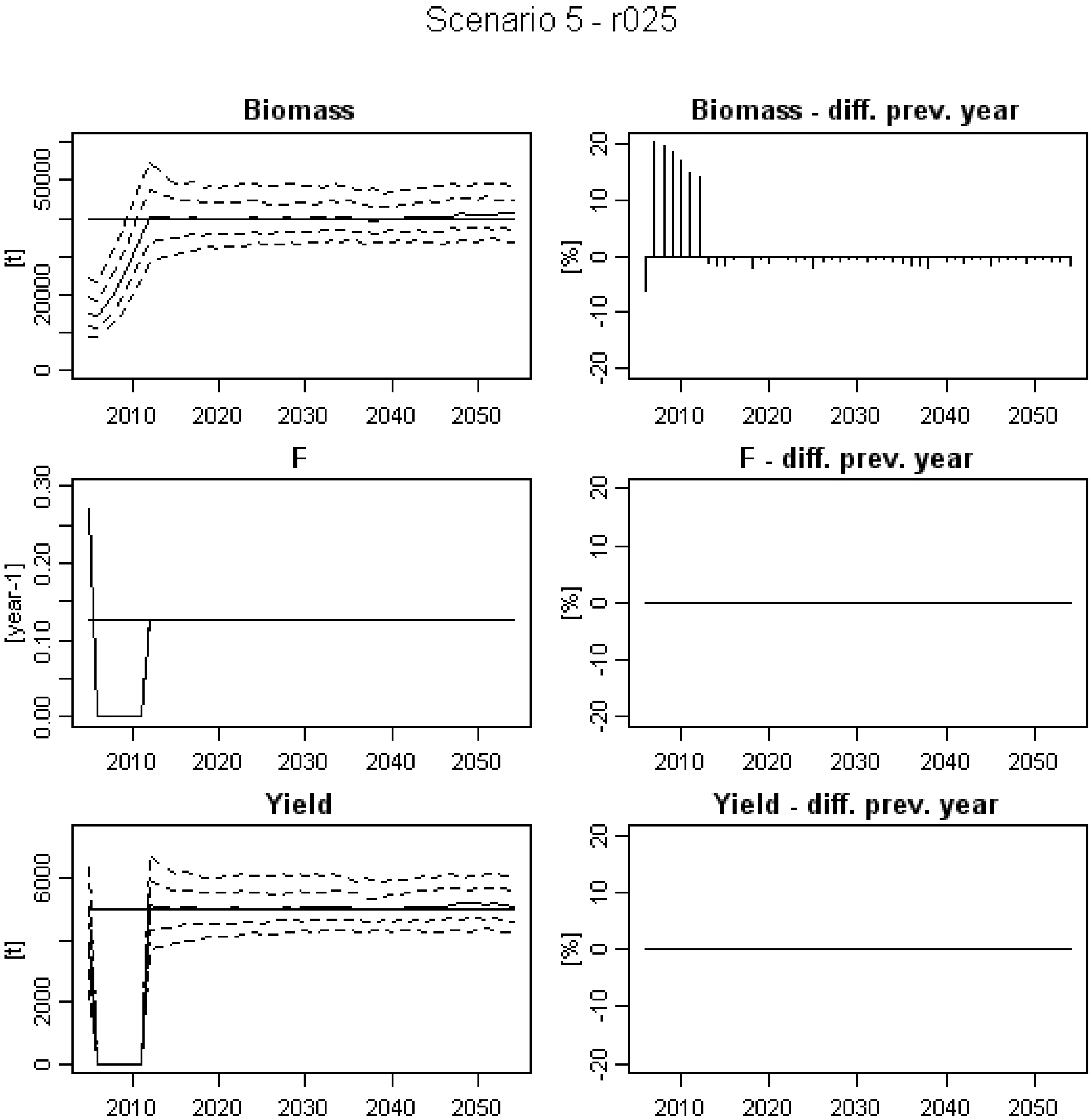
Annex 3, Figure 11. Scenario 4 results (F2006 = $0.7F_{sq}$; F2007 onwards: -30% every year; Target = F_{msy}; r = 0.25).



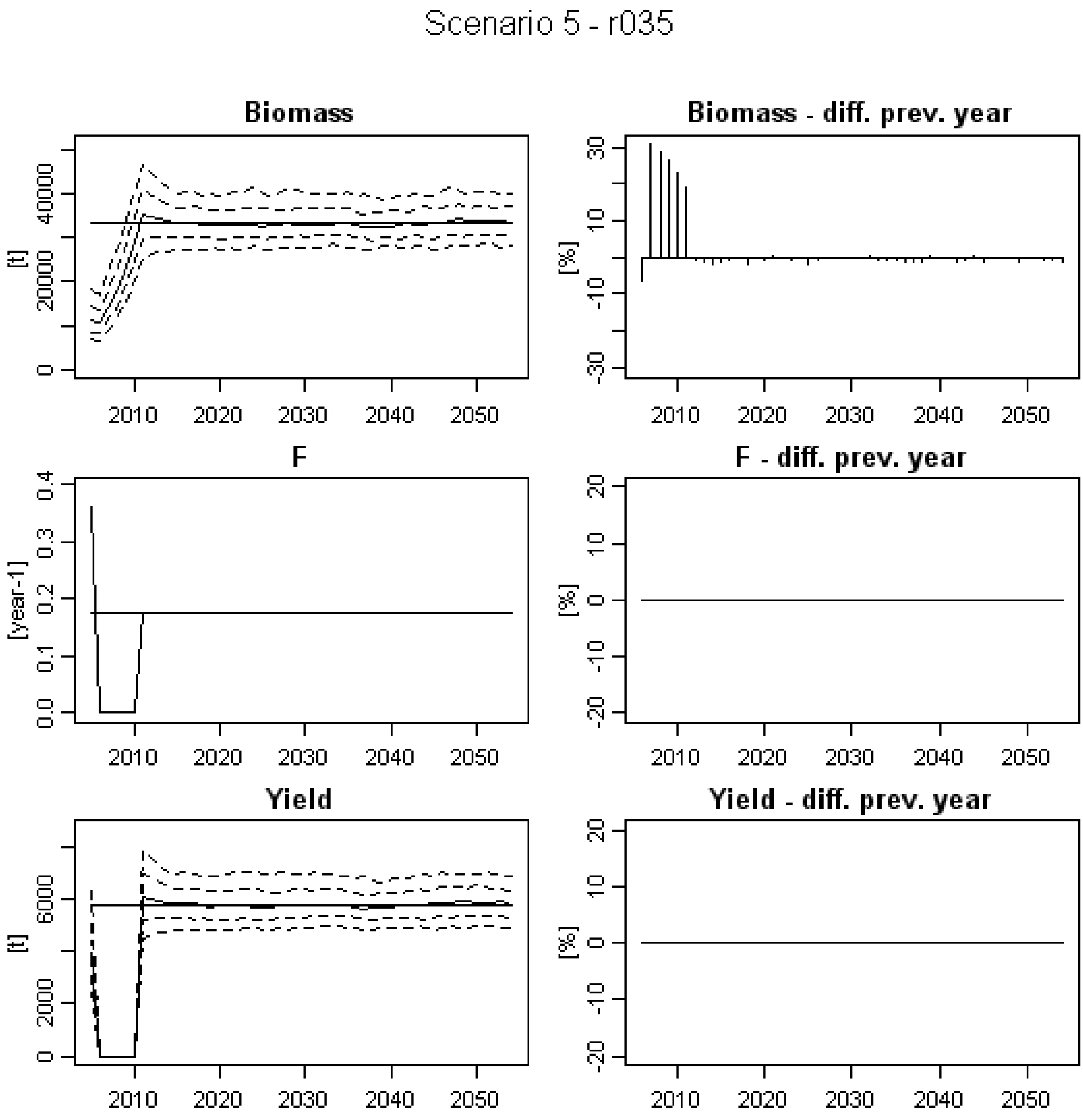
Annex 3, Figure 12. Scenario 4 results (F2006 = $0.7F_{sq}$; F2007 onwards: -30% every year; Target = F_{msy}; r = 0.35).



Annex 3, Figure 13. Scenario 5 results (F2006 = 0; F2007 onwards = 0, until B=B_{msy}; Target = F_{msy}; r = 0.17).



Annex 3, Figure 14. Scenario 5 results (F2006 = 0; F2007 onwards = 0, until B=B_{msy}; Target = F_{msy}; r = 0.25).



Annex 3, Figure 15. Scenario 5 results (F2006 = 0; F2007 onwards = 0, until B=B_{msy}; Target = F_{msy}; r = 0.35).

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